Household Food Gardens as HIV and AIDS Impact Mitigation Response in Poor Urban Communities in Southern Africa: An Economic Analysis

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by

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DEDICATION

To my daughter, Nyasha Kayla

DECLARATION

I, Netsai Lizy Dhoro, declare the following:

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ABSTRACT

HIV and AIDS impact mitigation remains a high priority for countries around the world, especially for Southern African countries where HIV and AIDS prevalence rates are high. In this region, there is increasing recognition of the need to promote interventions which mitigate the adverse effects of HIV and AIDS. Consequently, household food gardens have attracted considerable attention as an intervention strategy that can help to mitigate the impacts of HIV and AIDS. This thesis aims to examine the role of household food gardens in mitigating the impact of HIV and AIDS in poor urban communities in Lesotho, South Africa and Zimbabwe. The study employs data from a longitudinal quasi-experimental study using both quantitative and qualitative data collection methods. Basic descriptive and advanced econometric methods are employed to analyse the data in view of the various study objectives. *First*, the results show that within the informal urban food system, household food gardens are an important component of the food supply system. *Second,* the results also show how the sale, remittance and bartering of surplus garden produce enhance the availability of and access to food. The *final* result shows that household food gardens have a positive and significant impact on household food security, both for food gardens in general and for programme gardens. The study recommends that household food garden programmes be scaled-up, not only in the context of HIV and AIDS impact mitigation strategies, but in relation to development policies in general.

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AIDS	Acquired Immunodeficiency Syndrome
ANOVA	Analysis of Variance
ATT	Average Treatment Effect on the Treated
ART	Antiretroviral Therapy
ARV	Anti-Retroviral
BHASO	Batanai HIV & AIDS Service Organisation
BMI	Body Mass Index
CIA	Conditional Independence Assumption
CSPro	Census and Survey Processing System
FAO	Food and Agriculture Organisation
FD	First Difference
FDG	Focus Group Discussion
FE	Fixed Effects
FGLS	Feasible Generalized Least Squares
FCS	Food Consumption Score
GZU	Great Zimbabwe University
HDDS	Household Dietary Diversity Score
HIV	Human Immunodeficiency Virus
HFIAS	Household Food Insecurity Access Scale
HKI	Hellen Keller International
KM	Kernel Matching
LATE	Local Average Treatment Effects
LLM	Local Linear Matching
LM	Lagrange Multiplier
LPM	Local Polynomial Matching
LSNP	Lesotho National HIV and AIDS Strategic Plan
LPI	Lived Poverty Index
LR	Likelihood Ratio
LSDV	Least Squares Dummy Variable

MAHFP	Months of Adequate Household Food Provisioning
MUAC	Mid-Upper-Arm Circumference
NGOs	Non-Governmental Organisations
NN	Nearest Neighbour
NSP	National Strategic Plan
NUL	National University of Lesotho
OLS	Ordinary Least Squares
PLWHA	People Living with HIV and AIDS
PSM	Propensity Score Matching
PVO	Private Voluntary Organization
RE	Random Effects
RKKD	Re Kgaba Ka Diratswana
SADC	Southern African Development Community
SB	Standardised Bias
SNSP	South Africa National HIV and AIDS Strategic Plan
SWAA	Society for Women and AIDS in Africa
SWAALES	Society of Women and AIDS in Africa Lesotho
SLF	Sustainable Livelihood Framework
TPoC	Technical Proof-of-Concept
UFS	University of the Free State
UNAIDS	United Nations
WHO	World Health Organisation
ZAR	South African Rand
ZNSAP	Zimbabwe National HIV and AIDS Strategic Plan

Chapter 1: Introduction

1.1 Introduction

Southern Africa, home to two thirds of the world's HIV infected population and host of nine countries with the highest adult HIV prevalence rates in the world: Malawi (9.2%); Zambia (12.4%); Zimbabwe (13.5%); Namibia and Mozambique (14.3%); South Africa (18.9%); Botswana (21.9%); Lesotho (25%) and Swaziland (27.2%) (UNAIDS, 2017), continues to experience the negative impacts of HIV and AIDS.

In this context, governments, development practitioners, and international agencies emphasise the importance of integrating livelihood interventions and HIV and AIDS programming to mitigate the negative impacts of HIV and AIDS in Southern African communities (Aberman *et al*., 2014; WFP, 2010; UNAIDS, 2011). Several, arguments have been put forth for supporting the integration of livelihood interventions to mitigate the socio-economic impacts of HIV and AIDS on individuals, households, and communities. One argument is that livelihood interventions that are controlled by households are more reliable and sustainable than other inventions such as targeted nutritional supplementation and income transfers, which primarily rely on government good will and financial support (Aderman *et al*., 2014; Yager *et al*., 2011). Another argument is that livelihood interventions maintain people's dignity, instead of treating them as passive recipients of relief (Alderman *et al*., 2014).

Livelihood strategies, in the form of household food gardens, provides households with both direct and indirect access to food, and to household income, which supports household food purchases, education, and nutrition and health, are receiving increasing recognition as an important part of a comprehensive HIV and AIDS impact mitigation response (Drimie *et al*., 2006; Talukder *et al*., 2010; SADC HIV and AIDS, 2015). The urgency of a livelihood strategy such as household food gardening is underscored by vast evidence on the effect of food security and good nutrition in slowing progression of HIV to AIDS, and in enhancing the effectiveness of ART, with consequences not only for people living with HIV and AIDS (PLWHA) but also their children, families, and communities. The positive effects of food security and good nutrition on ART effectiveness are also significant to the achievement of UNAIDS's 90-90-90 strategy, in particular the third goal (i.e. that by 2020, 90% of all people receiving ART should have achieved viral suppression) (UNAIDS, 2015). Food security and nutrition is particularly important in achieving this goal.

While studies from Southern African countries and elsewhere investigating the impacts of household food gardens on household food security, poverty alleviation, and nutrition and health are extensive (Berti *et al,* 2004; Faber *et al.*, 2002; Galhena *et al*., 2013; Talukder *et al*., 2010), only relatively few studies (Akrofi, *et al*., 2012; Puet *et al.,* 2014; Gadzirayi *et al*., 2014) have documented direct evidence on the contribution of household food gardens in the context of HIV and AIDS impact mitigation. Moreover, available studies on the potential contribution of household food gardens have concentrated mainly on the rural poor and have been based on limited descriptive statistics, with few studies using advanced econometric methods (Kabunga *et al*., 2015; Bahta *et al*., 2018). As such, the question of whether household food gardens can contribute to the mitigation of the impacts of HIV and AIDS remains under-researched. This study follows an indirect approach in seeking to examine the potential role of household food gardens in mitigating the impact of HIV and AIDS in poor urban communities in three Southern African countries, namely Lesotho, South Africa, and Zimbabwe. The study creates a tangential link with PLWHA by conducting the study in high prevalence countries and specific more broadly impacted communities.

1.2 Context

The study was conducted in three poor urban communities in three Southern African countries, namely, Lesotho, South Africa, and Zimbabwe. The term “urban” takes on a relatively broad meaning in the context of this study, ranging from high density, urban informal settlements to peri-urban areas. Urban features of relevance to the choice of study community included, among others, demographic characteristics in regards to population size and density; the structure of the economy characterised by a more limited role of the primary, agricultural sectors as opposed to secondary and third sectors of the economy; governmental and institutional structures; access to and characteristics of housing; and service delivery infrastructure. Within the context of this study’s focus on HIV and AIDS, Table 1.1 provides an overview of the HIV and AIDS epidemic in each case study country and provides information on how food gardens feature in HIV and AIDS policy. Evidently, the research is particularly topical in these three settings, given the high impact burden and the policy relevance of household food gardens.

Table 1.1: HIV and AIDS epidemic, policy and gardening, by case study country and region

	Lesotho	South Africa	Zimbabwe	SADC
A. HIV and AIDS epidemic (UNAIDS, 2015):				
People living with HIV	310, 000	7,000,000	1,400,000	18,500,000
Adult prevalence (15-49)	22.7%	19.2%	14.7%	15,5%
Adult women living with HIV	170, 000	4,000,000	790,000	9,700,000
Children (0-14) living with HIV	13, 000	240,000	77, 000	2,000,000
Deaths due to AIDS	9,900	180, 000	29, 000	730,000
Orphans (0-17) due to AIDS	73, 000	2,100, 000	450, 000	9,500,000
Source: UNAIDS (2016)				
B. HIV and AIDS policy and food gardens:				
HIV/AIDS policy, food security and food gardens	The government advocates for promotion of activities that encourage HIV and AIDS affected households to control their food and nutrition security as an HIV and AIDS impact mitigation strategy. The government assist households and individuals in starting backyard gardens (key-hole gardens), community gardening, small livestock and poultry projects (LNSP 2012-16).	The Integrated Food Security and Nutrition Programme provide relief to households affected by HIV and AIDS. The aim is to give households or beneficiaries the equipment they need to produce their own food. The programme assists groups or individuals who want to start a small-scale garden (SNSP 2012-2016).	The government tries to ensure that HIV and AIDS affected households are empowered and capacitated to become self-reliant on food, through sustainable food production systems. The government collaborates with civil society organisations to assist households start household gardens and community gardens. (ZNSAP 2015-2018).	The region advocates for coordination of sectors, programmes and communities around issues of food security and nutrition for PLWHA and their households. It encourages investing in nutrition programmes that promote the production of food by HIV and AIDS affected households (SADC HIV and AIDS Strategic Framework, 2010-2015).

1.3 Problem statement

Empirical evidence has documented the adverse consequences of HIV and AIDS, both direct and indirect, which include increased household food insecurity, adult and infant mortality, loss of income from reduced labour supply and productivity, loss or reduced investment in children's education and health, and increased household poverty (Booysen, 2003; Chapoto & Jayne, 2008; Salinas & Haacker, 2006; Fox *et al*., 2004). In addition, despite the widespread availability of ART and its efficacy, HIV and AIDS is still the leading cause of death in Southern Africa (Lozano *et al*., 2012). Together, these realities threaten the achievement of Sustainable Development Goal 3 - "to ensure healthy lives and promote well-being for all at all ages". Solutions to mitigating these impacts of HIV and AIDS on households require integrated and multifaceted approaches that are well supported empirically. Indeed, international organisations and governments have increasingly called for the introduction of livelihood interventions into HIV and AIDS mitigation programmes. Yet, evidence to inform mitigation strategies such as household food gardens, particularly for poor urban communities with a high prevalence of HIV and AIDS, remains underdeveloped.

1.4 Rationale

Existing studies on household food gardens have documented the food security and poverty alleviation benefits of these household food gardens, particularly in rural communities (Faber *et al*., 2002; Galhena *et al*., 2013; Marsh, 1998). However, there is a dearth of evidence on the benefits of household food gardens to HIV and AIDS affected households in poor urban communities. Yet, the HIV and AIDS National Strategic Plans (NSP) from Lesotho, South Africa and Zimbabwe emphasise the effect of food insecurity in hampering efforts to mitigate the impact of HIV and AIDS in Southern African communities. For this reason, the plans call for governments and their partners to support and implement strategies to enhance food security in communities affected by HIV and AIDS. Within this framework, research on household food gardens in poor urban communities as an HIV and AIDS impact mitigation strategy speaks directly to the goals and objectives of the three countries' HIV and AIDS National Strategic Plans, which is important for informed and evidence-based policy making.

1.5 Aim

The aim of this study is to examine the role of household food gardens in mitigating the impact of HIV and AIDS in poor urban communities in Lesotho, South Africa and Zimbabwe.

1.6 Study Objectives

The study has the following three specific objectives:

- To investigate the role of household food gardens in the informal food system in poor urban communities impacted by HIV and AIDS
- To determine the role of household food gardens in the household food economy in poor urban households impacted by HIV and AIDS
- To assess the impact of household food gardening on the food security of poor urban households impacted by HIV and AIDS

The study represents an 'economic analysis' insofar as various advanced econometric methods are employed in the analysis. Moreover, the study investigates aspects of the food system (supply of food) and the food economy (sale, barter, and consumption of garden produce), which represents further economic aspects of household food gardens. For these reasons, the study falls in the domain of Economics.

1.7 Outline

The thesis is structured as follows: Chapter 2 reviews the literature by compiling the theoretical and empirical evidence on the impact of HIV and AIDS on household food security, the role of food security and nutrition in the management of HIV and AIDS, and the potential benefits of household food gardens. Chapter 3 describes the research design, the data and data sources and methods of data collection as well as research methodology utilised in the study. Chapter 4 presents and discusses the findings of the study. A summary of key findings and resultant policy implications, and suggestions for further research, are discussed in the concluding Chapter 5.

Chapter 2: Literature Review

2.1 Introduction

This chapter presents a review of the relevant theoretical and empirical literature. The chapter is structured into five sections. The first section discusses the economic and development models that are relevant to the study. The second section provides an overview of the food security concept, food systems and markets, and their role in achieving food security, pointing out how household food gardens fit into the food system. The third section discusses the impact of HIV and AIDS on food security, together with the HIV and AIDS food-related coping strategies. The fourth section reviews the role of food security and nutrition in the management of HIV and AIDS. The review concludes with a fifth section that presents a discussion of the benefits of household food gardens, drawing a distinction between food security and nutrition, income generation, and poverty alleviation.

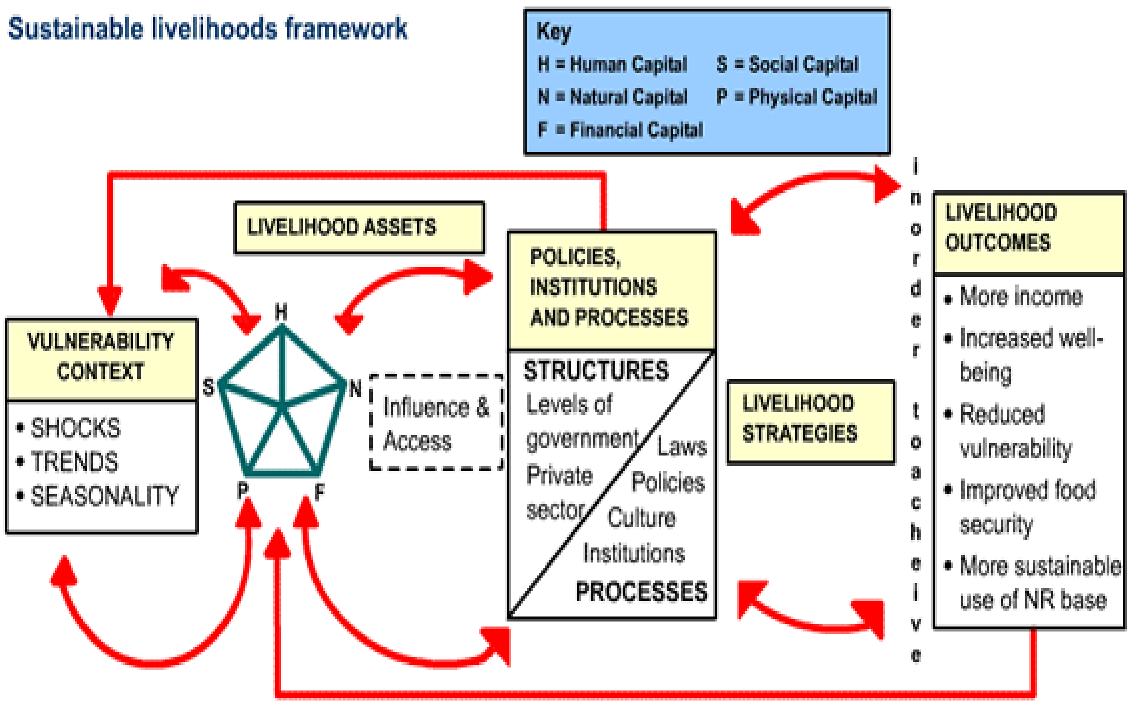
2.2 Theory

In this section, broader development and specific economic theories that are relevant to the study are discussed. First, theories that can be used to describe the impact of HIV and AIDS on household food security are discussed. Second, theories that can be used to conceptualise the possible pathways through which the economic benefits of household food gardens can mitigate the impact of HIV and AIDS are also identified and discussed.

2.2.1 The sustainable livelihood framework

Emerging from research in rural areas, the sustainable livelihood framework (SLF) (Chambers & Conway, 1992) is an analytical tool that was developed to improve researchers' understanding of the situation of people and how they utilise resources at their disposal to construct a livelihood. The SLF posits that households construct their livelihoods by drawing on a range of assets available to them, access to which is determined by the economic forces and social and political context in which they live (Carney, 1998). At the heart of the SLF are assets, defined as the endowments that the household own, and on which households draw to build their livelihoods. Five "vital" assets are distinguished in the SLF, although their boundaries are not always that clear nor is their categorisation exhaustive (Caney, 1998; Rakodi & Lloyd-Jones, 2002). These assets include: human capital (e.g., productive or marketable skills), financial assets (e.g., savings or cash), social capital (e.g., kinship, patronage, and other networks), physical assets (e.g., houses) and natural resources (e.g., land). These assets can be stored, accumulated, exchanged, or depleted and used to generate a flow of income or other benefits in the household. Accordingly, a livelihood is defined as comprising the capabilities, assets (including both material and social resources) and activities required for a means of living (Caney, 1998; Chambers & Conway, 1992). Livelihood strategies are therefore the activities that people undertake to achieve livelihood goals, such as increased household income, increased well-being, reduced vulnerability, and, importantly, improved food security (Rakodi & Lloyd-Jones, 2002; Owuor, 2006).

Figure 2.1: Sustainable livelihoods framework



Source: Carney (1988:22)

Livelihood strategies can be categorised in many dimensions depending on whether the household is proactive or reactive and whether the strategy increases or reduces assets (Masanjala, 2007). While accumulative strategies seek to increase the flow of income and stocks of assets through profitable enterprises, adaptive strategies seek to spread risk through livelihood adjustment or income diversification. In contrast, coping strategies seek to minimise the cost and impact of adverse livelihood shocks such that future livelihoods capacity is not seriously impaired. Survival strategies in turn are those undertaken to prevent destitution and death (Masanjala, 2007). The livelihoods concept therefore, is a realistic recognition of the multiple activities in which households engage to ensure their survival and to improve their well-being (Rakodi & Lloyd-Jones, 2002). In the context of this study, household food gardens represent a livelihood strategy the urban poor can adopt to enhance their livelihood goals. Also, important to note is that livelihoods must be sustainable. It means that households should be able to cope and recover from stress and natural (e.g., earth-quakes, floods and droughts), political (e.g., violent conflicts), health (e.g., HIV and AIDS) and economic (e.g., unemployment, price policies) shocks, without undermining the livelihoods of future generations (Chambers & Conway, 1992).

The SLF is credited for its holistic perspective on people's livelihoods, and for putting the poor and their situated agency at the centre of development discourse and practice. The SLF also recognises the crucial role of assets in people's livelihoods and in fulfilment of livelihood outcomes such as improved food security, increased economic well-being, and reduced vulnerability. Moreover, even though the SLF emerged in rural areas and has been extensively used to help comprehend the livelihoods of the rural poor, a number of authors (e.g., Moser, 1998; Rakodi & Lloyd-Jones, 2002; Seeley, 2002 and Satterwaite & Tacoli; 2002) have demonstrated its value and applicability to understanding the livelihoods of the urban poor. Seeley (2002), for example, suggested that the SLF can be used to understand the impact of HIV and AIDS on households, with respect not only to how the illness impacts people's health, but also its impact on social support and household well-being. In addition, the SLF's comprehensiveness makes it not to belong to any discipline, thus offering a neutral ground on which all disciplines can meet, including Economics (Chambers, 1997). This developmental framework, though not explicitly employed as a theoretical analytical tool in the subsequent analysis of the data, provides an important context to this study, particularly in regard to understanding the impacts of HIV and AIDS on urban household food security of relevance to this particular study.

2.2.2 Grossman's demand for health model

Grossman's demand for health model was the first formal economic model of the determinants of health and health care. In the model, health is a durable capital good requiring investment and an individual produce the commodity "good health" through combining time, medical care, and other social, economic, and environmental inputs (Grossman, 1972). In this way, the individual is thought of choosing his or her level of health and therefore his or her lifespan. The individual values the commodity "good health" both as an investment and consumption good. As a consumer good, "good health" enters the individual's utility function directly because the individual receives disutility from being sick. As an investment good, the commodity "good health" is treated as part of his/her human capital, and as such determines the total amount of time the individual allocates for market and non-market activities (since time sick is not very productive) and affects the length of one's lifetime. This justifies the rationale for the individual to demand health capital up to a point where the costs of one additional unit of health capital is equal to the value of additional time available for productive use plus the utility of being healthy per se that an additional unit of "good health" creates (Grossman, 1972). In the context of this study, "good health" among HIV and AIDS infected individuals is of utmost importance as it allows them to ward off opportunistic infections, slow disease progression and prolong lives (Rawat *et al*., 2014). "Good health" furthermore is not only important for HIV and AIDS infected individuals, but also to those that depend on them, especially children who rely on adults for protection, care, developmental stimulation, nutrition, and healthcare access (Rawat *et al*., 2014).

Grossman's demand for health model is based on the household production theory developed by Becker (1965). In the household production theory, households combine time and market goods to produce more basic commodities that directly enter their utility function. Applying this to the individual, Grossman (1972) assumes that individuals combine inputs to produce good health and specifies an inter-temporal utility function as:

$$U = U(\phi_t H_t, Z_t) \qquad (2.1)$$

Where: H_t is the stock of heath capital at age t or in time period t

ϕ_t is the service flow of health stock per unit stock,

Z_t is the consumption of another commodity,

$h_t = \phi_t H_t$ is the total consumption of health services,

The stock of health in the initial period H_0 is given, but the stock of health at any other age is endogenous. The length of life as of the planning date (n) also is endogenous. In particular, death takes place when $H_t \leq H_{\min}$. Therefore, an individual's length of life is determined by the quantities of health capital that maximise utility subject to production and resource constraints.

Grossman then assumes that individual health stock depends on health investment according to the following way:

$$H_{t+1} - H_t = I_t - \delta_t H_t \qquad (2.2)$$

, where I_t is gross investment and δ_t is the depreciation rate of the health stock during the t^{th} period ($0 \prec \delta_t \prec 1$). The rate of depreciation are assumed to be exogenous, but may vary with the age of the individuals. Under this framework individuals produce gross investment in health and the other commodities in the utility function according to a set of household production functions specified as follows;

$$I_t = I_t(M_t; TH_t; E) \qquad (2.3)$$

$$Z_t = Z_t(X_t; T_t; E) \qquad (2.4)$$

, where, M_t is medical care, X_t is the vector of inputs that contribute to the production of TH_t and Z_t and T_t are time inputs and E is the individual's stock of knowledge or human capital exclusive of health capital.

Chern (2003), extended Grossman's model to include food as another explicit input in the production of health based on the argument that food is an important input in the production of individual health, as is the case in this study, which focuses specifically on household food gardens and their health and economic impacts.

In this scenario equation 2.3 can be rewritten as:

$$I_t = I_t(F_t; M_t; TH_t; E) \quad (2.5)$$

, where F_t is the food or diet consumed by an individual.

In this extended Grossman's model, food represents an important input to achieving "good health". In line with Chern's argument, several studies (e.g., Fayissa & Gutema, 2005; Gbesemete & Jonson, 1993) have included food as a proxy for diet and nutrition in analysing the determinants of health. In the context of HIV and AIDS treatment and care, the importance of adequate food and good nutrition in the production of health by HIV and AIDS infected individuals has been emphasised (Rawat *et al*., 2010; Kadiyala & Rawat, 2012; Palermo *et al*., 2013). Moreover, extensive research has shown that consumption of adequate and nutritious food by HIV and AIDS infected individuals on ART treatment improve their health outcomes (Evans, *et al*., 2013; Ivers *et al*., 2010; Rawat *et al.,* 2014). In this way, food produced by households in gardens represents a potentially important input in the production of health by HIV and AIDS infected individuals, especially in resource constrained settings where ART is an integral part of medical care for patients. Therefore, one possible pathway from household food gardens to "good health" is through food as a nutritional input in the production of health, thus mitigating the impacts of HIV and AIDS.

2.3 Food security: the concept

Food security is achieved when "all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Household food security is the application of this definition at the family level, with individuals within households as the focus. In this definition, food security is interpreted in terms of stability of its three main dimensions: food availability, food access, and food utilisation. While food availability addresses the supply side and is referred to as sufficient production or imports to meet the food needs of the population, food access refers to the ability of households to obtain access to the type, quality, and quantity of food they require. In addition, food utilisation refers to the way the body makes use of various nutrients in achieving health and is determined by diversity of the diet, feeding practices, food preparation, and intra-household distribution of food (FAO, 1996). Food insecurity is therefore a situation when a person or household does not have sufficient physical, social and/or economic access to safe and nutritious food.

The concept of food security has developed through two paradigms. The first paradigm, following the Malthusian idea of "too many people, too little food", provided a supply-oriented definition of food security that framed the problem of food insecurity as a result of a disruption in the food supply (Barrett, 2002; Scanlan, 2009). This disruption in supply was established using nationally aggregated measures of food supply (Barrett, 2010). As such, more focus was on increasing global and national food supplies and guaranteeing stable prices. This paradigm, therefore, relied mainly upon macro trends in the supply and demand for food to explain food security and food insecurity (Barrett, 2002).

Although this view of food security is still widely held it was challenged by the key work of Indian economist Amartya Sen. Sen (1981) established what could be called the second generation of food security paradigms. Sen completely shifted the general food supply aspects of food security and ended the domination of the Malthusian idea. In contrast to the Malthusian sceptre of the growth of food supply falling behind the expansion of the population, Sen's (1981) "Entitlement Theory" provides a framework for conceptualising the mechanisms by which households gain access to food via exchange entitlements, and how these exchange entitlements relations might fail, leading to food insecurity. Sen observed that even during the severe famine of Bengal in 1943, no significant reduction in the ratio of food to population occurred and enough food was available, but people lacked the means to access food. As such, Sen argued that food availability per head is a very poor indicator of food insecurity. Food prices were exorbitant, and households lacked any "entitlement" to access food, which Sen defined as *entitlement failure*. Sen noted that a lack of entitlements was a root cause in the Bengali famine of 1943 and the Ethiopian famine of 1973 in which nationally aggregated measures of food supply remained stable or increased while the domestic population experienced famine. Sen framed entitlements as "the set of alternative commodity bundles that a person can command in a society using the totality of rights and opportunities that he faces". Sen outlined four types of entitlements: trade-based entitlements (a household is entitled to own what was legally traded for), own-labour entitlement (a household is entitled to own and trade their labour), inheritance or transfer entitlements (a household is entitled to transfer, or receive transfers, of legally owned resources), and production-based entitlement (a household is entitled to own what they produce). In this study, household food gardens represent a production-based entitlement through which households can command access to food.

Accordingly, in a market economy, a person can exchange what he owns for another collection of commodities. The set of all bundles of commodities that he can acquire in exchange for what he owns may be called the "exchange entitlements" of what he owns. Thus, it is when the exchange entitlements do not contain any feasible bundle including enough food that a household is exposed to food insecurity. This is not directly related to the aggregate food availability per head in the area, and in so far as aggregate availability has any effect at all, it must work through some variable or other that affects the person's legal entitlement to food (Sen, 1981). Given a household's endowment (those things owned by a household including material goods, labour power, and other resources), a household's exchange entitlements are influenced by such things as employment opportunities and earned income, value of non-labour assets, the market value of household production, and any social benefits accruing to the household. Any changes in any one of these affects the household's exchange entitlements. Thus, socioeconomic and environmental changes can induce changes in the household endowment set, from hyperinflation and a booming economy to economic depression, conflicts and natural epidemics like HIV and AIDS (Devereux, 2001), subjecting households to food insecurity, as will be explained later (see Section 2.4, page 17).

Sen's crucial insight that food insecurity occurs even when adequate food is available drew the attention of researchers who had previously focused on macro-scale availability to the micro-level context, i.e., household-scale and individual-scale access to and utilisation of food. Sen's theory thus challenged the idea that increased aggregate food production would inevitably lead to greater food security for all. Instead of using food output as the metric for measuring or anticipating food insecurity, Sen viewed food insecurity as a social construction, "a matter of command over and access to food, or entitlements". According to Sen, this is so as we do not live in a society in which food is equally distributed among all the members of the society. His articulation of a more complex, and realistic, understanding of food insecurity as well as his methodological focus on the household were major contributions and are particularly relevant to this study. Sen's theory is also of practical relevance when considering urban food security as it argues that food insecurity can still exist even when sufficient food is available. Often sufficient food is available in urban areas, but poor urban residents do not have the means to access this food (Frayne *et al.*, 2010). In essence, Sen was offering a microeconomic approach to a concept which had been previously conceptualised as a macroeconomic phenomenon. The entitlement approach also suggests lines of analysis for prevention of food insecurity through providing interventions which protect failures of entitlements, such as social security and livelihood interventions such as household food gardens that aim to provide a minimum entitlement to everyone, an intervention that is the focus of this study.

The entitlement approach, however, has been criticised by several scholars (see De Waal, 1990; Devereux, 2001; Kula, 1998). De Waal (1990), for example, notes that the theory is both apolitical and ahistorical and does not consider the historical and political processes which lead to vulnerability to food insecurity. When faced with food insecurity households are not passive victims as portrayed by Sen but resist hunger and impoverishment with vigour and skill. Households adopt various coping strategies, as will be explained later (see Section 2.4.1, page 22) many of which are preoccupied with avoiding asset depletion rather than maintaining consumption levels when their entitlements decline (De Waal, 1990). Moreover, other scholars (e.g., Devereux, 2001; Kula, 1998; Swift and Hamilton, 2001) argue that Sen concentrated on the legal ownership of entitlements while many of the entitlements at the disposal of households are informal and do not fall within his proposed legal framework. These informal entitlements are crucial when household food security declines (Devereux, 2001; Kula, 1998; Swift & Hamilton, 2001).

Despite such criticisms, Sen’s influence on the general understanding and analysis of food security is clear. Sen’s insights debunked the long-term belief that food supply is synonymous to food access and the model can be used to understand adaptive strategies in the face of chronic food insecurity. Moreover, Sen’s theory serves as a framework through which individual and household level factors, such as poverty, income, gender, restricted borrowing capacity, absence of safety nets, and ill health, that influence household food security can be examined. In this regard food access, the focus in this study, is critically important in the establishment of food security and in the augmentation and support of human health and livelihoods, including the mitigation of the impact of HIV and AIDS.

2.3.1 Urban food systems and food security

It is widely asserted that food availability and access to food is underpinned by food systems (Ericksen, 2008; Lourenco-Lindell, 1995). The food security status of any group can be considered as the principal outcome of food systems, if these systems are defined broadly and generically. In the literature, food systems have been defined in various ways. Kneen (1989) defines the food system as a single, worldwide, dominant, and highly integrated system that includes everything from farm input suppliers to retail outlets, from farmers to consumers, and, in this case, food gardeners. Tansey and Wolsey (1995), designate a food system as the how and why of what we eat. Smit *et al*. (1996) describes a food system as the structure of food demand (consumption), supply (the places of production), and distribution. MacRae and Donahue (2013) define the food system as comprising the activities of commercial and non-commercial actors, such as food gardeners, who grow, process, distribute, acquire, and dispose of food. Ericksen (2008) conceptualises an urban food system as a set of activities ranging from production through to consumption. These activities include production, processing and packaging, and distribution, retailing and consumption (Ericksen, 2008). Ericksen (2008) asserts that the overwhelming dependence of urban households on purchased food designates distribution and retailing activities, which include all activities involved in moving food from one place to the other and marketing food, as particularly important parts of the urban food systems. The final set of activities in the urban food system relates to the consumption of food, which include everything from deciding what to select through to preparing, eating, and digesting food (Ericksen, 2008), thus establishing a link with food security and nutrition.

Urban food systems, moreover, exist on a continuum between completely informal and entirely formal food systems. The distinction between relatively informal and formal food systems is important in the context of this study, although there are also important linkages between the two. The informal urban food system is characterised by production, processing, distribution and retailing of food undertaken by small enterprises, traders, and service providers in both a legal and unrecognised manner (Crush & Frayne, 2011; Drakakis-Smith, 1991; FAO, 2007). Household food gardening represents a noticeable activity in informal urban food systems (Battersby, 2011; Drakakis-Smith, 1994; Smith, 1998). Smith (1998) asserts that even in the most discouraging environments, vegetables and fruit bushes can be grown in household gardens using containers and sacks to supplement food, diets, and the income of poor urban households. The informal urban food system plays an essential role in the provisioning of food to urban households and satisfying the needs of the urban poor's demand for easily accessible, though often not necessarily cheaper food stuffs (Battersby, 2011; Crush & Frayne, 2011; Maxwell, *et al.,* 2000; Smith, 1998; Lourenco-Lindell, 1995; Drakakis-Smith, 1991). The informal urban food system also presents important livelihood opportunities for poor urban households, particularly poor urban female-centred households (Drakakis-Smith, 1997; Tinker 1997, Levin *et al*., 1999). On the other hand, the formal urban food system is characterised by production, processing, distribution and retailing of food undertaken by large enterprises, traders, and service providers that operate in both a legal and recognised manner (FAO, 2007). Seeing that the focus of this study is on the HIV and AIDS impact mitigation potential of household food gardens, there is a need for a brief review of how HIV and AIDS impacts household food security and nutrition. As such, a review of how HIV and AIDS impact food security of urban households is provided in the next section.

2.4 Impact of HIV and AIDS on urban household food security

As explained earlier (see Section 2.2.1, page 7), in this study, the SLF provides a framework for the description of the impacts of HIV and AIDS on household food security via its impacts on the assets upon which people's livelihoods are based. Livelihood assets enable households to engage in various livelihood strategies, to meet their various livelihood outcomes. As such, the urban poor deploy various livelihood strategies, of which food gardens is one, which often involve different family members in diverse activities and sources of support at different times of the year, yielding different livelihood outcomes such as access to housing, food security, income and other services that are necessary for families' upkeep and survival (Chambers, 1997).

While studies indicate that livelihoods of the urban poor draw on the urban poor's livelihood assets, one of the most common shocks that affects livelihoods of the urban poor is illness (Kaber *et al.,* 2000; Pryer, 1993). As a health shock, HIV and AIDS undermines livelihoods by eroding affected households' livelihood assets, producing severe impacts on household food security. For example, Gillespie *et al*. (2001) state that where the prevalence of HIV and AIDS is high, household food security is affected. De Waal and Whiteside (2003) further postulate that, HIV and AIDS has created a "new variant famine" in Southern Africa.

The most immediate impact of HIV and AIDS which threatens the ability of poor urban households to sustain household food security falls on the household's human asset capital base, principally in terms of availability and allocation of labour (Illeban & Fabusoro, 2011; Savio, 2014; Stokes, 2003). This is so as, HIV and AIDS disproportionately affects the economically active household members who are the main source of household income (Bukusuba *et al*., 2007; Tsai *et al*., 2011; Twine & Hunter, 2011). At the household-level, HIV and AIDS-infected individuals' labour input gradually diminishes as the individual succumbs to illness. The ultimate death of the individual constitutes a permanent loss of one source of labour. Together these effects lead to a fall in household labour supply. Further household labour supply losses are realised through labour that is expended on caring for ill household members. Studies from several African countries indicate that HIV and AIDS illness and death of a productive household member leads to a more permanent cut back in labour supply of affected households (Baylies, 2002; Bachmann & Booysen, 2003; Haddad & Gillespie, 2001; Topouzis, 2003). Reduced household labour supply constrains household participation in various livelihood activities, affecting the stability of the flow of income into the household, which is crucial to the access to food, thus increasing household vulnerability to food insecurity. Moreover, the fall in household income not only affect food purchases but affect other household income generating activities and livelihood pursuits, further compromising the ability of urban poor households to meet their food needs.

Several studies point to the impact of HIV and AIDS on household income (Booysen, 2003; Farahani *et al*., 2013; Mahal *et al.,* 2008; Palamuleni *et al*., 2003; Rajaraman. *et al*., 2006). Booysen, (2003) investigated the impacts of HIV and AIDS related mortality and morbidity on household income employing three measures of income, namely, average adult equivalent per capita household income, average monthly income per capita household income and average monthly household income. The study indicated that all three income indicators were lower in HIV and AIDS affected households[1] compared to non HIV and AIDS affected households, with the adult equivalent per capita income in HIV and AIDS affected households representing between 50-60% of the levels of income in non HIV and AIDS affected households. In rural Thailand, Kongsin *et al*. (2000), cited in Booysen (2003), found that the average income of households which experienced an HIV and AIDS illness and death was 46% lower than that of non HIV and AIDS affected households with no family deaths. Oni *et al.* (2002), cited in

[1] A household with at least one known HIV-positive household member.

Booysen (2003), investigated the economic impact of HIV and AIDS in South Africa and showed that the annual average household income of HIV and AIDS affected households was 35% lower than that of non HIV and AIDS affected households. Palamuleni *et al*. (2003) noted that HIV and AIDS related morbidity resulted in direct household income losses of up to 60% among a working cohort in an urban community in Malawi. These income losses resulted in increased levels of household food insecurity, as up to 56% of interviewed individuals indicated that they had stopped providing food for their households since they took ill (Palamuleni *et al*., 2003).

In addition, household income losses are also realised through caring for ill household members. The need to provide care for HIV and AIDS infected ill household members divert other household members from their daily activities, which may include participation in the labour market and in other productive activities. The schooling of children may also be affected where children take on the role of caregivers. These impacts, which in the livelihoods framework are related to the human capital asset, are especially true for women who are society's traditional caregivers (D'Cruz, 2004). Reallocation of productive time by caregivers to look after sick household members further reduces household income, hence further threatening household food security. Sentongo (1995), studying the livelihoods of women traders in the Owino market in Uganda, observed that the enterprises of female traders who traded in perishables such as vegetables, fish and cooked food collapsed due to lost earnings when they attended to the sick for long periods. A study by Rajamaran *et al*. (2006) in Molopelole, a large urban village in Botswana, showed that up to 40% of female caregivers lost paid income as a result of providing care to HIV and AIDS infected household members. Gwatirisa and Manderson (2009) noted that in Zimbabwe, female caregivers, lost income through reduced participation in economic activities to provide care for sick household members. Constrained household labour participation in economic activities by caregivers had negative impacts on household food security (Gwatirisa & Manderson, 2009). Mahal *et al*. (2008), found that in HIV and AIDS affected households income losses associated with sickness and caregiving constituted up to 40% of annual household income per capita. Bachmann and Booysen (2003), studying the socio-economic impacts of HIV and AIDS on households in the Free State province, South Africa, noted that in HIV and AIDS affected households 72% of ill members were cared for at home, by women and in some cases children, indicating a substantial burden of care in affected households, which in turn stands to translate into substantial income losses via the indirect impact of HIV and AIDS on the livelihood asset of human capital.

Although the most immediate impacts of HIV and AIDS falls on household human capital asset, the epidemic equally depreciates other categories of a household's livelihood assets, including financial and social assets, thus further threatening household food security. The human capital asset losses engendered by HIV and AIDS affect other livelihood assets, particularly financial capital rendering households vulnerable to food insecurity. Inevitably, the human capital losses described above translates to household financial shortfalls, an important asset in sustainable livelihoods, as incomes earned by both infected and affected household members decline. Moreover, treatment of HIV and AIDS induced illnesses put a heavy financial burden on households' already declining resources. Further financial demands arise in the form of funeral expenses when the death of an HIV and AIDS infected household member occurs. Household financial capital is therefore eroded as savings are constrained and depleted, assets sold, and debt incurred to finance increased household medical expenditures and compensate for household income losses. The sale of household assets however, jeopardise the household's future livelihoods, further weakening household food security.

In terms of empirical evidence of the above impact dynamics, Bachmann and Booysen (2003) noted that HIV and AIDS affected households saved approximately 40% less than non-affected households monthly. Booysen (2002), assessing the financial responses to HIV and AIDS morbidity and mortality, indicated that, in response to income shortfalls resulting from HIV and AIDS mortality, HIV and AIDS affected households were more likely to use borrowing, utilisation of savings, and selling of assets as financial coping strategies compared to non HIV and AIDS affected households. Approximately 40% of the HIV and AIDS affected households borrowed money to finance household food expenditures, suggesting how household income losses may impact directly on household food security (Booysen, 2002). Mahal *et al*. (2008) observed that, in Nigeria, 25% of households affected by HIV and AIDS sold assets to cope with declining incomes and illness-related expenses compared with only 2.5% of non-affected households.

Another important asset in the SLF, social capital, enable households to generate and develop sustainable livelihoods through increased access to goods and services that support non-monetary forms of exchange. The HIV and AIDS epidemic, however, depreciates social capital in that death and sickness fracture networks of extended family and friends, reduce social capital endowments, undermine reciprocity and redistribution, thus leading to a reduced ability to draw on social capital for instrumental assistance. De Waal and Whiteside (2003) argue that kinship relations are weakened by HIV and AIDS related illness and deaths, such that reliance on kinship relations for assistance becomes increasingly inoperable. The importance of social capital in underpinning the livelihood strategies of individuals and households has been emphasised by numerous authors such as Ellis *et al.* (2003); Kawachi (1999); Gallaher *et al*. (2013) as well as Lyons and Snoxell (2005). Lyons and Snoxell (2005), for example, investigate the social capital of urban petty traders in Senegal and Ghana, and show that family relations or inherited social capital and friendship networks played an important role in sustaining the trader's livelihood especially in the face of shocks like illness of a family member.

In other words, the impact of HIV and AIDS on social capital threaten household food security through weakening households' support systems. Favourable social capital endowments engender significant sharing of labour, food, income, and time among households, and can mitigate the negative effect of HIV and AIDS on food security on any specific household. The altruistic exchange of goods between households, particularly within family and between urban friends and neighbours, is related to improved household food security, and may be of immense importance in resource-poor settings where formal safety nets provide inadequate insurance against health, food insecurity, or income shocks (Tsai *et al*., 2011; Carter & Maluccio, 2003). For example, Hadley *et al*. (2007) observed that access to social capital was positively correlated with household food security. Studying the impact of social capital on household food security in urban slums in Kibera, Nairobi, Gallaher *et al.* (2013) report that households with more social capital were more food secure than those households with less social capital, suggesting that social capital provide the basic support system that mitigate or even prevent household food insecurity.

In sum, HIV and AIDS systematically cause food insecurity by negatively affecting the assets on which households depend on to engage in various livelihood strategies. Because of illness or death, depletion in human capital, financial assets and weakened social capital, household's ability to generate income is weakened, thwarting its ability to access food. For poor urban households, food insecurity is further worsened by the fact that when faced with declining household income, food expenditures are usually the first that households cut back. Topouzis

(1999) found that income decline in HIV and AIDS affected households resulted in a 40% drop in household food expenditures. Booysen and Bachmann (2003), indicate that HIV and AIDS affected households spent less on food than non HIV and AIDS affected households, with household per capita and adult equivalent levels of expenditure on food representing between 70-80% of levels of expenditures in non-affected households. In Kagera, the expenditure on food in households affected by an adult death fell by 32% (Lundeberg *et al*., 2000, as quoted in Bachmann & Booysen, 2003: 13). This leads to a question: how do households cope with this HIV and AIDS induced food insecurity? This question forms the basis of the next section, which focuses on the food-related coping strategies in HIV and AIDS affected households.

2.4.1 HIV and AIDS and adverse food-related coping strategies

As explained earlier (see Section 2.2.1, page 7) in the SLF, when faced with adversity and shocks, and illness such as HIV and AIDS, households do not act in a passive manner, but rather respond through adoption of various response mechanisms. As such, the impact of HIV and AIDS on household food security described above often cause households to adopt a variety of food-related coping strategies. Bukusuba *et al*. (2007) studied the food security status of households of PLWHA in urban Uganda. Their study found that households with PLWHA were severely food insecure and to cope with food insecurity, 95% ate less preferred foods, 82.6% reduced portions of meals served to household members, 62.3% skipped eating meals, and 21.5% skipped eating for the whole day (Bukusuba *et al*., 2007). In Ghana, HIV and AIDS affected households adopted similar strategies and relied on less expensive foods, reduced the number of meals per day, reduced meal portions, and skipped meals for the whole day to cope with food insecurity (Laar *et al*, 2015). The results of Senefeld and Polsky's (2006) study, conducted to assess the impact of HIV and AIDS on food security and coping strategies in Zimbabwe, indicated that households with at least one chronically ill HIV and AIDS infected member were more likely than non HIV and AIDS affected households to skip meals for more than one day, eat less preferred foods, reduce adult consumption of food within the household so children could eat, and prioritise food for working household members. In South Africa's KwaZulu-Natal province, a study by Knight *et al*. (2015) on household shocks and coping strategies in rural and urban areas showed that households who reported being affected by HIV and AIDS were more likely to change consumption patterns by buying less food, relying on cheaper foods, and eating fewer meals, together with skipping meals.

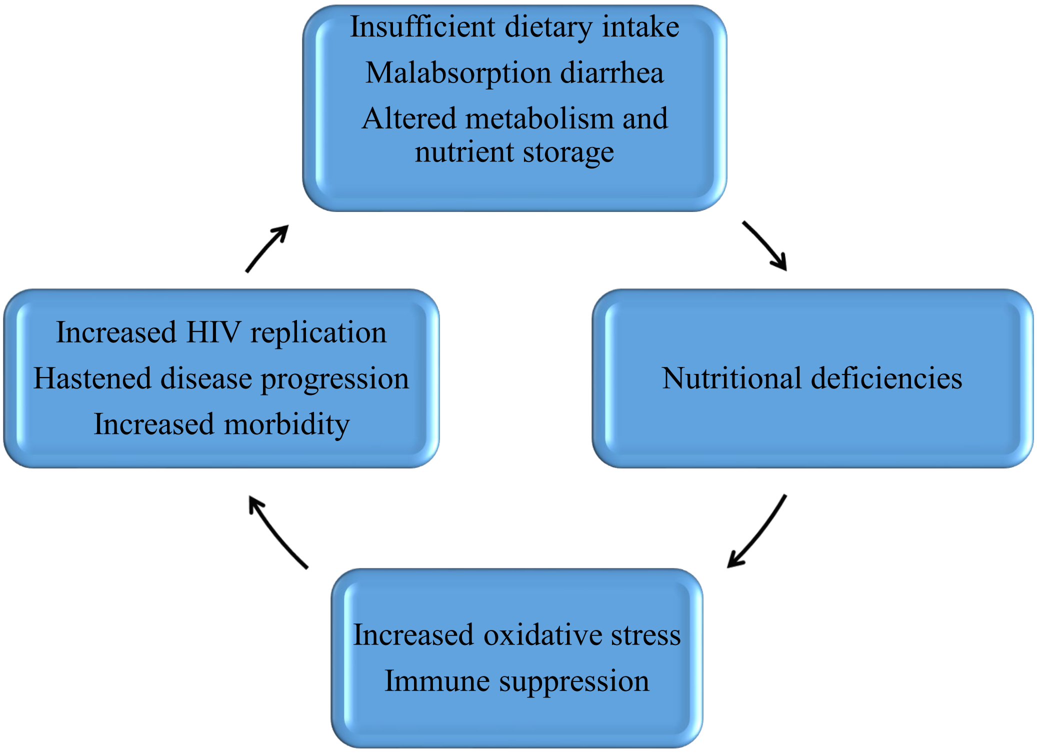
The conclusion drawn from these studies is that in the face of food insecurity resulting from the negative impacts of HIV and AIDS, affected households adopt various consumption rationing strategies. All in all, HIV and AIDS impact negatively on household food security and nutrition. For this one side of the coin, however, there is an opposite, namely how food security and nutrition is important in the response to the HIV and AIDS epidemic.

2.5 The role of food security and nutrition in HIV and AIDS management

The relationship between HIV and AIDS and nutrition in the infected individual is represented (See, Figure 2.2, page 24) as a "vicious cycle" of immune dysfunction, infectious disease, and malnutrition (Semba & Tang, 1999). At an individual level, insufficient dietary intake of food, malabsorption of food and nutrients, diarrhoea, impaired storage of nutrients and altered metabolism are ways that HIV and AIDS escalate malnutrition in HIV and AIDS infected individuals. The resultant malnutrition often lead to oxidative stress and immune suppression which in turn reduces the ability of the body to fight off co-infections and increases further risk to further infection and hasten disease progression and death (Semba & Tang, 1999). Semba and Tang (1999) further states that this vicious cycle of immune dysfunction, infectious disease and malnutrition, quickly progresses when an individual is already malnourished.

It is against this backdrop that in the context of HIV and AIDS, the role of food security and nutrition is important to acknowledge for a number of reasons. First, food security and nutrition has the potential to interface positively with an HIV and AIDS nutrition feedback loop. Adults living with HIV and AIDS have 10-30% higher energy requirements, and children living with HIV and AIDS require up to 100% more energy and 50% more protein, as well as more micronutrients (WHO, 2003). Higher energy and micronutrients are crucial in reducing susceptibility to co-infections, enhancing the immune system's ability to fight infections, and delaying the onset of full-blown AIDS, all which potentially enhance the quality of life and life expectancy of PLWHA (Friis, 2006; Mubvami & Manyati, 2007).

Figure 2.2: The vicious cycle of malnutrition and HIV and AIDS



Source: Semba and Tang (1999:182)

Second, adequate food security and nutrition enhances the pharmacokinetic efficacy of ART. Antiretroviral treatment reduce viral loads and improve health outcomes of PLWHA but is often associated with further nutritional and dietary needs, such that food security and nutrition becomes crucial as some antiretroviral drugs have to be taken with meals, because food facilitates the absorption and effectiveness of treatment (Castleman *et al*., 2003; Friis, 2006). Moreover, antiretroviral treatment increases appetite, an intended and desirable effect of therapy, one that is required to reverse loss of body mass and to promote recuperation and enhanced immune function (Ivers *et al*., 2009). A 2001 UNAIDS statement reiterates the importance of adequate food and nutrition in antiretroviral treatment, "If you include drug therapy but you do not have adequate nutritious food, you will not be able to fight the infection" (UNAIDS, 2001:12). Evidence abounds of the positive effects of food security and good nutrition on improved health outcomes in HIV and AIDS patients on ART. For example, Evans *et al*. (2013) showed that a nutritional supplementation in the form of future life porridge given to HIV and AIDS infected individuals on ART promoted weight gain and improved immune response in South Africa. Rawat *et al*. (2014) evaluated the impact of a household food assistance programme on the nutritional status of 180 HIV-positive individuals receiving ART in Uganda. Their findings show that food assistance significantly improved the body mass index (BMI) and mid-upper-arm circumference (MUAC) of HIV-positive individuals. Similarly, an evaluation of a targeted food assistance programme for individuals receiving ART in Haiti reported greater improvements in body mass index (BMI) among food recipients (Ivers, *et al*., 2010).

Moreover, the therapeutic effects of antiretroviral drugs are maximised when the treated persons are well nourished. Evidence from several studies from Sub-Saharan Africa show that a low body mass index (BMI) at the time of ART initiation lowers survival rates (Johannessen *et al*., 2008; Zachariah *et* al., 2006; Zanon *et al*., 2011). Drain (2007) show that HIV and AIDS infected individuals with mild malnutrition (body mass index <18) were twice as likely to die in the first three months of treatment. For those HIV and AIDS infected individuals with severe malnutrition (body mass index <15) the risk was six times greater than for those of healthy body weight (body weight index 18-22). Mortalities in the first three months of antiretroviral treatment initiation are highest (95%) among the most severely malnourished (Drain, 2007). Willig *et al*. (2009) also found that low weight and CD4 values at ART initiation are associated with increased probability of regimen discontinuation due to toxicity and side effects. Malnutrition, therefore, is a strong indicator of mortality among PLWHA.

Third, food security and nutrition is crucial in enhancing ART adherence. Treatment efficacy with ARV drugs relies on high levels of patient adherence (at least 95%), which is critical for viral suppression and the prevention of resistance, disease progression, and death (Kiwuwa-Muyingo *et al*., 2012). There is a growing recognition that individuals receiving ART do not adhere to their treatment when faced with a lack of food in their households, particularly for fear of taking drugs on an empty stomach as this potentiates the side effects of some anti-retroviral therapy medications (Agnarson *et al*., 2007; Kalichman *et al*., 2015; Musumari *et al*., 2013; Weiser *et al*., 2012). Evidence abounds for the negative effects of food insecurity on poor adherence to antiretroviral treatments adherence, with implications in turn for virologic failure, poor CD4 count, hastened progression from HIV to AIDS, increased mortality through treatment failure, development of widespread drug resistance and the need for a whole new regimen of second-line and third-line drugs that are significantly less accessible and affordable than first-line regimens (Bangsberg *et al*., 2001; Bloem & Saadeh, 2010; Kiwuwa-Muyingo *et al*., 2012; Maggiolo *et al*., 2005; Sungkanuparph *et al*., 2011). Since HIV and AIDS treatment's effectiveness can still be jeopardised by lack of food, food security and good nutrition becomes important in alleviating the negative consequences of HIV and AIDS, through enhanced treatment adherence.

Lastly, within the context of ART, adequate food security and nutrition stand to contribute to HIV and AIDS affected households' economic productivity and reconstitution of their livelihoods, through allowing HIV and AIDS infected household members to sustain healthy levels of physical activity, enabling them to remain in productive employment. Economists, in the "efficiency wage hypothesis", proposed the possibility that in addition to direct health benefits for individuals and households, increased caloric intake and improved nutritional status may lead to higher wages and labour productivity. Leibenstein (1957) postulated that malnutrition lowers the productivity of workers such that improved labour productivity is attained from improved nutrition at low levels of intake. Empirical evidence from resource constrained countries like Brazil, Cote d'Ivoire, Sierra Lione, and India have confirmed the efficiency wage model's predictions (Thomas & Strauss, 1997; Schultz & Tansel, 1997; Deolalikar, 1988; Strauss, 1986). In the context of HIV and AIDS, household food security and nutrition stand to improve household labour supply through improved calorie intake and ultimately labour productivity in HIV and AIDS infected household members. Moreover, improved ART treatment effectiveness resulting from adequate food security and nutrition also enhance the labour supply of HIV and AIDS patients and their household members. Empirical studies show that health improvements accompanying ART, lead to positive labour supply responses such as increased job search, labour force participation and labour supply, improved work performance, and reduced absenteeism by infected patients (Habyarimana *et al*., 2010; Thirumurthy & Zivin, 2012; Tirivayi *et al*., 2010). Furthermore, changes in the labour supply of HIV and AIDS infected household members also generate intra-household spill-over effects on time allocations, especially on women as they shift from care work to productive work, thus enhancing household labour supply (Thirumurthy *et al.,* 2011). These benefits have the potential to improve household welfare outcomes such as household food security and household income, through household members' enhanced engagement in various forms of economic activities.

Given the negative impact on the one side of HIV and AIDS on food security and nutrition and the importance on the other side of food security and nutrition for HIV and AIDS treatment, it is important to ask whether household food production can improve the food security of these households. This question forms the thrust of this study as it seek to assess the potential of household food gardens in mitigating the impacts of HIV and AIDS through enhancing the food security of poor urban households.

2.6 Household food gardens

Household food gardens are one of the oldest and integral local household food production systems found in both urban and rural areas in most countries around the world (Brownrigg 1985; Hoogerbrugge & Fresco, 1993; Mitchell & Hanstad, 2004).

The study of household food gardens has resulted in studies with numerous definitions, emphasising different aspects and in most instances suiting the objective of the researcher. Niñez (1985), based on research evidence and observations of household food gardens from developing and developed countries, defines a household food garden as a "small scale production system supplying plant and animal consumption and utilitarian items either not obtainable, affordable, or readily available through retail markets, field cultivation, hunting, gathering, fishing, and wage income which is located close to dwelling for security, convenience, and special care; utilises land marginal to field production, labour marginal to major household economic activities, low capital input and simple technology". Hoogerbrugge and Fresco (1993), define household food gardens as a "small scale, supplementary food production system by and for household members that mimics the natural, multi-layered ecosystem". Kumar and Nair (2004), define a household food garden as an "intimate, multi-story combination of various trees and crops, sometimes in association with domestic animals, around homesteads whose cultivation is fully or partially committed for vegetables, fruits, and herbs primarily for domestic consumption". In addition, other scholars describe a household food garden as a well-defined, multi-storied and multi-use area near the household dwelling that serves as a small-scale supplementary food production system maintained by the household members and encompasses a diverse array of plant and animal species that mimics the natural eco-system (Eyzaguirre & Linares, 2010; Krishna, 2006; Sthapit *et al*., 2004).

In the literature, household food gardens are classified as homestead gardens, mixed gardens, kitchen gardens, backyard gardens, or compound (Brownrigg, 1985; Kumar & Nair, 2004; Marsh, 1998; Mitchell & Hanstad, 2004). In this study, a household food garden is defined as a garden that is located near the homestead, contains a high diversity of plants, and focuses on supplementary food production rather than a main source of food consumption and income, occupies a relatively small area, and is accessible to poor households in terms of low cost and marginal labour requirements (Galhena *et al*., 2013). As such, the study used the following terms to search for literature: household food gardens, homestead gardens, kitchen gardens, backyard gardens; mixed gardens and compound gardens as these are used interchangeably in the literature. Importantly, the definition of household food gardens adopted in this literature review, excludes studies on forms of subsistence agricultural activities like subsistence farming and small-scale agriculture, the impact of which has been investigated in the former home lands (Pienaar, & von Fintel, 2014; Rogan, 2018).

The primary purpose of household food gardens is to grow and produce food for direct household consumption. Household food gardens can be diversified to produce outputs that have multiple uses, including indigenous medicine and home remedies for certain illnesses. Household gardens symbolise an uninterrupted small scaled and informal food production system established by the household to obtain and supplement the food requirements of the household and have great potential for improving household food security and alleviating micronutrient deficiencies (FAO, 2012).

2.6.1 Characteristics of household food gardens

Household food garden studies often refer to five intrinsic characteristics of household food gardens: first, household food gardens are located near the residence; second; household food gardens contain a high diversity of plants; third, household food gardens are a supplemental rather than a main source of family consumption (Michelle & Hanstad, 2004); fourth, household food gardens occupy a small area (Brownrigg, 1985), and lastly, household food gardens are a production system that the poor can easily enter at some level (Marsh, 1998). Galhena *et al*. (2013) list other general characteristics of household food gardens.

Table 2.2: Key characteristics of a typical household food garden

Characteristic	**General Practice**
Species density	High
Species type	Staple, vegetables, fruits, medicinal plants
Production objective	Home consumption
Labour source	Family (women, elderly, children)
Labour requirements	Part-time
Harvest frequency	Daily, seasonal
Space utilisation	Horizontal and vertical
Location	Near dwelling
Cropping pattern	Irregular and low
Technology	Simple hand tools
Input-cost	Low
Distribution	Rural and urban areas
Skills	Gardening and horticultural skills
Assistance	None or minor

Source: Galhena *et al*. (2013:3)

Research has shown that the socio-economic status of the household has a bearing on household food garden characteristics, for example, Wiersum (2006), observed that as households became economically stable, they shifted from cultivation of staples to horticultural crops. Coomes and Ban (2004) also observe that access to social capital increased species density and crop diversity of household food gardens. This is so as social capital enable households to share seedlings and other gardening materials (Coomes & Ban, 2004).

Household food gardens often rely on family labour (Sthapit *et al*., 2004). Work by women, children, and elderly is of particular importance to the management and existence of household food gardens (Finerman & Sackett, 2003; Howard, 2006; Mitchel & Hanstad, 2004). However, depending on the economic capacity of households, households may hire wage labourers to cultivate and maintain the household food garden (Galhena *et al*., 2013; Maroyi, 2009).

2.6.2 Benefits of household food gardens

The household food garden forms an essential part of households' production and consumption. According to Niñez (1985), the very persistence of household food gardens can be taken as proof of their provision of numerous intrinsic benefits. Extensive evidence points to numerous benefits of household food gardens, ranging from enhancing food security and nutrition, providing a source of household income, contributing to household livelihoods, to gender economic empowerment (Bushamuka *et al.*, 2005; Galhena *et al.*, 2013; Marsh, 1998; Mitchell & Hanstad, 2004; Talukder *et al.*, 2010). The importance of household gardens is further attested to by the fact that in times of need, households have had recourse to the garden strategy to improve food security. For example, Niñez (1985) indicated that the Irish potato gardens allowed the poor to feed themselves during the Great depression. Marsh (1998) pointed out that after the 1980s civil war in Kampala, Uganda, urban household gardens substantially fed the city in non-cereal foods. A study conducted in Cuba revealed that gardens were adopted as a strategy to ensure food security during the Cuban economic crisis and political isolation (Buchmann, 2009). To mitigate recurring food shortages and malnutrition, Cuban households obtained basic staple foods (rice and beans) through rations, but the households relied on their household gardens to obtain additional produce to diversify family diet. Consequently, household garden production increased in the country and became instrumental in reducing "hidden hunger" and diseases caused by micronutrient deficiency (Buchmann, 2009). A study by Tho Seeth *et al*. (1998), showed that poor and middle-income urban households adopted household food gardening as a response to economic stress resulting from Russia's 1992 price liberation.

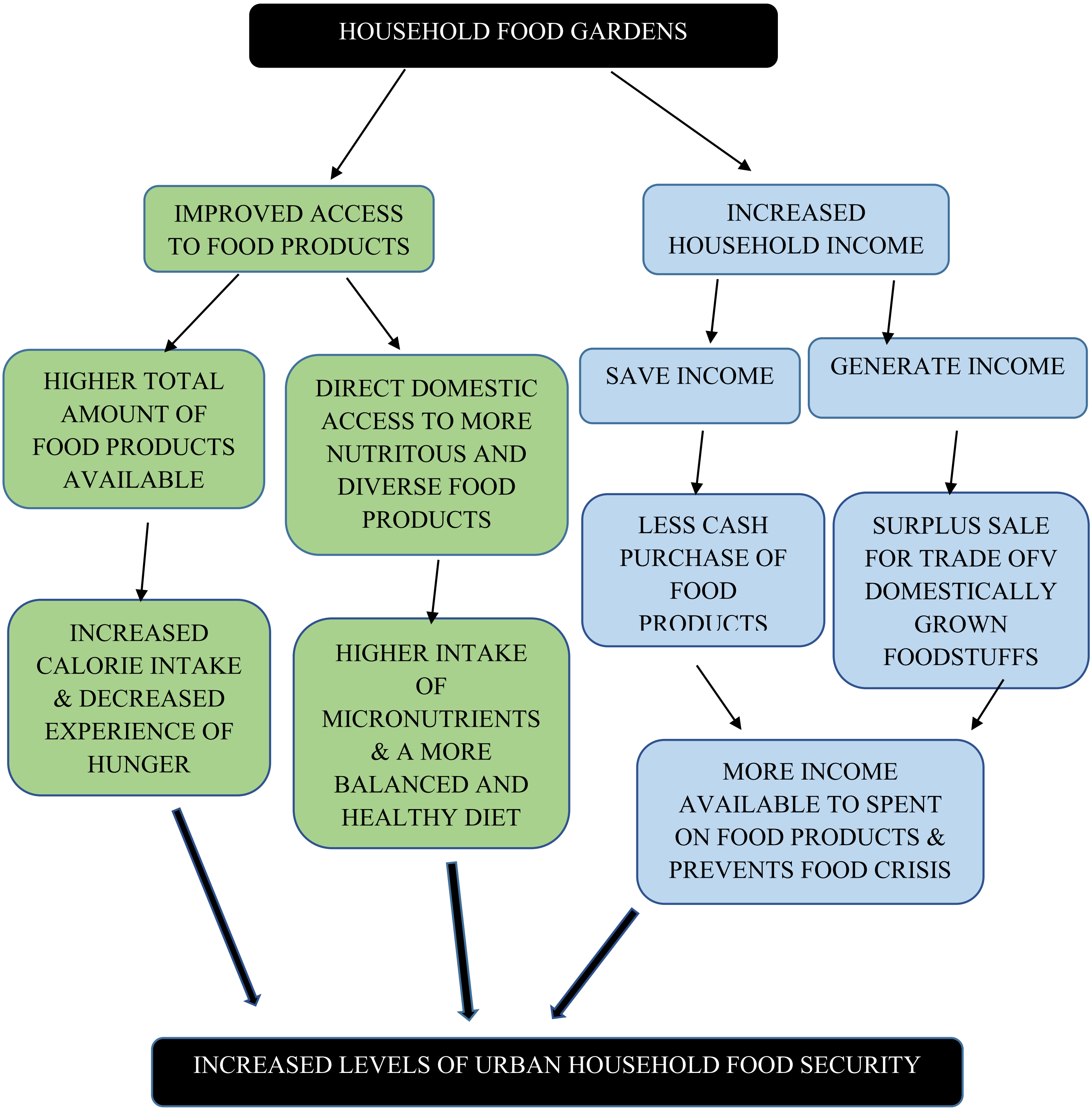
Against this backdrop, household food gardening has been widely promoted as an intervention aimed at addressing food insecurity, poverty, declining livelihood opportunities, malnutrition and hunger, and gender inequalities, especially for poor and vulnerable households, with much evidence coming from the Asian-Pacific region (Faber *et al*, 2011). This study asks similar questions regarding the benefits of household food gardens, this within the HIV and AIDS context. As a key question in this case surrounds the health related benefits of household food gardens, the focus now shifts to a more detailed discussion of gardens' role in food security and nutrition.

(a) Household food gardens and food security

Household food gardens are thought to contribute to household food security and nutrition through two main pathways: improved access to food, and increased income (Figure 2.3) (Stewart *et al*., 2013). First, food produce from gardens increase the amount of food that can be easily obtained and prepared to feed the family on a continuous basis, thereby reducing hunger and malnutrition. At the same time, the diversity of nutrient-rich fresh foods from the garden, particularly fruits and vegetables, enriches the nutritional status of household members, thereby improves health. Moreover, direct access to fresh garden food often allows particularly urban poor households to consume a more diverse diet than they would otherwise be able to afford, given their dependence on purchased food.

Second, household food gardens provide an important source of income through the sale of surplus produce and savings on food expenditures. For urban poor households who rely more on cash incomes to purchase food items (Battersby, 2011; Maxwell *et al.,* 2000) and for whom food expenditures take up relatively large proportions of their incomes, and whose cash incomes are in any case irregular, an increase in income improves greater access to other food products, both in terms of quantity and quality, thereby diversifying diets. Improved access to other food products also supply multiple nutrients, further enhancing household dietary diversity.

Figure 2.3: Household food gardening and urban household food security



Source: Stewart *et al.* (2013: 4)

A number of studies have evaluated the potential contribution of household food gardens to food security, as depicted in Figure (2.3), and have shown that household food gardens are an important source of food. Ochse and Terra's (1937), pioneering study on household gardens in Indonesia reported that 44 percent of the total calories and 14 percent of the protein consumed by households came from household food gardens. Sri Lankan household food gardens were reported to produce 60 percent of leaf vegetables and 20 percent of all vegetables consumed by the household (Hoogerbrugge & Fresco, 1993). A study by Vasey (1985), in Port Moresby, Papua New Guinea found that the direct contribution of garden production to family food energy consumption was 36%. Marsh (1998) established that in Bangladesh household food gardens provided more than 50 percent of vegetables and fruits. He further indicated that household food gardens contributed significantly to the percentage of recommended dietary allowance for protein (10 to 20 percent), iron (20 percent), calcium (20 percent), vitamin A (80 percent) and vitamin C (100 percent). A study carried out by Gautam *et al.* (2008) in Nepal showed that household gardens provided 60% of the household's total fruit and vegetable consumption. Talukder *et al*. (2000) monitored the consumption of vegetables from the gardens of low-income Nepalese households and reported that for more than 95% of the households, their own garden was the main source of vegetables consumed.

Schreinemachers *et al*. (2015) evaluated the contribution of household food gardens to household food security and nutrition in Bangladesh, using cross-sectional data from the World Vegetable Centre (AVRDC) household food garden project on 103 intervention households and 479 control households. The results showed that the amount of harvested vegetables, per capita nutrient yields, frequency of harvesting and planting, and diversity of vegetable consumption were significantly greater for the households in the intervention group than for households in the control group, which is indicative of the positive impacts of household food gardens.

Bushamuka *et al*. (2005), using data from a Hellen Keller International (HKI) programme evaluated the impact of household food gardens on food security in Bangladesh, using cross-sectional data for 2,160 households. Three groups of households, the active-participant (households receiving assistance for less than three years), former participant (households who had completed the programme and were still operating a household food garden for three years without assistance), and control households (households without food gardens) were included in the study. To assess the impact of the gardens on household food security each dimension of food security was measured: the availability of food in households, the ability of households to access food, and the utilisation of food by households. Household food garden produce estimated in kilograms was used as an indicator of food availability. Household food access was measured by the consumption levels of garden produce, the amount of income generated from the sale of garden produce, and by the extent to which garden income was spent on food and productive assets. Garden crop diversity was used as an indicator of the quality of food accessed by households. Findings from the study indicated that household food gardens increased household food security. The quantities of vegetables and fruits produced, consumption of vegetables and fruits, and income generated from the sale of garden surplus was higher in both active and former participant households compared to control households. The consumption figures showed that, using the World Health Organisation (WHO) daily per capita consumption of vegetables of 200g, active participant households obtained 80% of daily required per capita vegetable consumption from household food gardens compared to only 35% in the control households. In addition, expenditures out of the sale of garden produce showed that food was the most frequently purchased item, with significantly higher expenditure in the active and former participant households compared to control households. Furthermore, the study found that more than 3 years after the intervention, these positive effects had been sustained, although the effect on consumption had become less. These results show that household food gardening is an instrumental strategy that can augment food availability and access to quality foods, thus contributing to household food security. Expanding household food gardening practices can be an important strategy to combat household food insecurity and can be part of a mix of strategies to address the problem of food insecurity, particularly for HIV and AIDS impacted communities. However, the study potentially suffers from selection bias as there were clear differences between control and intervention households and these were not controlled for in the analysis.

Some researchers have also studied the food security benefits of household food gardens within the context of the HIV and AIDS epidemic. Roberfroid *et al*. (2011) examined the contributions of low-input household gardens to household food security in households with PLWHA in Chipinge, Zimbabwe. The study used a post-test design with 238 control households and 281 intervention households with a random selection. Three composite measures of household food security were used: the Household Food Insecurity Access Scale (HFIAS), Household Dietary Diversity Score (HDDS), and Food Consumption Score (FCS). Consumption of fruits and vegetables from low-input gardens production was higher in beneficiary households than control households who more often ate leafy vegetables received as gifts. Food consumption scores were statistically significantly higher for intervention households (40.5) than for control households (36.1) and more intervention households had acceptable FCS (>35; 59% versus 42%). Intervention households had higher dietary diversity scores (6.6 vs 5.7) compared to control households. The findings thus confirm the potential benefits of household food gardens for improving food security in poor households affected by HIV and AIDS, benefits that are also investigated in this study.

A study by Baiyegunhi and Makwangudze (2013) in KwaZulu-Natal, South Africa, examined the impact of household gardens on the food security of HIV and AIDS affected households. A cross-sectional survey of 23 HIV and AIDS affected households who participated in a household food gardening project and 10 HIV and AIDS affected households who were not participants of the household food gardening project was conducted. Household food security was measured using the Household Food Insecurity Access Scale (HFIAS). A simple OLS regression model was used to estimate the determinants of household food insecurity in the HIV and AIDS affected households. The linear regression model results showed that household food gardening significantly contributed to household food security. In this study, a pre-test-post-test treatment-control design is used to ask a similar research question, but with different measures of food security as key outcome.

(b) Household food gardens and dietary diversity and nutrition

Household food gardens are an important source of micronutrients and medicinal plants for households. The diversity of plants raised in household gardens provides households with a variety of fresh foods, including vegetables and fruits, which are an important source of multiple micro-nutrients, such as vitamin A, C, and B-complex and minerals (Bloem *et al*., 1998; Gari, 2003; Shrestha *et al*., 2002), thus diversifying their diets. For poor and marginalised households unable to afford expensive animal products to fulfil their households' nutritional needs, household gardens offer a cheap source of diverse diets (Bloem *et al*., 1998). A number of studies have evaluated the contribution of household gardens to dietary diversity. A study by Schreinemachers *et al*. (2015) in Bangladesh showed that household food gardens supplied a household with 5.4% of average household protein needs, 9.3 % of its calcium needs, 10.3% of iron needs, over 100% of its vitamin A needs, and 46.7% of its vitamin C needs. Gardening households also had a greater diversity than that of control households (6.33 vs 4.28) (Schreinemachers *et al*., 2015). Similarly, Cabalda *et al*. (2012) reports that household food gardens improved children's dietary diversity scores and frequency of consumption of fruits and vegetables in the Phillipines. Selepe and Hendriks (2014) also showed that a household food gardening project increased the dietary diversity and nutrient intake of vitamin A of children in South Africa.

Improved dietary diversity is associated with improved nutritional and health outcomes (Arimond & Ruel, 2004; Kennedy *et al*., 2007). Dietary diversity is particularly important to PLWHA who have increased nutritional needs (Filteau *et al*., 2001, Gillespie, 2006; Johns *et al*. 2006). Given the importance of good nutrition to PLWHA (see Section 2.5, page 20), several studies have also examined the impact of gardens on household dietary diversity, within the context of HIV and AIDS. Akrofi *et al*. (2010), in Eastern Region, Ghana, analysed how household dietary diversity of HIV and AIDS affected households is affected by household food gardens using a cross-sectional design and evaluated gardens' contribution to dietary diversity in HIV and AIDS affected and non-affected rural households. The results indicated that household food gardens contributed significantly to dietary diversity in HIV and AIDS affected households compared to non-affected households. The dietary diversity in HIV and AIDS affected households was 6.8 compared to 6.0 in non-affected households. The contribution of household food gardens to the household dietary diversity score was significantly higher in HIV and AIDS affected households (14.9%) than in non-affected households (9.1%) (Akrofi *et al*., 2010).

Keatinge and Amoaten (2006), focusing on low-input nutrition gardens in HIV and AIDS affected households in Zimbabwe, concluded that vegetable produce from the low-input gardens supplemented households' carbohydrate dense diets and improved their dietary diversity, a result similar to that found by Miura *et al.* (2003) in poor urban communities of the Philippines. Bukusuba *et al*. (2007) noted that consumption of a diverse diet in PLWHA in Jinja, Eastern Uganda, was significantly associated with the practice of household food gardening.

While there is agreement in general that household food gardens can improve food security and dietary diversity, the evidence of household food gardens' impact on nutritional outcomes has been inconclusive. A study by Faber *et al.* (2002), found that in KwaZulu-Natal, South Africa, production of yellow and dark green leafy vegetables in household gardens significantly improved the vitamin A status of children between the ages of two and five years, through improving the dietary intake of food items rich in vitamin A. Increased vitamin A intake significantly improved the mean serum retinol concentrations of children in households in the experimental group compared to a control group (Faber *et al*., 2002).

Talukder *et al*. (2010) investigated the impact of the HKI household food gardening programme on nutritional status of children and women in four Asian countries, Cambodia, Bangladesh, Philippines and Nepal, using anaemia prevalence as an indicator of nutritional status. The authors report that anaemia prevalence among children decreased in programme households in all the four countries after the programme' implementation, although the decrease in anaemia prevalence among children was significant only in Bangladesh and the Phillipines. For women in the programme households, positive and significant changes in anaemia prevalence were observed in Nepal and Bangladesh.

Olney *et al*. (2009) assessed the impacts of a household food gardening programme on household nutrition in Cambodia, using a pre-test post-test design with intervention and control households. The study employed a number of indicators of nutritional status, namely body mass-index (BMI) for women, height-for age and weight-for-height for children, and haemoglobin concentrations. The authors report that more intervention households produced and consumed more vegetables, had higher dietary diversity, and that their children and mothers consumed micronutrient-rich food more frequently than in the control group. However, there was no evidence that increased food production and consumption of micronutrient rich foods from household gardens led to either improved anthropometric indicators or reduced anaemia prevalence for mothers and children. Greater household production of fruits and vegetables was associated with greater household dietary diversity, which was associated with dietary diversity among mothers and children, though household dietary diversity was not associated with nutrition outcomes. Similar results were reported by Roberfroid *et al*. (2011) whose study found that, a low-input household food gardening programme in Chipinge, Zimbabwe increased household food consumption and household dietary diversity in intervention households compared to control households, but with no differences in body mass-index (BMI) and mid-upper arm circumference (MUAC) being observed in PLWHA between the two groups.

A study by Makhotla and Hendriks (2004) investigated the nutritional impact of home gardens in pre-school children, five districts of Lesotho, namely, Maseru, Mohale's Hoek, Mokhotlong, Qacha's Nek and Quthing. As nutritional indicators, height-for age, weight-for age and weight-for height of children were employed. They report that the nutritional status of pre-schoolers in households with and without home gardens was poor, and no statistically significant difference was found between the nutritional status of pre-schoolers from households with or without home gardens for the whole sample.

A review by Berti *et al*. (2004) of the effectiveness of 30 agricultural interventions, which included household food gardening, livestock rearing, cash cropping and irrigation, in improving nutrition outcomes showed that household food gardening improved dietary intake and anthropometric indicators, and household food security more than other interventions. Nutrition improved in 11 of the 13 household food gardening interventions reviewed (Berti *et al*., 2004). Haider and Bhutta's (2008) review of 23 studies found that household food gardens were associated with positive impacts for consumption of fruits and vegetables in 14 cases, improvements in anthropometric measures in six cases, improvements in serum retinol levels (a biomarker of Vitamin A deficiency) in one case.

(c) Household food gardens and poverty alleviation

Household food gardens are widely promoted as a livelihood strategy that the urban poor can adopt to lift themselves out of poverty (Rogerson, 2003; Simiyu & Foeken, 2013; Tontisirin, *et al.*, 2002; Van Averbeke & Khosa, 2007). The promotion of household food gardens in part focuses on their potential to improve the socio-economic status of the poor, through sustainable empowerment. Through household food gardening households are empowered to take responsibility for the nutritional quality of their diets, which improve their nutrition and health, and in turn is an essential path out of poverty (Faber, 2002). As such, the importance of household food gardens especially for the poor, has been emphasised.

The poverty alleviating potential of household food gardens lie in that, as a livelihood strategy, household food gardens production demands low-labour input, can be done with fewer or no economic resources, and are located near the homestead (Maroyi, 2009; Marsh, 1998; Niñez, 1985). Proximity to the homestead holds the additional advantages of being easily tended in the context of other household work, being easily guarded from animals or thieves, and minimising transport costs and inconvenience for household members to tend to their gardens. The nature of household food gardens thus make them a livelihood strategy suitable and appropriate for adoption by poor HIV and AIDS affected urban households. Moreover, recent evidence from Lesotho and Bangladesh show that key-hole household food gardens, which are a raised garden type that consist of circular bed of soil about six feet in diameter and roughly three feet or waist high, held together with stones of wall are now widely used (Aphane *et al.*, 2011; Schreinemachers *et al.,* 2015). Because the keyhole garden is a raised structure, it minimises the amount of physical work required to nurture the garden, making it easy for people who are sick, have disabilities, or even PLWHA to care for and cultivate the garden.

The economic benefits of household gardens also contribute to their poverty alleviating potential. Through the sale of surplus garden produce and savings on household food expenditures, households generate more disposable income. Mitchell and Hanstad (2004) posit that where household food gardens activities flourish, gardens can be developed into a small cottage industry, increasing their income generating potential. Income generation improves the financial status of the household, further strengthening the livelihoods of households. Moreover, the household garden may become the principal source of household income during periods of stress, e.g., during prolonged unemployment, health or other disabilities suffered by household members (Marsh, 1998; Murphy, 2008), such as when impacted by HIV and AIDS.

A number of studies have evaluated the economic contribution of household gardens. A study from South Eastern Nigeria reported that household gardens accounted for more than 60% of household income (Okigbo, 1990). Marsh (1998) found that in Bangladesh earnings from sale of garden produce constituted 14.8% of total average household monthly income, which increased to 25% when savings on purchased fruits and vegetables were considered (Marsh, 1998). A study in Bieha, Burkina Faso, found that households earned 60% of their cash income through household food gardening activities (Guuroh *et al.*, 2012). Prain and Piniero (1999), found that household gardens increased household income by 50% among urban food gardeners in the Southern Philippines. In Lima, Peru, household gardens were reported to provide earnings of up to US$300 for an average urban household over a five-month period, representing an additional income of almost 10% (Niñez, 1985). Households in mountain areas of Vietnam generated more than 22% of their cash income through household gardening activities (Trinh *et al*., 2003). Brun *et al*. (1989), who evaluated a household food garden project in Dakar, Senegal, found that food gardening households earned an average income of US$29 per season. As our study collected data on income generation, the present research also explore the nature of this benefit of household food gardens.

In summary, the evidence from the benefits of household food gardens suggests that gardens may contribute positively to food security and nutrition, and to poverty alleviation. However, as noted earlier, the studies on household food gardens' potential contribution to food security and nutrition have been based on limited descriptive statistical methods. This study contributes to this literature by using more advanced econometric techniques to investigate how food gardening impacts nutrition and food security. Literature on the contribution of household food gardens to nutrition and food security furthermore have mainly focused on rural areas. This study focuses on poor urban communities, thus expanding the literature on this important topic.

2.7 Conclusion

This chapter reviewed the theoretical issues surrounding the topic under study. First, the review of the literature showed that food is an important input in the production of health among PLWHA and their households and that livelihood assets are crucial to the enhancement of livelihood outcomes. Second, the chapter discussed the food security concept and food systems, clearly showing that the urban poor's access to food hinges on food systems, particularly informal food systems. In addition, the literature showed that it is within this informal food system where household food gardens feature. Third, the empirical literature showed that HIV and AIDS impacts negatively on household food security through its negative impacts on livelihood assets on which households depend on to participate in various livelihood strategies, creating a vicious cycle of HIV and AIDS and food insecurity. To deal with the HIV and AIDS induced food insecurity, households turn to adverse coping strategies such as reducing meal portions, skipping meals and maternal buffering, many of which contradict with the food and nutrition needs of the household members, particularly those living with HIV and AIDS. Fourth, the literature underscores the importance of food security and nutrition in enhancing HIV and AIDS treatment outcomes, adherence to ART and treatment retention, pharmacokinetic efficacy of ART, and reconstitution of livelihoods through improved labour supply. Fifth, and most importantly, the literature suggests that household food gardens may contribute positively to household food security and nutrition, poverty alleviation, household income, all of which may assist in mitigating the impacts of HIV and AIDS.

Chapter 3: Methodology

3.1 Introduction

"Scientific enquiry" necessitates a distinct plan that will lead to the production of accurate answers to the research questions under study. This chapter presents and discusses as well as motivate the methodological framework of the study. The chapter begins with the discussion of the key features of the study, including the interventions, the study population and study design, along with the sampling and data collection strategies. This is followed by an overview of the study's conceptual framework which guides the statistical and econometric secondary data analysis reported in the subsequent chapters. The remainder of the chapter presents and discusses the econometric methods adopted in the study.

3.2 Interventions

As outlined in the introduction, this study focuses on an investigation of household food gardens. In each case study country, a non-governmental organisation (NGO) with a food garden programme participated in the study as a partner. Table 3.1 provides brief details on each of the organisations and their food garden programmes.

Table 3.3: Household food garden programme, by country

Lesotho
Ramapepe, Leribe
The Society of Women and AIDS in Africa Lesotho (SWAALES)
The Society of Women and AIDS in Africa Lesotho (SWAALES) was responsible for the implementation of the intervention. SWAALES was conceptualised in response to the 1989 call by the Society for Women and AIDS in Africa (SWAA) for African women to be engaged in HIV and AIDS prevention, care, and support work. The organisation was formally registered under the Society Act of 1996 as a non-governmental organisation (NGO) in 2003. SWAALES is a voluntary organisation and has the following objectives: • Contribute to prevention of HIV and AIDS spread through educating individuals, households, and communities • Provide care and support to vulnerable children and their guardians • Mitigating the impacts of HIV and AIDS by providing home based care support for the sick and their caregivers; facilitating improvement of economic capacities through income generating activities and ensuring food security. Within the framework of these objectives, SWAALES focuses on improving food security through supporting constructions of household food gardens (Key hole garden - a raised bed garden which appear to have a wedge removed from a circular garden), community gardening, providing of technical support through training of community volunteers, nutritional counselling through providing guidance on gardening, and food preparation and preservation. The household food garden intervention was implemented in Ramapepe Village through field-based project officers. Field-based project officers were offered technical support in areas such as methods to control pests and harvest rain water and material agricultural inputs such as seeds, garden tools and nets. The intervention thus included assisting treatment households with garden construction, material, and technical support.

Table 3.1: Household food garden programme, by country (continued)

South Africa
Bloemspruit, Mangaung
Re Kgaba Ka Diratswana Programme **Free State Department of Agriculture and Rural Development**
The Re Kgaba Ka Diratswana programme of the Free State Department of Agriculture and Rural Development was launched in July 2013 to empower communities to secure their own sustainable food sources The programme's main objectives are to: • Encourage the household food production and use of culturally appropriate, traditional and under-utilised food crops, including grains, root crops, fruits and vegetables. • Promote home (backyard) and, where appropriate, school gardens and urban agriculture, using sustainable technologies, and encourage the sustainable utilization of unused or under-utilised resources. • To enable food insecure households, families, and individuals to meet their food and nutritional requirements through production of vegetables. The intervention comprised a training and skills development programme for Re Kgaba Ka Diratswana coordinators and participants. The LIMA Rural Development Foundation (NGO), was responsible for implementing the training and skills development programme, trained and mentored twenty-one Re Kgaba Ka Diratswana (RKKD) coordinators. Training and skills development focused on the following topics: garden and bed design; planting, pest control, disease, and fruit trees; hydroponics; harvesting, preservation, and nutrition; seed harvesting and saving; winter crop preparation, and frost and cold. Coordinators in turn trained and provided support and assistance to the twenty-five beneficiary households in the intervention group to duplicate and implement what they have learnt. The training facilities and demonstration area and training hub are located at Lebone Village in Bloemspruit, Mangaung. The motive behind the focus on training and a train-the-trainer (or more correctly, train-the-facilitator) intervention was that of long-term sustainability and capacity development, with trainees passing on their knowledge to others involved in implementing the programme and to programme beneficiaries.

Table 3.1: Household food garden programme, by country (continued)

Zimbabwe
Mucheke and Rujeko, Masvingo Town
Batanai HIV & AIDS Service Organisation (BHASO)
Batanai HIV & AIDS Service Organisation (BHASO) was responsible for the implementation of the household food gardens intervention. Established in 1996 as a registered Private Voluntary Organization (PVO), BHASO is now a recognized non-governmental organization (NGO). BHASO's principal focus is on empowering individuals, households and communities particularly those living and affected by the HIV and AIDS epidemic. BHASO's goal therefore is to improve the lives of PLWHA, through food security livelihoods programmes and health and nutrition programmes. In recent years, BHASO has focused on improving the food security and nutrition of PLWHA through provision of therapeutic feeding and establishment of household gardens, community gardens, and small livestock farming. As part of enlarging its programming, BHASO plan to incorporate distribution and offering of ARVs and providing family planning services to clients who come for post-test counselling into the organisation's programming. The household food gardens intervention was implemented in Masvingo's two low-income suburbs Mucheke and Rujeko. The intervention involved the provision of inputs and hardware to the programme beneficiaries. In addition, beneficiary training and skills development in gardening was provided using support groups' leaders and agricultural extension officers from the ministry of agriculture. Support group leaders also provided skills around nutrition.

3.3 Study population

The target study population on the one hand comprise the programme beneficiaries of the three implementing partners at each of the country sites, i.e., food gardening households. The second group of study participants comprises non-beneficiary households.

3.4 Study design

Originally, the study was designed as a pre-test post-test case-control pilot study focused on a "technical proof-of-concept" (TPoC) (also described as a proof-of-principle or proof-of-mechanism) (Thabane *et al*, 2010). In such a design, data are collected on treatment and control groups and both groups are assessed on a pre-test measure. A treatment is then administered to a treatment group, and then both treatment and control groups are assessed on a post-test measure.

Table 3.2 shows the number of households in each group in each season by the original treatment-control assignment. In Lesotho and South Africa, 25 households were in the treatment group in each season. In Zimbabwe, only 24 households in the treatment group were in the study at follow-up. Control households were also lost to follow-up throughout the study in all three countries; in summer 5 households were not reached in Lesotho and 1 in South Africa. In winter, 3 households were lost to follow-up in Lesotho, 2 in South Africa and 1 in Zimbabwe. Overall, the treatment group had 75 households at baseline and 74 in both summer and winter, while the control group had 75 households at baseline and 69 in both summer and winter.

Four factors, however, impacted the clear-cut assignment of households as "cases" and "controls" and, as a result, the classification of measurements as purely "pre" and "post" the intervention. For starters, the prevalence of household food gardening was very high and even near universal in some communities, notably in Zimbabwe. This fact precluded the selection of non-gardening households at baseline for either the "control" or "treatment" groups. Secondly, there are self-starters, i.e., non-beneficiary households without food gardens taking up food gardening when the study is in progress. Study participants cannot be prohibited from doing so on ethical grounds. This happened to a great extent in Lesotho. Also, programme beneficiaries without food gardens recruited at baseline may not be reached by the programme when the time comes for implementation or may voluntarily opt out or involuntarily drop out of the gardening programme, thus not receiving any treatment during follow-up, which transpired in South Africa in a number of cases. In addition, households with gardens, whether in the programme beneficiary or non-beneficiary groups, may abandon or fail to maintain their food gardens over the course of the study. These four factors, as explained below played out differently in each of the case study countries.

Table 3.4: Household observations by country and treatment-control assignment

	Treatment	Control	Total
Lesotho			
Baseline	25	25	50
Summer	25	20	45
Winter	25	22	47
Total	***75***	***67***	***142***
South Africa			
Baseline	25	25	50
Summer	25	24	49
Winter	25	23	48
Total	***75***	***72***	***147***
Zimbabwe			
Baseline	25	25	50
Summer	24	25	49
Winter	24	24	48
Total	***73***	***74***	***147***
Total			
Baseline	75	75	150
Summer	74	69	143
Winter	74	69	143
Total	***223***	***213***	***436***

Table 3.3 shows the actual gardening status of the total sample of 436 observations throughout the study period. In Lesotho, 42 households had non-programme gardens at baseline (this number included both households that might have had gardens in the past 12 months but did not have gardens when the baseline interview was conducted and households that had gardens at baseline), while 8 households did not have a garden. In summer, 18 households did not have gardens, 2 households had non-programme gardens and 25 households had programme gardens. In winter, 15 households did not have gardens, 8 households had non-programme

gardens, indicating a marginal increase in households starting own gardens and 24 households had programme gardens. In South Africa, all households did not have gardens at baseline, either programme gardens or their own gardens. In summer, 18 households remained in the no-garden group with 6 households starting their own gardens and 25 households having programme gardens. In Zimbabwe, all households had gardens at baseline, and only 2 households did not have gardens respectively in summer and winter, be it programme or non-programme gardens.

Table 3.5: Household observations by gardening status

	No garden	Non-programme garden	Programme garden	Garden	Total
Lesotho					
Baseline	8	42	-	42	50
Summer	18	2	25	27	45
Winter	15	8	24	32	47
Total	***41***	***52***	***49***	***101***	***142***
South Africa					
Baseline	50	-	-	-	50
Summer	18	6	25	31	49
Winter	19	6	23	29	48
Total	***87***	***12***	***48***	***60***	***147***
Zimbabwe					
Baseline	-	50	-	50	50
Summer	1	25	23	48	49
Winter	1	24	23	47	48
Total	***2***	***99***	***46***	***145***	***147***
Total					
Baseline	58	92	-	92	150
Summer	37	33	73	106	143
Winter	35	38	70	108	143
Total	***130***	***163***	***143***	***306***	***436***

Households, moreover, for reasons explained above, over time transition between these three states, i.e. no garden, non-programme garden, and programme garden. Theoretically and hypothetically, under the original pre-test post-test treatment-control design, the transition matrix would look like the one presented in Table 3.4. More specifically, all those households without gardens at baseline, would be observed as having programme gardens at follow-up, in this case summer season. Hence, there is a 100% transition from no garden to programme garden. In addition, those households observed as having programme gardens in summer would again be observed with programme gardens in winter. In other words, the full sample of households remain in the programme garden group. However, for reasons outlined above, this was not the case.

Table 3.6: Hypothesised transitions in food gardening status

		Garden status (follow-up)			
		No garden	Non-programme garden	Programme garden	**Total**
Garden status	No garden	**0.0**	0.0	100.0	**100.0**
	Non-programme garden	0.0	**0.0**	0.0	**100.0**
	Programme garden	0.0	0.0	**100.0**	**100.0**

Tables 3.5; 3.6; 3.7; and 3.8 show the transition matrices for each country and for the aggregated data, respectively. In each matrix, the diagonal elements show the percentage of households that remained in each state between consecutive survey rounds, i.e., between baseline and summer season and between summer and winter season. The transition matrix in Table 3.5 shows that in Lesotho, households experienced large changes in their gardening status. Of the households that started out without gardens, only 56.5% remained in the same status one season later, while 26.0% acquired non-programme gardens and 17.3% acquired programme gardens. Of those households with non-programme gardens at baseline or summer season, just more than half acquired programme gardens, while four in ten had no garden at follow-up. Only 7.5% of these households remained in the non-programme garden group. At the other end of the matrix, however, almost all the programme garden households remained in the group once having acquired programme gardens, while only 4% transitioned to the no-garden group. Therefore, few households dropped out of the intervention group.

Table 3.7: Transitions in food gardening status - Lesotho

		Garden status (follow-up)			
Percentage (n)		No garden	Non-programme garden	Programme garden	**Total**
Garden status	No garden	**56.5 (13)**	26.0 (6)	17.3 (4)	**100.0 (23)**
	Non-programme garden	40.0 (16)	**7.5 (3)**	52.5 (21)	**100.0 (40)**
	Programme garden	4.0 (1)	0.0 (0)	**96.0 (24)**	**100.0 (25)**

Note: Sample sizes are reported in parentheses.

Compared to Lesotho, transitions in gardening status is less pronounced in South Africa, with larger percentages on the diagonal. A visual inspection of the matrix in Table 3.6 shows that of the (33) households who did not have gardens at baseline, half or 50% still did not have gardens in winter, while 12.1% transitioned to the non-programme garden group and a relatively large proportion, i.e., 37.8%, became programme gardens participants. Two thirds of the households with non-programme gardens still had no-programme gardens when they were re-interviewed at summer or winter. A third however, was not cultivating a garden despite having a garden earlier. A high percentage of households with programme gardens were observed a second time while participating in the NGO's good garden programme. The uptake, therefore, of programme gardens is relatively low, but for those starting programme gardens, the retention rate is substantial.

Table 3.8: Transitions in food gardening status - South Africa

		Garden status (follow-up)			
Percentage (n)		No garden	Non-programme garden	Programme garden	**Total**
Garden status	No garden	**50.0 (33)**	12.1(8)	37.8 (25)	**100.0 (66)**
	Non-programme garden	33.3 (2)	**66.0 (4)**	0.0 (0)	**100.0 (6)**
	Programme garden	8.0 (2)	0.0 (0)	**92.0 (23)**	**100.0 (25)**

Note: Sample sizes are reported in parentheses.

In Zimbabwe, the transition matrix in Table 3.7 shows that, not a single household was observed without a garden in the first period of observation, i.e., at baseline or summer season. Of the households that fall into the non-programme gardening group at baseline, 67.1% retained the same status at summer or winter, while 31.5% transitioned into the programme garden group and only 1.3% moved to the no garden group. Of the households observed in the programme garden group at the first point in time, the majority (95.6%) subsequently was observed in the programme garden group for a second time. The matrix shows that in general households did not transition much between alternative gardening statuses and that very few households initially did not garden or continue to garden at follow-up.

Table 3.9: Transitions in food gardening status - Zimbabwe

		Garden status (follow-up)			
Percentage (n)		No garden	Non-programme garden	Programme garden	**Total**
Garden status	No garden	**0.0 (0)**	0.0 (0)	100 (1)	**100.0 (1)**
	Non-programme garden	1.3 (1)	**67.1 (49)**	31.5 (23)	**100.0 (73)**
	Programme garden	4.3 (1)	0.0 (0)	**95.6 (22)**	**100.0 (23)**

Note: Sample sizes are reported in parentheses.

The transition matrix in Table 3.8 shows that on aggregate, of the households that started out without gardens, 51.1% remained in the same status at follow-up, be it at summer or winter season, while 15.3% joined the non-programme garden group and a third (33.3%) moved into the programme garden group. Over two thirds of the households with non-programme gardens still had non-programme gardens when they were re-interviewed at summer or winter, showing that gardening is not a relatively short-term endeavour. Less than two percent of households was not cultivating a garden despite having a garden earlier, thus signifying a very low drop-out rate, while almost one third transitioned into the programme garden-group. A total of 95.6% of the households observed in the programme gardens group remained in the same state, with only 4.3% transitioning into the non-garden state. There is considerable variation therefore in gardening status between survey rounds, in particular for households observed without a garden and with a non-programme garden.

Table 3.10: Transitions in gardening status - aggregate sample

		Garden status (follow-up)			
Percentage (n)		No garden	Non-programme garden	Programme garden	**Total**
Garden status	No garden	**51.1(46)**	15.3 (14)	33.3 (30)	**100.0 (90)**
	Non-programme garden	15.9 (19)	**47.0 (56)**	36.9 (44)	**100.0 (119)**
	Programme garden	5.4 (4)	0.0 (0)	**94.5 (69)**	**100.0 (73)**

Note: Sample sizes are reported in parentheses.

Using this information, three types of comparisons are conducted to elucidate the various dimensions and impacts of household food gardens. First, use is made of the original baseline "control" and "treatment" assignments (see Table 3.2, page 47). Essentially, this amounts to a form of "intent-to-treat" analysis, in acknowledgement of the fact that programmes face implementation realities not dissimilar to the ones described above. Given that each intervention is complex and unique, it is not possible really to draw strong comparisons between countries. Rather the focus in these treatment-control comparisons is on the differences and trends within each country.

Given the resultant methodological complications and their substantive implications, use is made of two additional types of policy-related comparisons, each describing "treatment" and "control" conditions in a different manner. On the one hand, households are simply classified as having a functional food garden or not: the research question, therefore, is whether food gardens as such make a difference to nutrition and food security. On the other hand, the sub-sample of households with food gardens can be further disaggregated into two groups, namely "programme" and "non-programme" gardens (see Table 3.3, page 48). In this case, the focus of the research question is on establishing whether the food gardens of programme beneficiaries in some ways are superior or inferior or not different from food gardens in general.

In the case of these two sets of comparisons, the data is pooled across countries to maximise the statistical power of the econometric analysis, where techniques are used that require relatively large samples. As shown in Table 3.3, moreover, numbers in some sub-groups are extremely small for some countries. Specifically, there are relatively few households without food gardens in Zimbabwe, while in South Africa there are relatively few households with non-programme food gardens. This precluded country-level analysis in terms of the latter comparisons.

Theoretically, therefore, due to various practical, environmental, and contextual factors, the study's original design could not be implemented in the field. Therefore, for most of its part, the study rather follows a quasi-experimental design, in which the researcher only has full control over when and what measurement takes place, but not full control over who receives treatment and when exactly treatment is provided to study participants. Here, for example, selection into treatment more generally is based either on self-selection (by which participants choose treatment for themselves, e.g., by starting a household food garden or enrolling in an NGO's food gardening programme) or administrator selection, the latter which is also the case in this study (e.g., treatment status being determined by officials representing implementing agents) or both routes (Stufflebeam & Coryn, 2014). As such, the study design can best be described as longitudinal, observational, and quasi-experimental in nature.

3.5 Sampling strategy

For programme beneficiaries, purposive sampling, a non-random probability sampling method, was used to select 25 intervention (treatment) households from each study site. Given the nature of the study, purposive sampling was deemed appropriate as it allows the researcher to select only those cases that illuminate and test the hypothesis of the study (Tashakkori & Teddlie, 2003). Thus, according to Tashakkori and Teddlie, (2003), the logic and power of purposive sampling lie in selecting information-rich cases for study in depth, with an underlying focus on intentionally selecting specific cases that will provide the most information for the research question under study. According to the study protocol, intervention households were to be selected from amongst programme beneficiaries who did not have a backyard garden at the point of enrolment into the study, even if they might have had a garden in the 12 months preceding the intervention. However, due to the high prevalence of gardens in some communities, particularly in Zimbabwe (see Section, 3.4 page 46) programme beneficiaries with already existing food gardens were recruited into the study.

Regarding the selection on the other hand of control households (i.e. households who did not have food gardens at the beginning of the study and were not programme beneficiaries), the implementer in each study case site (in each country) conducted a census of the entire community in the relevant geographical location to identify the non-gardening group of households from which to select 25 control households from each site. The census process was done in such a way that clear distinctions were drawn between (i) households who had no garden (there is no physical evidence of a garden), (ii) no functional garden (there is a physical garden, but the garden is not maintained and has not produced any crops in the past season), (iii) a functional garden but a garden of a type different from the gardens to be provided to the intervention group, and (iv) has a functional garden which is a garden of a type similar to the gardens that was provided to the intervention group. From each study site, 25 control households were to be selected randomly from the census categories of households with (i) no garden or (ii) no functional garden. This was the case for Lesotho and South Africa but not Zimbabwe, since the prevalence of gardens was high in the community (see Section 3.4, page 46).

The total target sample size in the survey in each study site was 50, "25 in the intervention group and 25 in the control group". With two follow-up measurements, the total target sample size in each community amounts to 150 and the total sample size to 450. The sample size, determined in large part based on budgetary constraints, was deemed sufficient for the purpose of such a small-scale technical proof of concept study.

3.6 Data collection strategy

The study adopted a concurrent mixed methods approach where quantitative and qualitative data were collected to answer the study objectives. The two data collection methods used in the study are discussed below. A household survey was used to collect quantitative data from both control and treatment households in each study site, while qualitative data was collected through focus group discussions.

3.6.1 Household survey

Following the longitudinal nature of the study, the household survey was conducted at three time periods; before the outset of the programme (baseline, June 2014), at follow up at the end of summer season (follow-up 1, May 2015), and at the conclusion of the winter harvest season (follow-up 2, August 2015), approximately fifteen months after the baseline. A structured questionnaire was administered to all households in the sample (see Annexure A.1). The main aim of the household survey was to collect quantitative data, although open ended questions in the questionnaire provided supplementary qualitative data. The questionnaire was designed to elicit information on a wide variety of topics, including: basic socio-demographic and socio-economic characteristics of the households; household livelihood strategies; household sources of food supply; constraints and challenges of maintaining and starting a garden; the use of household garden produce; contribution of household gardens to household livelihoods and household food security; health benefits of gardens and the contribution to household income of gardens. The survey questionnaire was pretested during field training of research enumerators on a sample of ten households to identify problems which might occur for both respondent and enumerator regarding question content, following which questions were amended and existing gaps were filled where necessary. Pre-testing is essential in order to revise a questionnaire to maximise reliability and validity (Golafshani, 2003). In this study, no major amendments were made to the questionnaires and the questionnaires remained sufficiently standardised across countries.

Enumerators were trained to administer the questionnaire using face-to-face interviews. Face-to-face interviews were appropriate in that interviewers could ask all questions and use extensive probes. Face-to-face interviews are also appropriate where respondents are illiterate or less educated as in the case of this study, given the focus on households living in poorer urban and peri-urban locations. Methodologically, face-to-face interviews allow for good cooperation from participants such that illiterate participants can be reached (Tashakkori & Teddlie, 2003). All data collected through the household survey was captured using CSPro 5.0 software.

3.6.2 Focus group discussions

A focus group discussion (FGD) is an organised discussion with a selected group of individuals who have certain factors in common to gain information about their views, perspectives and experiences of a topic under study (Creswell, 2012). According to Morgan (1997), the aim of a focus group discussion is to allow a group to interact, to compare thoughts and experiences based on topics that the researcher wishes to explore. During a focus group discussion, individuals present their own opinions, perspectives and beliefs, which are further sharpened and refined through group interactions and discussions (Finch & Lewis, 2003; Krueger & Casey, 2000). The main advantage of a focus group discussion is that free discussions enable a generation of ideas because participants stimulate each other's thinking and are less threatening to participants as the sense of belonging to a group increase the participants' sense of cohesiveness (Krueger & Casey, 2000), thus yielding important information (Morgan, 1997). Additionally, the interactions that occur among participants can create the possibility for more spontaneous responses and provide a setting where the participants can freely discuss problems and provide possible solutions (Morgan, 1997).

In this study, the main aim of conducting focus group discussions was to gather information that would assist in answering the various objectives of the study and also provide qualitative data to enrich the analysis and interpretation of the quantitative data collected in the household survey. Following the longitudinal approach of the study, three focus groups discussions were conducted at baseline, end of summer season, and end of winter season with 4-6 randomly selected programme garden households with the use of a focus group discussion guide (see Annexure A.2) comprising of open-ended questions. The focus group discussions covered topics on the economic benefits of gardens, the health benefits of gardens, the impact of gardens on the lives of women, the impacts of gardens on the lives of people living with and affected with HIV and AIDS, and, lastly, constraints and difficulties of maintaining gardens. In addition, focus group discussions gathered information on the general perceived benefits and impacts of the household food gardening programme on study participant's lives.

3.6.3 Mixed methods

The main advantage of such a mixed method data collection model is that it is intuitive and efficient and gives a more complete understanding of the research questions than if either a qualitative or quantitative method by itself is adopted (Tashakkori & Teddlie, 2003). Using the mixed method data collection model, research questions are simultaneously addressed, and one type of inference is made based on both data sources (Tashakkori & Teddlie, 2003). In addition, a mixed method data collection model provides complementarities enabling overcoming the shortcomings of mono-methods and is more capable of revealing the diverse dimensions of behaviour (Burke-Johnson & Onweugbuzie, 2004; Castro *et al.*, 1996; Scrimshaw, 1990). Mixed method data collection models also enhance the richness of information while neutralising the weaknesses of each method, thereby enhancing credibility, reliability and validity of study results (Tashakkori & Teddlie, 2003). Moreover, various authors recommend the use of a combination of qualitative and quantitative methods to aid interpretation of findings and identifying programme impacts that have high plausibility (Winters *et al*., 2010; Pritchard *et al*., 2017). Thus, there is wide consensus that mixing different types of data collection methods can strengthen a study (Greene & Caracelli, 1997).

The data collection strategy in this study, on these grounds and in recognition of the fact that the household food gardening programme comprised a complex event implemented in a complex, adaptive system, comprised a mixed methods model, with mainly quantitative and supplementary qualitative data collection strategy. As the two forms of data speak to different objectives, with quantitative data's objective being to produce generalisations about causal relationships between aspects of the study using numerical data and statistical analysis (Chapman & Maclean, 1990), while qualitative data is directed towards gaining an understanding of the meaning of people's everyday lives from their own perspectives and views using text data and thematic analysis (Creswell, 2012), their fusion was deemed appropriate. Creswell (2012) defines a mixed methods model as a procedure involving the collection or analyses of both qualitative and quantitative research methods in a single study to understand the research problem. In this kind of model data are collected concurrently or sequentially, are given priority and are integrated at one or more stages in the process of the research. Therefore, this study adopted a convergent parallel mixed methods model in which quantitative and qualitative data are collected concurrently, while quantitative data carries more weight than qualitative data. The data was collected between June 2014 and August 2015.

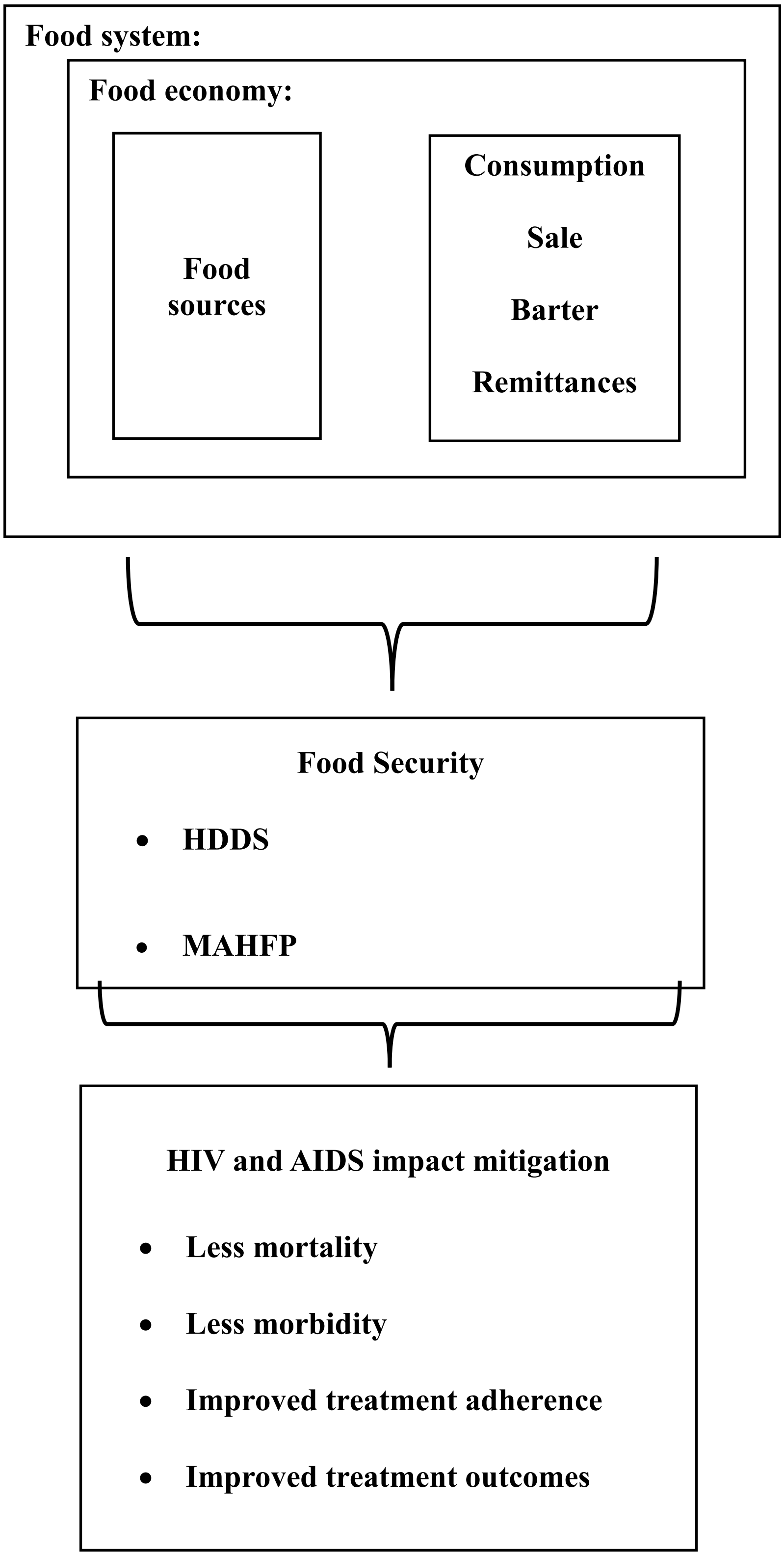
3.7 Ethics

The study was executed in accordance with the 2002 guidelines of the Declaration of Helsinki and approved by the relevant ethics committees in each of the three countries. In each case study, participants were fully informed of the nature and purpose of the research, the possible risks and benefits to their participation in the research and were given a verbal guarantee that any information offered will be kept anonymous and confidential and that participation in the study was voluntary. Written informed consent were obtained from all study participants and informants, including household respondents, providers, and programme implementers, using a written informed consent form (see Annexure A.1 Household Survey Questionnaire, page 275). In terms of post-trial access to treatment, the household food garden intervention(s) implemented as part of the study remained the property of study participants. Households in the control group were not restricted from starting their own food garden and/or enrolled in the household food garden programme conducted as part of the study or similar programmes implemented by another party following the baseline survey: ethically, households were not discouraged to do so nor explicitly constrained by the research team from such action(s). As such, no study participants were eliminated from the study post-baseline. Treatment households continued to benefit from the intervention after completion of the study, at least insofar as the household continued to maintain their household food gardens.

3.8 Conceptual framework

The literature discussed in Chapter 2 lays the basis for a conceptual framework for understanding the different pathways through which household food gardens are thought to affect HIV and AIDS related morbidity or ill health and mortality, treatment outcomes and treatment adherence of PLWHA in the process of mitigating the impacts of HIV and AIDS in affected households. As such, based on the literature, a conceptual framework was developed and is depicted in Figure 3.1 below, showing how each of the three main study objectives feature in the schematic presentation of the main study constructs. The figure shows the pathways through which household food gardening could mitigate the impacts of HIV and AIDS on affected households. Within this framework, it is expected that the adoption of household food gardens affects food security through enhanced access to food and consequently an availability of more diverse food for the household. The resultant own consumption of garden produce, and selling, bartering and, remitting of garden produce, also contributes to household food security and nutrition in a direct and indirect manner (Akrofi *et al.,* 2010; Marsh, 1998; Roberfroid *et al*., 2011). Together, improved household food security and nutrition is expected to lead to enhanced caloric, protein and micronutrient intake which in turn is expected to lead to less morbidity, less mortality, better treatment adherence, and better treatment outcomes among household members living with HIV and AIDS.

Figure 3.4: Conceptual framework



The study thus envisages that the adoption of household food gardens can mitigate the impact of HIV and AIDS on households through improving household food security and nutrition. This framework thus, serves as a guide in assessing and analysing the impacts of household food gardens in the subsequent chapters and helps in identifying the pathways through which this impact can be enhanced. However, given the study design and nature of the available data this study does not explicate the bottom part of the conceptual framework in terms of investigating the actual impact of improved food security on these outcomes, but rather infers that such improvements in food security is likely to translate in these benefits.

3.9 Analytical strategy

The study makes use of comprehensive descriptive analysis as well as advanced econometric techniques, which are described below.

3.9.1 Descriptive comparative analysis

Descriptive analysis was performed using the following quantitative tools: Chi2 or exact tests were employed to assess the statistical significance of comparisons across categorical variables; analysis of variance (ANOVA) and t-tests were used to compare differences in the means of continuous variables across dichotomous and multiple categorical variables. The descriptive analysis used a number of variables based on the various questions asked in the household survey questionnaire. Following, is a brief outline of the main variables employed in the descriptive analysis.

The impact of HIV and AIDS on households is based on questions relating to HIV and AIDS. Respondents were asked if they knew someone who had died from HIV and AIDS, who was HIV and AIDS infected, and who were taking ARV drugs and for all the three questions, whether the person was a member of their households. To assess how households from the survey are impacted by HIV and AIDS, the questions on whether the household respondent knew someone infected by HIV and AIDS and whether the respondent knew someone taking ARVs were used. The question relating to whether the household respondent knew someone who had died from HIV and AIDS was not used. Although this underestimates the extent of the impact of HIV and AIDS on surveyed households and their communities, the question was omitted since it was feared that responses might reflect deaths not from the reference period but relate to the past impact in general. Based on the responses to the two questions, two "affected" status variables were constructed. The first "affected" status dummy variable captures whether the household respondent knew someone infected by HIV and AIDS or knew someone who was taking ARV drugs. This "affected" status variable proxy the 'indirect' impact of HIV and AIDS. The second "affected" status variable captures whether that person, i.e., the household respondent, knew a household member infected by HIV and AIDS or knew a household member who was taking ARV drugs. This "affected" status variable proxy the "direct" impact of HIV and AIDS on households (see Annexure A.1 for questionnaire, Section I). To analyse the illness of household members, the following question was asked, "Thinking back over the past 12 months, has any usual member of your household who lived in the household for at least 9 months been ill in the past 12 months?" Households could answer "yes" or "no" (see Annexure A.1 for questionnaire, Section H).

Analysis of food sources was based on a question which asked households where they normally obtain their food and the frequency with which they obtained food from each of the food sources. Among the responses was growing (food) in the garden and the response was coded as one for yes and zero otherwise. The frequency with which food was obtained from the specific source, including food gardens, was measured as: at least five days a week, at least once a week, at least once a month, and at least once a year (see Annexure A.1 for questionnaire, Section C).

The consumption of vegetables was analysed based on the question "How frequently do adults or children in the household eat vegetables" and this question was asked separately for adults and children. The frequency with which children and adults consumed vegetables was measured as several times a day, once a day, a few times a week, once a week, rarely, and almost never (see Annexure A.1 for questionnaire, Section C).

The food economy analysis, which focuses on the use of household food garden produce, asked the same set of questions for selling, bartering and remittances, which together are considered aspects of the "trade" of food garden produce. Households were asked whether they received remittances from gardens and whether they remitted, sold or bartered food from their household garden. Households answering yes to any of the three trade aspects (remit, sale, and barter), were further asked about whom they traded with (parent, spouse, siblings, close relatives, needy people) and where the people with whom they traded with resided (urban or rural), how often they traded (almost every week, almost every month, a few times a year, when there is a special need, and rarely), the value of their trade, and how important this trading was to their household food security and livelihood (see Annexure A.1 for questionnaire, Section F).

Changes in food security was analysed using two food security indicators, the household dietary diversity score (HDDS) and the months of adequate household food provisioning (MAHFP) (see Annexure A.1 for questionnaire, Section C). Given the multi-dimensional nature of food security, identifying an appropriate household food security indicator is a difficult task (Hendriks, 2008). As such, over the years, practitioners and policy makers have long recognised the need for a variety of household food security measurements (Kennedy, 2007) and the literature has proposed a plethora of indicators, each focusing on one of the many facets of food security. Comprehensive reviews of the pros and cons of most common indicators have been provided by Carletto *et al*. (2013); De Haen *et al*. (2011) and Headey and Ecker (2013). However, as pointed out by Habicht and Pelletier (1990), the quality of a food security indicator cannot be determined in absolute terms but needs to be assessed on a case-by-case basis in relation to the consistency between its informational content and the purpose for which the indicator is adopted, because different household food security indicators tend to capture different elements of food security. For example, the household dietary diversity score (HDDS) captures food access, and diversity and quality of a household diet. Furthermore, given a set of theoretically suitable indicators, the final choice of the researcher is often constrained by the availability of data. The present study is no exception and choose only those household food security indicators that can be computed using the available data. Thus, the study adopts two recently developed household food security indicators to measure food security at household level: the household dietary diversity score (HDDS) and the months of adequate household food provisioning (MAHFP). The selection of the two household food security indicators was also informed by the food security literature (Mango *et al*., 2014; Rawat *et al*., 2014; Roberfroid *et al*., 2011). Furthermore, the use of the HDDS and MAHFP simplifies the complex and expensive processes associated with quantitative food security measurement (Kabunga *et al*., 2015). As they are the primary outcomes in the econometric analysis (see discussion below), these two household food security indicators are now discussed in some detail:

(a) Household Dietary Diversity Score (HDDS)

The household dietary diversity score (HDDS) is defined as the number of different food groups consumed by a household over a given reference period (Swindale & Bilinsky, 2006). According to Swindale and Bilinsky (2006), the number of food groups consumed better reflects a quality of diet, rather than the number of different individual foods consumed since households may consume several different individual foods from the same food group. HDDS measures households' access to food. HDDS is recognised by nutritionists as a key element of high quality diets, which is associated with a number of improved outcomes, such as birth weight, child anthropometric status and reduced risk of mortality from cardiovascular disease and cancer (Hoddinott & Yohannes, 2002; Ruel, 2002). This is so as a diverse diet increases exposure to more foods, with potentially more micronutrients (Ruel, 2002). The index is composed of 12 food groups and is measured by summing the number of food groups consumed over a specific reference period (usually 24 hours). Each food group has an equal weight (Swindale & Bilinsky, 2006). For this study, a 24-hour reference period is used. Thus, the score is calculated by counting the number of food groups consumed by the household and each food group is given a weight of one (Swindale and Bilinsky, 2006). The closer the score is to twelve, the greater the household's food security.

The main advantage of the HDDS is that it is a rapid, user-friendly and cost-effective measure of household food security and is well suited for tracking trends in food security (Swindale & Bilinsky, 2006). This is so as the HDDS consists of questions which are relatively straightforward to answer, are not considered intrusive, and do not impose burdensome demands on time, typically taking less than 10 minutes per respondent to administer (Swindale & Bilinsky, 2006), thus making the score relatively cheap to construct (Headey & Ecker, 2013). In addition, a 24-hour reference period is subject to less error, less cumbersome for the respondent, and also conforms to the recall time period used in many other dietary diversity studies (FAO, 2007). Another attraction of the HDDS is that it has been validated as a measure of household food security in different developing countries (Coates *et al.*, 2006; Frongillo & Nanama, 2004; Hoddinott & Yohannes, 2002; Webb *et al.,* 2006), showing strong correlations with indicators of food consumption. Moreover, the HDDS is highly correlated with factors such as the adequacy of a household's intake of calories, protein, and nutrients (Goshu *et al.,* 2013; Headey & Ecker, 2013).

Against the above mentioned strengths, the HDDS has however also been critiqued, for example by Uraguchi (2012), who criticises the HDDS for two main reasons: first, there is no universally accepted standard for the main and appropriate groups of food types used for the computation of the score, an aspect that has the advantage of allowing for comparability between studies; and secondly, although the HDDS show the changes in the dietary energy consumption of households, it has not been easy to empirically demonstrate the significance of the HDDS in nutrient adequacy. In addition, the HDDS does not allow an estimate of how much food is lacking because it cannot be used directly to quantify the amount of food consumed by the household, since portion sizes are not measured (Mango *et al.,* 2014). Despite the criticism, however, the HDDS remains useful as a proxy of nutrient adequacy of the household‘s diet as well as an important indicator of household food security (Ekesa *et al*., 2008; Hoddinot & Yohannes, 2002; Ogle *et al*., 2001).

(b) Months of Adequate Household Food Provisioning (MAHFP)

Household food access depends on the resources available to the household as well as the management of these resources. The months of adequate household food provisioning (MAHFP) is defined as the number of months in which the household had adequate food to meet its food needs (Bilinsky & Swindale, 2010). Analogous to the HDDS, the MAHFP is an indicator of household food access which aims to establish whether the food security status of a household vary throughout the year. Household respondents are asked to answer a yes or no response question for whether there were months in which they did not have adequate food and identify the specific months, using a recall period of one year (Bilinsky & Swindale, 2010). The focus of these questions is the months in which there was limited access to food regardless of the source of the food (i.e., purchase, barter, or production). The MAHFP score is then calculated by subtracting the number of months the household did not have adequate food from 12, e.g., if a household experienced inadequate food provisioning for 4 months, the score would be 8. Thus, the higher the score, the greater the levels of food security (Bilinsky & Swindale, 2010).

Using the MAHFP as a food security indicator has the advantage of capturing the changes in household’s ability to access food all year round (Bilinsky & Swindale, 2010). Similar to the HDDS, the MAHFP is also a cost-effective measure of household food security as the battery of questions used are simple and non-intrusive and can be administered over a short period of time (Bilinsky & Swindale, 2010). In addition, the MAHFP has the advantage of capturing the combined effects of a range of interventions and strategies, such as improved agricultural production, storage and interventions that increase the household's purchasing power (Bilinsky & Swindale, 2010). This advantage however also makes it difficult to attribute changes in MAHFP to specific interventions, as required in programme evaluations, a question of specific relevance in this study.

Descriptive analysis such as these however cannot reveal the causal impacts of food garden programmes. As such, the challenge in this study is to estimate the casual effect of household food gardens on household food security. What we cannot observe is the outcome variable for treatment households, in the case that they were not given the treatment. That is, we do not observe the outcome variables of treatment households, had they not received the treatment, i.e., the counter-factual. In experimental studies, this problem is addressed by randomly assigning households to treatment and control status, which assure that the outcomes observed in the control households without the treatment are statistically representative of what would have occurred without the treatment. Thus, randomising observational units into treatment and control groups, provide a clean estimate of programme impacts because both observable and unobservable characteristics are then uncorrelated with treatment assignment, thus negating selection bias. In non-experimental studies a simple comparison of the food security outcomes in treatment and control households may lead to the mistaken conclusion that household food gardens have improved food security outcomes, because there may also be differences, e.g., in abilities and enthusiasm of participants. As in our case, for reasons explained above, treatment is not randomly assigned to the two groups of households (treatment and control). Therefore, treatment and control households may differ in systematic ways, and this difference may manifest itself in differences in household food security outcomes that could be mistakenly attributed to the programme (Diaz & Handa, 2006). Thus, without controlling for these differences, conclusions obtained from the analysis may be biased. Most studies have utilised non-econometric models to assess the impact of household food gardens on household food security (Akrofi *et al*., 2010; Olney *et al*., 2009; Bushamuka *et al*., 2005). This study employs two different econometric approaches - propensity score matching (PSM) and linear Fixed Effects (FE) panel data regression models in the analysis of the impact of household food gardens programmes on household food security. These methods help address problems of selection bias. Moreover, when longitudinal data or panel data on the participants and non-participants in a programme before and after the programme implementation are available, we can get unbiased estimators of programme impacts which allow for "selection on unobservables". Applying both methods in evaluating the impact of household food gardens enhances the attribution of household food security gains to household food gardens. Consequently, these two econometric methods are now discussed in concluding this chapter. For the two econometric methods discussed below, the study excludes country-level data analysis because the country sample sizes are too small. There are insufficient numbers, and this makes it difficult if not impossible to draw country-specific recommendations from the study.

3.9.2 Propensity score matching (PSM)

(a) Propensity score matching theory

One of the methods used for this study is Propensity Score Matching (PSM), which Rosenbaum and Rubin (1983) defined as the probability of treatment assignment conditional on observed baseline covariates. The basic idea of PSM is to find in a large group of non-participants those individuals who are similar to the participants in all relevant pre-treatment characteristics *X* (Caliendo & Kopeinig, 2008). Each participant is matched with an observationally similar non-participant on the basis of a single propensity score (balancing score), which is defined as a unit's probability of receiving the treatment conditional on observed baseline covariates (*X*), i.e. $P(X_h) = P(D_h = 1 | X)$ (Rosenbaum & Rubin, 1983). By so doing, PSM develops a statistical counterfactual or control group that is as similar to the treatment group as possible in terms of observed characteristics (*X*). The average difference in outcomes across the treatment and control group is then compared to obtain the average treatment effect on the treated (ATT). The main goal of a matching procedure is to reduce the selection bias among covariates, thus balancing matching datasets (Guo & Fraser, 2010; Rosenbaum & Rubin, 1983; Stuart & Rubin, 2007).

Estimation of ATT using PSM relies on two key assumptions (Rosenbaum & Robin, 1983). The first assumption, which is variously known as "selection on observables" (Heckman & Robb, 1985), the "unconfoundedness assumption" (Imbens, 2004), or the "conditional independence assumption" (Black & Smith, 2004), is critical to the validity of PSM. The conditional independence assumption (CIA), states that given a set of observable covariates *X* that are not affected by treatment, potential outcomes *Y* in the untreated states are independent of treatment assignment (Rosenbaum & Rubin, 1983). This assumption implies that selection into the treatment group is solely based on observable characteristics *X* (Rosenbaum & Rubin, 1983), such that potential outcomes in the untreated states are independent of treatment assignment status (selection on observables) (Caliendo & Kopeinig, 2008). If unobservable characteristics influence selection into the programme and outcomes, this will imply the presence of hidden bias, with the result that between-group differences may reflect those characteristics rather than the treatment (Bryson *et al*., 2002). The CIA or "strong unconfoundedness" or "selection on observables" can be given as:

$$Y_i^T Y_i^C \coprod D \mid X \quad (3.1)$$

, where $\coprod$ denotes independence, i.e. given a set of observable covariates *X* which are not affected by treatment, potential outcomes are independent of treatment assignment, Y_i^T represent outcomes for treatment units and Y_i^C outcomes for non-treated units, and D is a binary indicator variable indicating participation in the intervention or programme. The CIA assumption is a strong assumption and is not a directly testable criterion and is justified by the data quality available to the researcher (Caliendo & Kopeinig, 2008). If unobserved characteristics determine programme participation and the outcomes, CIA will be violated and in such a case PSM is not an appropriate method.

Second, the other requirement for conducting the matching method is the satisfaction of the common support or overlap condition (Rosenbaum & Rubin, 1983). The common support or overlap condition rules out the phenomenon of perfect predictability of *D* given *X*. The common support is the area where the balancing score (propensity score) has positive density for both treatment and comparison units. Heckman *et al.* (1997b) point out that it is only in the overlapping subset of the comparison and treatment groups that comparable observations can be matched. No matches can be made to estimate the average treatment effects on the treated (ATT) parameter when there is no overlap between the treatment and non-treatment groups. The overlap condition is defined as follows:

$$0 < P(D = 1 \mid X) < 1 \quad (3.2)$$

By the common support assumption, the propensity score is bounded between 0 and 1, excluding the tails of the distribution of $p(X)$, i.e., there must be no level of the balancing score at which the treatment is received with certainty, or not received with certainty. The common support condition ensures that units with the same X values have a positive probability of being both participants and non-participants (Heckman *et al.*, 1998b). The common support assumption also prevents X from being a perfect predictor so that for each unit in the treatment sample, a counterpart in the control population can be found and vice versa (Caliendo & Kopeinig, 2008; Dehejia & Wahba, 2002; Stuart, 2010; Zhao, 2004). If there are regions where the support of X does not overlap for the treatment and comparison groups, matching is only justified when performed over the common support region. A violation of the common support condition is a major source of bias due to comparing incomparable individuals (Caliendo & Kopeinig, 2008; Heckman *et al.*, 1997a). Units that fall outside the region of common support have to be discarded and so the treatment effect can be estimated only for those units which fall in the region of common support (Bryson *et al.*, 2002).

When both of the above conditions are satisfied, ATT is calculated as the mean difference of the treatment units matched with non-treated units who are balanced on the propensity scores and fall within the region of common support, expressed as:

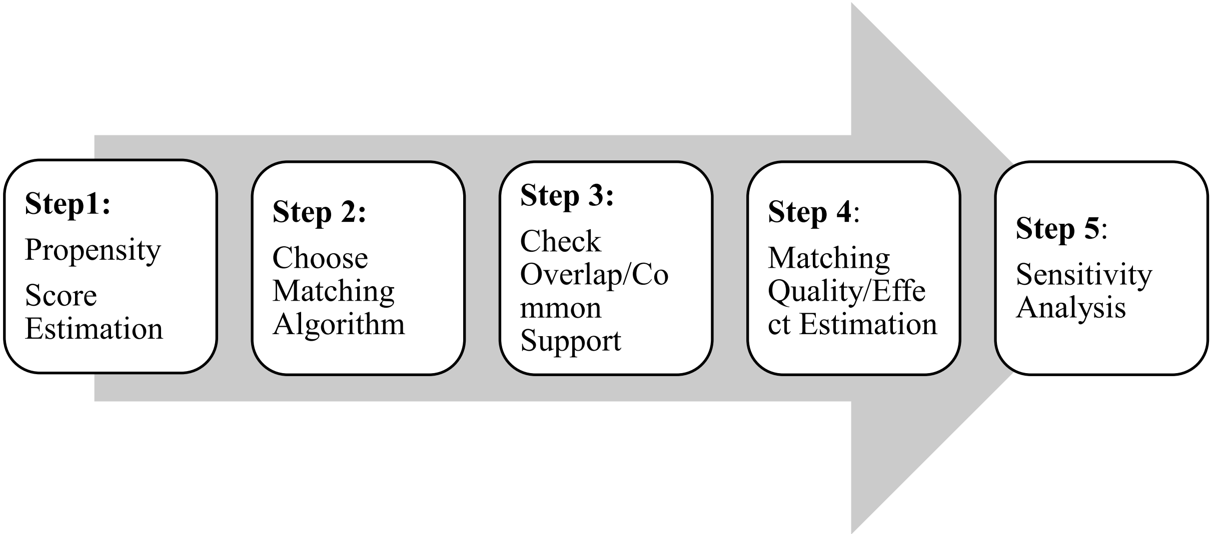
$$\tau_{ATT}^{PSM} = E_{P(X)|D=1}\{E[Y(1) \mid D=1, P(X)] - E[Y(0) \mid D=0, P(X)]\} \quad \text{(3.3)}$$

, where $Y(1)$ is the outcome of the treated group and $Y(0)$ is the outcome of the non-treated group (Caliendo & Kopeinig, 2008).

(b) Implementation of propensity score matching

Caliendo and Kopeinig (2008) outline the five steps in the implementation of PSM, which are discussed below:

Figure 3.5: Propensity Score Matching - Implementation steps



Source: Caliendo and Kopeinig (2008:33). PSM: Propensity Score Matching

(i) Propensity score estimation

The first step in PSM analysis is the estimation of propensity scores. Normally, to obtain these propensity scores any standard probability model can be used (for example, logit, probit or multi-nominal logit) (Caliendo & Kopeinig, 2008)[2]. One of the key issues in characterising the propensity score is the specification of the selection model, i.e., the identification of the vector *X* of variables that determine programme participation. There is no all-inclusive list of clearly relevant variables to assure that the matched comparison group provides an unbiased impact estimate. However, Caliendo and Kopeinig (2008) suggest that only variables that simultaneously influence the participation decision and the outcome variable be included in the propensity score estimation model. This might encourage one to err on the safe side; that is, to include anything that might potentially be confounded with the treatment effect. Indeed, Heckman *et al*. (1997a) and Dehejia and Wahba (1999) have shown that models with more covariates tend to be less biased than those that are smaller. Yet, having a propensity score model that includes a wide range of covariates has its drawbacks. Bryson *et al*. (2002), warns against the use of over-parameterised models. They argue that although including extraneous variables does not influence the bias of the matching estimates, it does introduce more variance

[2] Several other methods have been developed for fitting propensity scores including machine-learning approaches such as classification and regression trees (Lee *et al*., 2010).

and makes defining the common support region much more difficult (Bryson *et al*., 2002). That is, the better the model is at predicting participation, the more likely the propensity scores are "correct" that is, for the treatment group, propensity scores will be close to one. For the control group, they will be close to zero. In that case, the area of overlap or common support can be quite small (Bryson *et al*., 2002). On the other hand, Rubin and Thomas (1996) recommend against "trimming" models in the name of parsimony. Unfortunately, the literature does not provide enough guidance as to how to strike a balance between these competing tensions (Smith & Todd, 2005). Construction of the propensity score thus involves a trade-off between minimising the bias through the inclusion of many covariates, yet risking violating the common support region because the two groups are so dissimilar (Black & Smith, 2004; Smith & Todd, 2005). This study uses the probit model to estimate the propensity scores of two outcomes, i.e., having a household food garden or not, or, when having a food garden, participating in the household food garden programme (refer discussion in Study Design), and is specified as follows:

$$Prob[y_i = j] = \frac{\exp(\beta_j x_i)}{s(j=0-1)\exp(\beta_j x_i)}, j = 0,1 \ldots \ldots J \ldots\ldots \quad (3.4)$$

, where the left side represent the probability of being in the relevant "treatment" group for *j*th household and x_i variables are the observed characteristics of the household, which are the same across all outcomes.

(ii) Matching algorithms

After estimation of the propensity score, the next step in the analysis entails matching the treated to control participants based on the estimated propensity scores. Seeking an appropriate matching algorithm is a major task. A variety of matching algorithms exist for matching on the propensity score, such as nearest neighbour matching, caliper matching, radius matching, kernel matching, and local linear matching. Matching algorithms differ not only in the way the neighbourhood for each treated individual is defined, but also with respect to the weights assigned to these neighbours. The matching quality depends on the closeness of the match or distance measured to determine whether an individual is a good match. Asymptotically, all matching algorithms should yield the same results (Smith & Todd, 2005). However, in practice, there are trade-offs in terms of bias and efficiency involved with each algorithm and the choice of a matching algorithm could become important in small samples (Caliendo & Kopeinig, 2008; Heckman *et al.*, 1997b). Each matching algorithm has its strengths and weaknesses, which are discussed in the next section. As such, no one matching algorithm is preferable in all circumstances as the choice of an algorithm involves a trade-off between bias and variance (Caliendo & Kopeinig, 2008). Below, only the most applied matching algorithms are described.

- **Nearest neighbour matching**

The nearest neighbour (NN) matching algorithm is the most straightforward and commonly used matching algorithm, which just as the name implies, matches a treated unit with the closest control unit in terms of the propensity score. That is, if P_i and P_j are propensity scores for treated and control units respectively, I_1 is the set of the treated units and I_0 is the set of control units, a neighbourhood $C(P_i)$ contains a control unit *j*, $(j \in I_0)$ as a match for treated unit *i* , $i \in I_1$ if the absolute difference in propensity scores is the smallest among all possible pairs of propensity scores between *i* and *j,* as

$$C(P_i) = \min_j \|P_i - P_j\|, j \in I_0 \quad \text{(3.5)}$$

The NN matching algorithm has two variants, i.e., matching "with replacement" and matching "without replacement". In the former case, a control unit can be used as a match more than once, while in the latter case it is considered only once. The main strength of NN matching with replacement is the fact that allowing controls to be used more than once as matches improves the average quality of the matching process by increasing the set of possible matches and thus decrease treatment effect bias (Abadie & Imbens, 2006a; Caliendo & Kopeinig, 2008; Dehijia &Wahba, 1999; Smith &Todd, 2005). This, however, reduces the number of distinct control units to be used to construct the counterfactual outcome and thereby increases the variance of the treatment effect (Smith & Todd, 2005). Moreover, if propensity score distributions are different between treatment and control groups, matching with replacement is a preferred choice, because it minimise the propensity-score distance between the matched control units and treatment units (Dehejia &Wahba, 2002).

A common complaint however regarding NN matching without replacement is that it can discard a large number of observations, which may lead to reduced power (Caliendo & Kopeinig, 2008; Stuart, 2010). An additional concern over the use of the NN matching algorithm is that it faces the risk of poor matches if the closest neighbour is far away since it fails to reduce the total distance between the treated units and controls (Caliendo & Kopeinig, 2008). One strategy suggested in the literature to avoid poor matches when NN is implemented is to impose a caliper and only select a match if it is within the specified caliper (Caliendo & Kopeinig, 2008).

- **Caliper and radius matching**

Caliper matching is a refinement of the NN matching in which a unit from the comparison group is chosen as a matching partner for a treated unit that lies within the caliper (propensity score range) and is closest in terms of the propensity score. The caliper is an imposed tolerant level on the maximum propensity score distance between the treated and control unit, i.e. $\|P_i - P_j\|$. Using this caliper, a match for unit *i* is only selected if $\|P_i - P_j\| \prec \varepsilon, j \in I_o$ where ε is a pre-specified tolerance and P_i and P_j are propensity scores for treated and control units respectively.

Treated units for whom no matches can be found within the caliper are excluded from the analysis, which is one form of imposing a common support condition. The advantage of caliper matching is that poor matches can be avoided, thus improving the matching quality (Caliendo & Kopeinig, 2008). However, if fewer matches can be performed, the variance of the treatment effect estimates increases. A drawback of caliper matching is that it is difficult to know *a priori* the tolerance level that is reasonable and as such the size of the caliper is determined by the investigator (Smith & Todd, 2005). However, Rosenbaum and Rubin (1985) suggested using a caliper size of a quarter (0.25) standard deviation of the sample's estimated propensity score. This caliper size or one close to it is also recommended by Austin (2011), as this value minimises the mean square error of the estimated treatment effect in several scenarios. Radius matching is a variant of caliper matching that uses not only the nearest neighbour within each caliper but all control units within the caliper. A benefit of radius matching is that it uses only as many control units as are available within the caliper, allowing for the use of extra (fewer) units when good matches are (not) available (Dehejia & Wahba, 2002). This reduces the likelihood of bad matching, while still enforcing a common support. As indicated or recommended by Rosenbaum and Rubin (1985) the study use a caliper value of a quarter (0.25) standard deviation of the propensity score to find the region of common support.

- **Kernel and local-linear matching**

Kernel and local-linear matching algorithms are non-parametric estimators that use the weighted averages of (nearly) all units in the comparison group to construct the counterfactual (Caliendo & Kopeinig, 2008). Kernel and local linear matching constructs matches in such a way that control units that are closer (in terms of the estimated propensity score) to the treatment units are given more importance (via weights) and those that are further away receive lower weights. Weights depend on the distance of the propensity score between each unit from the control group and the treatment unit. By so doing, kernel and local-linear matching allows estimation of treatment effects for the treated by using information from all possible controls within a predetermined propensity score span, hence comparatively using more information than other matching algorithms. When kernel and local linear matching are used, the kernel function and the bandwidth parameter have to be selected. In practise, the choice of the kernel function and the bandwidth parameter is often arbitrary. According to Caliendo and Kopeinig (2008), the choice of the bandwidth parameter is more important as it is the one on which the trade-off between bias and variance depends. A high bandwidth value for kernel matching produces a smoother estimated density function, resulting in a better fit and reducing the variance between the estimated and the true underlying density function (prediction curve). On the other hand, a large bandwidth may smooth away the underlying features and lead to a more biased estimate. As such the bandwidth choice is a compromise between a small variance (large bandwidth) and an unbiased estimate of the true density function (small bandwidth) (Caliendo & Kopeinig, 2008).

Local linear matching differs from kernel matching in that it includes a linear term in the weighting function that is helpful when the data are asymmetric with respect to the balancing score (Caliendo & Kopeinig, 2008; Diaz & Handa, 2006). The main advantage of kernel and local-linear matching is that they yield ATT estimates with lower variance because using all of the control units gives one more information on which to match (Caliendo & Kopeinig, 2008; Heckman *et al.*, 1998b). A drawback of these methods is that, possibly units that are poor matches can be used in the matching process, by giving consideration to scores that are far from the treated score that is being matched, which may increase bias in the estimates of the treatment effect (Caleindo & Kopeinig, 2008; Heckman *et al.,* 1998b). Hence, the proper imposition of the common-support condition is of major importance for kernel and local-linear matching (Caliendo & Kopeinig, 2008).

The kernel matching estimator generally takes the following form (Diaz & Handa, 2006):

$$B_m = \frac{1}{n_1} \sum_{i \in I_1 \cap S}^{n_1} \left[Y_{1i} - \sum_{j \in I_0 \cap S} W(i,j) Y_{0j} \right] \text{...} (3.6)$$

, where B_m is the matching estimator, n_1 is the total number of participants (treated), Y_{1i} is the outcome for the participants, and Y_{0i} is the outcome for the non-participants, I_i and I_0 denote the set of participant group and non-participant group respectively, S represents the region of common support, and the term $W(i, j)$ represent a weighting function that varies depending on the matching estimator. The weighting function of the kernel estimator is as follows:

$$W(i,j) = \frac{G_{ij}\left(\frac{P_j - P_i}{a_n}\right)}{\sum_{k \in I_0} G_{ik}\left(\frac{P_k - P_i}{a_n}\right)} \text{...} (3.7)$$

Where $G_{ij} = G\left(\frac{P_j - P_i}{a_n}\right)$ is a kernel function and $G_{ik} = G\left(\frac{P_k - P_i}{a_n}\right)$ is a kernel function, where a_n is the bandwidth and P_k and P_j are estimated propensity score for non-participants units *k* and j and P_i is the estimated propensity score for the participant unit i. $W(i, j)$ measures the weighted averages of all individuals in the non-participant group matched to participant i on propensity score.

There is a trade-off between a matching algorithm's ability to minimise bias and variance. As such, there is no "winner" for all situations and the choice of the estimator largely depends on the situation and data structure at hand (Zhao, 2004). This indicate that in practice an explicit trade-off exists between bias and variance where decreasing one increases the other. Minimising the total error of the estimator requires a careful balancing of these two forms of error. Table 3.9 below show how the different matching estimators perform in terms of the trade-off between bias and variance. These trade-offs between the estimators also provide an argument for conducting sensitivity analysis to assess the robustness of treatment effect estimates obtained from different matching approaches.

Table 3.11: Trade-offs in bias and efficiency

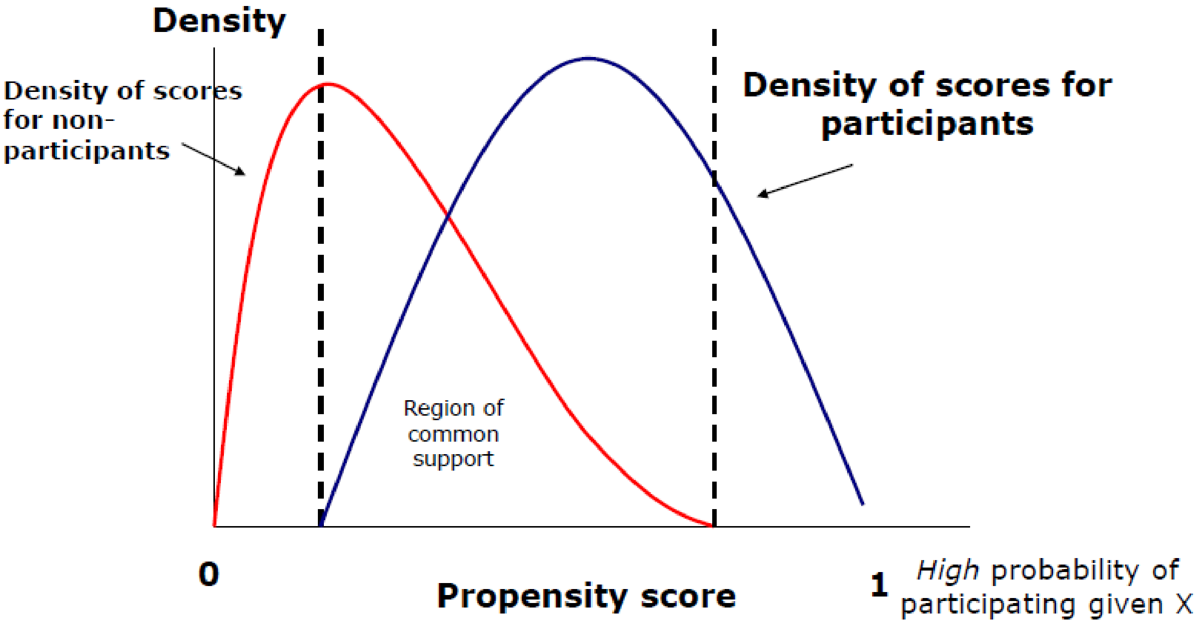
Decision	Bias	Variance
Nearest neighbour matching:		
multiple neighbours/single neighbour	(+)/(-)	(-)/(+)
with caliper/without caliper	(-)/(+)	(+)/(-)
Use of control individuals:		
with replacement/without replacement	(-)/(+)	(+)/(-)
Choosing method:		
NN matching/Radius matching	(-)/(+)	(+)/(-)
KM or LLM/NN methods	(+)/(-)	(-)/(+)
Bandwidth choice with KM:		
small/large	(-)/(+)	(+)/(-)
Polynomial order with LPM:		
small/large	(+)/(-)	(-)/(+)

Source: Caliendo and Kopeinig (2008:44). KM, kernel matching; LLM, local linear matching; LPM, local polynomial matching; NN, nearest neighbour; increase (+); decrease (-).

(iii) Overlap and common support

An important step in the implementation of PSM is to check for overlap and a region of common support between the treated and control groups. The common support is defined as the overlapping ranges of propensity score distributions of the treatment and control group. The violation of the common support condition is a major source of bias (Caliendo & Kopeinig, 2008; Heckman *et al*., 1997a). Most of the methodological studies of PSM (e.g., Caliendo & Kopeinig, 2008; Rosenbaum & Rubin, 1985; Rubin, 1977) emphasise the necessity of sufficient common support for the distributions of the propensity scores between treatment and control groups as the ATT is only estimated across the region of common support. This also enables the programme evaluator to avoid comparing the incomparable, i.e., only the subset of the control group that is comparable to the treatment group should be used in the matching analysis (Dehejia & Wahba, 1999). Caliendo and Kopeinig (2008) suggest two methods for establishing the common support region, namely a minimum and maximum comparison approach and the trimming method. The minimum and maximum comparison approach compare the minimum and maximum propensity scores in both groups and delete all treated observations whose propensity scores is smaller than the smallest minimum or larger than the largest maximum in the non-treated group (Caliendo & Kopeinig, 2008). In this way treated units which fall outside the common support region are discarded from the analysis. The trimming method define the region of common support as those propensity score values that have positive density within both the $D = 1$ and $D = 0$ distributions (Caliendo & Kopeinig, 2008). Once the common support region has been defined, individuals that fall outside this region are discarded and for these the treatment effect cannot be estimated. The common support region can be shown graphically as depicted by Figure 3.3 below. The minimum and maximum method is adopted in this study because it is simple and straightforward to implement (Caliendo & Kopeinig, 2008).

Figure 3.6: Common support condition



Source: Ravallion (2005:61)

(iv) Assessment of matching quality

PSM does not condition on all covariates but on the propensity score. As such there is a need to determine if the matching procedure can balance the distribution of the covariates in both the treatment and control group. Balance is the similarity between the multivariate empirical distributions of the covariates in the treatment and matched control groups (Imai *et. al*., 2008). There is neither an accepted method for assessing balance nor a common view about what constitutes adequate balance (Hill, 2008). However, the literature identifies several approaches for assessing the balance of covariates between treatment and control groups. The basic idea of all approaches is to compare the situation before and after matching and to establish if there remain any differences after conditioning on the propensity score (Caliendo & Kopeinig, 2008). The first approach to assess the distance in the marginal distributions of the covariates is the standardised bias (SB) (Rosenbaum & Rubin, 1985). For each covariate, SB is defined as the difference of the sample means in the treated and (matched) comparison sub-samples as a percentage of the square of the average of the sample variances in both groups. The absolute standardised bias between participating and non-participating groups is compared before and after matching. The only challenge with the use of this method is that one does not have a clear indication of the success of the matching procedure (Caliendo & Kopeinig, 2008). Rosenbaum and Rubin (1985) recommended that a mean absolute standardised bias greater than 20% after matching is an indication that matching has failed. However, the rule of thumb adopted in most empirical studies is an aggregate mean standardised bias between 3-5% or lower (Caliendo & Kopeinig, 2008).

The second approach is the t-Test statistic, in which the existence of significant differences in covariate means for both groups are established after matching (Rosenbaum & Rubin, 1985). A rejection of the group means difference test after matching implies a good balancing of the covariates.

Third, matching quality can be assessed by determining the joint significance of all covariates in the selection model based on the likelihood ratio (LR) test. All variables should be jointly significant before matching and jointly insignificant after matching (Sianesi, 2004).

Lastly, one can estimate the propensity score only for the matched treated and non-treated units and compare the pseudo R^2 before and after matching. To indicate that matching was successful, the pseudo R^2, which indicates how well the covariates explain the participating probability, should be fairly low after matching, because there should be no systematic differences in the distribution of covariates between the treated and non-treated groups (Sianesi, 2004). In this study, all four methods are used to assess the matching quality of the propensity score analysis.

(v) Sensitivity analysis

Although a sensitivity analysis of average treatment effects is an integral part of PSM analysis (Caliendo & Kopeinig, 2008; Guo & Fraser, 2010), it is not adopted as a common practice in empirical evaluation studies. Sensitivity analysis of treatment effects measures how treatment effects can be altered by some unobserved factors (Caliendo & Kopeinig, 2008). Even if the matching procedure is used to balance the distribution of observed covariates, hidden bias might still arise if there are unobserved variables that simultaneously affect the assignment into treatment and the outcome variable (Rosenbaum, 2002). For example, with negative unobserved bias, households with initial high levels of food security become beneficiaries, and thus the estimated impacts are underestimated and require upward adjustment. With positive unobserved bias, which may be present in this study, households with initial low levels of food security become beneficiaries, hence the estimated impacts are overestimated and require downward adjustment. Since PSM is not robust (does not correct for bias due to unobserved characteristics) against "hidden bias", this problem can be addressed by sensitivity analysis, the approaches to which are discussed below. The underlying question of the sensitivity analysis is to determine whether unobserved factors can alter the inference regarding the treatment effects (Caliendo & Kopeinig, 2008; DiPrete & Gangl, 2004; Rosenbaum, 2002). In other words, an evaluator's aim is to determine how strongly unobserved heterogeneity must influence the selection process to undermine the implications of the results of the matching analysis.

Approaches to addressing this unobserved confounding include applying difference-in-difference methods (Stuart *et al*., 2014) and conducting sensitivity analysis for unobserved confounding (Rosenbaum, 2002). The Rosenbaum method of sensitivity analysis is discussed here as it is the one that the study employs. Rosenbaum's method of sensitivity analysis relies on the sensitivity parameter gamma (Γ) that measures the degree of departure from a study that is free from hidden bias (Rosenbaum, 2002). Two subjects with the same observed characteristics may differ in their odds of receiving treatment by a factor of Γ. In the case of a randomised experiment, Γ=1, however in an observational study, if Γ=2, and two subjects are identical on matched covariates then one might be twice as likely as the other to receive the treatment because they differ in terms of unobserved covariate (Rosenbaum, 2002). If after matching, the estimates are free from hidden bias from an unobserved confounder, then the probability π_j that unit *j* receives treatment is only a function of observable covariates x_j that describe unit *j*. Hidden bias exist if two units with the same values of *x* have differing chances of receiving the treatment. More formally, we have hidden bias if $x_j = x_k$ but $\pi_j \neq \pi_k$ for some units *j* and *k.* Thus, Rosenbaum's sensitivity analysis asks how large the differences in π would need to be to change the inference drawn from the analysis. This is answered using the odds ratio. If π_j is the probability of treatment unit *j*, then the odds that unit *j* receives the treatment is $\pi_j/(1-\pi_j)$, with the same being true for unit *k*.

$$\frac{1}{\Gamma} \leq \frac{\pi_j/(1-\pi_j)}{\pi_k/(1-\pi_j)} \leq \Gamma \quad (3.8)$$

for all j and k with $x_j = x_k$. If the value of Γ is one, then it implies that the odds ratio of treatment is the same and the study is free of hidden bias. If Γ=2 then two units that have the same values of x could differ in their odds of receiving treatment by such a factor of 2, meaning that one unit is twice as likely to receive treatment as the other unit.

Rosenbaum (2002) developed various sensitivity tests, including the McNemar's test, the Wilcoxon's signed-rank test, and the Hodges-Lehmann point and interval estimates for sensitivity analysis. These methods use the Rosenbaum bounds approach that check the critical levels of the sensitivity parameter Γ at which treatment effects may be questioned. In this study, the bounds are calculated for continuous outcomes using the Rbounds routine that is based on Wilcoxon signed rank test statistic and the Hodges-Lehmann point estimate for the sign rank test (DiPrete & Gangl, 2004). For each fixed $\Gamma \geq 1$, the sensitivity analysis computes bounds on inferences quantities such as the interval of P values reflecting uncertainty due to hidden bias. As the value of Γ increases the interval becomes longer and eventually uninformative. The point, Γ, at which the interval becomes uninformative is a measure of sensitivity to hidden bias (Rosenbaum, 2002). The level of significance at which Γ becomes uninformative is 5% (Keele, 2010).

Unfortunately, the literature on sensitivity analysis does not provide clear guidance as to which value of Γ should be taken as a threshold for concluding whether matching results are robust to hidden bias. Based on the proposal advanced by DiPrete and Gangl (2004), i.e., that the critical value of Γ depends on the research question, Lee (2013:103) argues that: "If more track records for the sensitivity parameters are established in future through more applications so that the researchers can agree on how big is big for sensitivity analysis parameters, then the sensitivity analysis may become a useful tool in dealing with unobserved confounders." However, Rosenbaum and Rubin (1985) state that a gamma value greater than 1 indicates a more robust estimates against hidden bias.

(c) Advantages and disadvantages of propensity score matching

The main advantage of using PSM is that it offers the researcher a way of overcoming the fundamental evaluation problem and address the possible occurrence of selection bias, through the construction of a counterfactual group with the aid of observations data (Caliendo &

Kopeinig, 2008). When PSM is not used, matching is based on conditioning on all relevant covariates. However, in the case of a highly dimensional vector *X* conditioning on all relevant covariates is limited. PSM avoids this 'curse of dimensionality' associated with matching participants and non-participants on every possible characteristic when *X* is very large (Caliendo & Kopeinig, 2008) through matching on a balancing score p(x) which encapsulates multiple characteristics. PSM also draws attention to the problem of common support, which when absent diminishes the robustness of traditional regression methods, especially when there is poor overlap in support between the treated and the non-treated (Bryson *et al*., 2002, Rubin & Thomas, 2000). Furthermore, unlike traditional regression methods which usually impose a linear functional form on relationships between covariates and the outcome, because PSM is non-parametric it does not suffer from functional form restrictions (Dehejia & Wahba, 1999). Thus, PSM allows the estimation of mean impacts without arbitrary assumptions of functional forms and error distributions (Ravallion, 2005). This is particularly relevant in the case of household food gardens and household food security, where there is no theoretical or empirical reason to believe that the effect of household food gardens is constant.

However, PSM is not without its drawbacks. First, since PSM depends on observable differences, unmeasured confounding or latent heterogeneity may remain, leading to biased treatment effects (Hill, 2008). Second, PSM may be sensitive to the number of observations available for analysis, and its efficiency is especially limited with small samples (Bryson *et al*., 2002), although the literature does not specify any criteria regarding acceptable sample sizes. Third, PSM does not estimate the local average treatment effect (LATE), which is the average impact of the programme on those whose participation status is affected by a targeting criterion (Bryson *et al*., 2002).

In addition to propensity score matching, linear OLS panel data regression models are employed to estimate the impact of food gardens on household food security. These methods are discussed below.

3.9.3 Panel data analysis

When longitudinal data or panel data on the participants and non-participants in a programme before and after the programme implementation are available, unbiased estimators of programme impacts can be obtained. This is achieved by using panel data to eliminate unobserved bias. In this section, pooled OLS regression, Random Effects, Fixed Effects, and First Differences regressions are discussed.

(a) The nature of panel data

Panel data, also known as longitudinal or cross-sectional time series data, refer to the pooling of observations on a cross-section of units or subjects or entities over several time periods; that is each unit is observed over at least one or more repeated periods of time (Baltagi, 2005). This indicate that panel data combine a time series dimension with a cross-sectional dimension, in such a way that there are data on N units, followed over T time periods, which represents a special case of a clustered sample. These units could be countries, states, firms, households, or individuals. A panel is constructed by observing a large number of units (N) over a time period (T). These panels can either be balanced or unbalanced, where in the former, each cross-sectional unit is observed in all time periods and in the latter, cross-sectional units are observed for different periods of time. The structure of the data used in this study meets the definition of the "unbalanced" panel data. The sample consisted of 150 households and all 150 households were observed at baseline. At the first follow-up, 143 households were interviewed, constituting a 4.7% attrition rate. During the last follow-up, the same number of households were interviewed (n=143), representing a 4.7% attrition rate. The loss to follow-up in the intervention group and control group was small. Not being at home was the most common reason for loss to follow-up in the control group versus migration in the intervention group. A total of 139 households were interviewed in all three data collection rounds, yielding an aggregate attrition rate of 7.3%. 4 households were interviewed at baseline and first follow-up, while 4 households were interviewed at baseline and last follow-up and 3 households were interviewed at baseline only. The attrition rates among the intervention and the control groups are 2.4% and 13.4%, respectively. Generally, one would expect the treatment group's rate of attrition to be lower than the control group, because these households have an extra incentive to remain in the study, i.e., access to treatment.

(b) Advantages and disadvantages of panel data

There are several advantages of panel data as compared with purely cross-sectional or purely time-series data. The major advantage of panel data is increased precision of estimation (i.e., lower standard errors), resulting from an increased sample size through pooling all the observations into one large dataset (Cameron & Trivedi, 2010; Verbeek, 2008). With more data points, degrees of freedom are increased, multicollinearity reduced, and efficiency of parameter estimates improved, thus broadening the scope of inference (Hsiao, 2003). The combination of time series with cross-sections in panel data can enhance the quality and quantity of data in ways that would be impossible using only one of these dimensions (Gujarati, 2003). Another attraction of panel data is its ability to control for individual-specific, time-invariant, unobserved heterogeneity across measurement units, e.g., cultural factors and differences in gardening practices across households, the presence of which could lead to bias in standard estimators like OLS, thus enhancing the validity of inference (Baltagi, 2005; Wooldridge, 2010). Not controlling for these unobserved individual specific effects can lead to biased estimates of the regression coefficients (Baltagi, 2005; Mátyás & Sevestre, 2008). Hence, panel data analysis can better detect effects that are not observable in pure cross-sections or pure time-series data. Panel data can also be used to solve the omitted variables problem. Moreover, in panel data, units can retain their heterogeneity which can be studied separately as some estimators accommodate these individual effects. Lastly, panel data also gives great flexibility in modelling differences in behaviour across units and are also better able to identify and estimate effects that are not detectable in pure cross-sections or pure time-series data (Greene, 2003). This is because cross sections only provide data for units of observation and outcomes at a single point in time, whereas panel data can show how these units change over time (Wooldridge, 2010).

However, panel data is not free of limitations. The main drawbacks of using panel data are the issues of sample selection bias and heterogeneity (Baltagi, 2005). Analogous to cross-section and time-series datasets, the problem of multicollinearity and autocorrelation needs to be addressed in panel datasets (Baltagi, 2005). These limitations however can be addressed by the choice of the estimators, which are discussed below.

Moreover, panel datasets are often characterised by missing observations resulting from attrition, which may be selective, i.e., those lost to follow up being different from those staying in the study in terms of certain observable or unobservable characteristics. Normally attrition analysis is conducted to investigate the nature of this selection bias. In this study, however, the total number of cases lost to follow-up is only 11, which precludes meaningful descriptive statistical or regression analysis of the nature of attrition.

(c) Panel data estimators

There are four main panel data estimators, each of which are described below in more detail.

(i) The Pooled Ordinary Least Square (OLS) Model

As the name suggests, a pooled regression simply pools the observations across multiple cross-sections from two or more points in time into one large cross-section, hence disregarding the heterogeneity between the units as well as the time variant effects of the data. (Wooldridge, 2010). The pooled OLS assumes that $x_{it}^{'}$ is uncorrelated to both μ_i and v_{it} ; the model allows for both household fixed effects and idiosyncratic error which vary between households and over time. The pooled OLS is mathematically expressed as follows:

$$y_{it} = \alpha + x_{it}^{'}\beta + \mu_i + v_{it} \qquad (3.9)$$

Where:

α is the intercept

x' is a vector of all the independent/explanatory variables for unit i at time t

β is the regression coefficient that is estimated for x'

μ_i is the unobserved household effects

v_{it} is the idiosyncratic error.

A major advantage of the pooled OLS model is that the sample size can be easily increased by pooling observations from different time periods. This is important in cases where many explanatory variables are to be included in the regression equation, as data pooling across cross-sections and time points increase the degrees of freedom, which facilitates a more accurate and consistent estimation of the regression coefficients (Woodridge, 2002). The main limitation of the pooled OLS model is that it suffers from the problem of unobserved heterogeneity as it assumes that there is neither significant individual nor significant time effects. This assumption, however, is not realistic and hence the results are likely to be biased. Hsiao

(2003:20) warned that, "unless both cross-section and time-series analyses of covariance indicate the acceptance of homogeneity of regression coefficients, unconditional pooling may lead to serious bias". Thus, when heterogeneity is present in the panel dataset, the estimators of the pooled OLS-regression will become inconsistent and biased (Wooldridge, 2010). In addition, the pooled OLS assumption of no autocorrelation can be easily violated when multiple data periods are used, thus rendering the estimator biased (Moyo, 2013). If the unobserved variable μ_i is correlated to any of the explanatory variables, then the Gauss Markov theorem will be violated (Wooldridge, 2010) and using pooled OLS on the panel data results in biased and inconsistent estimates of coefficients.

Thus, in the pooled OLS model, the assumption is that in each period the error term is uncorrelated to the explanatory variables. However, for some datasets this assumption is too strong (Wooldridge, 2010). Wooldridge (2010) points to the fact that the primary motivation of panel data models is to solve the "omitted variable problem". Other panel data models take into account these unobserved individual unit-specific factors (i.e., unobserved heterogeneity). These models are distinguished based on the assumptions they pose regarding the relation between the unit specific unobserved heterogeneity and the explanatory variables and are discussed in the next section. However, pooled models are generally used as a comparative "baseline" against which to compare the results of other panel data regression models.

(ii) Random Effects Model

In the FE model formulation, the unobserved individual effect (α_i) is treated as an unknown "nuisance parameter" which, if ignored, causes bias and inconsistency in estimators because it is thought to be correlated with one or more of the exogenous explanatory variables ($x_{it}^{'}$). As such, in the FE model transformation, the goal is to eliminate α_i because it is thought to be correlated with the one or more of the explanatory variables ($x_{it}^{'}$). On the contrary, the Random Effects (RE) model assumes that the unobserved effect (α_i) is purely random and uncorrelated with each of the exogenous explanatory variables in all time periods (Cameron & Trivedi, 2010; Wooldridge, 2010). Thus, the crucial distinction between the FE and RE is whether the unobserved individual effect embodies elements that are correlated with the explanatory variables in the model, not whether these effects are stochastic or not (Greene, 2003). The RE model approach to estimating parameters (β) effectively puts the unobserved effect α_i into the error term, under the assumption that the unobserved effect α_i is orthogonal to the explanatory variables ($x_{it}^{'}$) and accounting for the implied serial correlation in the composite error $v_{it} = \alpha_i + u_{it}$ using the Feasible Generalised Least Squares (FGLS) analysis (Wooldridge, 2010).

The RE assumptions are:

Assumption 1: $E(x_{it}\alpha_i) = 0$ α_i uncorrelated with x_{it}

Assumption 2: $E(x_{it}u_{is}) = 0$ for $s = 1,2,...,T$ (strict exogeneity)

Thus, the RE model combine the strongest assumption underlying the FE model (i.e., that of strict exogeneity), with the strongest assumption underlying pooled OLS models (i.e., no correlation between the time invariant part of the residual and the explanatory variable).

The RE model can be written as:

$$y_{it} = \beta_0 + x'_{it}\beta + v_{it} \qquad t = 1,2,...,T; i = 1,2...,N \text{ .... (3.10)}$$

, where:

y_{it} is the independent variable, where *i* is unit and *t* is time

x_{it} is a $1 \times K$ vector of regressors,

β is a $K \times 1$ vector of parameters to be estimated

$v_{it} = \alpha_i + u_{it}$ is the composite error term

Because α_i is in the composite error in each time period, the v_{it} are serially correlated across time. Because of this serial correlation the RE model cannot be estimated using the pooled OLS. In this case, the RE model is estimated using the FGLS which eliminates serial correlation resulting from the presence of the unobserved effect in the composite error term. Following the FGLS transformation the RE model is then defined as follows:

$$(y_{it} - \theta_i \bar{y}_i) = \beta_0(1-\theta) + \beta_1(x_{it} - \theta \bar{x}_{it}) + \{(1-\theta_i)\alpha_i + (u_{it} - \theta_i \bar{u}_i)\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.11)$$

, where θ_i is a consistent estimate of

$\theta_i = 1 - \sqrt{\dfrac{\sigma_u^2}{T\sigma_\alpha^2 + \sigma_u^2}}$ and the overbar denotes time averages.

In cases where $\theta = 1$, the RE is identical with the FE model, and when $\theta = 0$ the estimator is reduced to a pooled OLS, and the estimator is only efficient when $0 < \theta < 1$ (Wooldridge, 2010).

The main advantage of RE models over FE models is that RE models retain both the unobserved heterogeneity and the n-degrees of freedom in the regression model. FE estimators, on the other hand, disregard this heterogeneity and also lose n-degrees of freedom (Hsiao, 2003). In addition, the RE model allows for the estimation of the partial effects of time-constant variables since it assumes that the unobserved effect is uncorrelated with all explanatory variables, whether they are fixed over time or not. The main limitation of the RE model is that the parameter θ is never known in practice (Hsiao, 2003). Moreover, allowing the unobserved effect to be correlated with explanatory variables in the RE model requires a critical condition that almost all explanatory variables be controlled for, a condition which is often difficult to meet, therefore leading to omitted variable bias in the model (Wooldridge, 2010).

(iii) Fixed Effects Model

The Fixed Effects (FE) model assumes that a sample is non-random and that units have constant slopes but different cross-sectional intercepts. The FE model allow for arbitrary dependence between the unobserved heterogeneity (α_i) and the explanatory variables ($x_{it}^{'}$) in all time periods (Wooldridge, 2010). This is so as the FE model explore the relationship between the explanatory variable and the dependant variable within a unit and takes into consideration that unit characteristics may influence the explanatory variables. Wooldridge (2010) summarises the assumption of the FE estimator as:

Assumption 1: $E(x_{it}\alpha_i) \neq 0$ α_i freely correlated with x_{it}

Assumption 2: $E(x_{it}u_{is}) = 0$ for $s = 1,2,...T$ (strict exogeneity)

The second assumption is the key assumption of the FE model and states that the idiosyncratic errors are uncorrelated with any of the explanatory variables in each time period. The strict exogeneity assumption rules out feedback from the past u_{is} shocks to the current x_{it} .

The FE model is given by:

$$y_{it} = x_{it}\beta + \alpha_i + u_{it}, \quad t = 1,2,....T; i = 1,2,...,N, \ldots\ldots\ldots\ldots\ldots (3.12)$$

Where:

y_{it} is the independent variable, where *i* is unit and *t* is time

x_{it} is a $1 \times K$ vector of regressors,

β is a $K \times 1$ vector of parameters to be estimated

α_i is the unobserved household effects

u_{it} is the idiosyncratic error term

N and T are the cross-section and time-series dimensions respectively

In the FE model the unobserved unit specific effects α_i that would contaminate OLS estimates are eliminated through the process of time demeaning. The time demeaning process involves subtracting time averages of each unit from the corresponding variables. After averaging over time for each *i* the equation becomes:

$$\bar{y}_i = \bar{x}_i\beta_1 + \bar{\alpha}_i + \bar{u}_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.13)$$

Where $\bar{y}_i = {}^1\!/_T \sum_{t=1}^{T} Y_{it}$

After subtracting the second equation (3.11) from the first equation (3.10) for each t (within transformation) the following is obtained;

$$\ddot{y}_{it} = \beta_1 \ddot{x}_{it} + \ddot{u}_{it} \quad (3.14)$$

, where $\ddot{y}_{it}$; $\ddot{x}_{it}$ and $\ddot{u}_{it}$ is the time-demeaned data on y ; x and μ respectively.

The most important feature of the equation is that the unit-specific unobserved effect α_i now has been eliminated. This time-demeaning process allows for the use of OLS to estimate β consistently. However, not only is α_i eliminated from the equation, but also all explanatory variables that are constant over time, implying that the partial effects of all time-invariant variables cannot be estimated. Hence, if a key explanatory variable is time invariant, the FE estimator is inappropriate and the RE estimator would be appropriate. The key insight in the FE model is that if the unobserved variable effect does not change over time, then any changes in the dependent variable must be attributed to influences other than these fixed unit characteristics (Wooldridge, 2003). The FE models can be estimated using the within effect models or the least squares dummy variable model (LSDV). These two techniques produce identical parameter estimates for non-dummy independent variables.

The FE model specification is more appropriate when a study is focusing on a specific set of N units and inference is restricted to the behaviour of these sets of units (Baltagi, 2005). The main inferential attraction of the FE models is that they allow for some form of endogeneity, i.e. the unobserved individual effects (α_i) are permitted to be correlated with the explanatory variables ($x_{it}^{'}$). According to Wooldridge (2010:477), the FE model is "widely thought to be a more convincing tool for estimating ceteris paribus effects", since it allows arbitrary correlation between α_i and $x_{it}^{'}$. In addition, in many applications the whole idea of using panel data is to allow for the unobserved effect to be arbitrarily correlated with the explanatory variables ($x_{it}^{'}$) and the FE model achieves this purpose explicitly, thus allowing for the consistent estimation of partial effects in the presence of the time-invariant omitted variables (Wooldridge, 2010). Moreover, FE models control for all time-invariant differences between units, so that the estimated coefficients of the FE models cannot be biased because of omitted time-invariant characteristics.

FE models are not without their drawbacks. FE models suffer from a loss of degrees of freedom because of the time demeaning process, since for each cross-sectional observation one degree of freedom is lost (Wooldridge, 2010). FE models may have too many cross-sectional units requiring too many dummy variables for specification. Too many dummy variables may sap the model of sufficient degrees of freedom and can aggravate the multicollinearity problem among the explanatory variables, leading to poor statistical power (Wooldridge, 2010). Another drawback of FE models is that the effects of the time-invariant variables (variables that have no within-subject variation) cannot be estimated as these are all swept away by the time demeaning transformation. FE models also discards the between-unit variation and focus only on the within-unit variation. Unfortunately, discarding the between-unit variation can yield standard errors that are considerably higher than those produced by methods that utilise both within-unit and between-unit variation (Wooldridge, 2002). Moreover, FE estimators are only efficient when there are variations in the exogenous explanatory variables (Cameron &Trivedi, 2010; Wooldridge, 2010).

(iv) First Differences Model

The first difference (FD) model is one solution to the problem of unobserved heterogeneity in the context of panel data. First differencing is another panel approach to estimation which allow for unobserved heterogeneity to be correlated to the model's regressors. Wooldridge (2010) summarises the assumption of the FD estimator as:

Assumption 1: $E(x_{it}\alpha_i) \neq 0$ α_i freely correlated with x_{it}

Assumption 2: $E(x_{it}u_{is}) = 0$ for $s = t, t-1$ (weaker exogeneity assumption)

The first difference model is given by:

$$y_{it} = x_{it}\beta + \alpha_i + u_{it}, \quad t = 1,2,....T; i = 1,2,..., N, \quad \ldots\ldots\ldots\ldots\ldots (3.15)$$

, where:

y_{it} is the independent variable, where *i* is unit and *t* is time

x_{it} is a $1 \times K$ vector of regressors,

β is a $K \times 1$ vector of parameters to be estimated

α_i is the unobserved household effects

u_{it} is the idiosyncratic error term

N and T are the cross section and time series dimensions respectively

Differencing equation 3.10 gives the first difference estimator;

$$y_{it} - y_{t-1} = (x_{it} - x_{i,t-1})\beta + (\alpha_i - \alpha_i) + (u_{it} - u_{i,t-1})$$

$$\Delta y_{it} = \Delta x_{it}\beta + \Delta u_{it} \quad \text{.......} \quad (3.16)$$

By taking the first difference the time invariant unobservable characteristics (α_i) is removed, so OLS estimation of this model leads to consistent estimates of β. However, with differencing, the coefficients of time invariant regressors in the model are not identified.

Differencing panel data over time, as a way of eliminating the unobserved effect is a valuable method of obtaining causal or treatment effects (Greene, 2003). Nevertheless, differencing suffers from several drawbacks. When explanatory variables do not vary much over time, first differencing becomes less useful. FD can be subject to a lot of biases even when there is sufficient time variation in the explanatory variables. The strict exogeneity assumption of explanatory variables is a critical assumption and the first differencing method is prone to measurement errors of explanatory variables. Differencing a poorly measured explanatory variable reduces its variation compared to its correlation with the differenced error, resulting in a potentially sizeable bias (Wooldridge, 2010). Moreover, differencing also removes any time-invariant variables from the model (Greene, 2003). If the time-invariant variables in the model are of no interest, then this is a robust approach that can estimate the parameters of the time-varying variables consistently, although this is not helpful for the application in a situation where time invariant variables are the primary object of the analysis.

The FE model and first difference models are both designed for removing unobserved unit-level effects and rely on the same identification assumptions. The fact that FE models and FD models can be used to deal with "selection on unobservables" make them important in evaluating the impact of interventions or treatment. In addition, FE models and FD models give the same estimation results in the context of a two period panel dataset.

(d) Poolability tests

The choice of which panel data econometric technique to adopt depends on the assumptions. However, a more common and reliable technique is to apply panel statistical tests to determine the most efficient technique as described by data characteristics. The common statistical tests on whether data will be pooled or not is tested by the fixed effects test (Chow test), which compares the pooled and FE estimators, and the Breusch Pagan Lagrange Multiplier test, which compares the pooled and RE estimators. The Hausman test is used to choose between the RE and the FE models when the Chow test and the Breusch Pagan Lagrange Multiplier test rejects the pooled OLS technique.

(i) The Chow test

The chow test is used to choose between the pooled OLS model and FE model as the more appropriate estimator. The Chow test can be used to test the joint significance of the included fixed effects parameters. Based on Greene (2003), the Chow F ratio used for this test is:

$$F(n-1, nT-n-K) = \frac{(R_{FE}^2 - R_{POLS}^2 / n-1}{(1-R_{FE}^2 / (nT-n-K)} \qquad (3.17)$$

Where R_{FE}^2 and R_{POLS}^2 are the residual sums of squares of the fixed effects model and pooled OLS models, respectively, $(n-1)$ and $(nT-n-k)$ are degrees of freedom, the total number of observations is NT . The null and alternative hypothesis are stated below as:

$H_o =$ Pooled OLS Model

$H_1 = 0$ Fixed Effects Model

If the calculated value of F is smaller than the critical value, the null hypothesis of equality is accepted, and hence pooled OLS is more appropriate. Rejecting the null hypothesis suggest adopting the FE model.

(ii) Breusch Pagan Lagrange multiplier test

If explanatory variables are strictly exogenous and the idiosyncratic error term is uncorrelated and homoscedastic, then the pooled OLS and the RE model are both efficient, assuming no unobserved effects. The most common test, the Lagrange Multiplier (LM) test developed by Breusch and Pagan (1980), is used to choose between the pooled OLS model and the RE model. The test statistic is based on the pooled OLS residuals, and is written as:

$$LM = \frac{NT}{2(T-1)}\left[\frac{\sum_i(\sum_t \hat{u}_{it})^2}{\sum_i\sum_t \hat{u}_{it}^2} - 1\right]^2 \qquad (3.18)$$

, where $\hat{u}_{it}$ is the residual from regressing y_{it} on a constant and x_{it} (pooled OLS residual). The LM statistic is distributed as a chi-squared with one degree of freedom. The null and alternative hypothesis for the LM test are stated as:

$H_0 : E(u_{it}u_{is}) = 0$ Pooled OLS model

$H_1 : E(u_{it}u_{is}) \neq 0$ Random Effects model

The null hypothesis in the LM test is that variances across units is zero. That is, no significant difference across units (for instance, no panel effect), implying that the model is a fully pooled one. Acceptance of the null hypothesis means the classical regression model with a single constant term is appropriate for the data (pooled OLS). The pooled OLS model is not used where the test statistic exceeds the critical value. Rejecting the null hypothesis points at the RE model as appropriate. The RE model, however, needs to be contrasted to the FE model using the Hausman test. The LM test in other words is complimentary to the fixed effects test. The major drawbacks of the Breusch-Pagan statistic are that it is two sided in spite of the fact we know that variances cannot be negative, and that LM tests often have low power (Greene, 2003). Hence, for testing for poolability, the Chow test is more reliable.

(iii) Hausman test

The main advantage of the RE model over the FE model is that the RE model retain both the unobserved heterogeneity and the n-degrees of freedom in the regression model. FE models, on the other hand, disregard this heterogeneity and also lose n-degrees of freedom (Green, 2003). However, when T approaches infinity the FE model and the RE model produce the same estimates, which makes RE model more attractive than FE model. The Hausman test for random effects is used to evaluate the appropriateness of adopting either the FE model or RE model. It basically tests whether the unique errors (α_i) are correlated with the explanatory variables, the null hypothesis being that they are not. The Hausman test compares the coefficient vectors from the FE model and RE model. If they are both consistent estimators, then their point estimates should not differ greatly, whereas if both of the estimators is inconsistent, its point estimates are likely to differ widely from those of a consistent estimator. The Hausman test statistic is given by:

$$H = \hat{q}\left[Var(\hat{q})\right]^{-1}\hat{q} \approx \chi^2(k) \quad (3.19)$$

, where $\hat{q} = \hat{\beta}^{FE} - \hat{\beta}^{RE}$, $Var(\hat{q}) = Var(\hat{\beta}^{FE}) - Var(\hat{\beta}^{RE})$ is variance and k denotes degrees of freedom. This test has a chi-squared degrees of freedom.

The null and alternative hypotheses of the Hausman test are stated as:

$H_0 : Cov(x_{it}, \alpha_i) = 0$ Random Effects model

$H_1 : Cov(x_{it}, \alpha_i) \neq 0$ Fixed Effects model

The null hypothesis is that the RE model is consistent (for instance, the household-specific unobserved factors are uncorrelated with the explanatory variables) and it should be preferred and the alternative state that the FE model is consistent (for instance, the household-specific unobserved factors are correlated with the explanatory variables). If the calculated value is greater than the critical value, this suggests that the RE model is inconsistent and the FE model should be used instead. Put differently, rejecting the null hypothesis implies that the FE model is the most appropriate, and failure to reject null hypothesis points at the RE model as the best model. However, like many tests, the Hausman test is performed conditional on the assumption of proper specification of the underlying model, implying that when an important explanatory variable is omitted then this leads to the comparison of two inconsistent estimators of the population model. The Hausman test might produce biased results in small samples (Baltagi, 2005), and as a result it is possible to get a statistical rejection of the RE model with the differences between the RE model and FE model estimates being practically small. According to Wooldridge (2002), the typical response is to conclude that the RE assumptions hold and to focus on the RE estimates.

3.10 Model specifications

The estimation of the different models in the two analytical approaches discussed above, which aims to examine the impact of a household food gardening on household food security involves the use of both dependent variables and different explanatory variables. This section introduces the dependent variables adopted by the study and the explanatory variables expected to determine treatment access, as defined elsewhere above (See section 3.4, page 46), and food security.

3.10.1 Propensity score matching model specification

The variables used in the specification of the probit participation model to estimate the propensity score are based on empirical evidence of factors that affect the outcomes of interest (household food security) but are not affected by participating in the treatment. The dependent variable(s) in the probit participation model are those reflecting "treatment" status, which, as explained in the study design, takes on two forms. The "garden" variable captures or pools all households with food gardens and compare them with households without food gardens, thus it is a dummy variable which takes the value of one if the household has a food garden and zero otherwise. The second dummy variable, called "programme garden", takes the value of one, if the household is a participant and zero if a household has a non-programme garden. Households that do not have a food garden are excluded from the latter comparison. The independent variables in the model include, both household level and individual level variables. Individual level variables include: age of household head; education of household head; marital status of household head; and gender of household head. Household level variables include: household size, household dependency ratio, and a dummy variable showing whether the household is HIV and AIDS affected. The HIV and AIDS affected dummy takes the value of

1 if the household respondent knew someone infected by HIV and AIDS or knew someone taking ARVs and zero otherwise.

3.10.2 Panel data regression model specification

In the panel regression analysis, the dependent variable(s) in the regression models are the measures of food security and specifically, the HDDS and MAHFP (see section 3.9.1, page 62). The independent variable(s) of main interest are those reflecting "treatment" status, which, as explained in the study design, takes on two forms. The "garden" variable captures or pools all households with food gardens and compare them with households without food gardens, thus it is a dummy variable which takes the value of one if the household has a food garden and zero otherwise. Using this dummy variable, the study tries to evaluate whether gardens in general are important to household food security. The second dummy variable, called "programme garden", captures the impact of participation in the household food gardening programme on household food security and this variable also takes the value of one, if the household is a participant and zero if a household has a non-programme garden. Households that do not have a food garden are excluded from the latter comparison.

Table 3.12: Variable definitions and measurement

Variable	Type and definition	Measurement
Dependant variables:		
PSM		
Garden	Dummy, participation in household food gardening	1 if yes, 0 otherwise
Programme garden	Dummy, participation in household food gardening programme	1 if yes, 0 if a household has a non-programme garden
Panel Models		
HDDS	Continuous, household dietary diversity score	Score ranging from 0 - 12
MAHFP	Continuous, months of adequate household food provisioning	Score ranging from 0 - 12
Independent variables:		
Age	Continuous, age of household head	Years completed
Age squared	Continuous, age of household head squared	Years completed squared
Female	Dummy, sex of household head	1 if female, 0 otherwise
Marital status	Dummy, marital status of household head	1 if unmarried, 0 otherwise; 1 if living together, 0 otherwise; 1 if married, 0 otherwise
Education	Dummy, education of household head	1 if has no formal education, 0 otherwise; 1 if has primary education, 0 otherwise; 1 if has secondary education, 0 otherwise
Household size	Continuous, size of household	Number of household members
Dependency ratio	Continuous, dependency ratio	Ratio of dependent members to household size
HIV and AIDS affected	Dummy, HIV and AIDS status of household	1 if yes, 0 otherwise

In terms of *a priori* expectations, the literature shows that household food gardens impact positively on household food security (Akrofi *et al*., 2010; Bushamuka *et al*., 2005; Galhena *et al*., 2013). Household food gardening, whether in general or through a particular gardening programme, is therefore hypothesised to be positively associated with household food security. This analysis also controls for household characteristics such as household head's age of, education, marital status, gender, and household size, household dependency ratio, and a dummy variable showing whether the household is HIV and AIDS affected and as discussed above the variable takes on a value of 1 if the household respondent knew someone infected by HIV and AIDS or knew someone taking ARVs and zero otherwise. Time and country fixed effects were also included in the models. The inclusion of the controls is guided by existing literature on household food security (Feleke *et al*., 2005; Mutisya *et al*., 2016; Wilde & Nord, 2005). Table 3.10 clearly shows the dependant and independent variables used in the specification of the models in the two analytical methods.

3.11 Conclusion

The first part of this chapter discussed the study design, together with the sampling techniques and the data collection methods adopted by the study. The chapter reviewed the strengths and weaknesses of the study design and the sampling and data collection methods. The second part of the chapter outlined the analytical strategy employed in estimating the impact of household food gardens in general on food security and the impact of programme gardens on food security, which include the use of both descriptive and econometric methods. The variables used in both the descriptive and econometric analysis conducted as part of the study are also described.

Chapter 4: Results

4.1 Introduction

This chapter presents and discusses the empirical findings in order to determine the HIV and AIDS impact mitigation potential of household food gardens. The chapter begins with a brief description of the households that participated in the study in respect to certain sociodemographic characteristics. This is followed by a presentation and discussion of the findings of the study in the context of the study objectives, and this is divided into four main sections: (i) HIV and AIDS and morbidity; (ii) the food system; (iii) the food economy; and (iv) household food security.

4.2 Baseline sociodemographic household characteristics

This section presents the baseline sociodemographic characteristics of the households in the study. Given that the analysis in the study is based on three comparisons; the treatment and control comparisons, the garden and no-garden comparisons, and the programme gardens and non-programme gardens comparisons, the household sociodemographic characteristics are reported based on these groupings. From Table 4.1, which shows the comparisons for the whole sample, based on treatment and control groups, the results show that the mean age of household heads is 48.2. Fifty-one percent of the households are headed by women. Women headship is however more pronounced in Zimbabwe, with no significant statistical differences observed between the treatment and control groups. A high percentage of household heads (50.6% treated and 60.0% of the control) are unmarried. Slightly above half of all household heads had a primary education. The mean household size of the sample was 4.5, with treated households having a statistically significantly larger household size (4.9 vs 4.0; $p< 0.05$) than control households. Table 4.2 in turn shows the characteristics based on the garden and no-garden groupings and the programme gardens and non-programme gardens. For the garden and no-garden comparisons, results depict that relatively more households in the garden group have older household heads, are headed by female heads and have larger household sizes, all of which exhibit statistical significance. Significantly, more households in the no-garden group are likely to have co-resident household heads. Comparisons based on programme-garden households and non-programme households show that significantly more households in the non-programme garden group are headed by females, by unmarried household heads, and have a higher dependency ratio.

4.3 Baseline impact of HIV and AIDS and morbidity

This section pays attention to the extent to which households are impacted by HIV and AIDS and the household morbidity rate at baseline, the purpose being to show that the poor urban communities in general and programme participants in particular, are heavily impacted by HIV and AIDS and its impacts on morbidity. To assess the impact of HIV and AIDS on households, the two HIV and AIDS dummy variables discussed in Chapter 3 (see Chapter 3, Section 3.9.1, page, 60) are used. Results on the household morbidity rate are based on the question from the survey instrument which asked respondents whether a household member had been ill in the past 12 months. The evidence from the three countries (Lesotho, South Africa, and Zimbabwe) are presented and discussed in turn. Results for the garden and no garden comparisons, and programme gardens and non-programme gardens are also reported.

4.3.1 Impact of HIV and AIDS on households

Figure 4.1 shows that households in all three countries generally are "indirectly" impacted by HIV and AIDS to a considerable extent. According to Figure 4.1, relatively high proportions of households (>80%) from the three countries are impacted by HIV and AIDS, the exception being South Africa's control group (76%). However, even in this case, the level of impact is considerable, i.e., three in four households. When group differences are considered, households in the treatment group in the three countries are impacted more by HIV and AIDS compared to households in the control group (92% vs 84% in Lesotho, 84% vs 76% in South Africa and 96% vs 88% in Zimbabwe), although no statistically significant differences are noted. These treatment and control differences between countries may be attributed to the fact that treatment households in the three countries were targeted purposively *via* the NGOs involved in HIV and AIDS counselling and care (see Chapter 3, Section 3.2, page, 42).

Table 4.13: Baseline sociodemographic characteristics

	Lesotho			South Africa			Zimbabwe			Total		
	T	C	Total	T	C	Total	T	C	Total	T	C	Total
Characteristics of household head												
Age	56.3	52.7	54.5	45.2	38.0	41.6	45.8	50.5	48.2	49.2	47.2	48.2
Gender (1=female)	0.32	0.32	0.32	44.0	36.0	40.0	76.0	88.0	82.0	50.6	52.0	51.3
Education												
No formal schooling	0.0	16.0	8.1	4.3	4.1	4.2	4.1	0.0	2.0	2.8	6.7	4.8
Primary level education	79.1	64.0	71.4	52.1	41.6	46.8	37.5	44.0	40.8	56.3	50.0	53.1
Secondary education level	20.8	20.00	20.4	43.4	54.1	48.9	58.3	56.0	57.1	40.8	43.2	42.0
Marital status												
Unmarried	40.0	52.0	46.0	36.0	48.0	42.0	76.0	80.0	78.0	50.6	60.0	55.3
Living together	0.0	0.0	0.0	36.0	32.0	34.0	0.0	0.0	0.0	12.0	10.6	11.3
Married	60.0	48.0	54.0	28.0	20.0	24.0	24.0	20.0	22.0	37.3	29.3	33.3
Characteristics of the household												
Household size	5.3	4.1	4.7	4.4	3.2	3.8**	4.9	4.8	4.9	4.9	4.0	4.4**
Dependency ratio	0.459	0.520	0.489	0.362	0.355	0.358	0.392	0.426	0.409	0.404	0.433	0.419
Total (n) – maximum	25	25	50	25	25	50	25	25	50	75	75	150

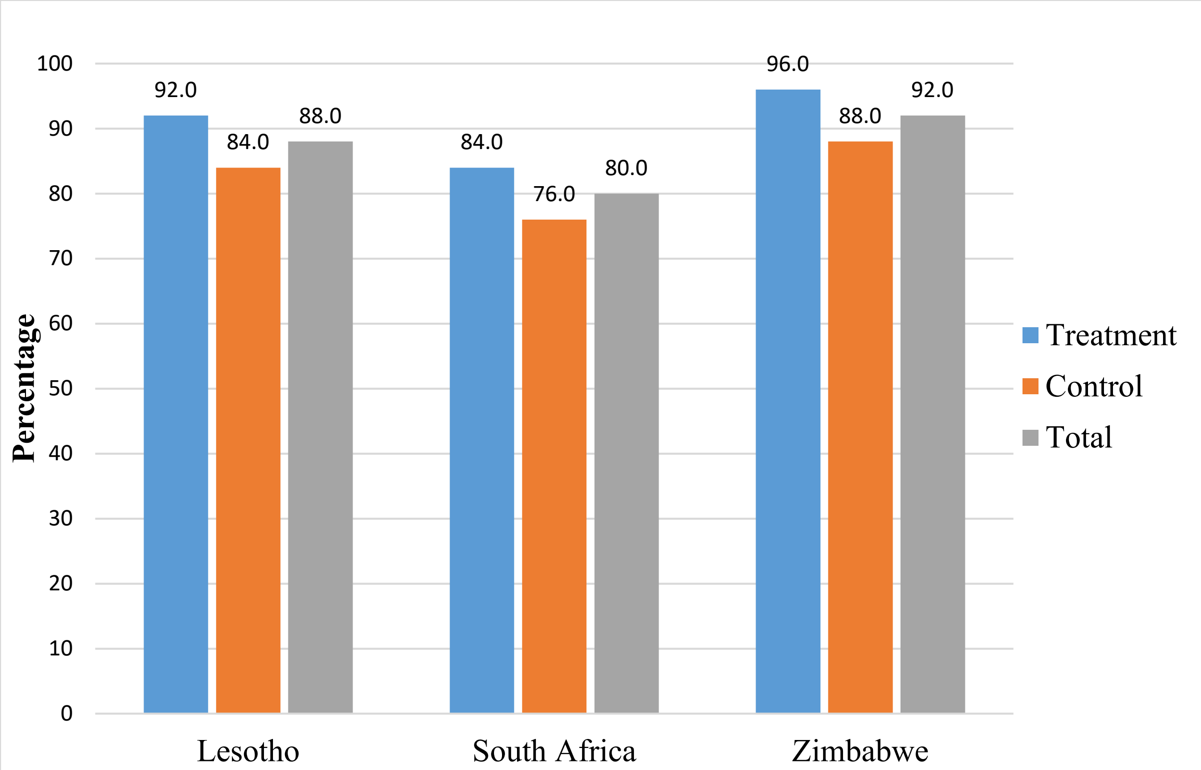
Note: "T" treatment/intervention group; "C" control group. *** 1%, ** 5%, * 10%. Sample sizes do not reflect missing values.

Table 4.14: Baseline sociodemographic characteristics

	Garden	No-garden	Total	Programme-garden	Non-programme garden	Total
Characteristics of household head						
Age	51.4	45.1	49.5***	52.4	50.5	51.4
Gender (1=female)	57.5	36.9	51.3***	51.0	63.1	57.5**
Education						
No formal schooling	5.0	6.4	5.4	3.62	6.2	5.0
Primary level education	53.3	43.2	50.3	56.5	50.6	53.3
Secondary education level	41.6	50.4	44.2	39.8	43.1	41.6
Marital status						
Unmarried	60.1	50.7	57.34	53.8	65.6	60.1**
Living together	5.5	18.4	9.40***	8.3	3.0	5.5
Married	34.3	30.7	33.2	37.7	31.2	34.3
Characteristics of the household						
Household size	4.5	3.8	4.3***	4.6	4.5	4.5
Dependency ratio	0.397	0.435	0.408	0.36	0.42	0.39*
Total (n)	306	130	436	143	163	306

Note: ***1%, **5%, *10%

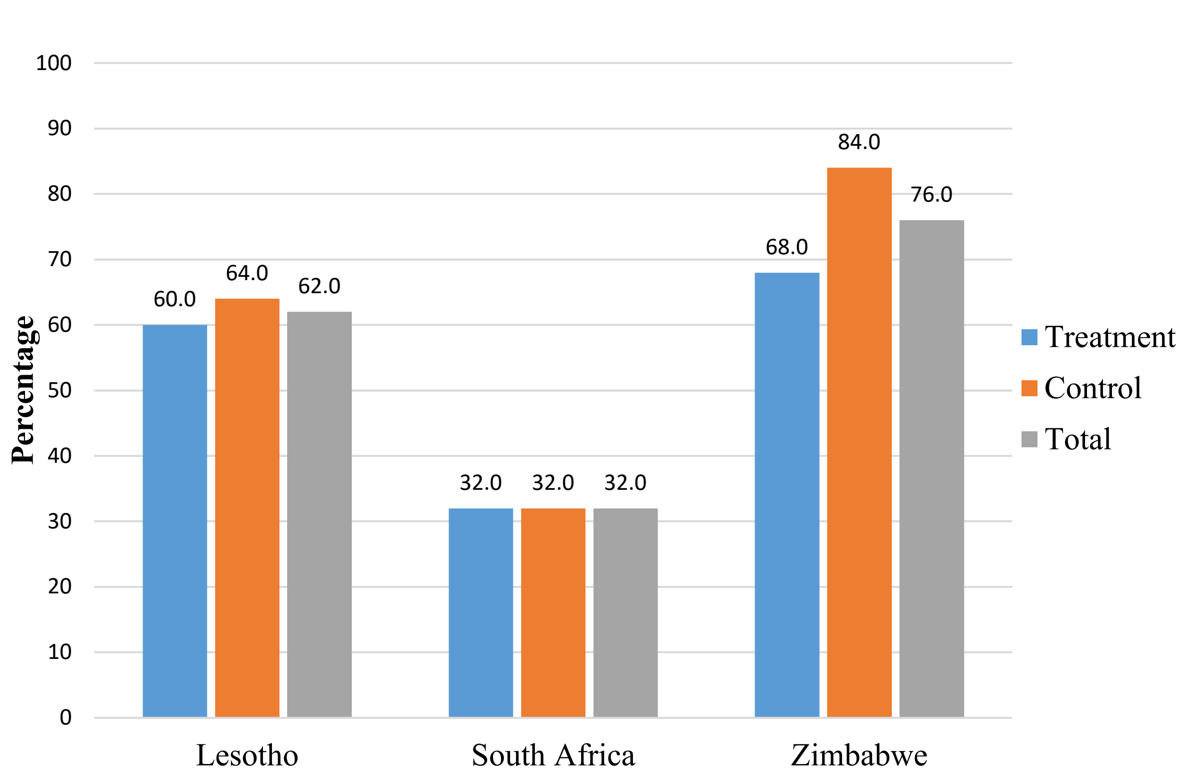
Figure 4.7: Indirect HIV and AIDS impact at baseline, by treatment-control



Note: "Indirect impact" refers to the household respondent knowing someone living with HIV or receiving ARV.

Figure 4.2 shows results pertaining to the question whether the respondent knew a household member living with HIV or a household member taking ARVs, which captured the "direct" impact of HIV and AIDS on households. Based on the responses, the results, as expected, indicate a smaller percentage of households directly impacted by HIV and AIDS, compared to the results shown in Figure 4.1. The proportion of households impacted by HIV and AIDS are lowest in South Africa, 32%, followed by Lesotho, 62% and Zimbabwe 76%. Treatment and control differences indicate that, control households in Lesotho and Zimbabwe are impacted more by HIV and AIDS (64% vs 60% in Lesotho and 84.0% vs 68% in Zimbabwe), but with these differences being statistically insignificant. As for South Africa, no group differences were observed. Overall, Figures 4.1 and 4.2 indicate that the poor urban communities where the study was conducted are impacted by HIV and AIDS in general and to a relatively high degree, especially in relation to the "indirect" impact of HIV and AIDS.

Figure 4.8: Direct HIV and AIDS impact at baseline, by treatment-control



Note: "Direct impact" refers to the household respondents knowing a household member living with HIV or receiving ARV treatment.

4.3.2 Morbidity

Figure 4.3 illustrates that the levels of morbidity are relatively high, which is expected given the relatively high extent of impact on the community of HIV and AIDS (see Figure 4.1 and Figure 4.2). In Lesotho, the incidence of morbidity is 40%. Morbidity is more prevalent in the control group than the treatment group, (48% vs 32%) although the difference is not statistically significant. Of the reported illnesses, HIV and AIDS and related illnesses such as tuberculosis and diarrhoea, possibly due to underreporting, are not as common as one would think. However, the fact that various HIV and AIDS infected household members are on ARV treatment (71.4%) could explain this result. In South Africa, in terms of the presence of an ill household member(s), households in the treatment group are significantly more affected by morbidity than the control group: (72% vs 68%). This difference is, however, statistically insignificant. As in Lesotho, the type of reported illness shifted somewhat away from HIV and AIDS and related diseases, and this may be due to access to ARV treatment, as 39.4% of household members are on treatment. In Zimbabwe, the incidence of morbidity is the same for treatment and control households (76%). However, illnesses reported by both treatment and control group household members are mainly non-HIV and AIDS-related, which may be the result of high levels of access to ARV treatment. More than seven in ten respondents reported someone resident in the household being on ARV treatment (73.3%). Overall, the morbidity rates obtained from the present study show that households experienced high incidences of morbidity, as one would expect in urban communities facing high HIV prevalence rates.

Figure 4.9: Households with ill members(s), by treatment-control - baseline

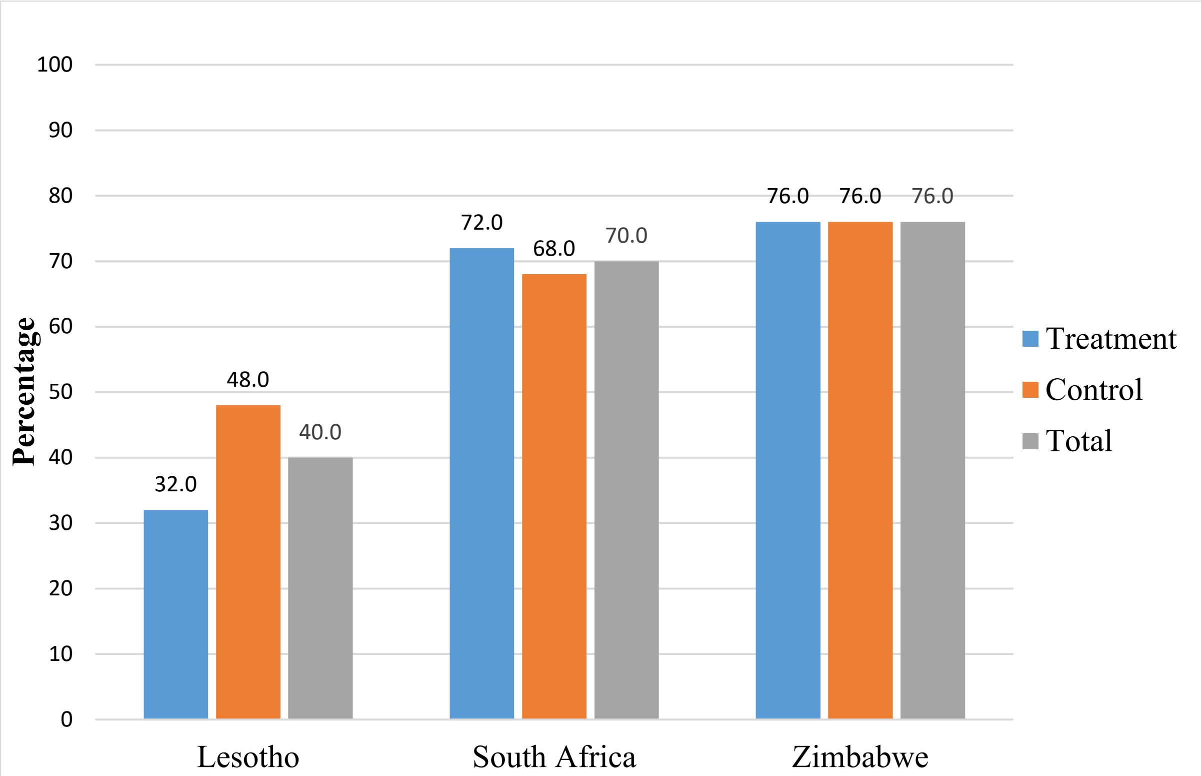
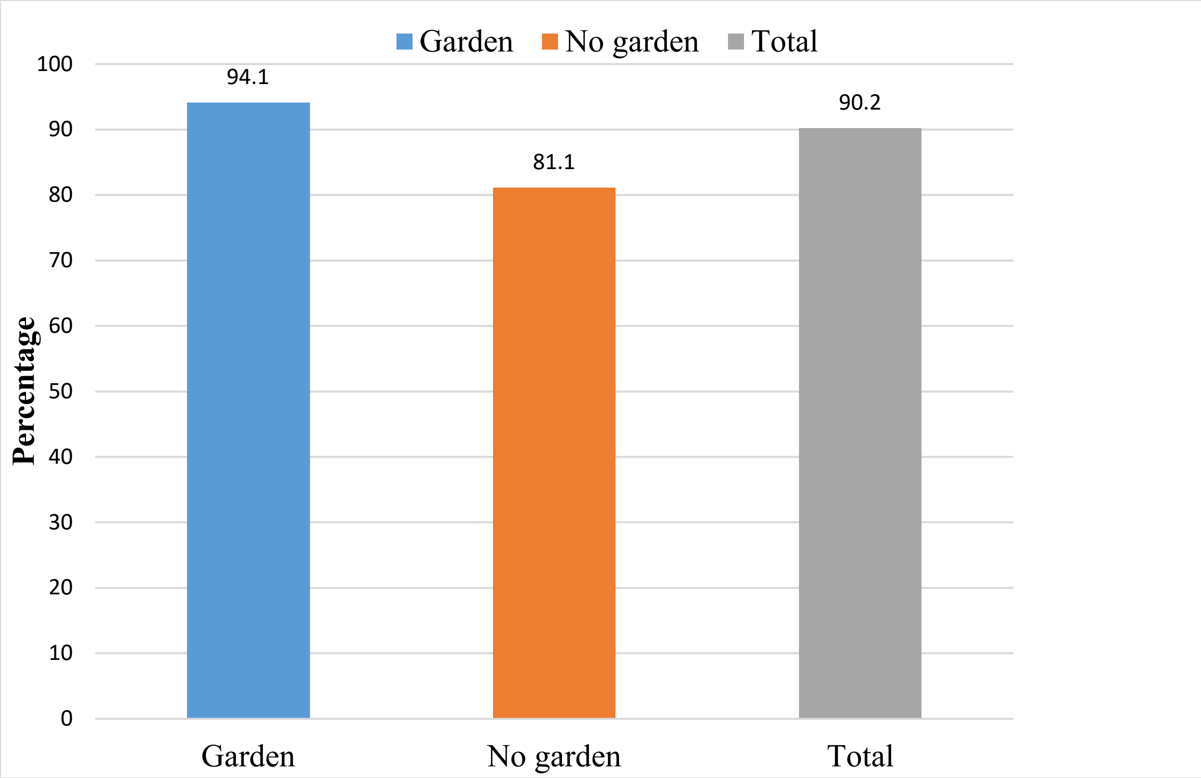


Figure 4.4 show results based on garden and no garden comparisons and indicate that the sampled households are generally "indirectly" impacted by HIV and AIDS (90.2%). Comparisons by garden and no garden groupings indicate that a statistically significant higher proportion of households in the garden group than households in the no-garden group are impacted by HIV and AIDS (94.1% vs 81.1%, p<0.000).

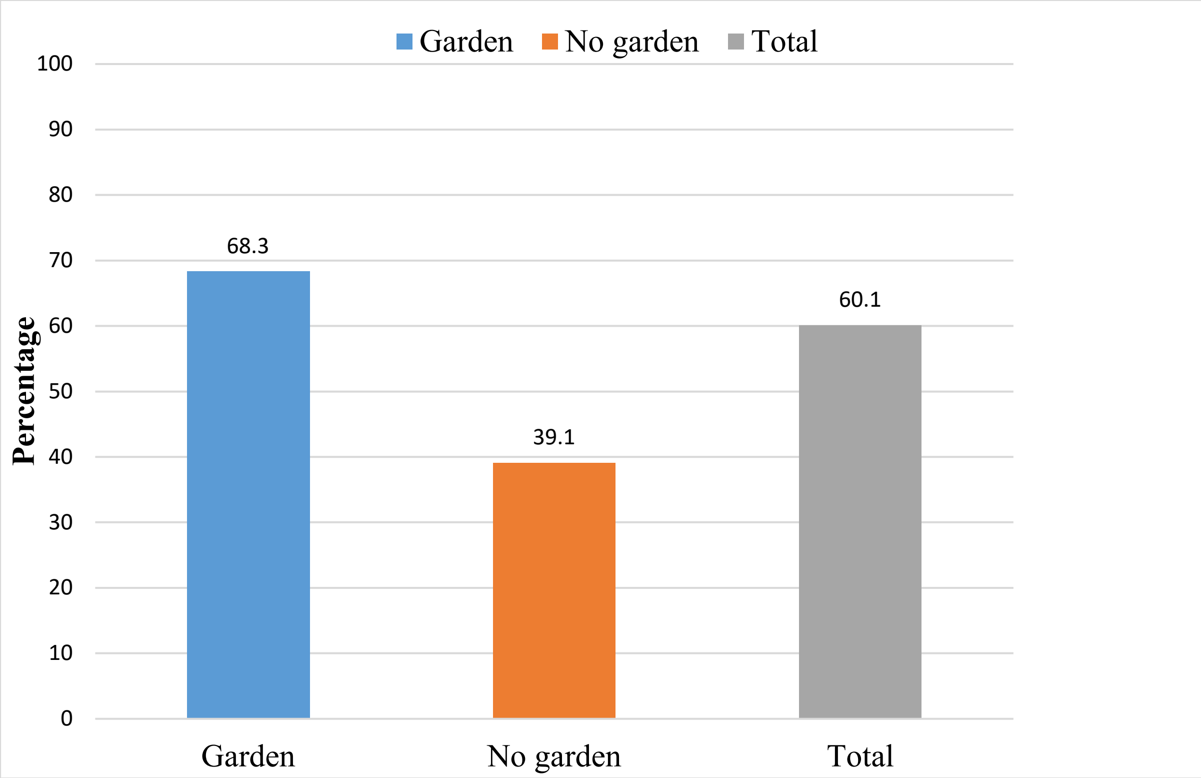
Figure 4.10: Indirect HIV and AIDS impact, by garden status



Note: "Indirect impact" refers to the household respondent knowing someone living with HIV or receiving ARV.

Figure 4.5 shows that more households in the garden group than in the non-garden group are "directly" impacted by HIV and AIDS (68.3% vs 39.1%, $p<0.000$). This difference is statistically significant. This could be attributed to the fact that programme households, who are also part of the garden group, were selected *via* the NGOs involved in HIV and AIDS counselling and care (see Chapter 3, Section 3.2, page 42).

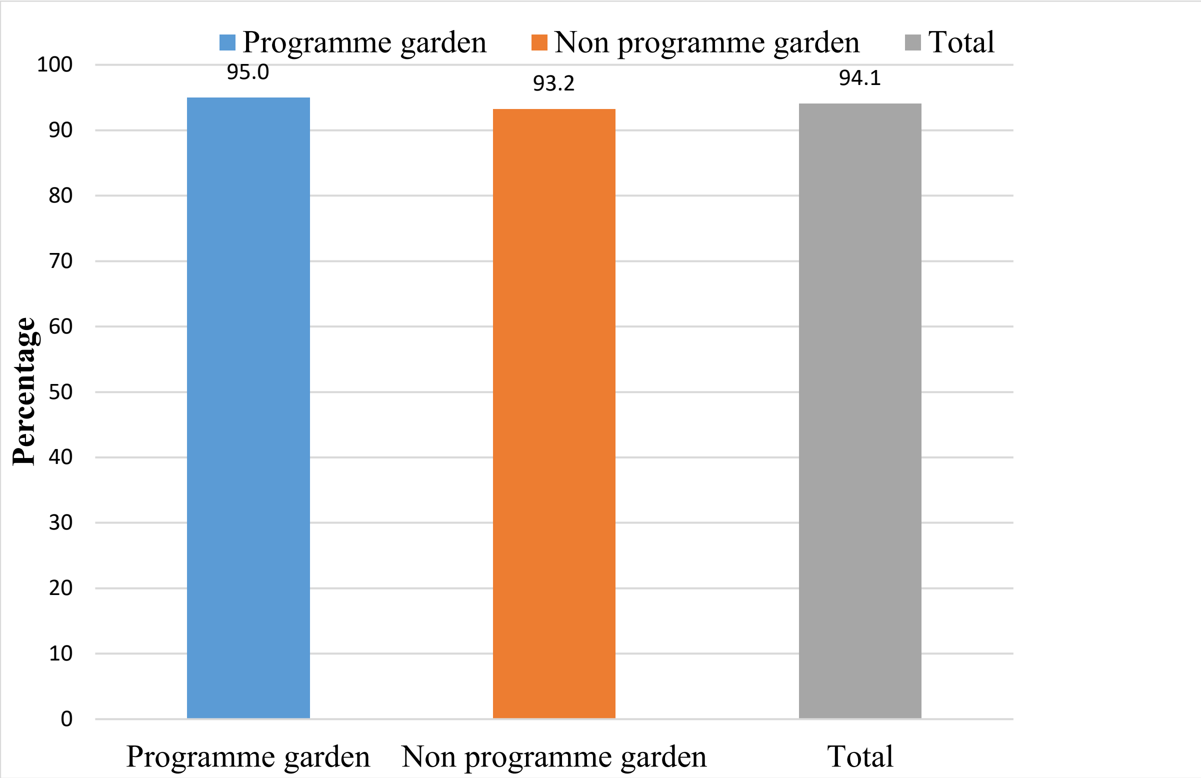
Figure 4.11: Direct HIV and AIDS impact, by garden status



Note: "Direct impact" refers to the household respondents knowing a household member living with HIV or receiving ARV treatment.

Figure 4.6 reports the "indirect" impact of HIV and AIDS, differentiating between households in the programme garden group and households in the non-programme garden group. Results show that households in the programme group are slightly more impacted by HIV and AIDS compared to households in the non-programme garden group (95% vs 93.2%) and this difference is not statistically significant.

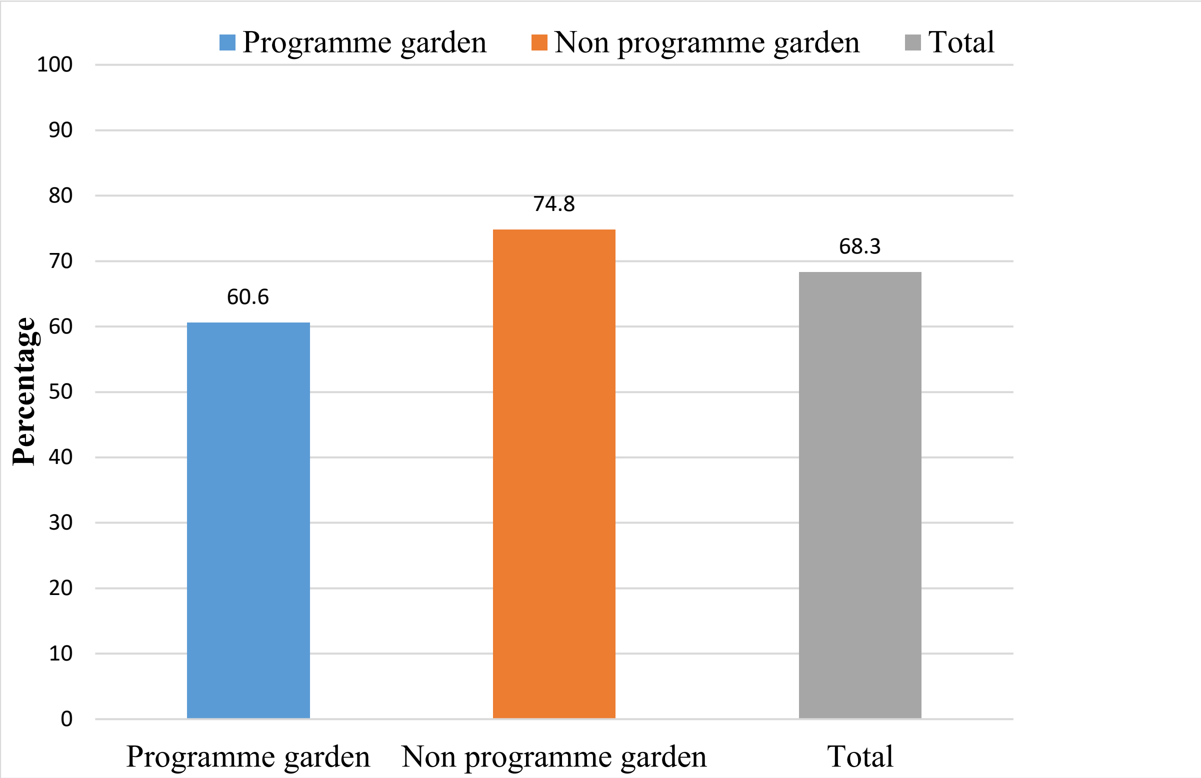
Figure 4.12: Indirect HIV and AIDS impact, by programme and non-programme garden status



Note: "Indirect impact" refers to the household respondent knowing someone living with HIV or receiving ARV.

Figure 4.7 indicates that households in the non-programme garden group are impacted more "directly" by HIV and AIDS compared to households in the programme garden group (74.8% vs 60.6%). This difference is statistically significant, ($p < 0.05$).

Figure 4.13: Direct HIV and AIDS impact, by programme - non-programme garden status



Note: "Direct impact" refers to the household respondents knowing a household member living with HIV or receiving ARV treatment.

Figure 4.8 shows that households in the garden group are more likely to have an ill household member(s) compared to households in the non-garden group (49% vs 43.8%), although this difference is not statistically significant.

Figure 4.14: Households with ill members(s), by garden status

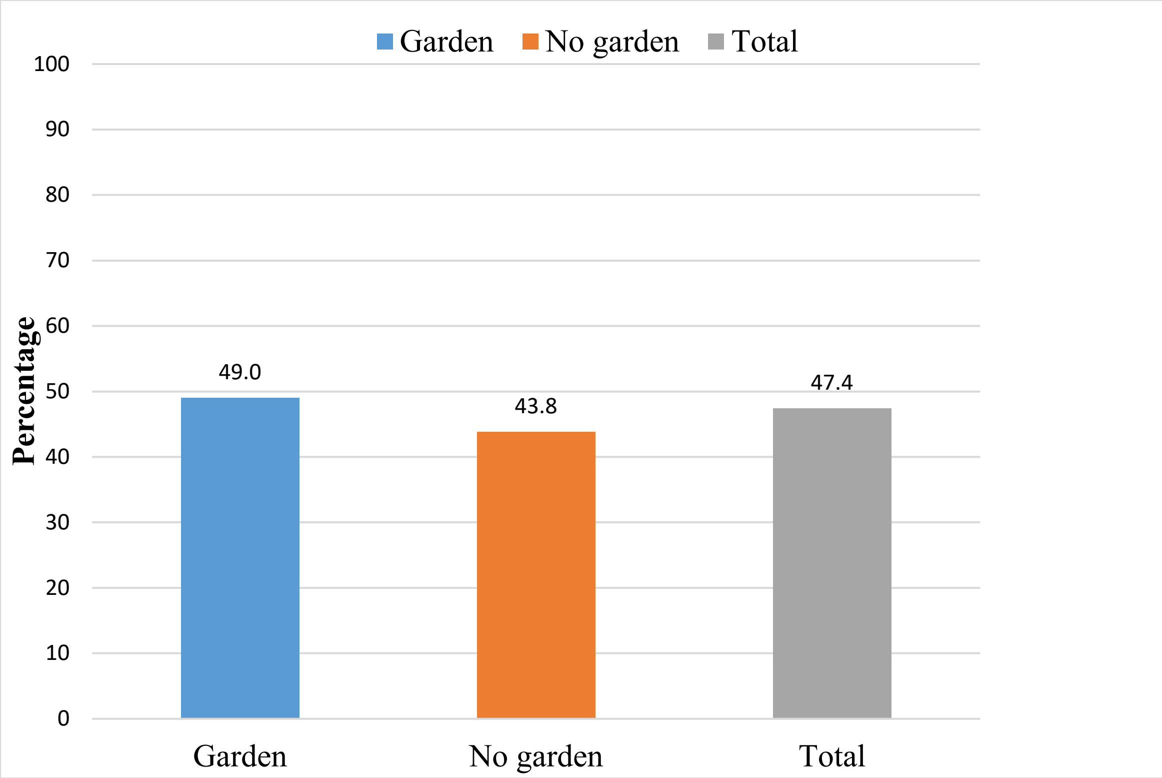
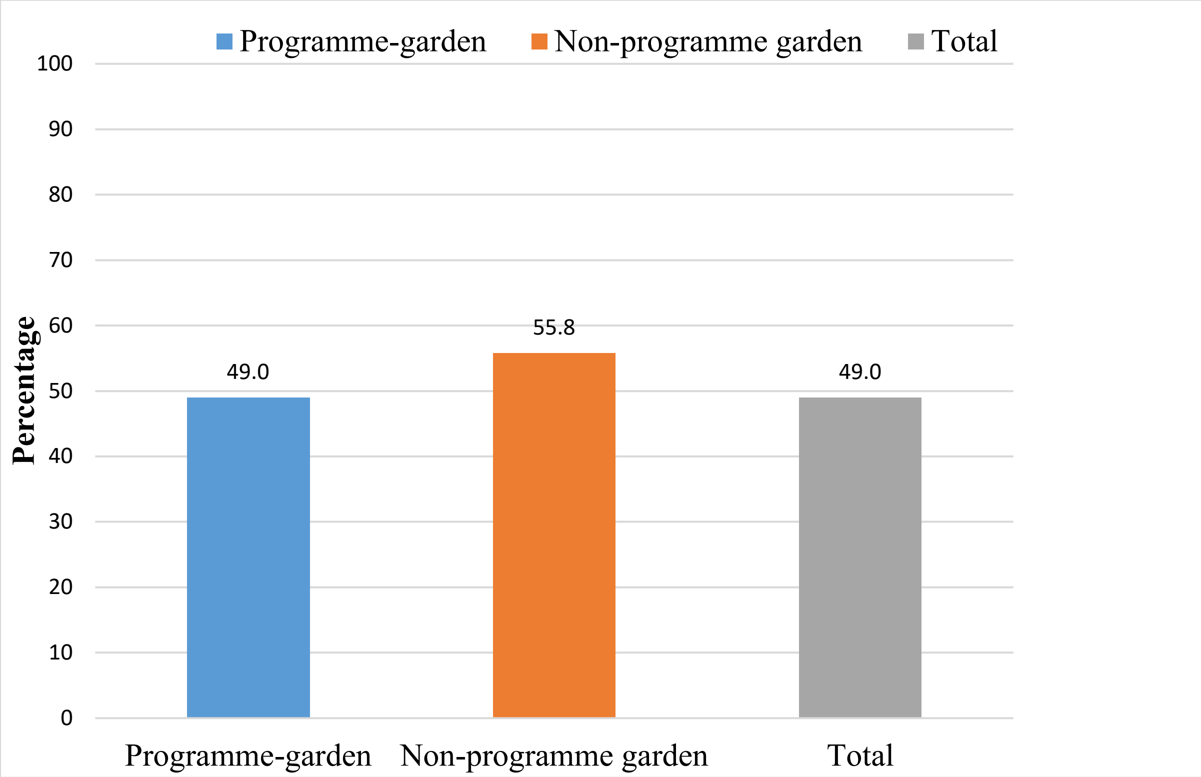


Figure 4.9 shows that morbidity is statistically significantly more prevalent in the non-programme garden group than in the programme garden group (55.8% vs 49.0%, $p<0.05$). This is contrary to the expectation that programme garden group households are more likely to have higher prevalence of morbidity since they were selected *via* NGOs involved in HIV and AIDS counselling and care (see Chapter 3, Section 3.2, page, 42).

Figure 4.15: Households with ill members(s), by programme - non-programme garden status



4.4 The food system

In this section, the emphasis is on the role of gardens as a food source. Attention is paid to both the prevalence and frequency of using the garden as a food source. The relative importance of a food source is also indicated by the frequency with which a household sources food from it since the fact that a household relies on a particular source for some of their food says nothing about how often it obtains food from this source. In addition, attention is also paid to food remittances from household food gardens, as these represent an important component of the food supply system of household food gardens. The evidence from the three countries is discussed in turn: Lesotho and South Africa, followed by Zimbabwe.

Figure 4.10 show the various food sources for Basotho households at baseline. Results indicate that in both treatment and control households, supermarkets (84% vs 100%), gardens (84% vs 84%), small shops (68% vs 60%), informal markets (36% vs 48%), and remittances (28% vs 20%), feature as the top five aggregate prominent food sources. The relative importance of the top five main food sources shifts however when households are asked how frequently they obtained food from each source. Supermarkets, small shops and informal markets, although indicated as important food sources, are less frequented daily by treatment and control households: (9.5% vs 4%; 22.2% vs 6.0%; 22.2% vs 6.0%) respectively. Gardens are a relatively utilised food source by Basotho households and their importance as a food source is depicted by the frequency with which food is sourced from them. When treatment and control households are combined, four in ten households indicate consuming food garden produce at least five days a week (Figure 4.13). More households in the treatment group than control group (57% vs 29%) frequently use gardens at least five days a week at baseline than control households, with this difference being statistically significant ($p<0.10$) (Figure 4.10). When it comes to the prevalence of the use of other food sources, differences between treatment and control households indicate that comparison households (100% vs 84%, $p<0.05$) are more likely to use supermarkets as a food source than households in the treatment group.

In the summer season, as indicated in Figure 4.11, with the introduction of programme gardens, the use of gardens as a food source increase marginally in the treatment group from 84% (baseline) to 100% (summer), indicating an increased importance of gardens as a food source between baseline and summer as expected. The use of the garden as a food source in the treatment group falls marginally in winter from 100% in summer to 96% (Figure 4.12). In summer and winter seasons, the use of the garden as a food source in the treatment group exceeded that in the control group (100% vs 15.7%; 96% vs 85%) respectively, with statistical significance in the summer season ($p<0.01$). The frequency of getting food from the garden also increased markedly over time in the treatment group, further indicating the increased relative importance of gardens as a food source. The proportion of treatment households harvesting at least five days a week increased from 57% (baseline) to 67% (summer) to 75% (winter) as shown in Figure 4.13. In summer and winter, the frequency of use of the garden at least five days a week in the treatment group exceeded that in the control group, (67% vs 33%; $p<0.05$) and (75% vs 29%; $p<0.05$), respectively, with a statistically significant difference observed in both summer and winter seasons. A counter-intuitive trend is observed in the control group with regards to the frequency with which control group households source food from the garden, with the percentage first dropping significantly between baseline and summer (84%versus 15.7%) and then increasing between summer and winter season (15.7% versus 85%). This is the result of the fact that these household had had household food gardens in the year leading up to the study, but not at the time the recruitment phase of the study was conducted. Between summer and winter however many households had started their own household food gardens.

Figure 4.16: Baseline food sources - Lesotho

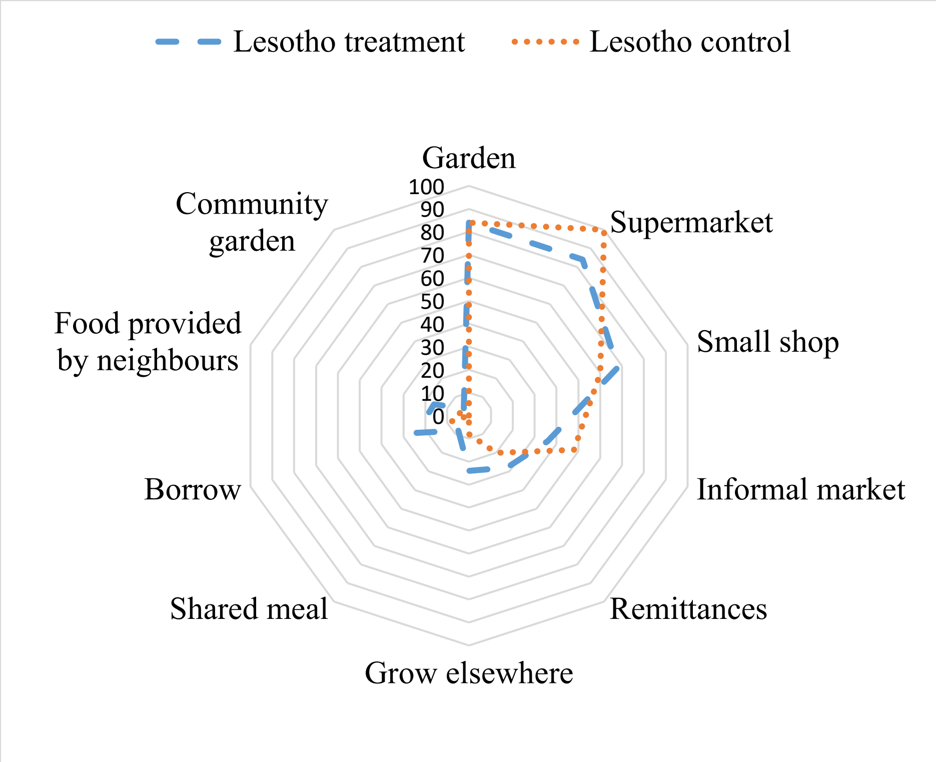


Figure 4.17: Summer food sources - Lesotho

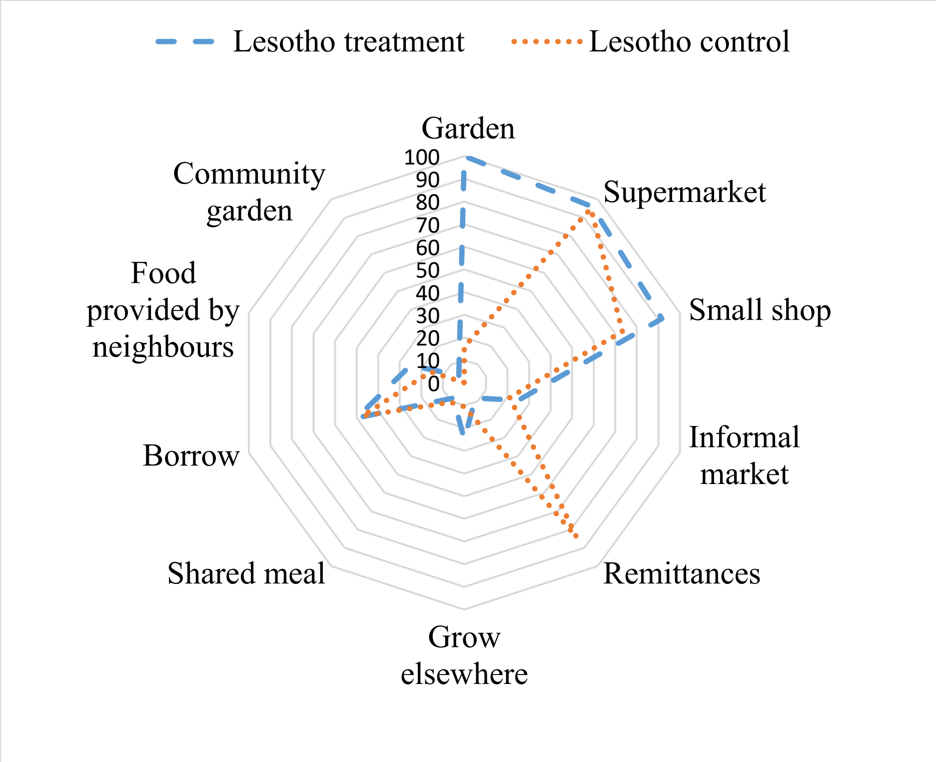


Figure 4.18: Winter food sources - Lesotho

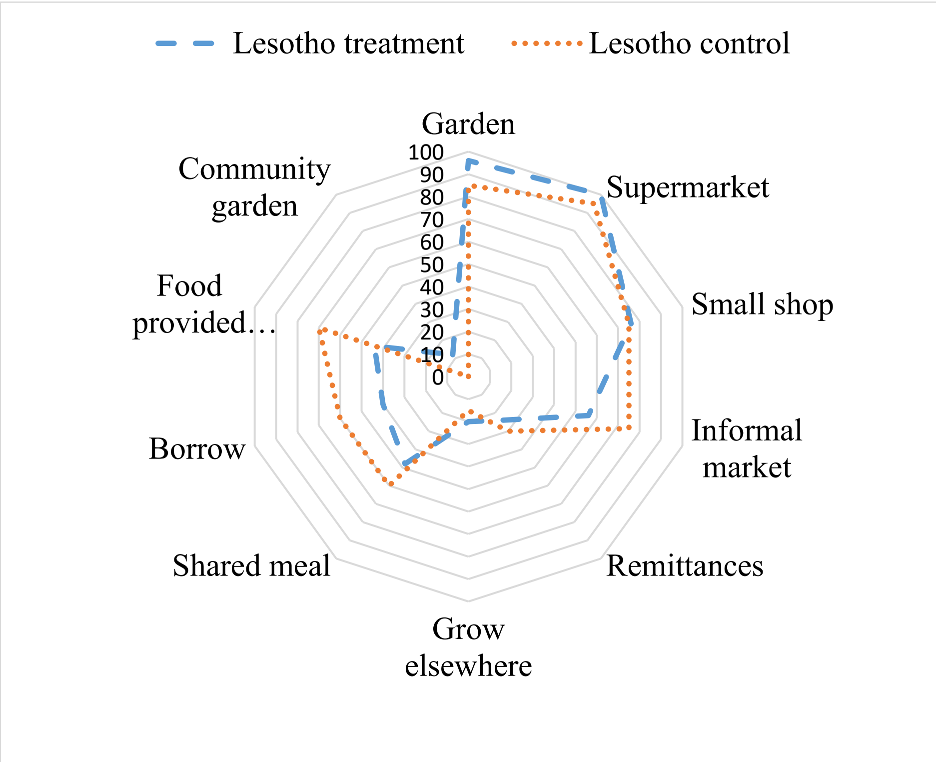
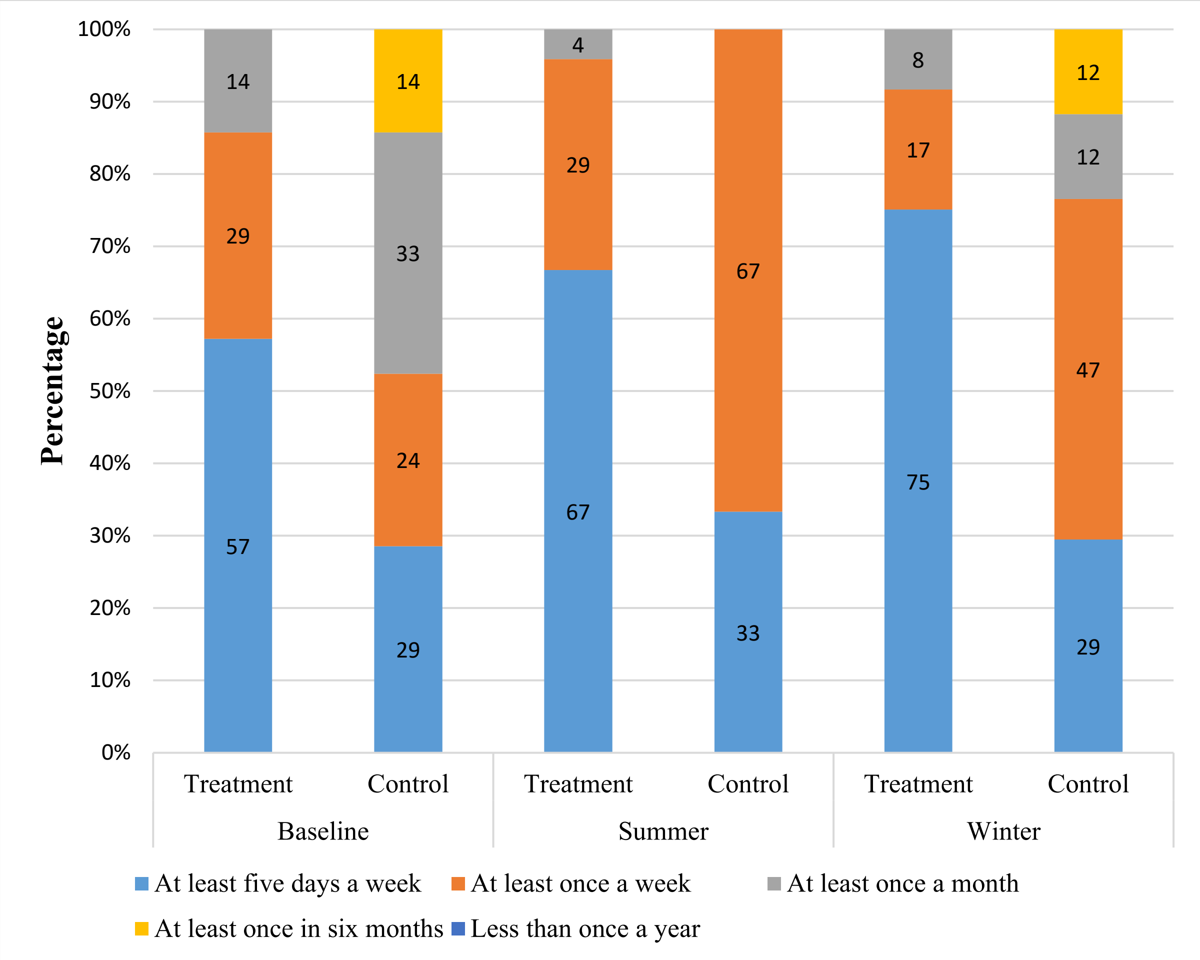


Figure 4.19: Frequency of accessing food from own gardens - Lesotho



At baseline, the top aggregate five food sources for South African treatment and control households are supermarkets (96%), informal markets (94%), sharing of meals (70%), small shops (64%) and community food kitchens (60%), (Figure 4.14). Other food sources in both treatment and control households include food grown elsewhere, food provided by neighbours, and food from a community food garden (54%; 52%; 42%) respectively, which can indirectly originate from household gardens (Figure 4.14). Although supermarkets are indicated as the first important food source, none of the treatment and control households frequent them at least five days a week. When it comes to the prevalence of the use of other food sources, households in the treatment group more often report sourcing food from community food gardens (54% vs 28%; $p<0.05$) and community soup kitchens (72% vs 48%) with weakly statistical significance ($p<0.10$) than did households in the control group. Importantly, treatment and control households are however relatively similar at baseline.

In summer and winter, as expected, gardens featured as top five prominent food sources, ranking 3rd in summer and 5th in winter (Figures 4.15 & 4.16). On aggregate, the proportion of households indicating using the garden as a food source increased from 12% (baseline) to 61.2% (summer) to 64.5% (winter) (Figure 4.15 & Figure 4.16). Figure 4.15 and Figure 4.16 show that significantly more households in the treatment group than control group use the garden as a food source in summer (92% vs 29.1%, $p<0.01$) and in winter (100% vs 26%; $p<0.01$). When the frequency of getting food from the garden is considered, compared to baseline where gardens are frequented less than once a year, gardens became a relatively frequently accessed food source that was accessed at least five days a week in summer (50%) and at least once a week in winter (72%) on aggregate (Figure 4.17).

The frequency of use of the gardens as a food source increased in the treatment households between baseline, summer and winter. At baseline, none of the treatment households reported using gardens at least once a week or at least once a day. By summer season, almost five in ten households (48%) of the treatment households indicate sourcing food from the garden at least five days a week, with (39%) indicating sourcing food at least once a week (Figure 4.17). In winter, most of the treatment households obtained food from the garden at least once a week (72%) (Figure 4.17). The frequency with which households in the control group with household food gardens source food from gardens at least five times a week is higher than that of households in the treatment group in both summer (57% vs 48%) and winter (33% vs 0%; $p<0.01$) seasons, with statistical significance in winter season. When treatment and control groups are compared considering the prevalence of the use of the other food sources, indications are that remittances are a more common food source in the treatment group than in the control group in winter (32% vs 8.7%; $p<0.05$). In addition, treatment households are also more likely to use food grown elsewhere (12% vs 0%; $p<0.10$), compared to control households, with statistical significance in winter, although the proportion of treatment households using food grown elsewhere in treatment is lower in summer (4%) and winter (12%), compared to baseline (56%). This may be associated with the fact that treatment households substituted the use of food grown elsewhere with food from their own household food gardens. As was the case in Lesotho, more households in the control than treatment group used food provided by neighbours as a food source in winter (78% vs 44%), a difference that is statistically significant ($p<0.05$).

Figure 4.20: Baseline food sources - South Africa

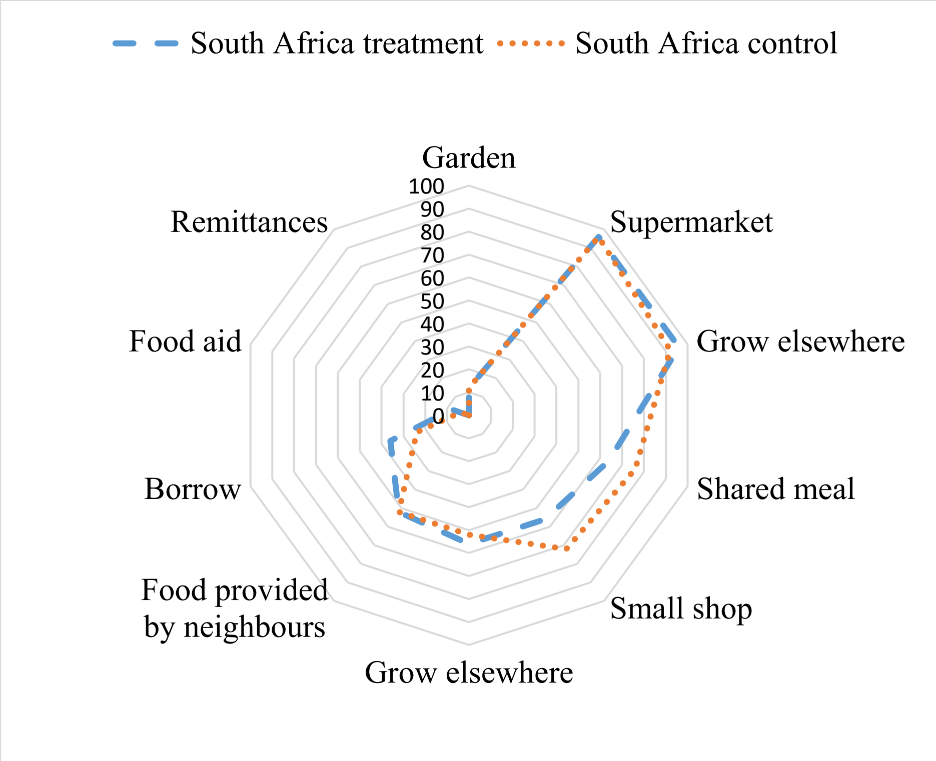


Figure 4.21: Summer food sources - South Africa

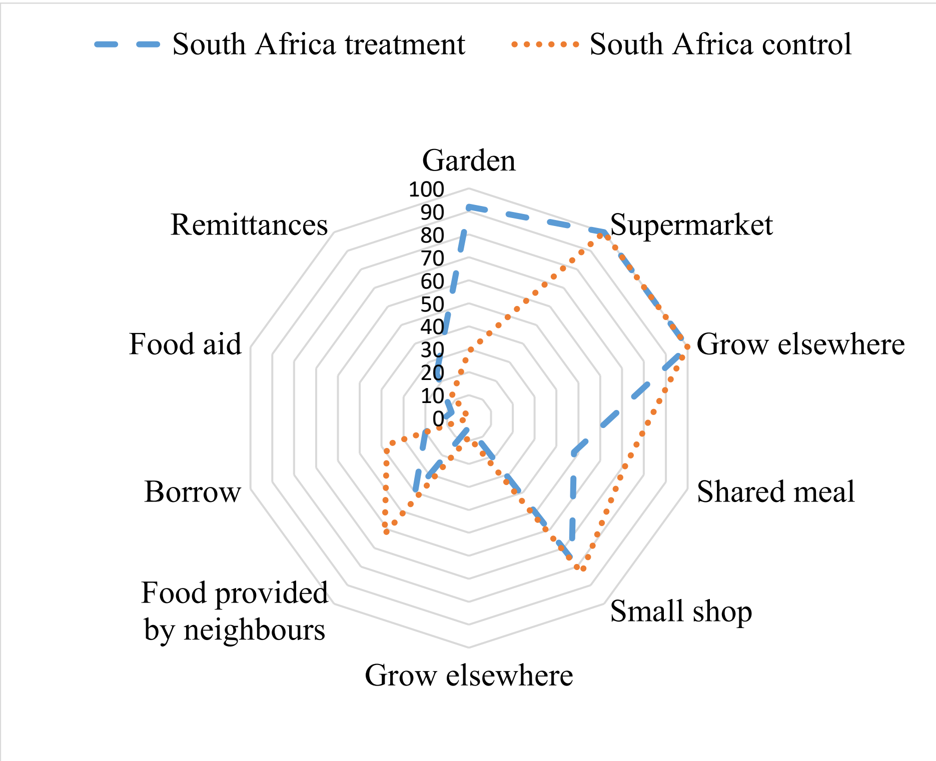


Figure 4.22: Winter food sources - South Africa

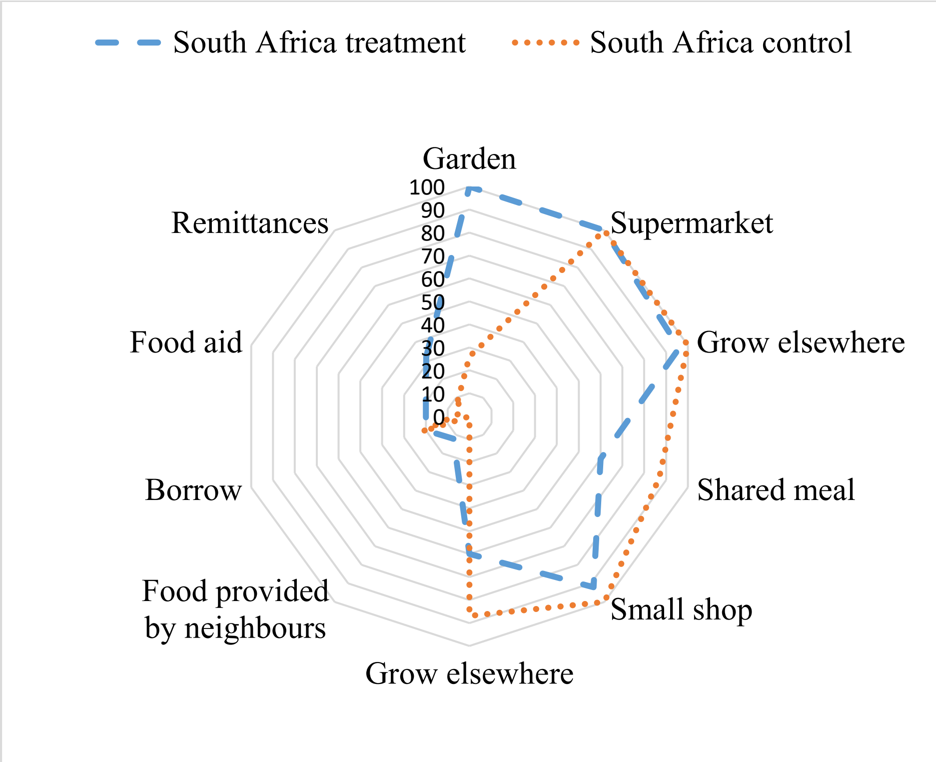
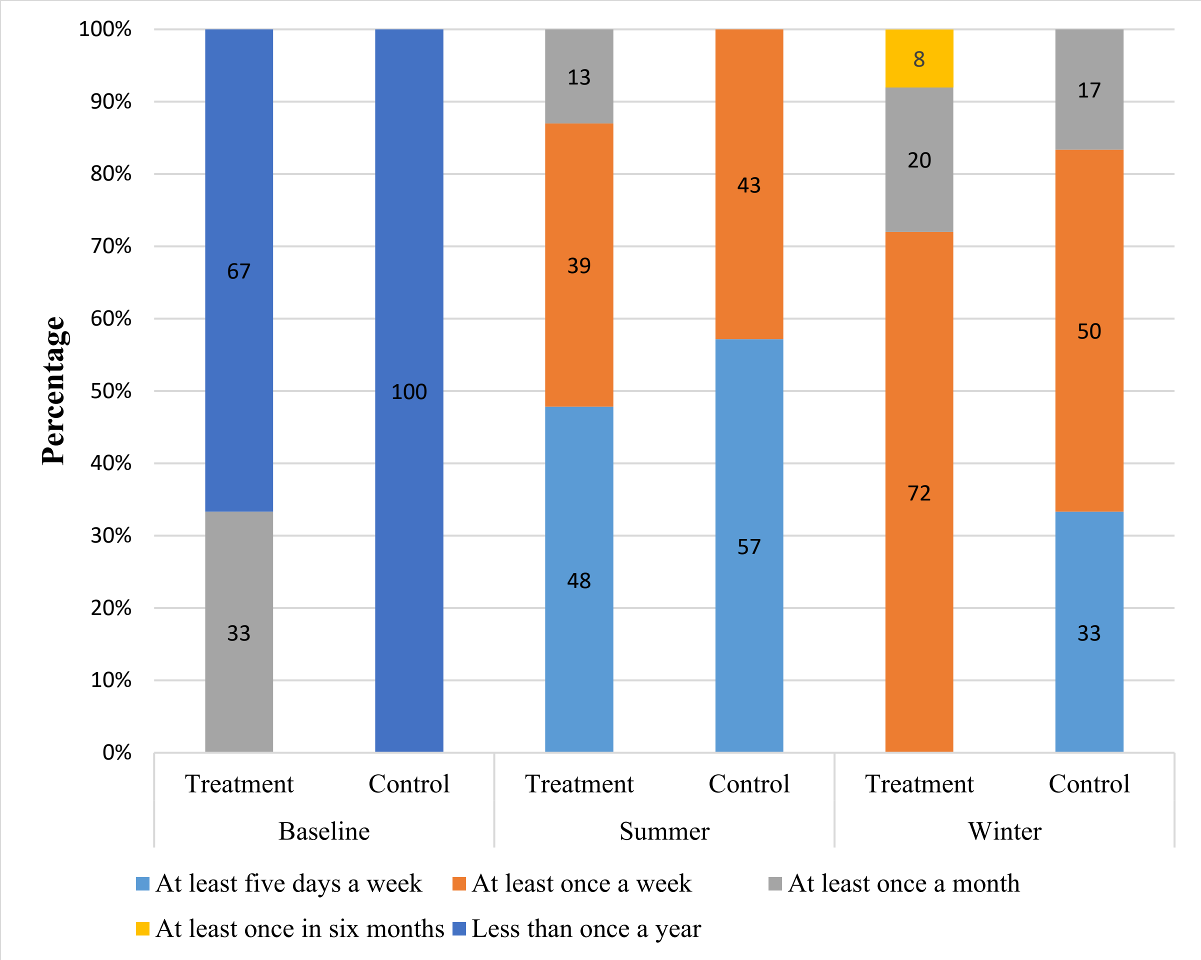


Figure 4.23: Frequency of accessing food from own gardens - South Africa



Figures 4.18 to 4.20 show the various food sources used by Zimbabwean households. At baseline, the prominent food sources for the Zimbabwean treatment and control households are gardens, small shops, growing food elsewhere, informal markets and supermarket (100%; 90%; 74%; 70%; 64%), respectively, with gardens featuring as a priority food source (Figure 4.18), both in the treatment and control groups. When the differences between the treatment and control groups are considered, regarding the prevalence of the use of different food sources, food remittances are a more important food source among households in the control group (60% vs 20%; $p<0.05$) than within households in the treatment group (Figure 4.18).

In the summer season, gardens are slightly less prominent in the hierarchy of food sources, and they swap places with small shops and are ranked 2nd (Figure 4.19). Gardens retain their position as priority food source in the winter season (Figure 4.20). Regarding the frequency with which the garden is used, the proportion of households in the treatment group who obtain food at least five days a week was higher than in the control group in both summer (96% vs 78%) and winter (83% vs 79%) seasons (Figure 4.21). These differences are particularly stark in summer and least in winter, although not statistically significant. With regards to the prevalence of the use of other food sources, households in the treatment group in winter are almost twice as likely to use borrowing as a food source compared to control households (54.1% vs 28.0%; p<0.10).

Figure 4.24: Baseline food sources - Zimbabwe

Figure 4.25: Summer food sources - Zimbabwe

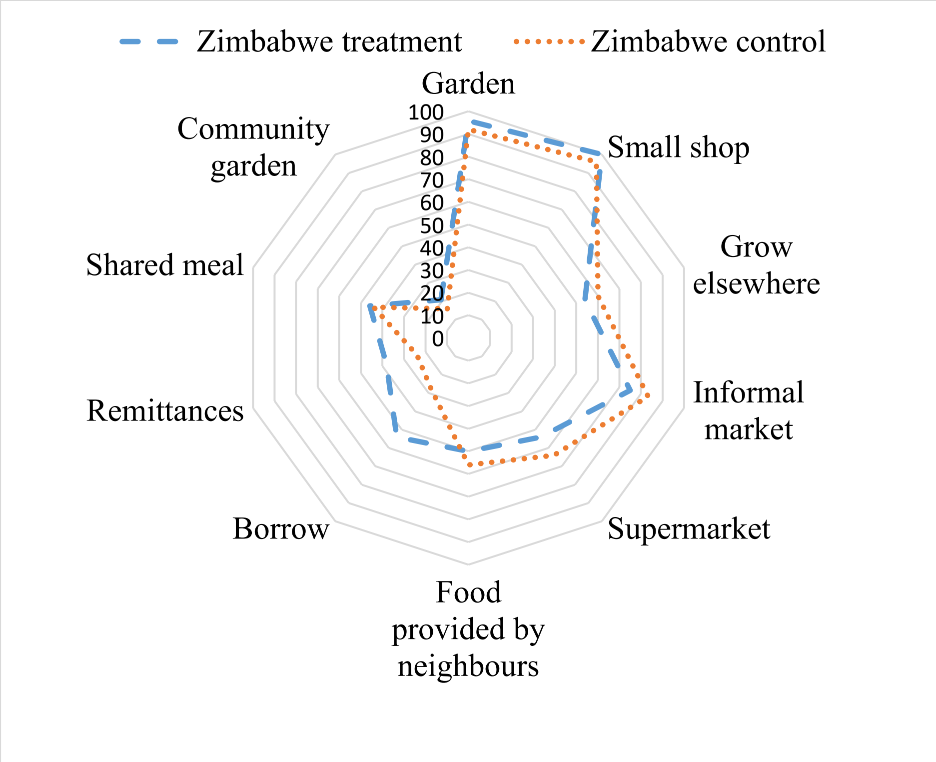


Figure 4.26: Winter food sources - Zimbabwe

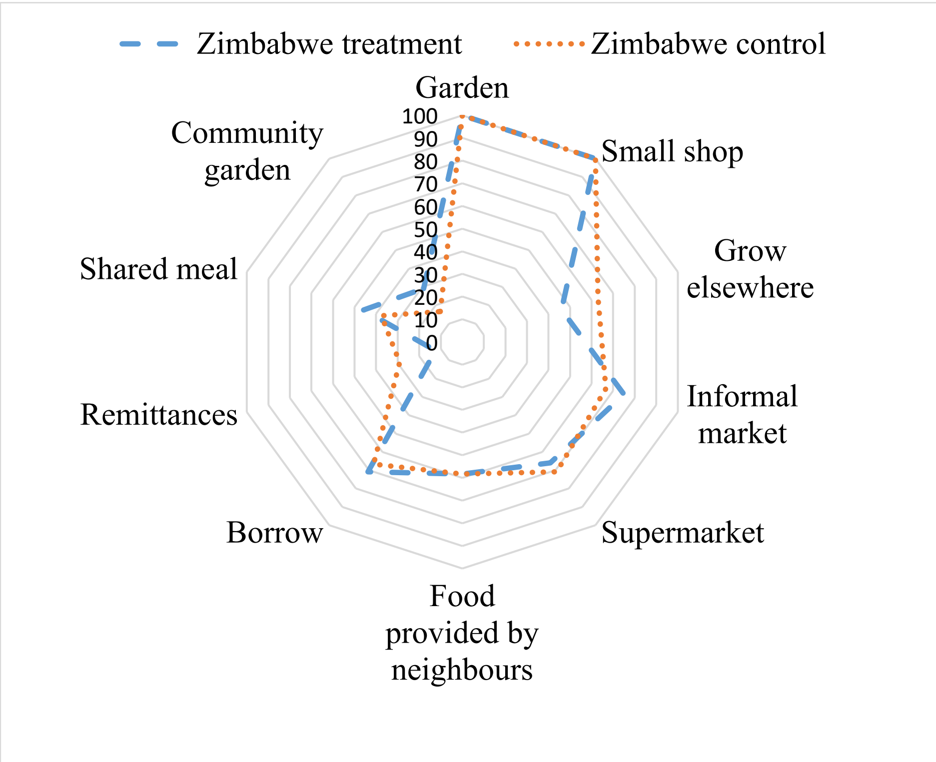
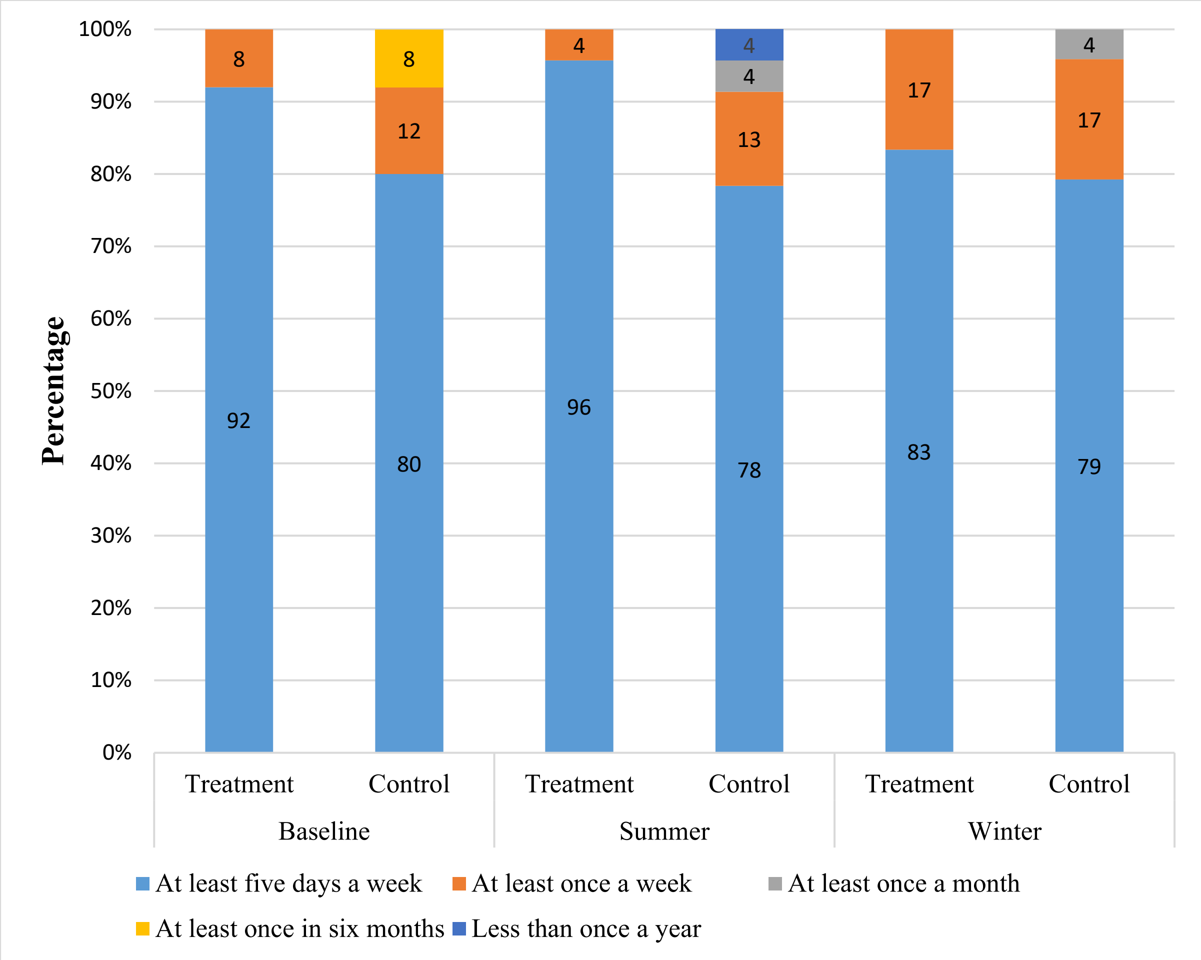


Figure 4.27: Frequency of accessing food from own gardens - Zimbabwe

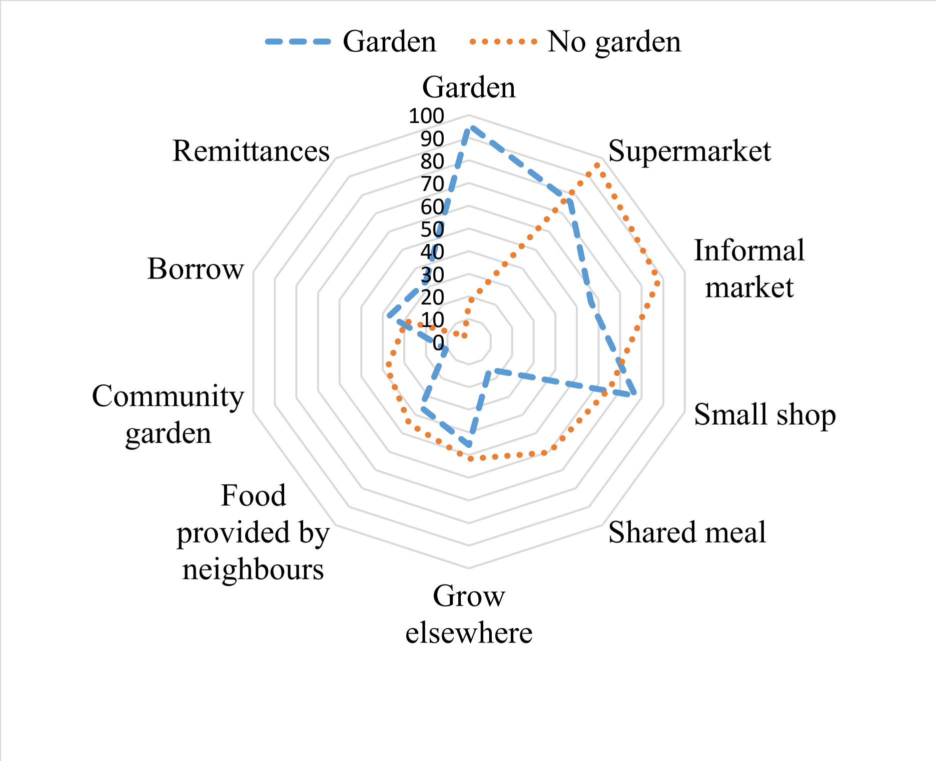


Country comparisons indicate that with regards to the use of different food sources, on aggregate, supermarkets and small shops consistently feature among the top five food sources in each of the three countries in each season. In Lesotho, these are the 1st, and 3rd ranked sources (baseline), 1st and 2nd (summer) and 1st and 2nd (winter), while in South Africa these are ranked 1st, and 4th (baseline), 1st and 3rd (summer) and 1st and 3rd (winter). In Zimbabwe, small shops rank 2nd and supermarkets rank 5th (baseline), 1st and 4th (summer) and 1st and 5th (winter). Gardens feature consistently among the top five food sources throughout in Zimbabwe and Lesotho. Gardens are ranked 1st (baseline), 2nd (summer) and 1st (winter) food sources in Zimbabwe and 2nd (baseline), 3rd (summer) and 2nd (winter) food source in Lesotho. The prominence of gardens in the food system, and in particular the role of households' gardens as a food source in Lesotho and Zimbabwe suggest the importance of household food gardens in household food security enhancement. Compared to Lesotho and Zimbabwe, gardens, as expected, do not feature as a top five food source at baseline in South Africa because the sampling strategy included only households with no gardens. Gardens however feature as a top five food source in summer and winter season and are ranked 4th and 5th respectively in South Africa. The lower ranking of gardens in South Africa, compared to Lesotho and Zimbabwe, indicate a low prevalence of household food gardens in South African households. It also reflects the fact that subsistence agriculture more generally is far less common in South Africa than in other SADC countries.

The differences across countries in the sample composition outlined in Chapter 3 (see Chapter 3, Section 3.4, page, 46) mean that country comparisons are fraught with difficulty and that the results thereof should be interpreted with caution. Country comparisons based on treatment groups show that the use of gardens as a food source over baseline-summer-winter increase notably in South Africa, compared to Lesotho and Zimbabwe, where gardens consistently remained a very prominent food source; 12% to 92% to 100% (South Africa) vs 84% to 100% to 96% (Lesotho) and 100% to 95.8% to 100% (Zimbabwe). Although the use of the garden as a food source increased in the treatment group in South Africa, the proportion of households in the treatment group that accessed food from gardens at least five days a week in summer is 48% and none in winter as compared to Lesotho's 66% in summer and 75% in winter and Zimbabwe's 97% in summer and 83% in winter. This result may be attributed to the fact that South African households were yet to fully adapt to the use of household food gardening a food source, or the fact that their gardens were giving lower yields, or the realities of different climatic conditions across the countries. When aggregating the cross-country data into a "garden" and "no garden" comparison groups, the following comes to light:

As shown in Figure 4.22, as expected at baseline, gardens as food source feature significantly more in the gardening group compared to the non-gardening group (96.6% vs 17.2%, $p<0.01$). Households in the no-garden group are statistically significantly more likely to use informal markets (87.9% vs 56.5%; $p<0.01$), supermarkets (96.5% vs 76%; $p<0.01$), shared meal (60.3% vs 15.2%; $p<0.01$), community kitchen (53.4% vs 5.4%; $p<0.01$) and community gardens (37.9% vs 10.8%; $p<0.01$) as food sources than households in the garden group, possibly indicating the relative importance of informal food sources in the no-garden group. Households in the garden group are also more likely to use remittances as a food source compared to no-garden group households (32.6% vs 3.4%, $p<0.01$).

Figure 4.28: Baseline food sources, by garden status



In summer, households in the garden group are statistically significantly more likely to use gardens (95.2% vs 8.3%; p<0.01); small shops (90.4% vs 77%, p<0.05) and growing food elsewhere (33.3% vs 11.1%, p<0.05) than households that do not garden. Households that do not garden are statistically significantly more likely to use remittances (47% vs 28.8%; p<0.05) and supermarkets (97.2% vs 80.0%; p<0.05) (Figure 4.23). As in the summer season, households with gardens are more reliant on gardens (98.1% vs 42.4%), small shops (93.5% vs 81.8%; p<0.05), and food grown elsewhere (31.4% vs 9.0%; p<0.05) in winter compared to households in the no garden group. Households that do not garden are more likely to use food provided by neighbours in (79% vs 52%; p<0.05) and supermarkets (100% vs 85.1%; p<0.05) (Figure 4.24). This indicates that informal food sources remain relatively important in household without food gardens.

Figure 4.29: Summer food sources, by garden status

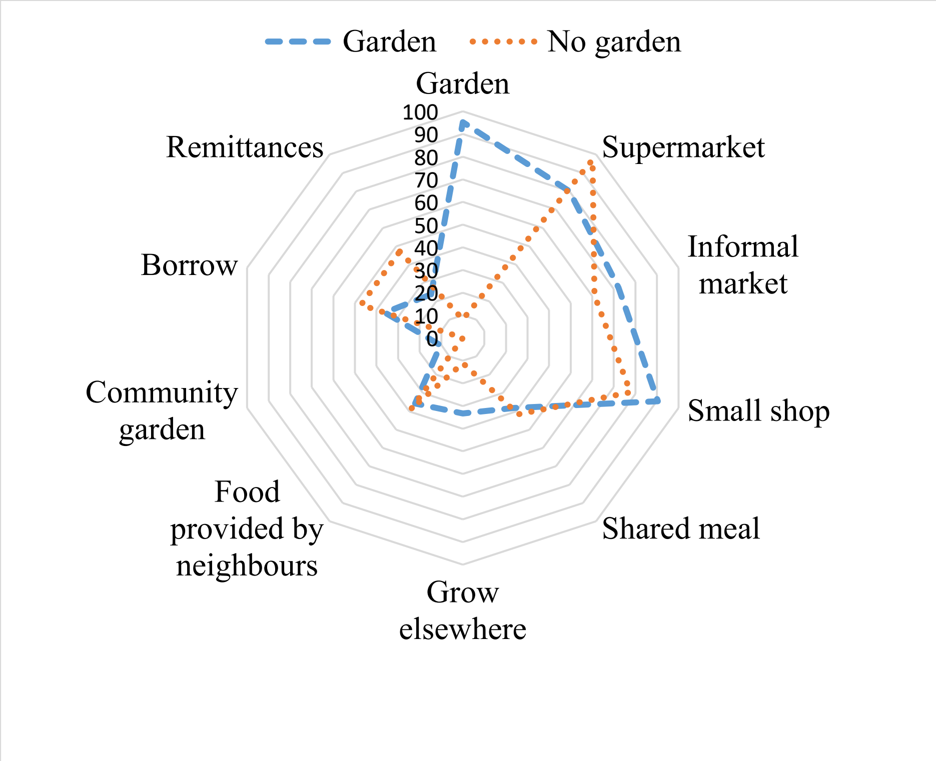
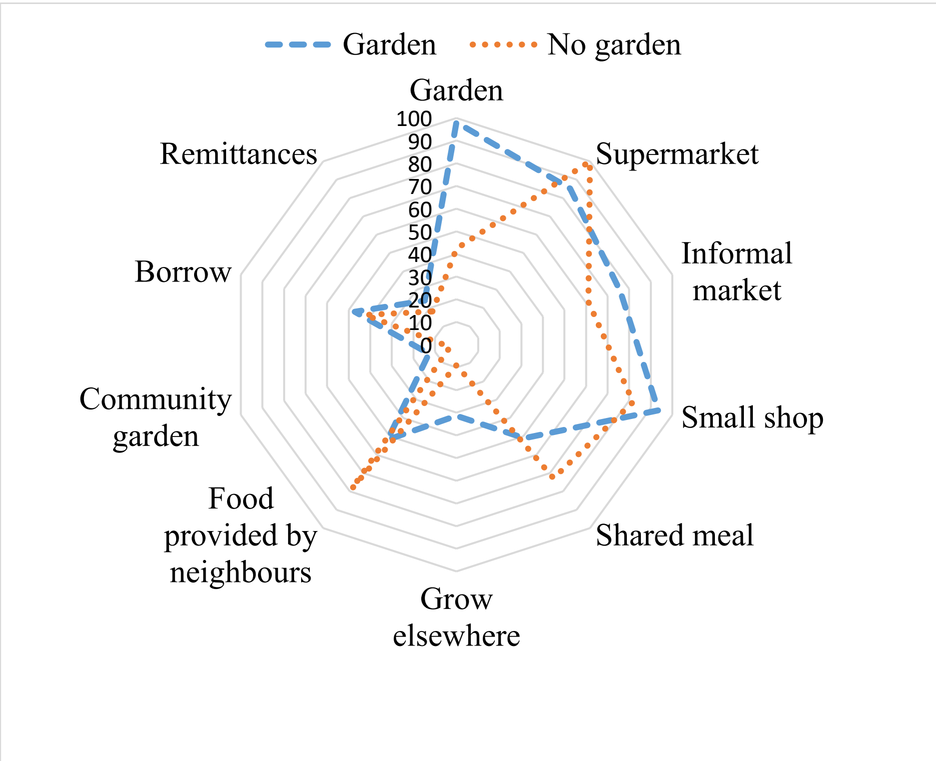
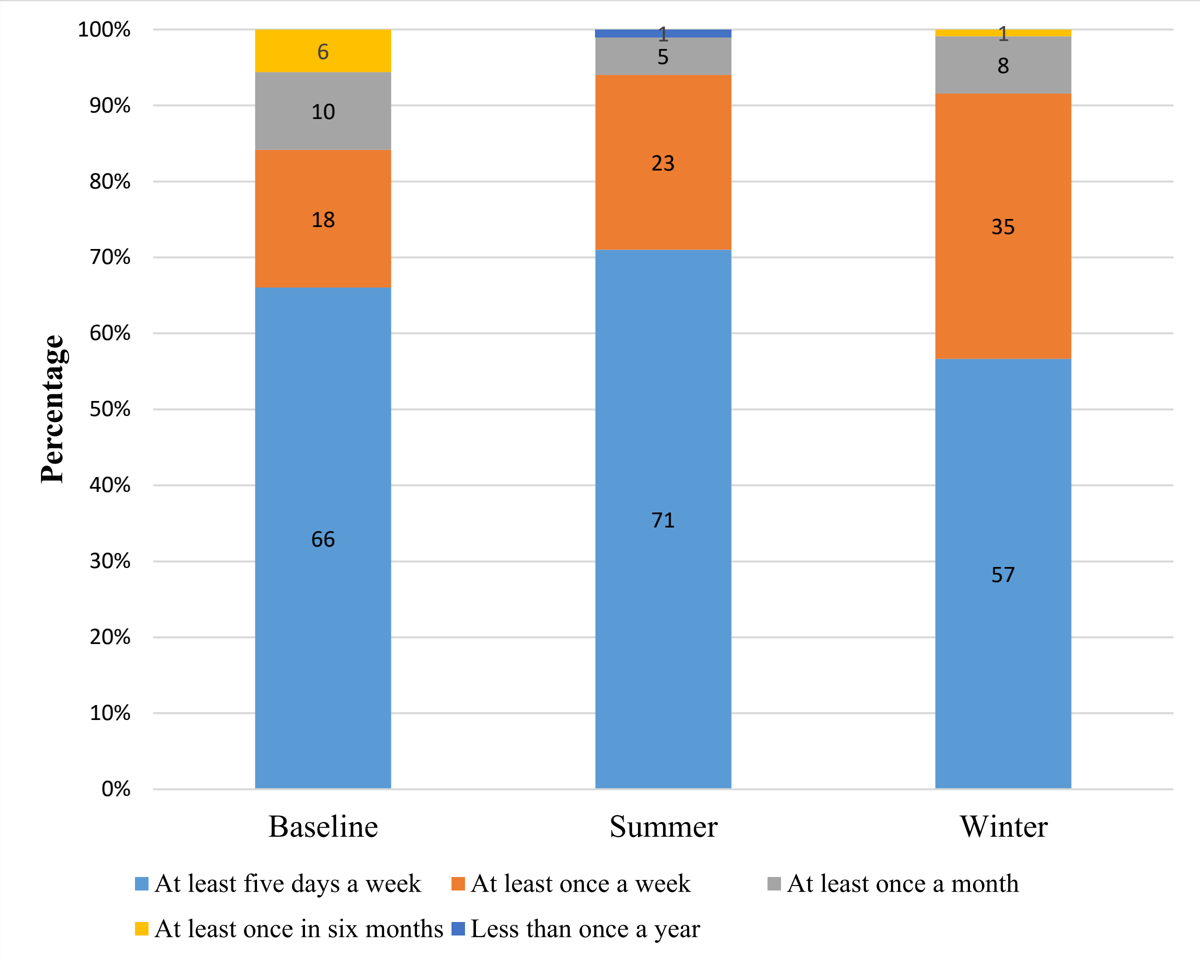


Figure 4.30: Winter food sources, by garden status



The frequency with which food is obtained from a food source signifies the importance of a food source. The frequency of obtaining food from food gardens by households in the garden group (at least five days a week) increased from 66.9% at baseline to 71% in summer but declined to 56.6% in winter (Figure 4.25).

Figure 4.31: Frequency of accessing food from gardens - gardening households



Turning the discussion to programme garden and non-programme garden comparisons brings the following results: Since programme gardens were introduced after baseline, comparisons based on programme and non-programme gardens groupings are only done at two time points; summer and winter. Figure 4.26 and 4.27 considers the main sources of household food according to programme gardens and non-programme gardens groupings and the results show that in both summer and winter, gardens, small shops, supermarkets, and informal markets are the main food sources for both households in the programme garden and non-programme garden groups. In both summer (95.8% vs 93.9%) and winter (98.5% vs 97.3%), households in the programme garden group are slightly more likely to use gardens as a food source than households in the non-programme garden group, although this difference is not statistically significant (Figure 4.26 and Figure 4.27). In summer, households in the non-programme garden group are more likely to use informal shops as a food source than households in the programme garden group (84.3% vs 66.6%, p<0.10) (Figure 4.26). Figure 4.28 shows that the sourcing of food for at least five days per week from food gardens is higher in households in the non-programme garden group than the programme group in both summer (65% vs 52%) and winter (75% vs 70%). These differences are not statistically significant.

Figure 4.32: Summer food sources, by programme - non-programme garden status

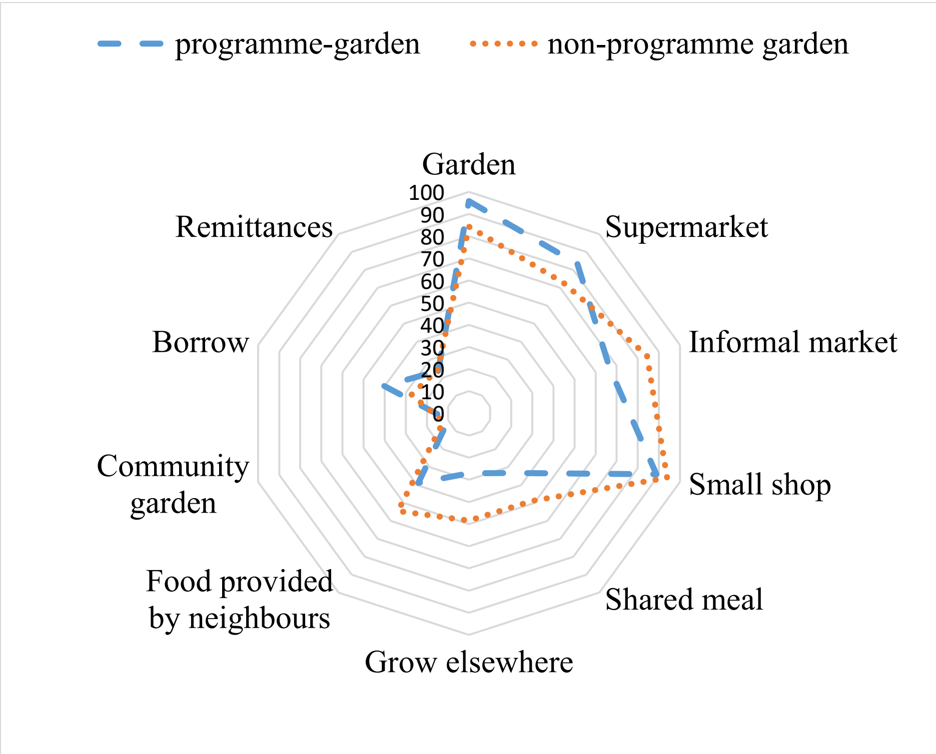


Figure 4.33: Winter food sources, by programme - non-programme gardens

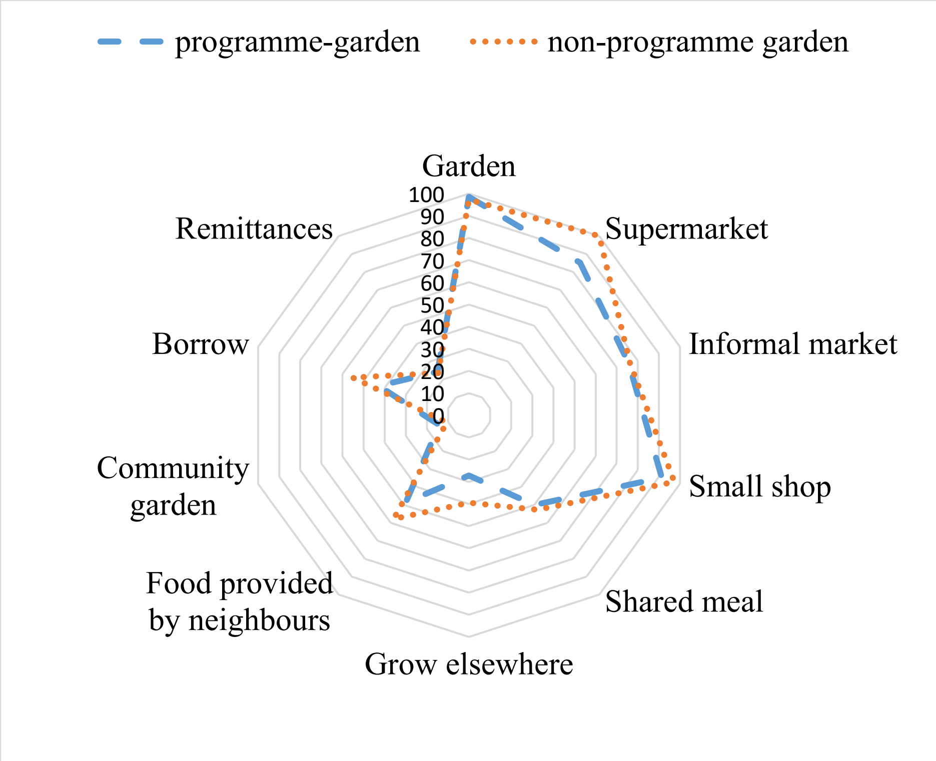
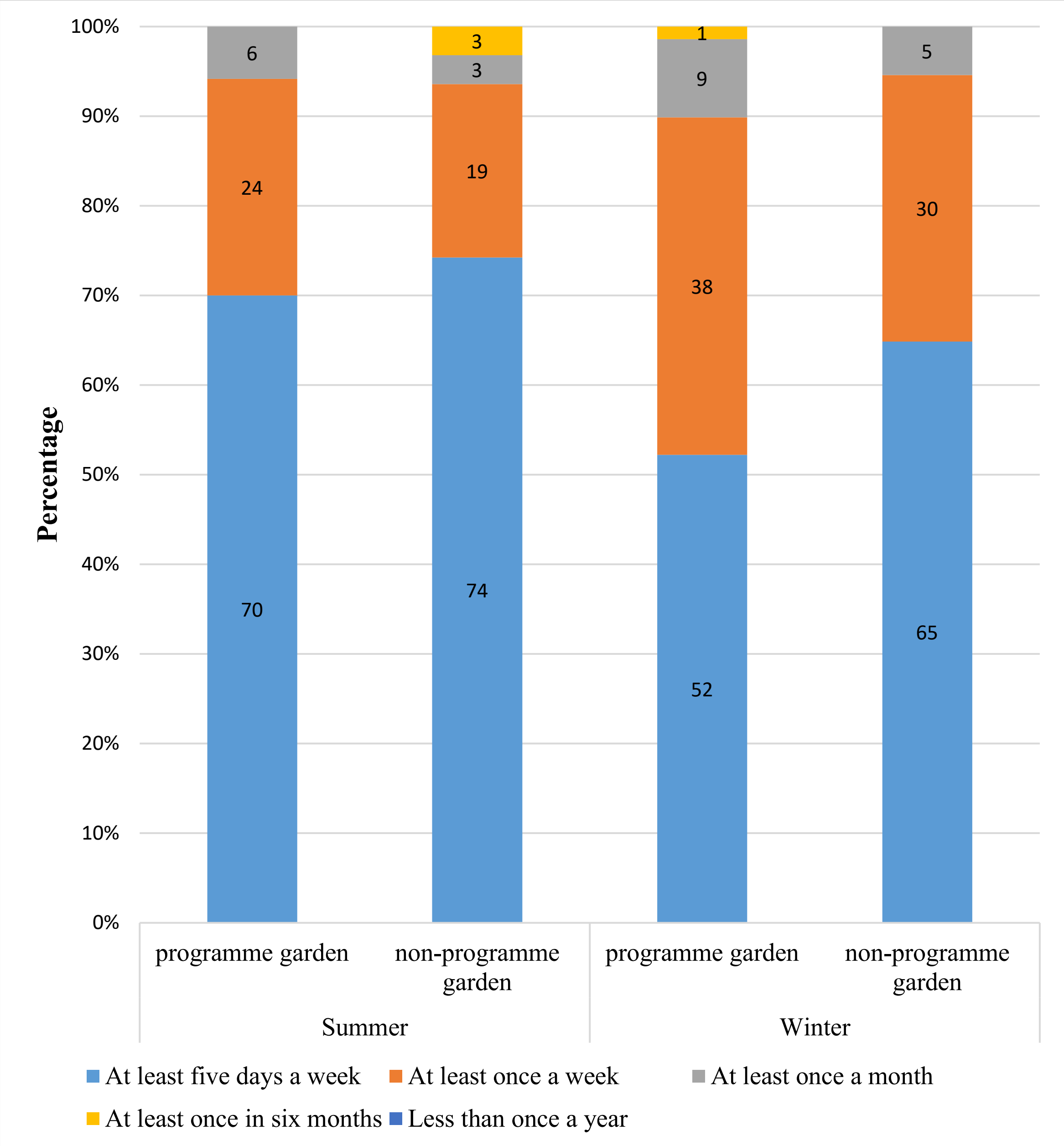


Figure 4.34: Frequency of accessing food from gardens by programme gardens - non-programme status



The discussion now turns to remittances received from household gardens, which provides more information on the extent to which food gardens represent an important food source. Food remittances received from gardens represent an important component of the food supply of gardens in the food economy. Results are discussed for the three countries in turn: Lesotho, South Africa and Zimbabwe:

Figure 4.29 indicates that in Lesotho, a higher proportion of control group households receive food remittances from gardens than those in the treatment group: (68% vs 36%) in summer and (68.1% vs 36.0%) in winter, and by a statistically significant margin in the winter season ($p<0.05$). This was also the case at baseline (75% vs 64%; $p<0.05$). Households mainly receive food remittances from neighbours and close relatives, who reside in urban areas, at varied frequencies. At baseline, treatment households receive food remittances of higher value compared to control households (ZAR640.7 vs ZAR598.8), though not statistically significant. In summer and winter, the value of food remittances received by control households is statistically significantly higher than that received by treatment households; (ZAR282 vs ZAR131.3; $p<0.05$) in summer and (ZAR168.4 vs ZAR54.7; $p<0.10$) in winter. Within the control group, the value of food remittances received in winter is low compared to summer (ZAR168.4 vs ZAR282.2). Baseline remittances value (ZAR598.8) by far exceed those in summer (ZAR282) and winter (ZAR131.3) seasons. This is most likely due to differences in the recall period: 12 months for baseline and seasonal for follow-ups. The summer season, moreover, is longer than the winter season, thus rendering comparisons across time difficult. Both control and treatment households consider food remittances to be important to their household food security, with no statistically significant differences between the two groups.

Figure 4.35: Remittances of food received from gardens - Lesotho

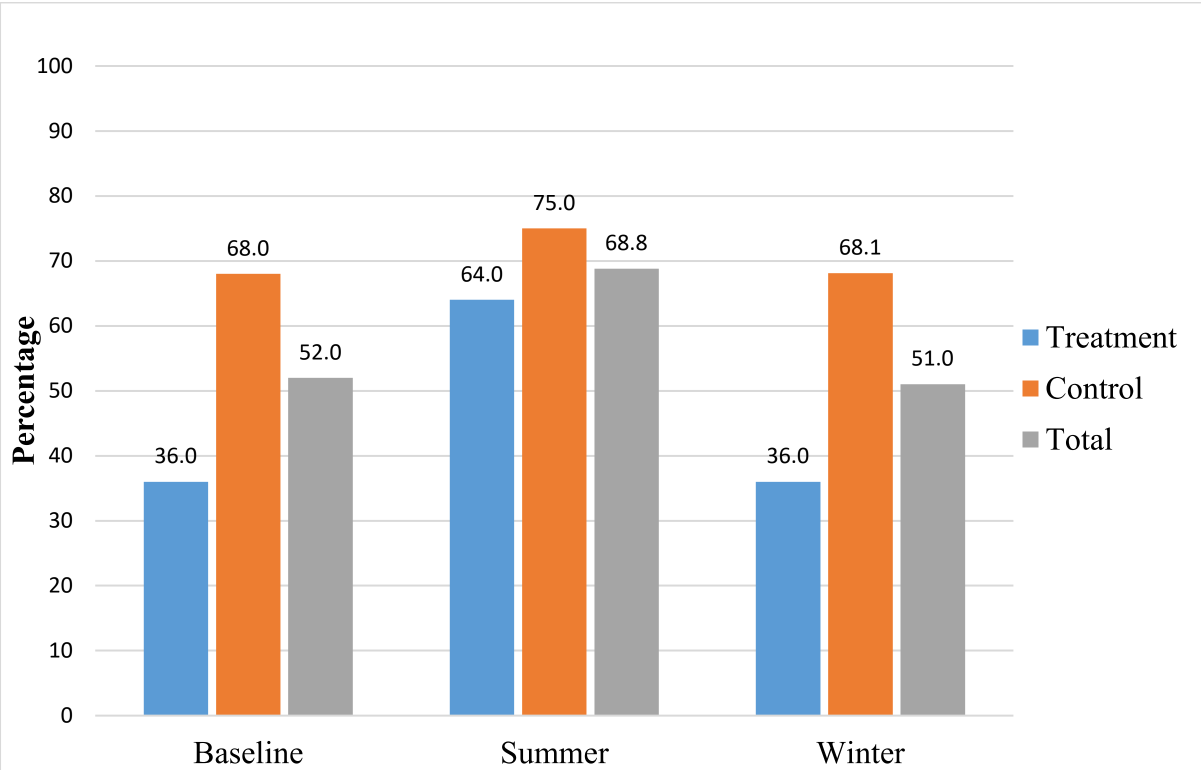


Figure 4.30 depicts that in South Africa, the proportion of households receiving food remittances increased from 26% (baseline) to 58.3% (summer), yet declining to 45.8% (winter). More households in the control group than in the treatment group receive food from gardens at baseline (28% vs 24%) and in the summer season (58.3% vs 48%), although these differences are not statistically significant. In winter, treatment households receive food remittances more often than control households (52.0% vs 39.1%), although not statistically significant. Food remittances received by both treatment and control households predominantly originated from urban areas, from neighbours and friends, with varied frequencies. At baseline, households in the control group receive food remittances of a higher value compared to households in the treatment group (ZAR700 vs ZAR500), with this difference being statistically insignificant. Treatment group households receive food remittances of a higher value compared to control group households in summer (ZAR205.8 vs ZAR126.0) and winter (ZAR147.6 vs ZAR82.2), but not by a statistically significant margin. Control households consider food remittances to be very important to household food security, compared to treatment households in the summer season (78.5% vs 28.5%), by a statistically significant margin ($p<0.10$).

Figure 4.36: Remittances of food received from gardens - South Africa

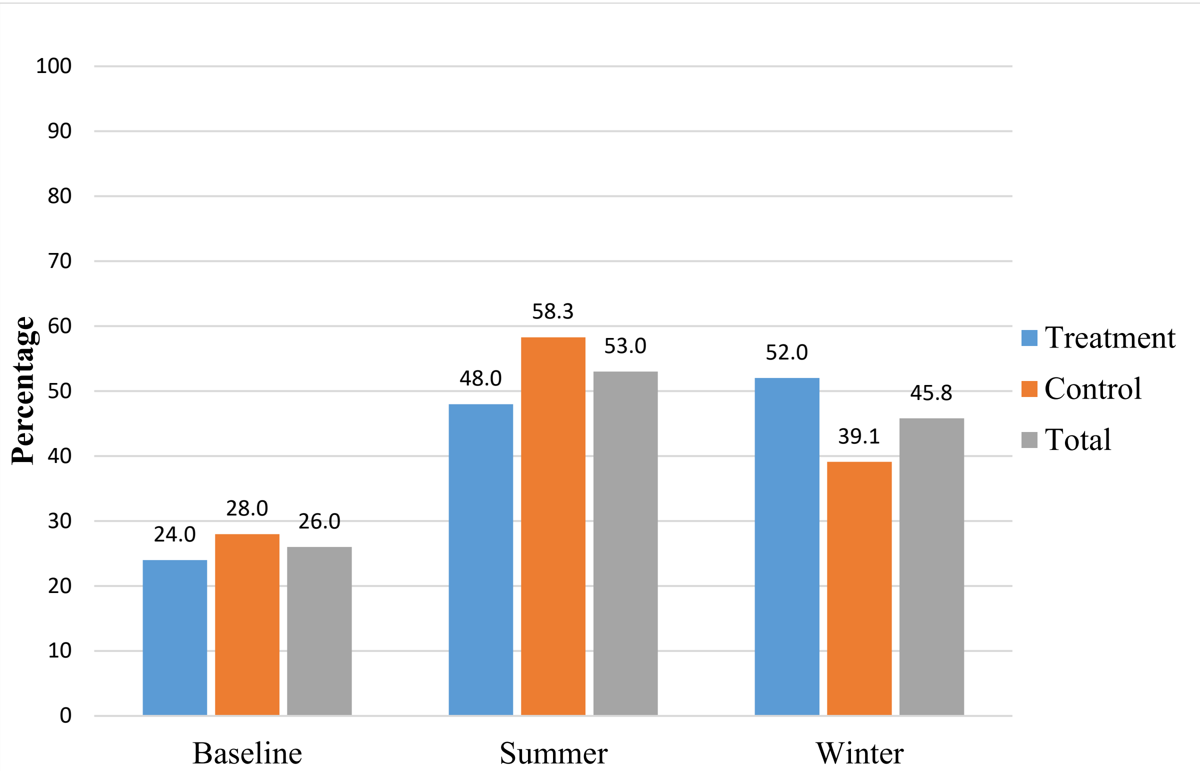
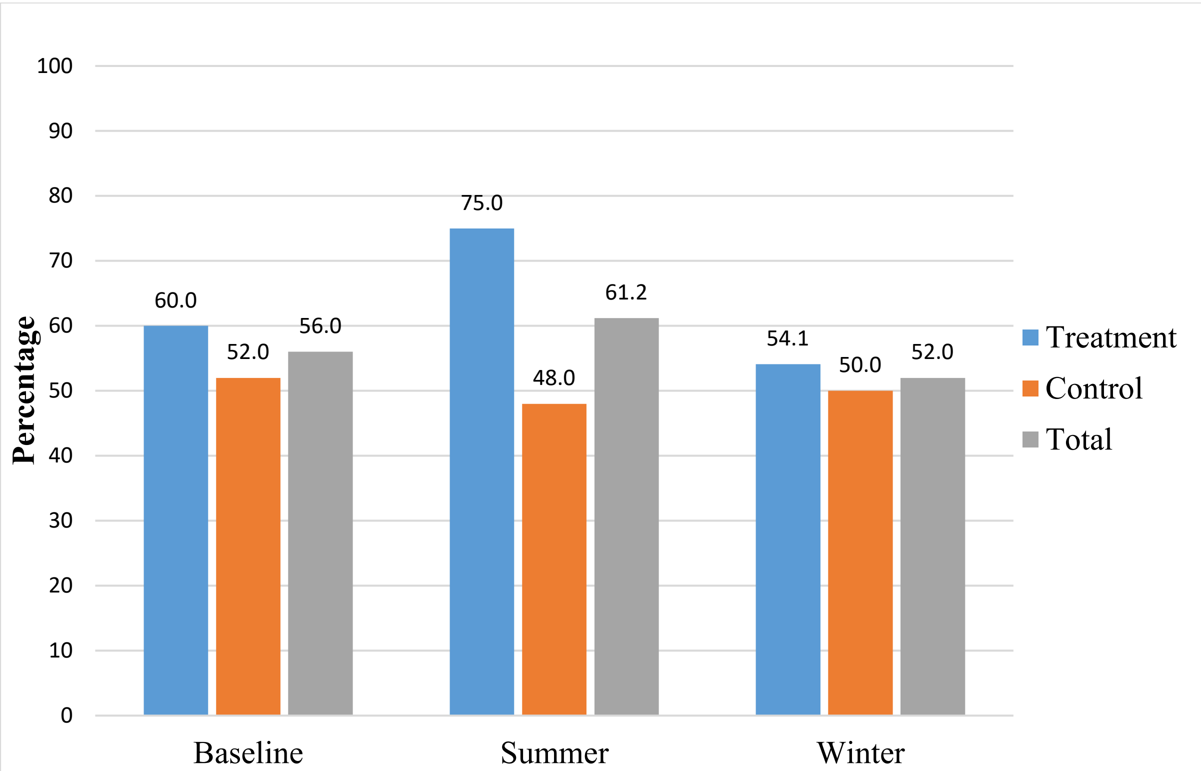


Figure 4.31 show that just more than half of the households in Zimbabwe receive remittances of food at baseline (56%), summer (61.2%) and winter (52%). More households in the treatment group than in the control group report receiving food from gardens in each season (60% vs 52%) at baseline, (75% vs 48%) in summer and (54.1% vs 50.0%) winter, with weak statistical significance in summer ($p<0.10$). Inward food remittances are received mainly from urban populations, and these are less frequent and mostly only a few times a year. In value, the remittances received by control households exceed those secured by treated households in each season, (ZAR121.8 vs ZAR71.8) at baseline, (ZAR73.3 vs ZAR64.7) in summer, (ZAR115.7 vs ZAR56.6) in winter, but not by a statistically significant margin. Consequently, households in the control group ranked remittances to be of relatively more importance to food security than households in the treatment group, particularly in winter season, with statistical significance (58.3% vs 8.3%, $p<0.05$).

Figure 4.37: Remittances of food received from gardens - Zimbabwe



Aggregating data into the garden and no-garden groupings give results in Figure 4.32. As shown in Figure 4.32, at baseline, households in the garden group are more likely to receive food produced in gardens, compared to households in the no-garden group (56.5% vs 25.8%, $p<0.01$). The trend is reversed in summer, where more households in the no-garden group are likely to receive food from household food gardens than households in the garden group (64.8% vs 59.4%), although this difference is statistically insignificant. In winter, slightly more households in the garden group are likely to receive food produced in gardens compared to households in the no-garden group (51.8% vs 42.8%), though again the difference is statistically insignificant. Households receive garden food produced predominantly from urban areas, from close relatives, friends and neighbours. There is greater variation in the frequency of receiving remittances. Households generally receive food almost every month, a few times a year, and when there is a special need. The value of food received is higher in households in the no-garden group to compared to households in the garden group in summer (ZAR217.5 vs ZAR117.2) and winter (ZAR158.3 vs ZAR96.9), with statistical significance in summer ($p<0.05$). In essence, a relatively large proportion of households benefit from food gardens in terms of the supply of food, regardless of whether they themselves garden or not.

Figure 4.38: Remittance of food received from gardens, by garden group

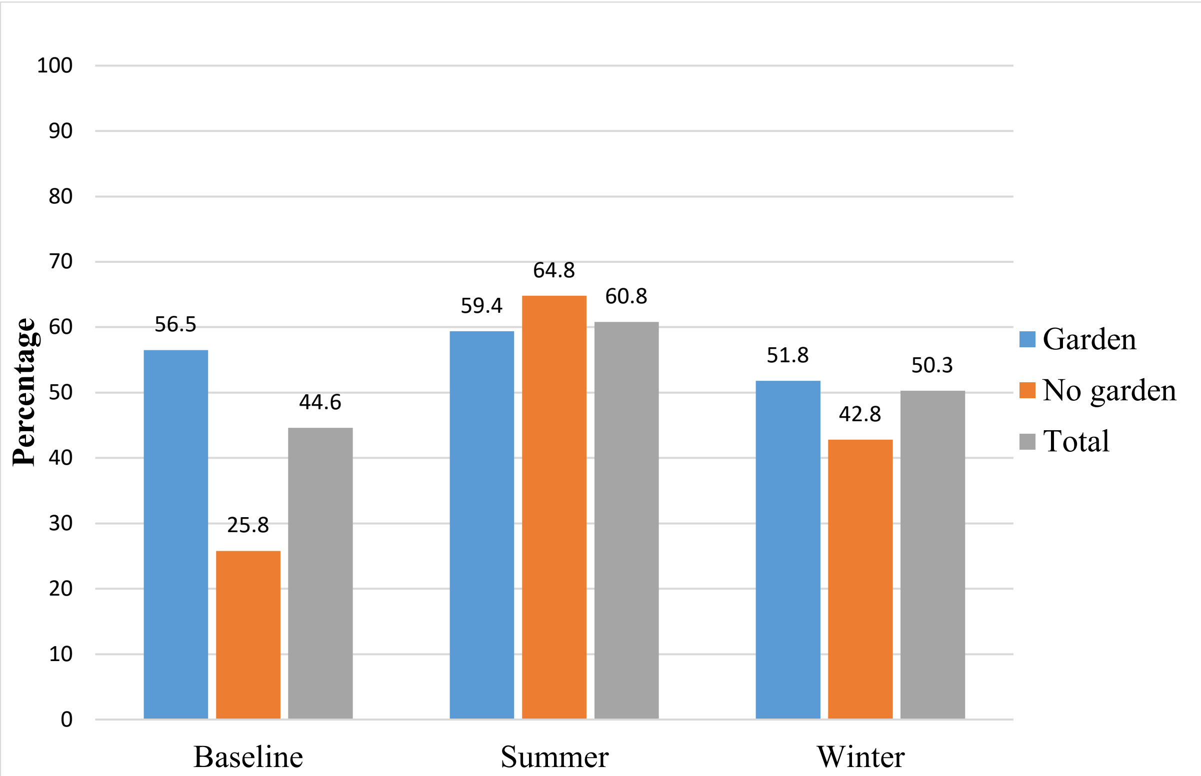
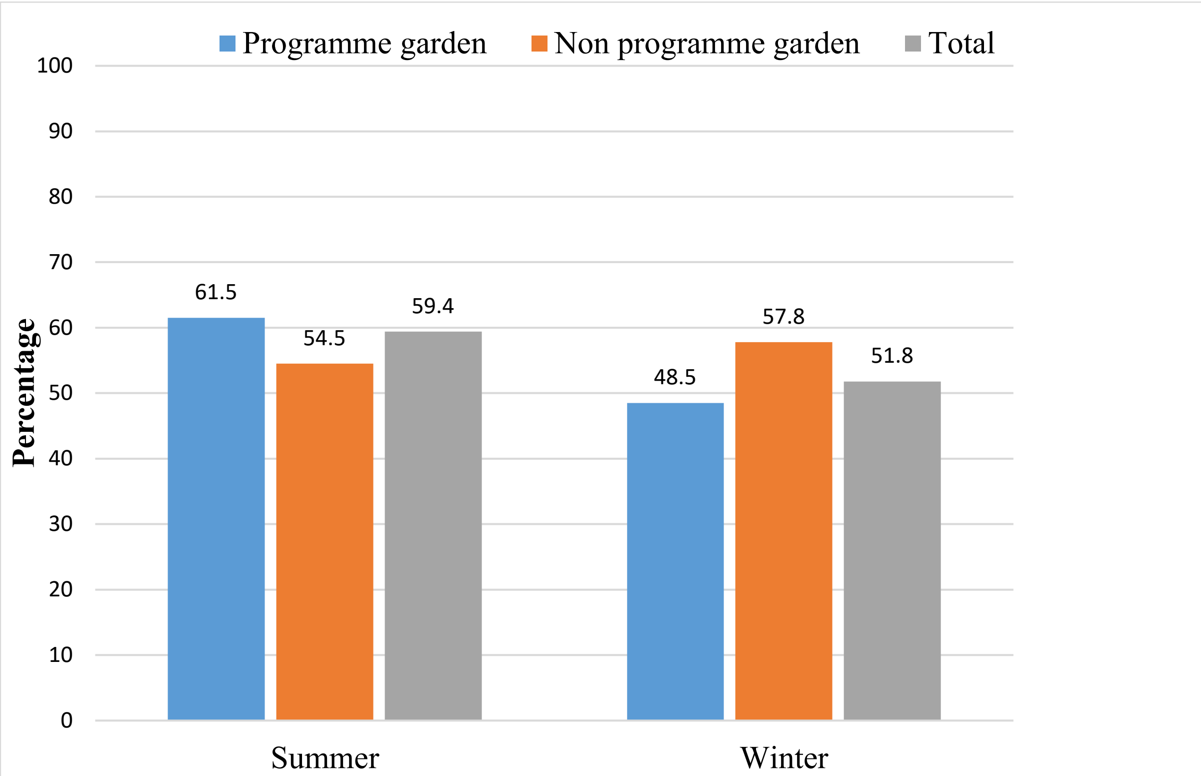


Figure 4.33 shows results based on programme and non-programme garden groupings. The results show that households in the programme garden group are more likely to receive food from gardens than households in the non-programme group in summer (61.5% vs 54.5%). This trend is reversed in winter, where more households in the non-programme garden group receive

more food from food gardens than households in the programme gardens group (57.8% vs 48.5%). These differences however are statistically insignificant. Food garden remittances are mainly from friends, close relatives and neighbours who reside in urban areas and are received at varied frequencies (almost every month, a few times a year and when there is a special need). Households in the programme garden group receive food of higher value in summer compared to households in the non-programme garden group (ZAR126 vs ZAR 93), though not by a statistically significant margin. In winter, households in the non-programme garden group receive food of higher value than households in the programme garden group (ZAR106 vs ZAR 90). Again, the evidence emphasises how the produce from gardens is shared beyond those conducting the gardening, including with households already gardening. As explained below, this often is used as a strategy to further diversify food sources.

Figure 4.39: Remittance of food received from gardens, by programme - non-programme garden status



The overall findings of this section indicate that gardens are an important source of food particularly in the treatment groups and in households with gardens, either programme gardens or food gardens in general. This suggests that gardens provide a basic support system that contributes to household food security. This is further supported by results from focus group discussions with programme beneficiary households. Participants in these focus group discussions repeatedly stated that a positive benefit of household food gardening for them was that they knew that there was always a source of food to turn to if they ran out of other food in the house. As one respondent explained when asked about the benefits of food gardening: “The first thing is that it helps a lot. I never go to sleep hungry, even my children never go to sleep hungry”. The next section discusses the food economy.

4.5 The food economy

In this section, the food economy is discussed, paying attention to the various ways in which household gardens can confer benefits to households. Two components are discussed in this section: household consumption of household food garden produce, and the trade of garden produce, i.e., the selling, remitting, and bartering of garden produce.

4.5.1 Consumption of household garden produce consumption

In this sub-section, the consumption of food garden vegetables by both children and adults is analysed. Consumption of food is an important indicator of food availability. As done before, results are discussed in turn: Lesotho, South Africa, and Zimbabwe.

Unexpectedly, as shown in Figure 4.34, the frequency with which adults in Lesotho’s treatment group households consume vegetables several times a day declined markedly over time, from 80% (baseline) to 52% (summer) to 40% (winter). In turn, the proportion of adults in the treatment group eating vegetables once a day increased from 12% (baseline) to 20% (summer) to 36% (winter). In winter, adults in the treatment group households are more likely to eat vegetables once a day than those in the control group (36% vs 4.5%; $p<0.05$). On the other hand, Figure 4.35 indicates that children in control households are more likely to consume vegetables several times a day than children in treatment group households, (84.2% vs 66.6%) at baseline, (40% vs 30.4%) in summer and in winter with statistical significance (64.2% vs 40%; $p<0.05$). This may be attributed to a targeting phenomenon, where poorer households were recruited into the gardening programme. It is also not clear as to whether this is the result of households remitting, bartering or most likely selling (surplus) garden produce and using the money to substitute food groups in their diet and/or to meet other household needs, rather than consuming the garden produce. Overall, the results indicate that vegetable consumption for both adults and children worsened over time in the treatment group.

Figure 4.40: Adult vegetable intake - Lesotho

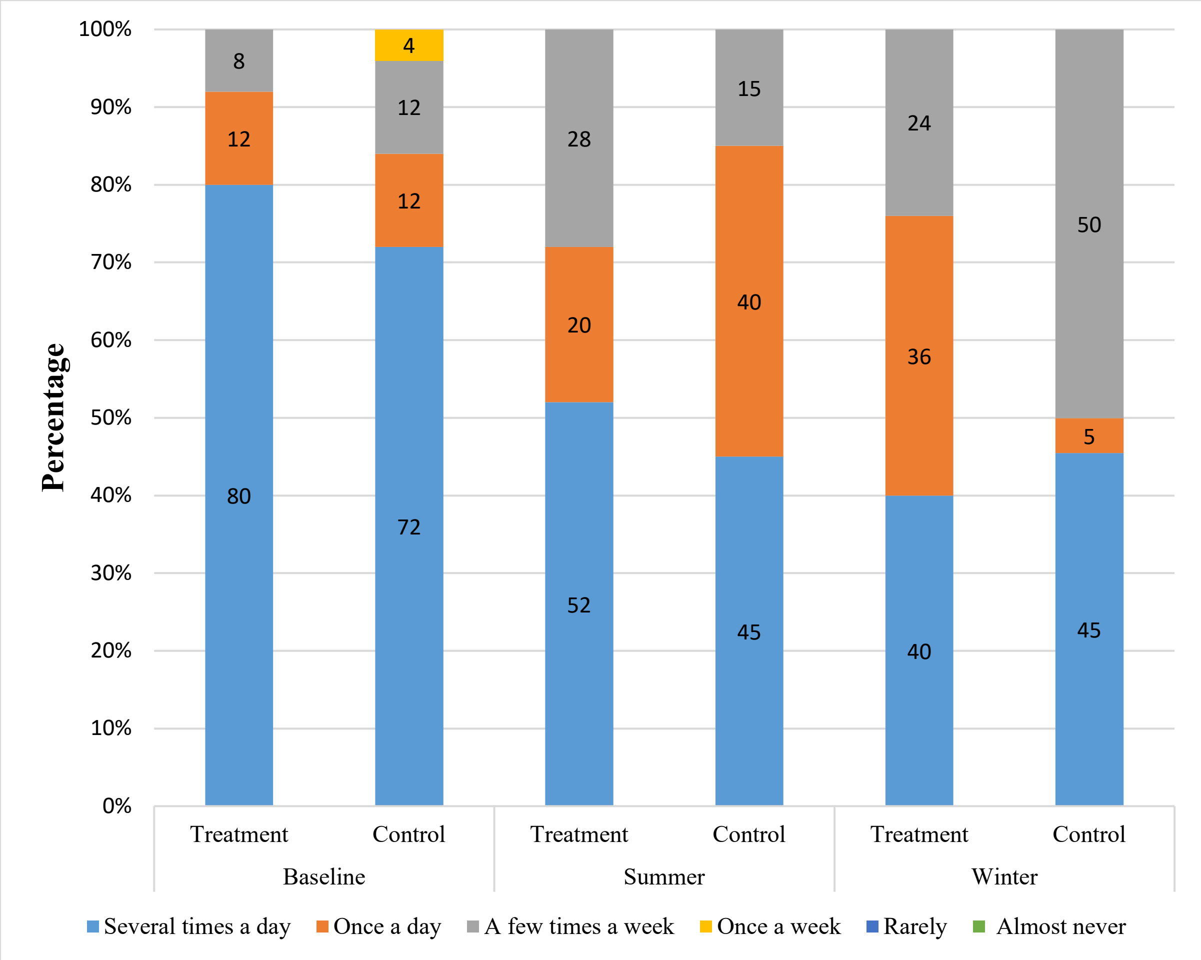
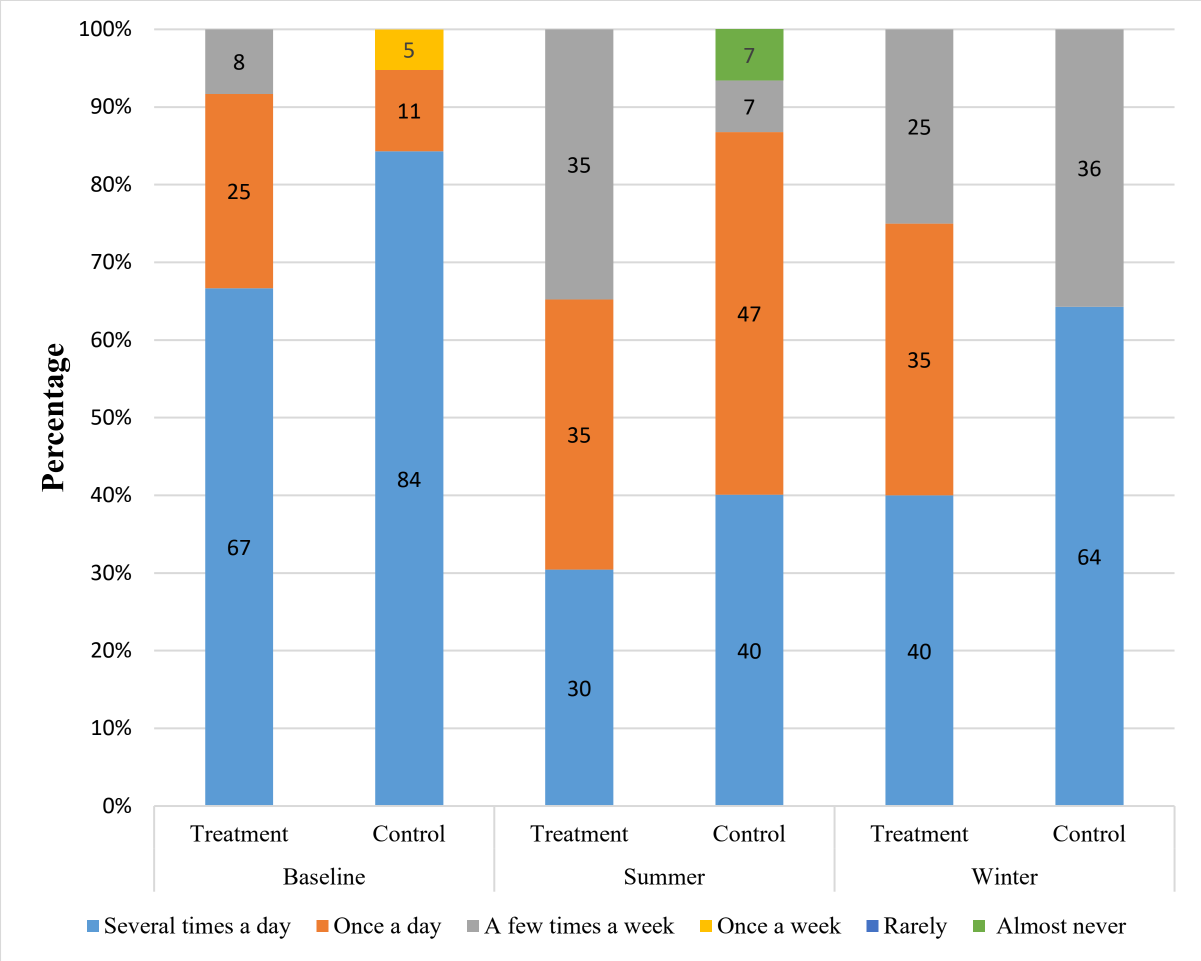


Figure 4.41: Child vegetable intake - Lesotho



Disconcertingly, as food source in South Africa, the frequency with which adults and children eat vegetables several times a day decline in the treatment group, particularly in summer (Figure 4.36 & Figure 4.37). This might be attributed to gardens being less voluminous or treatment households using more garden produce for bartering and selling than for home consumption. Vegetable consumption in the treatment group, moreover, is lowest in summer but better in winter. A similar trend is observed in the control group but no statistically significant differences are observed between the treatment and control groups. This result can also be attributed the fact that South African households are heavily dependent on social grants, and these social grants can have an influence on household consumption patterns. Through the social grants households can access food from other food sources other than their own household food gardens.

Figure 4.42: Adult vegetable intake - South Africa

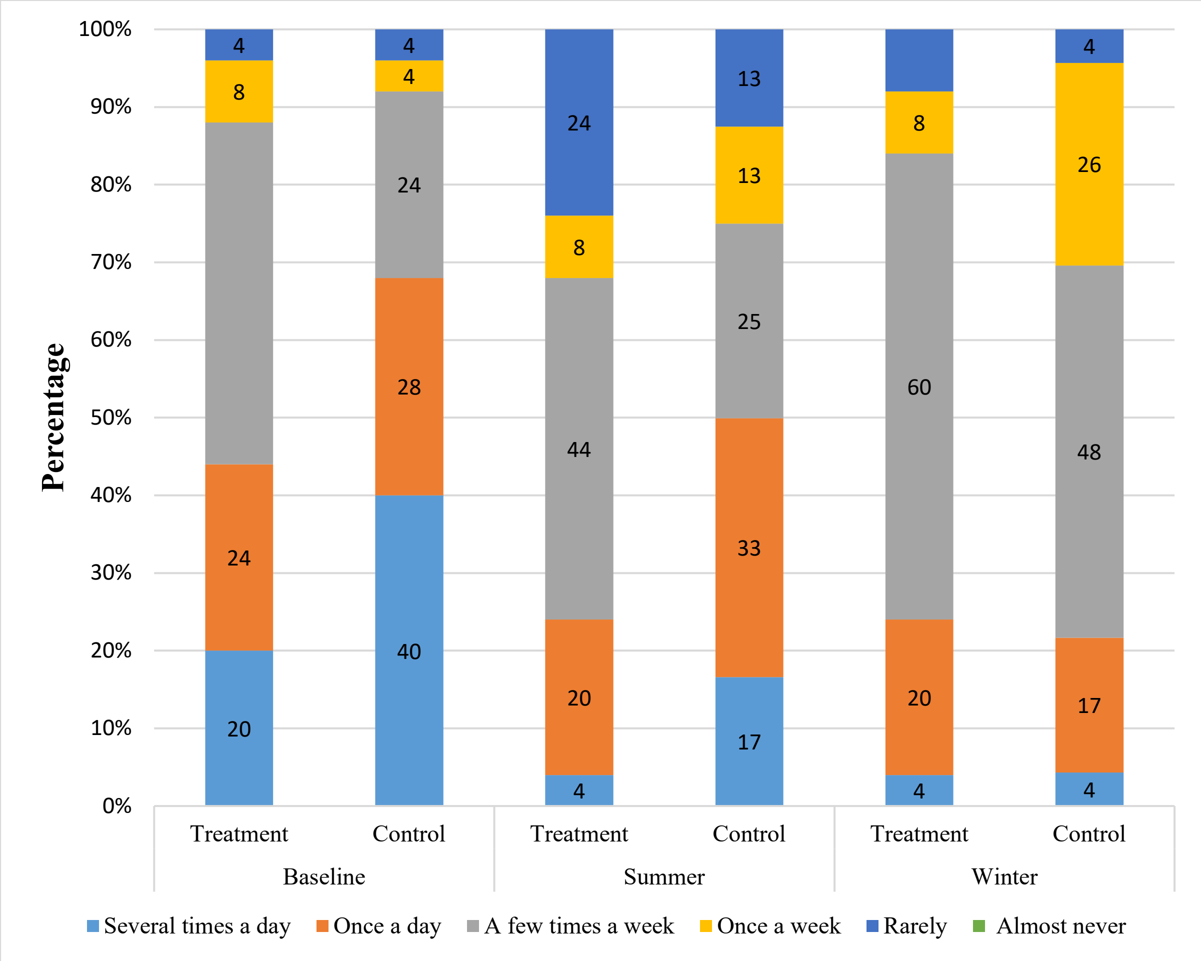
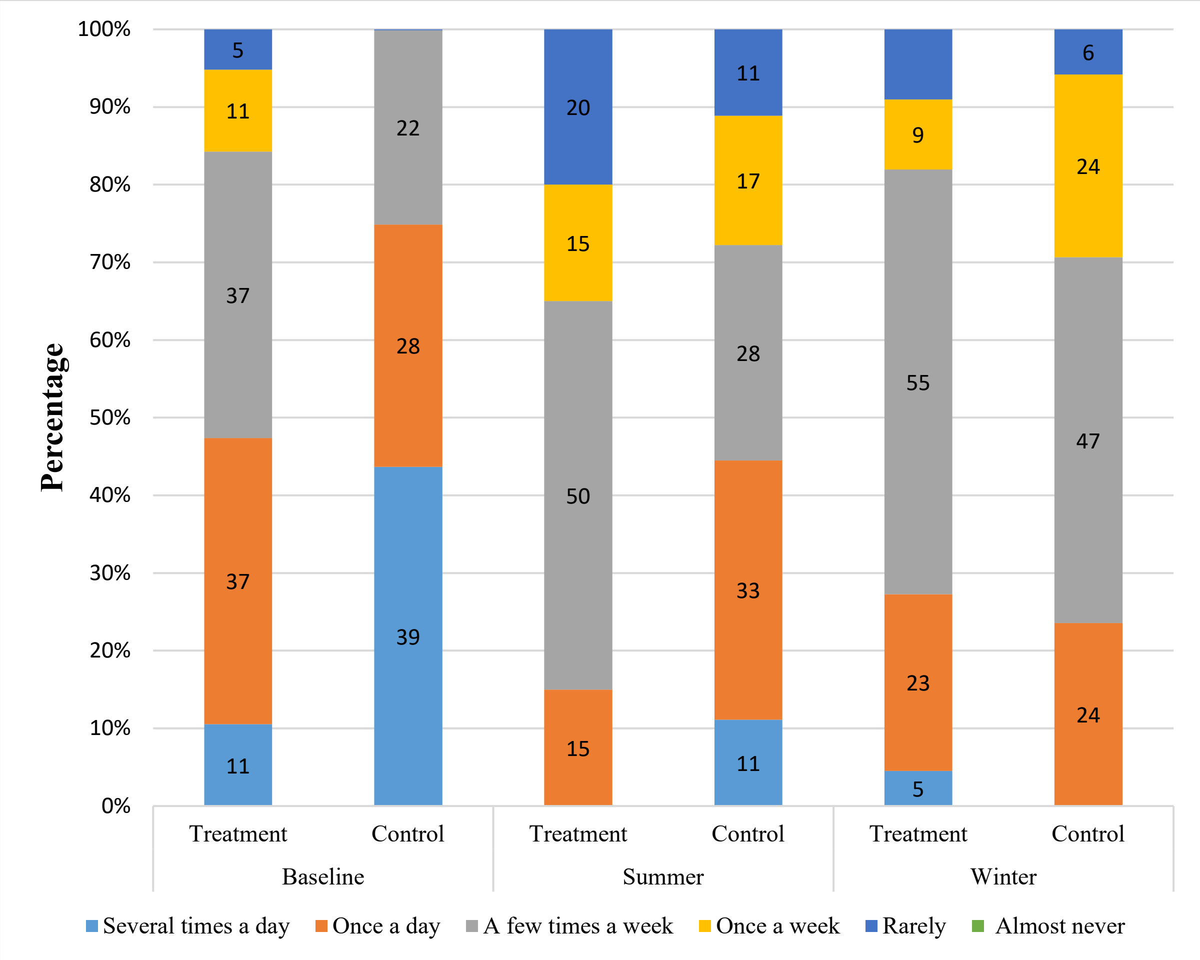


Figure 4.43: Child vegetable intake - South Africa



In the case of Zimbabwe, Figures 4.38 and 4.39 tell a similar story to South Africa's situation. Contrary to the expectations of the study, the assumption being that consumption of vegetables is higher in households in the treatment group: adults (24% vs 17% in summer and 42% vs 33.3% in winter) and children (21% vs 17% in summer and 42% vs 33% in winter) in the control group are more likely to eat vegetables several times a day than those in the treatment group, most of whom eat vegetables only once a day (Figure 4.38 & Figure 4.39). This might be attributed to NGOs targeting poorer households. The differences, though, are not statistically significant. There is no evidence that adults are eating vegetables more frequently than children or vice versa. Frequency of vegetable consumption, though, both in adults and children, was greater in winter than in summer (Figure 4.38 & Figure 4.39). Results also show that the frequency of vegetable intake in both summer and winter seasons is worse than in the year preceding the baseline survey.

Figure 4.44: Adult vegetable intake - Zimbabwe

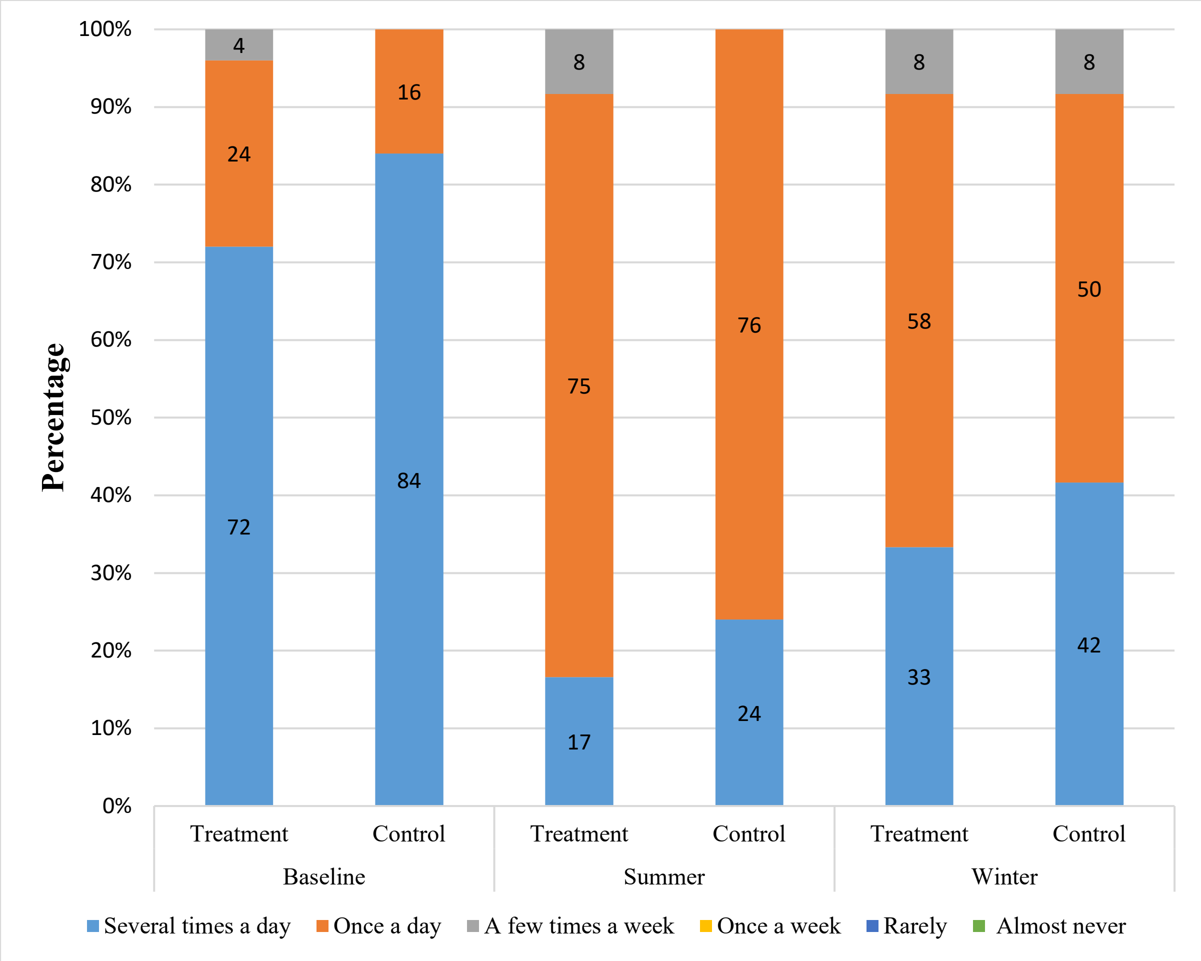
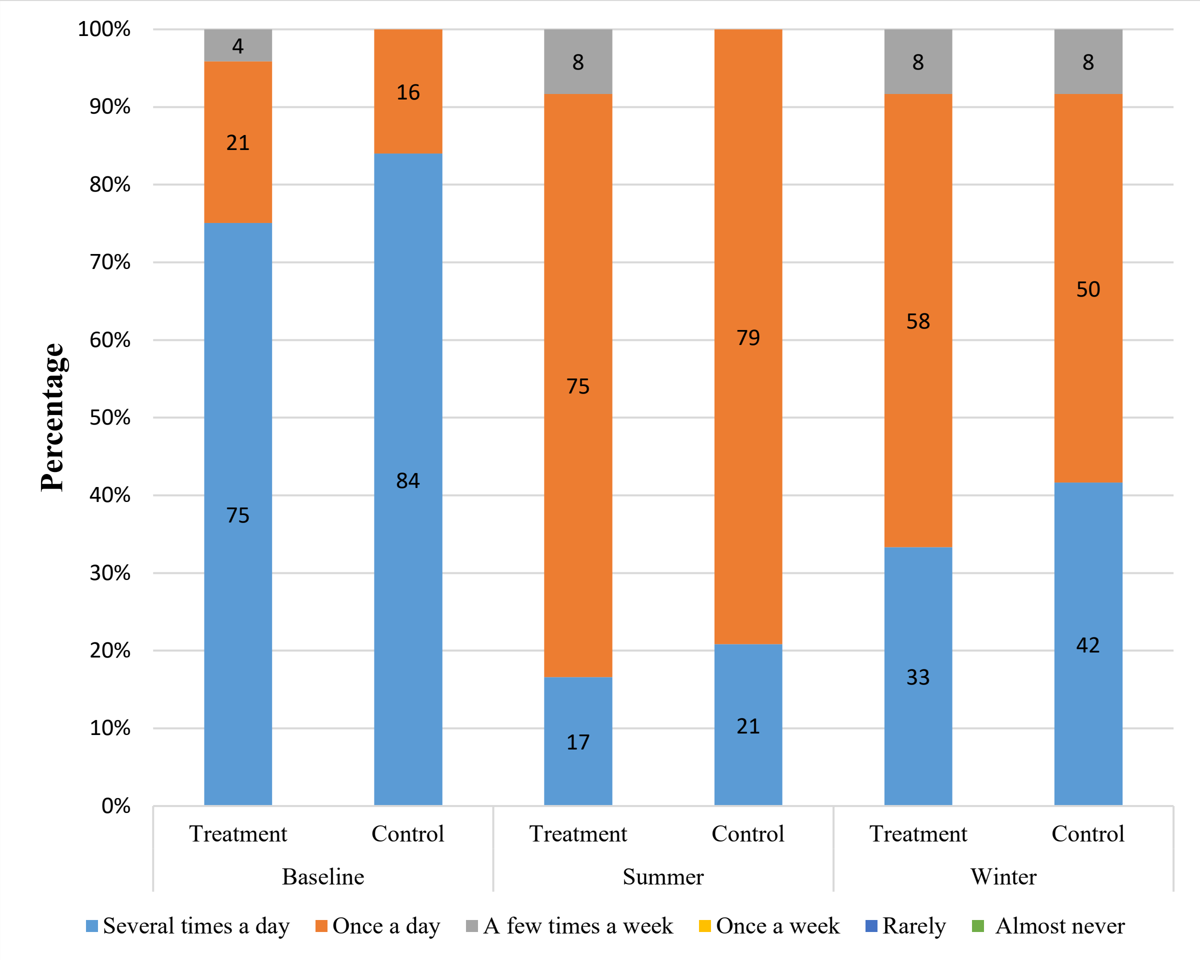


Figure 4.45: Child vegetable intake - Zimbabwe



For the garden and no-garden group comparisons results, Figure 4.40 shows that adults' vegetable intake at baseline differed statistically significantly between households in the garden group and households in the no-garden group (78.2% vs 34.4%; $p<0.01$). The consumption of vegetables several times a day by adults in the garden group fluctuates throughout the study period, declining markedly in summer from 78.2% (baseline) to 24.5% (summer) and improving marginally in winter to 28.7% (winter) (Figure 4.40). The consumption of vegetables several times a day by adults in the no-garden group declines throughout the study period from 34.4% (baseline) to 29.7% (summer) to 25.7% (winter). In winter, adults in the garden group are more likely to consume vegetables once a day (38% vs 11%; $p<0.01$) than adults in the no-garden group. Figure 4.41 indicates that the consumption of vegetables several times a day by children in the garden group fluctuates over time, dropping to 17.8% in summer and rising to 30.2% in winter. A similar trend is depicted in the non-garden group, where the consumption of vegetables several times a day by children drop to 24.1% in summer, rising marginally to 28% in summer. Children in the garden group are more likely to consume vegetables once a day than children in the no-garden group in both summer (52.6% vs 37.9%) and winter (38.5% vs 20%). This is statistically significantly in winter ($p<0.05$). Looking at the proportion of households that consume vegetables at least once a day (i.e. either once or several times a day), the joint proportions are however greater in the garden than in the non-garden group, i.e. vegetable intake generally is more frequent in gardening than non-gardening households.

Figure 4.46: Adult vegetable intake, by garden status

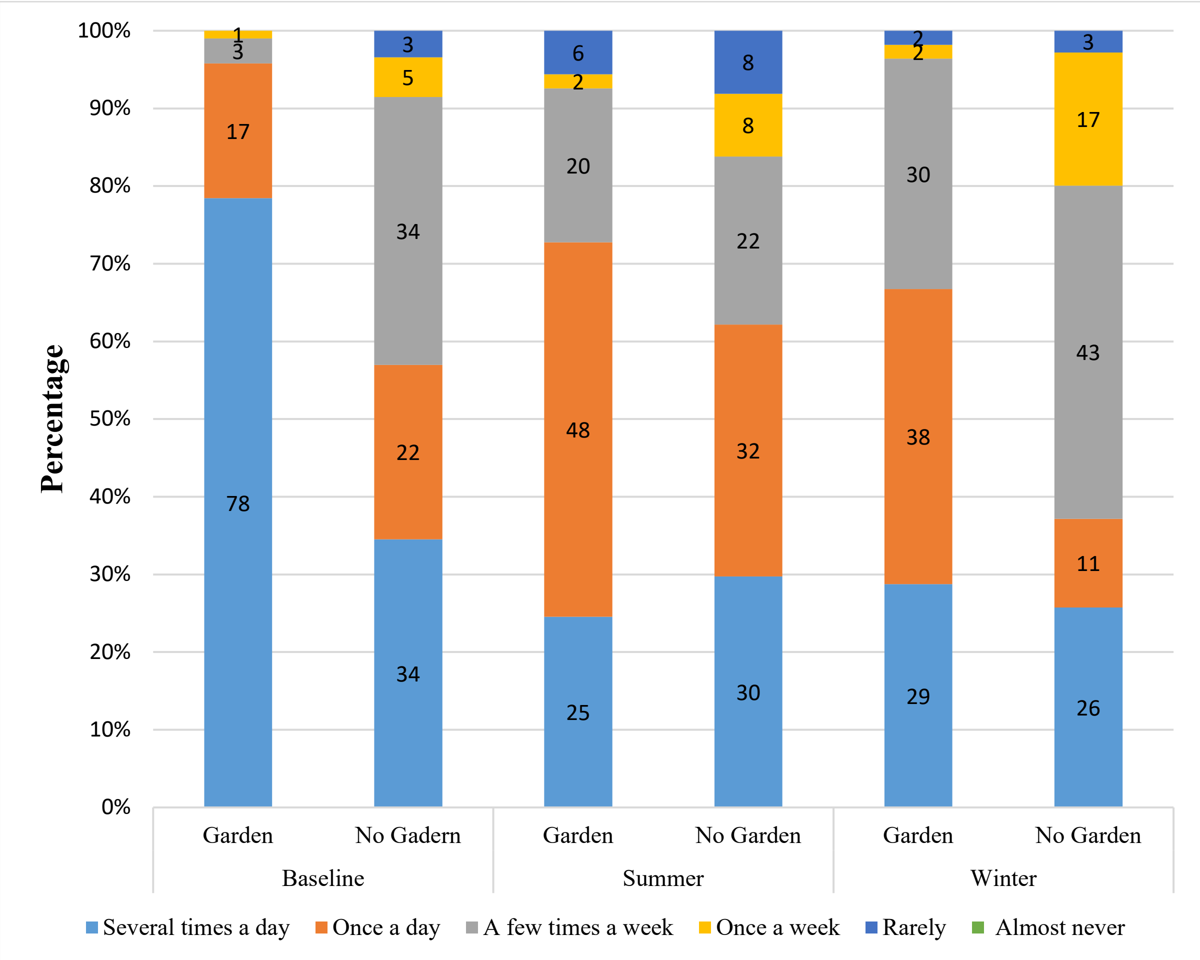
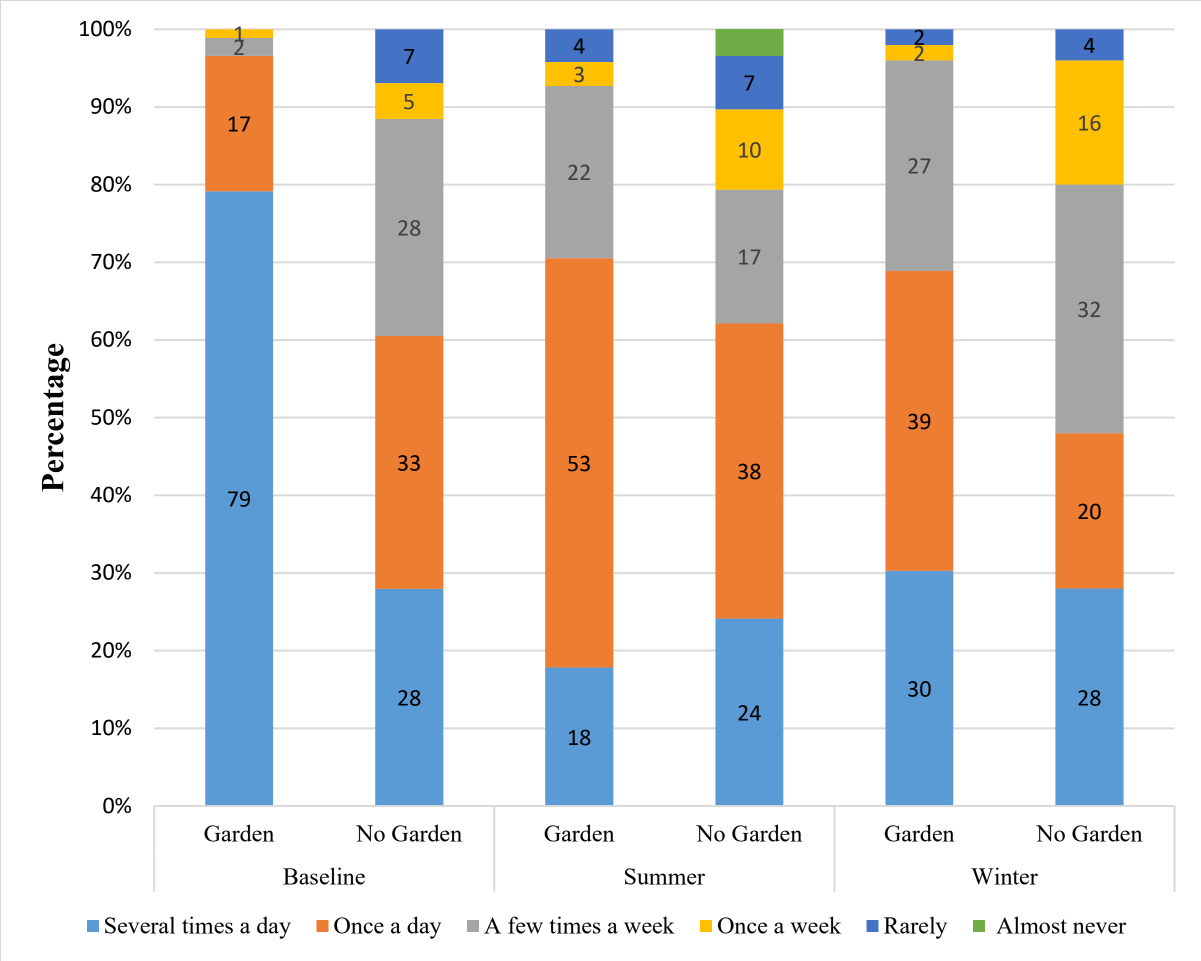


Figure 4.47: Child vegetable intake, by garden status



For the programme and non-programme garden groupings, Figure 4.42 shows that in summer, adults in the non-programme garden group are significantly more likely to consume vegetables once a day than adults in households in the programme garden group, (72.7% vs 36.9%; $p<0.05$). There is no statistical difference in the consumption of vegetables several times a day or once a day by adults in both groups in winter, although adults in the non-programme garden group are slightly more likely to consume vegetables several times a day (34.2% vs 27.7%) and once a day (39.4% vs 37.1%) than adults in the programme garden group. Figure 4.43 indicates that in summer, children in the non-programme garden group are statistically significantly more likely to consume vegetables once a day than children in households in the programme garden group (75.8% vs 42.2%; $p<0.05$). In winter, children in the non-programme garden group are more likely to consume vegetables several times a day (37.5% vs 26.5%) and once a day (40.6% vs 37.5%), although these differences are statistically insignificant. Overall, not much variation is observed in the consumption of vegetables in both groups in both summer and winter.

Figure 4.48: Adult vegetable intake, by programme - non-programme garden status

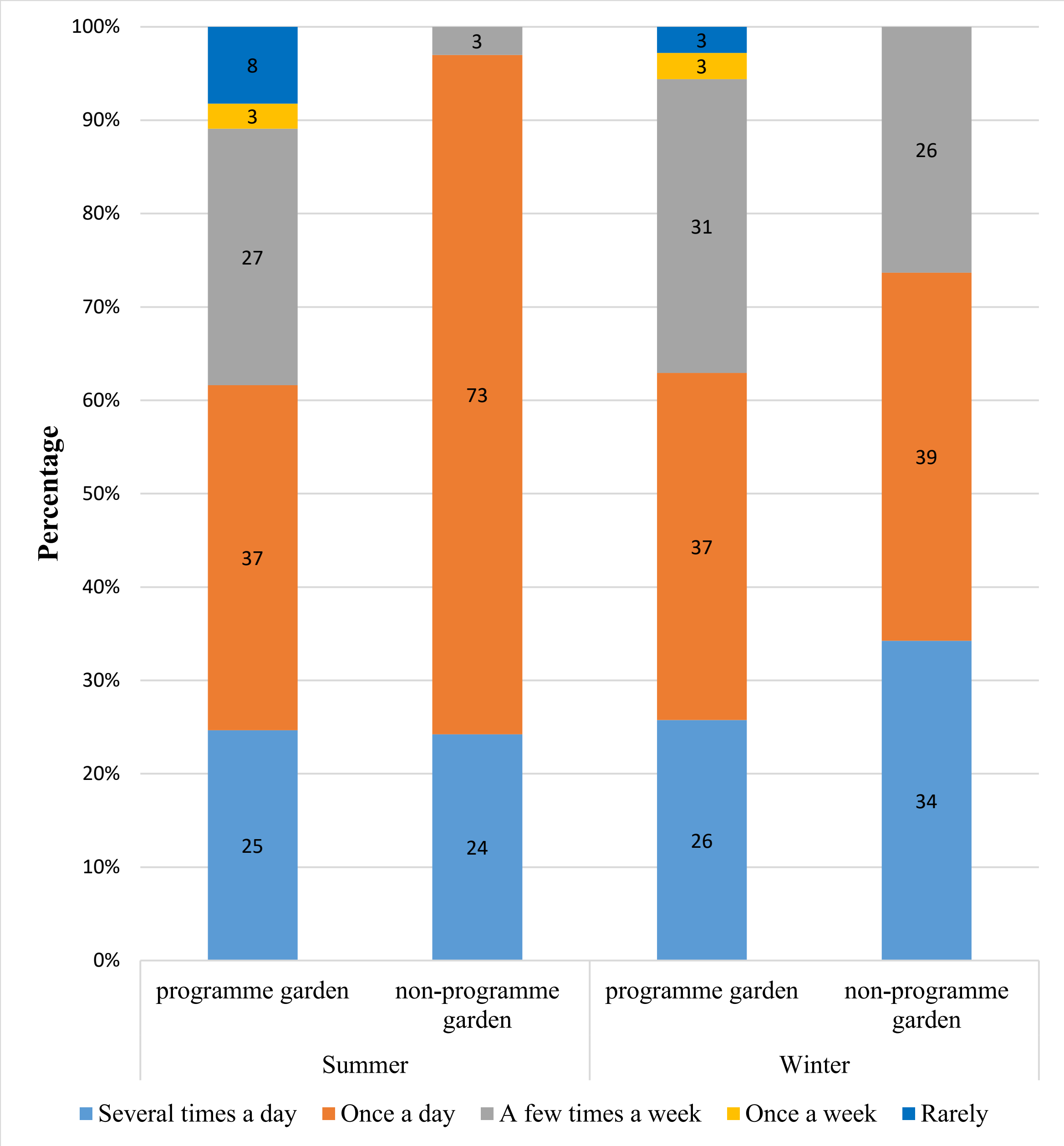
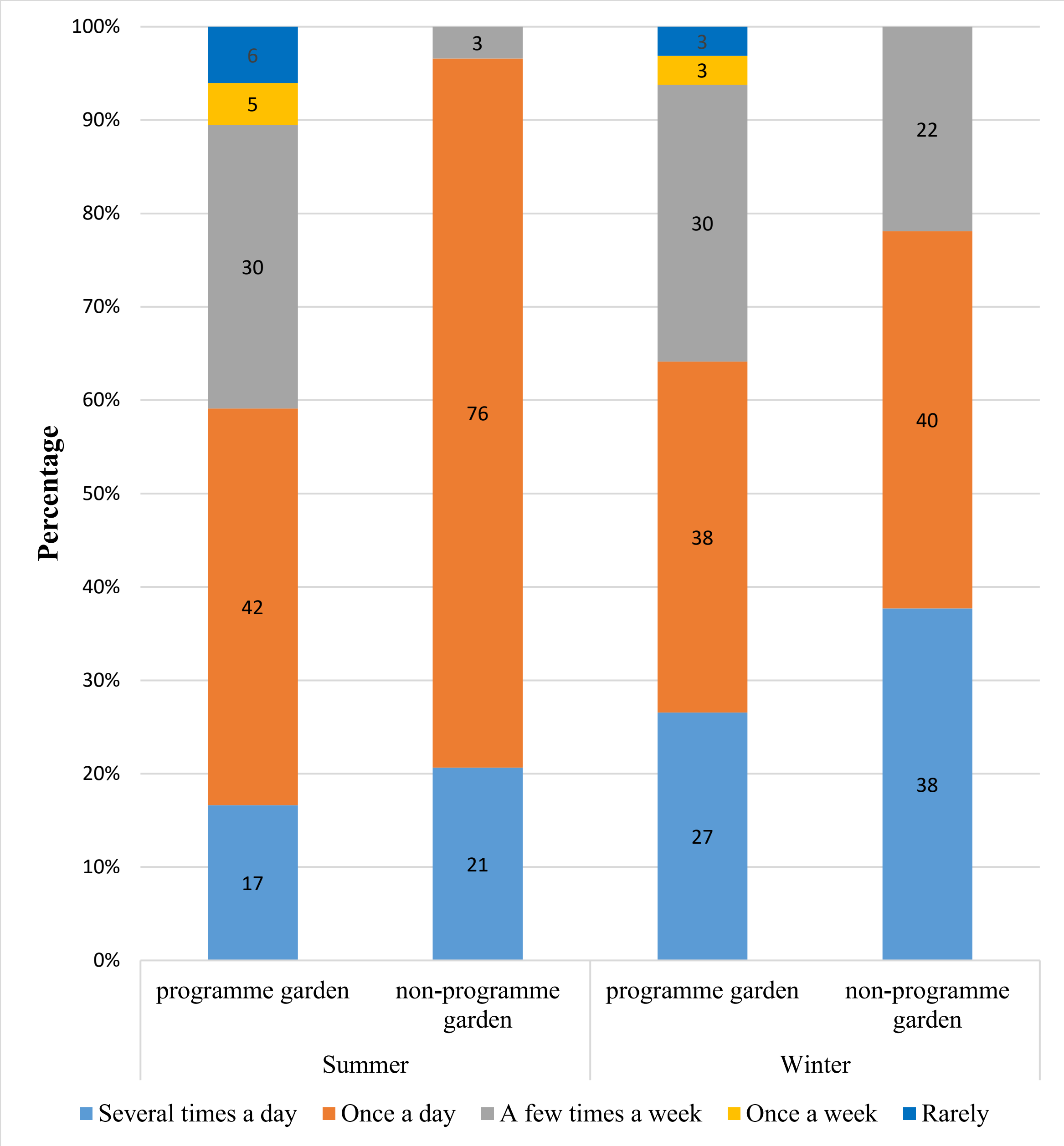


Figure 4.49: Child vegetable intake, by programme - non-programme garden status



4.5.2 Trade of garden produce

This sub-section analyses the various ways in which households "trade" garden produce and the subsequent potential implications for household food security, drawing a distinction between the sale, barter and remittance of food garden produce.

(a) Sale

Figure 4.44 shows that in Lesotho, an increased proportion of all households sold food from their gardens, from 48% (baseline) to 53.3% (summer) to 63.8% (winter). As expected, the proportion of treatment households who report selling food from their gardens increases between baseline-summer-winter, 72% - 92% - 92% respectively. Treatment group households are more likely to sell food than control group households, by a statistically significant margin in both summer and winter (92% vs 5%; $p<0.01$; 92% vs 31.8%; $p<0.01$), respectively, but this was also the case at baseline (72% vs 24%, $p<0.01$). Up to 92% of treatment households sell food grown in their household food gardens, mainly to urban-based populations. Treatment households mainly sell garden produce to neighbours, at varied frequency, yet often almost every week (31.8% in summer; 43.4% in winter). The frequency of selling garden produce almost every week increased throughout the period in the treatment group, from 18.7% (baseline) to 31.8% (summer), to 43.4% (winter).

Households in the treatment group earned a total of ZAR1264 (baseline), ZAR306.1 (summer) and ZAR1152.1 (winter) from the sale of surplus garden produce. Treatment group winter sales outstripped summer sales by a substantial margin (ZAR1152.1 vs ZAR306.1). One possible explanation of this result might be that the summer garden produce spilled over into winter, hence the high sale values recorded in winter. The amount of income earned by the treatment group households from garden produce sales are larger than the amount earned by control group households at baseline (ZAR1264 vs ZAR480.6). This could be explained by the fact that households in the control group may have had gardens in the preceding twelve months, although they did not have gardens when they were recruited into the study. In summer and winter, respectively, compared to control households, treatment group households earn more income (ZAR306.1 vs ZAR200) and (ZAR1152.1 vs ZAR144). These differences are statistically significant in winter ($p<0.10$). Income earned from the sale of garden produce by treatment households is mainly spent on purchasing additional food for the household (88.8% at baseline, 95.6% in summer and 100% in winter). Households mainly purchase meat, oils and other household food stuffs. Consequently, households in the treatment group consider the income as relatively important to their household food security, particularly in the summer season, by a significant margin ($p<0.05$).

Figure 4.50: Sale of food from own gardens - Lesotho

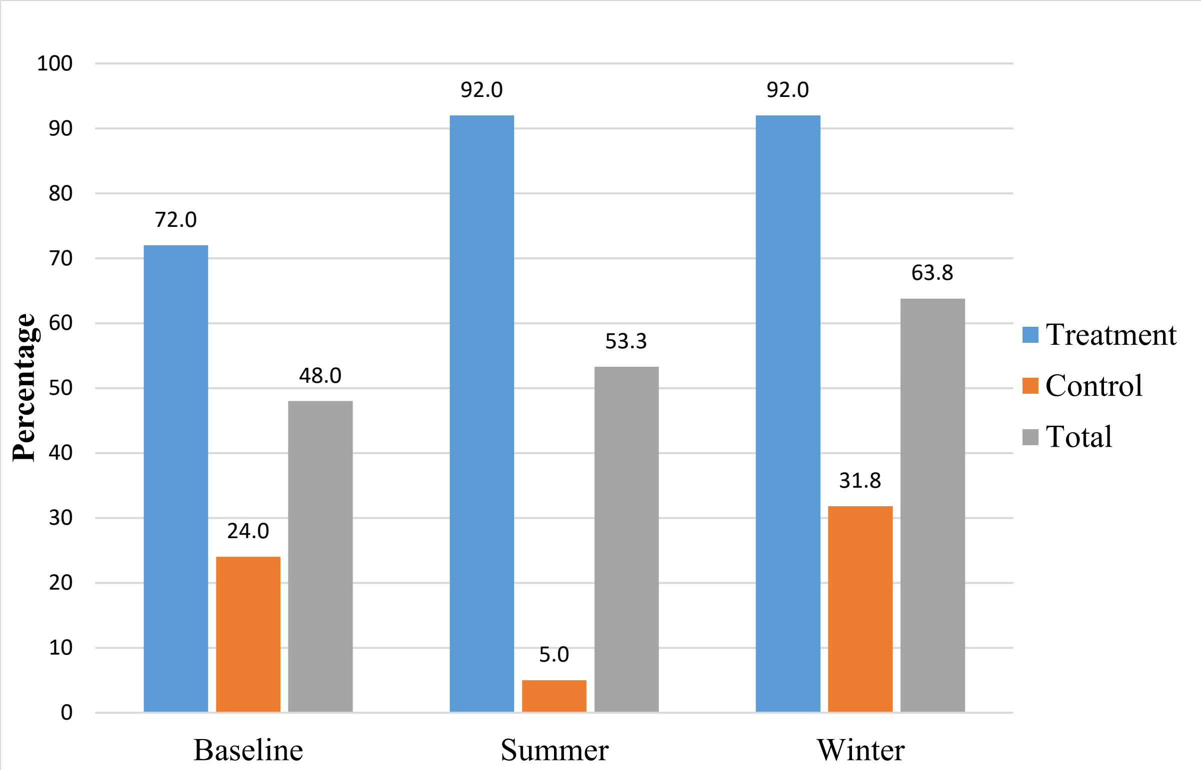


Figure 4.45 shows that, in South Africa, on aggregate, less than thirty percent of the households participating in the study reported selling food from their gardens in each of the three seasons. As not one household had a functional garden at baseline or in the preceding year, there are no sales from household food gardens. Households in the treatment group, as expected, are more likely to sell food from their gardens in summer (28% vs 20.8%) and winter (32% vs 8.7%;), with statistical significance in the winter season ($p<0.05$). Treatment households mainly sell food garden produce in urban areas to needy people, almost every week or every month. Surprisingly, though, treatment households earn less from the sale of garden produce than control households in both summer and winter seasons (ZAR885 vs ZAR990; ZAR1075 vs ZAR1150) respectively, although these differences are not statistically significant. With regards to how the income from the sale of garden produce are utilised, households in the treatment group, indicate spending their income on food, particularly meat and cereals, 57.1% (summer) and 80% (winter). More households in the treatment than control group consider the income from the sale of garden produce as critical to their own household's food security (75% vs 0.0 %), by a statistically significant margin ($p<0.10$), and to their overall livelihood (57.1%

vs 20.0%), particularly in the summer season, though this difference is not statistically significant.

Figure 4.51: Sale of food from own gardens - South Africa

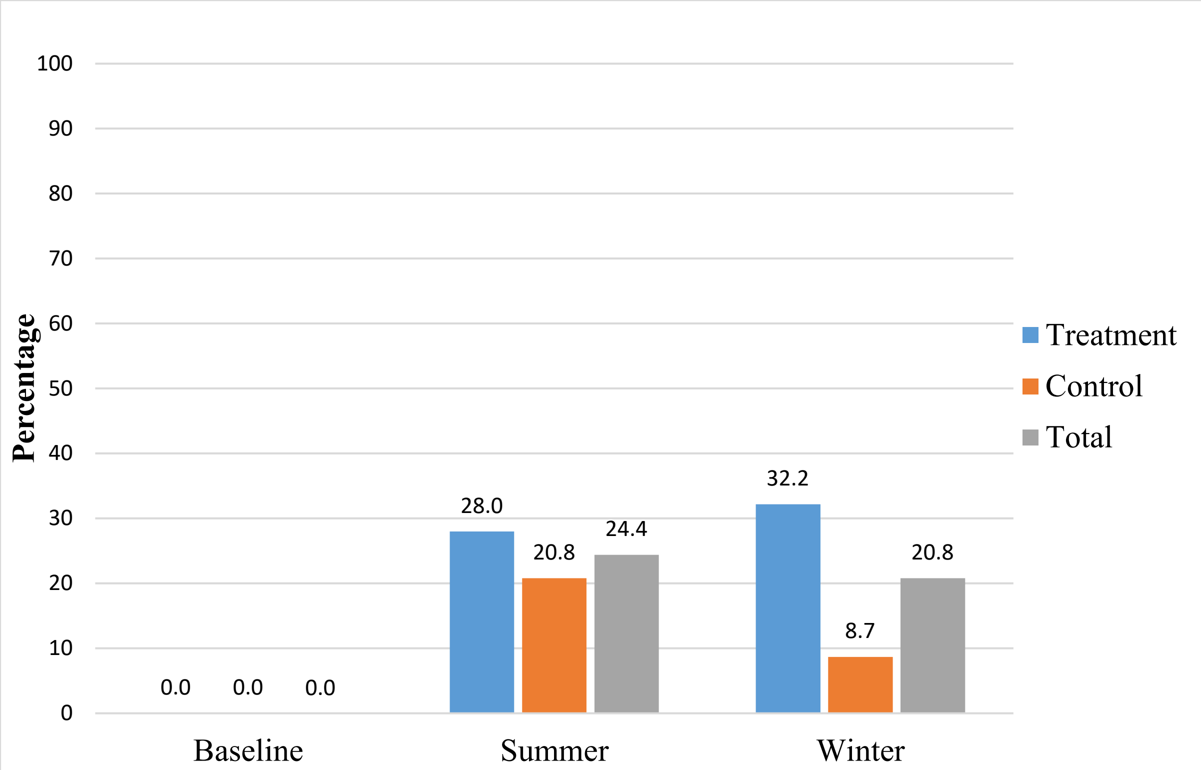
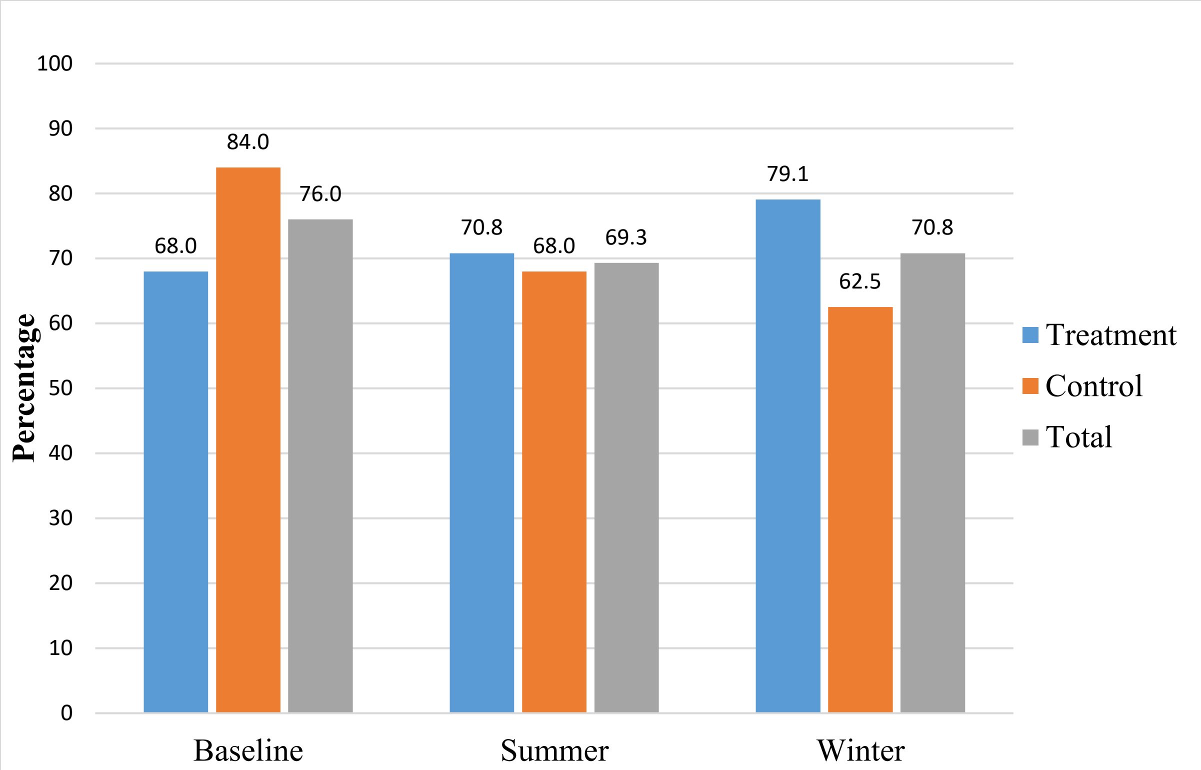


Figure 4.46 shows that, in Zimbabwe, on aggregate, a substantial proportion of households sell food; 76% (baseline); 69.3% (summer) and 70.8% (winter). The sale of food is more common among households in the treatment group compared to households in the control group; (70.8% vs 68%) in summer and (79.1% vs 62.5%) in winter, although not by a statistically significant margin. The prevalence of selling food increased throughout the study period in the treatment group, from 68% (baseline) to 70.8% (summer) to 79.1% (winter). Treatment households sell food from gardens exclusively to urban areas, mostly to their friends. Sales are made generally almost every week (47% in summer and 60% in winter). Compared to treatment households, the sale of food in the control group households declined between summer and winter, from 68% (summer) to 62.5% (winter). Control households earned more income from the sale of garden produce in both summer and winter than treatment households, although not by a statistically significant margin; (ZAR353 vs ZAR244.3) in summer and (ZAR693.57 vs ZAR443.1) in winter. Households generally purchase food using household food garden income, 89.4% (baseline), 85.2% (summer) and 91.1% (winter). More households in the

control group than in the treatment group report purchasing food with the income generated from the sale of garden food; (90.4% vs 88.4%) at baseline, (94.1% vs 76.4%) in summer, and (100% vs 85%) in summer, though not by a statistically significant margin. The food items purchased include cereals, meats, oils, and fats.

Figure 4.52: Sale of food from own gardens - Zimbabwe



Country comparisons, paying attention to treatment households, indicate that the sale of household food gardens produce by treatment households is not as common in South Africa (24% in summer & 28% in winter) compared to Lesotho (92% in winter & 92% in summer) and Zimbabwe (70.8% in summer & 79.1% in winter). However, even though the proportion of South Africa's treatment households who report selling food is low, they earn more income (ZAR885) from selling garden produce in summer compared to treatment households from Lesotho (ZAR306) and Zimbabwe (ZAR244). Only in winter are South Africa's treatment households' value of sales (ZAR1075) lower than that of Lesotho's treatment group (ZAR1152), though by a small margin. Sales, however, remain higher than those of Zimbabwe's treatment households (ZAR443). Thus, while Lesotho and Zimbabwe report more treatment households selling garden produce than South Africa, South African treatment households generated more income from the sale of garden produce. This might be explained by the fact that the proportion of households reporting selling of garden produce does not indicate the volume of produce sold and the type and price of the produce sold, such that even though more treatment households from Lesotho and Zimbabwe report selling garden produce, their sales volume might have been low compared to those of South Africa's treatment households, thus reducing the income derived from the sales. In South Africa and Zimbabwe, treatment group households earn less income from the sales of surplus garden produce in summer and winter compared to households in the control group, an observation that is different from Lesotho, where households in the treatment households earn more.

The sale of surplus garden produce points to the income generation potential of household food gardens. Overall, this potential for income generation through household food gardens via the sale of garden produce is also illustrated in the literature. A study of household gardens in Bangladesh found that households earned an average of US8 bimonthly from selling fruits and vegetables (Talukder *et al*., 2000). In Dakar, Senegal, Brun *et al*. (1989), found that food gardening households earned an average income of US$29 per season. Bushamuka *et al*. (2005) have also reported that garden produce was marketed and households earned a median income of 347 taka (US$1 = 51 taka) in Bangladesh.

In Lesotho, South Africa and Zimbabwe, similarities are observed in the extent to which treatment households spend money from the sale of food garden produce on food (91.3%, 75%, 85%), respectively. These results are consistent with findings from previous studies that show that households that maintain household gardens sold food from gardens and used the income to purchase additional food stuffs for the household. Talukder *et al*. (2010), assessing the impact of a household food gardens project on household food security in four Asian countries, for example, reported that up to 92% of households in Cambodia and 70% of households in Bangladesh with gardens earned income from sale of surplus garden produce, with over 80% of households in Cambodia and close to half of households in Bangladesh (46%) spending the income obtained to purchase additional food stuffs for the household. Marsh (1998) also reported that households maintaining household food gardens spent income from the sale of garden produce primarily on food, especially rice. In addition, results from Lesotho, South Africa and Zimbabwe show that income generated from the sale of food gardens produce from households in the treatment group is critical to household food security.

In addition, similarities are observed in the way in which women in the treatment households controlled the income generated from the sale of garden produce and how this income enhanced household food security. During focus group discussions, women expressed that household food gardening allowed them to generate income through the sale of food garden produce and control the use of that income. In addition, focus group discussions with programme garden beneficiaries also revealed that households realised additional income through savings made from not having to buy vegetables, although this was not quantified in this study. As one respondent explained, "One benefit of household food gardening highlighted by a study participant, is that when I harvest vegetables, I don't have to buy them. I save the money I would have spent, and I can even buy meat and eggs." This indicates that these savings increased the income generated from gardens and were also used to purchase other food items, thereby contributing to household food security and nutrition.

Women viewed their gardening income as a means of gaining economic independence and autonomy in controlling household food consumption. As one woman put it, "Now I have access to money and I can make household decisions. I have more control than before because I can purchase food and other things for the family" Another respondent said; "Because I make some money from the sale of garden produce, I don't ask my husband for money and he knows that whether he is there or not we cannot go hungry in this house. Even when my husband dies, I can generate income for my family through gardening."

Control of income allowed the women to provide their households with more food, and of better quality, thereby diversifying their diets. Several women also mentioned that because they did not ask their husbands to buy vegetables, they could occasionally ask them to buy other foods such as fish or meat, further contributing to dietary diversity. In this way, income from gardens afforded women the ability to meet their household food needs. This result supports the notion that, to improve the households' food security, nutrition and health, it is imperative that women have access to and control of income.

In addition, women's access and control over income yielded other positive results, including women's engagement in social networks, further enhancing household food security. Control of gardening income allowed women to participate in group based savings groups. Several women reported that gardening income formed an important basis for their participation in social networks, through enabling them to meet their obligatory financial contributions. In these savings groups, women contribute equal amounts of money at given intervals. The money collected is used to buy food which is shared after a stipulated period. On how women had benefited from membership of the savings groups, one woman said; "Being a member of a savings group helped me get more food for my family. Even when visitors come you will not be stressed or embarrassed because you have food to give them. People can tell that you are a responsible woman who can maintain a household and take care of herself and her children" Thus, participation of women in these savings groups enabled them to further contribute to their household food needs. This result is in line with previous literature. For example, Simiyu and Foeken (2013) found that home gardening enhanced women's capacity to provide food for their families, as it allowed them to join social groups using their gardening income.

In sum, women's contribution towards household food security through garden income also corresponds with other research relating to women's control of income through household food gardening. Bushamuka *et al.* (2005) found that in the context of Bangladesh, women's access to and control of income through their participation in household food gardening improved household food security. Patalagsa *et al.* (2015) found that women's control of gardening income is a key factor to gaining control over household food supplies. Finerman and Sackett (2003) show that household food gardening income offered women freedom from dependence on husbands, as well as neighbours and friends, for food.

(b) Remittance

Figure 4.47 shows that in Lesotho, more households in the treatment group than control group remit food from gardens; (92% vs 72%, $p<0.10$) at baseline, (96% vs 5%; $p<0.01$) in summer and (92% vs 36.3%; $p<0.01$) in winter. Households in the treatment group remit garden produce to other households, mainly to close relatives and neighbours. A significant proportion of households (25% in summer and 22% in winter) from the treatment group also share their garden produce with needy people. Food remittances are to both urban and rural areas in summer, but only to urban areas in winter. Treatment households are more likely to remit food to urban areas, generally at more frequent intervals compared to rural areas. Remittances are made once a month and less frequently, but they constituted a small monetary value of ZAR192 in summer and ZAR263 in winter. In the summer season, the value of remittances in treatment group households, exceeded that in the control group, but not by a statistically significant margin (ZAR192 vs ZAR30). This was not the case in winter, where the value of remittances is almost equal to that in the treatment and control groups (ZAR262 vs ZAR275).

Figure 4.53: Outward remittance of food from own gardens - Lesotho

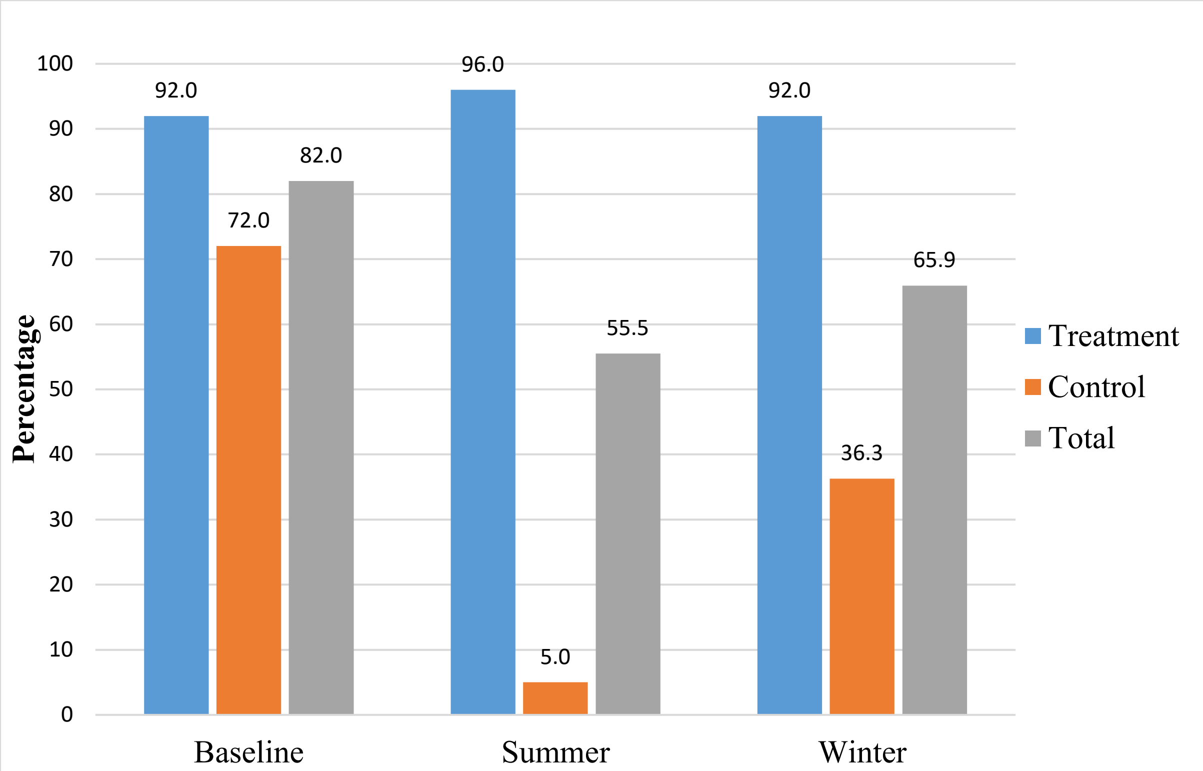


Figure 4.48 shows that in South Africa, there is not one household that had a functional garden at baseline, thus not one household sent food remittances from their gardens. With the introduction of gardens, 55.1% of all households start to remit food from gardens in summer, with 58.3% remitting in winter. As per the a priori expectation, the prevalence of remittances increases in the treatment group between baseline and winter from 0% (baseline) to 84% (summer), a value that is maintained in the winter season. In both summer and winter, more households in the treatment group compared to those in the control group remit food from gardens, (84% vs 25%, $p<0.01$) in summer and (84% vs 30.4%, $p<0.01$) in winter. Food remittances from treatment group households are less frequent, and they are exclusively sent when there was a special need. Households shared food mainly with their close relatives, friends and neighbours, who exclusively resided in urban areas. Treatment households' remittances are smaller in value in winter (ZAR142.6) than in summer (ZAR230.4). However, contrary to a priori anticipation, the value of remittances from households in the control group

are higher than those from treatment group households; (ZAR230.4 vs ZAR286.6) in summer and (ZAR142.6 vs ZAR154.5), although these differences are not statistically significant.

Figure 4.54: Outward remittance of food from own gardens - South Africa

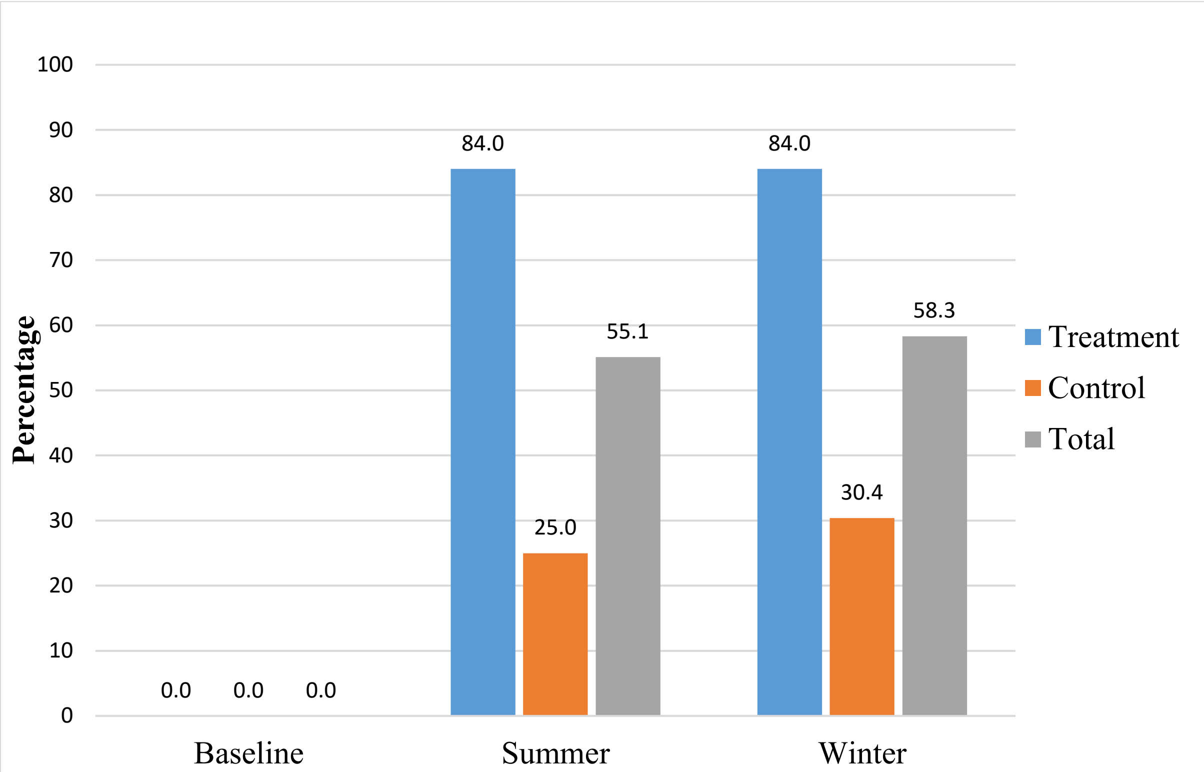
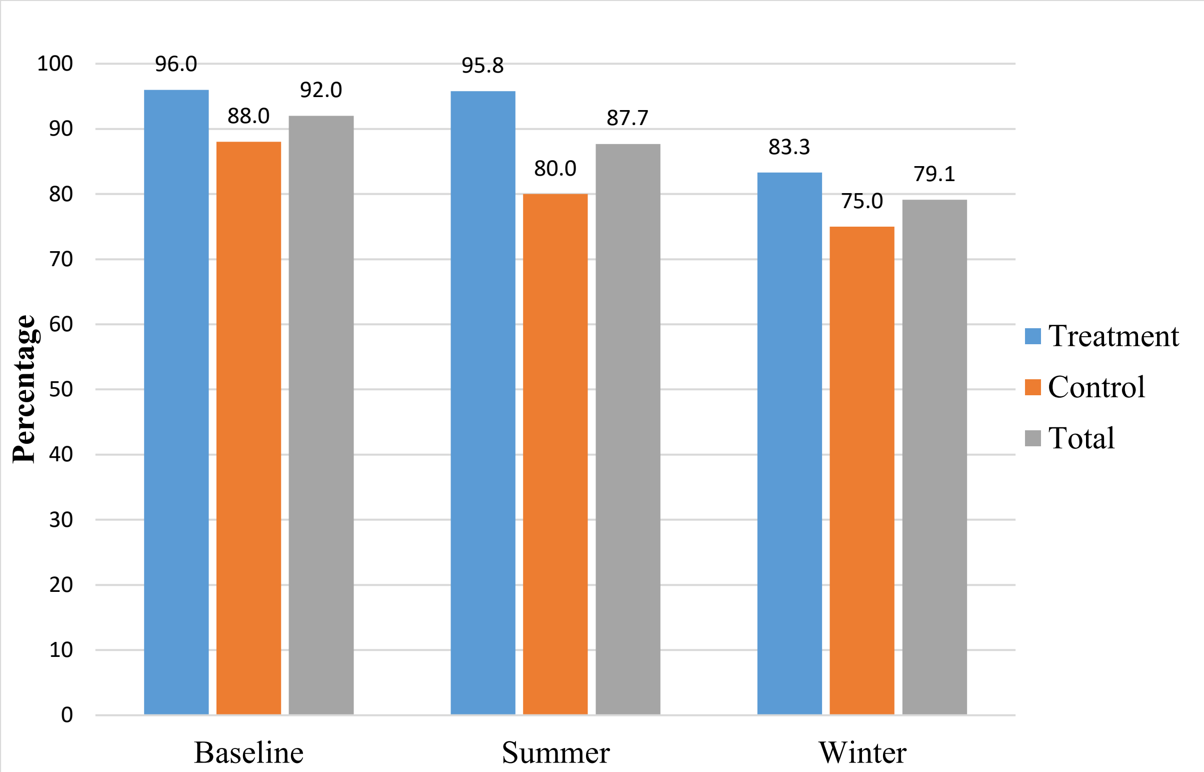


Figure 4.49 indicates that, in each season, on aggregate, approximately 75% or more Zimbabwean households remit food produced in their gardens to other households. More households in the treatment group than in the control group send food remittances from their gardens; (96% vs 88%) at baseline, (95.8% vs 80%) in summer and (83.3% vs 75%) in winter. These differences are marginally statistically significant, in summer only ($p<0.10$). Remittances are slightly less common in winter than in summer. As is the case elsewhere, food remittances are mainly sent to friends and to close relatives in urban areas, yet in some instances to rural areas. Treatment households send remittances of ZAR304.7 (baseline), ZAR145.4 (summer) and ZAR131.9 (winter). Households in the control group at baseline send food remittances of higher value than households in the treatment households (ZAR373.5 vs ZAR304.7) and in winter (ZAR238.1 vs ZAR131.9), though this is not statistically significant. Only in summer are food remittances values higher in the treatment group than in the control group (ZAR145.4 vs ZAR112.2), though not by a statistically significant margin.

Figure 4.55: Outward remittance of food from own gardens - Zimbabwe



Comparing treatment households across the three countries shows that, compared to Lesotho and Zimbabwe, fewer South African households report remitting food in each season. The relevance of the outward food remittances from food gardens is consistent with the literature. Maroyi (2009), for example, shows that households maintaining food gardens remitted garden produce to their neighbours and relatives. Similar results were reported by Schreinemachers *et al.* (2016), where household food garden project participants shared up to 5kgs of garden food with their family, friends, and neighbours in each season. Results of an urban food garden project in the southern Philippines also showed that about 5% of garden produce was given as a gift to family members and friends (Holmer & Drescher, 2006).

(c) Barter

Results in Figure 4.50 indicate that in Lesotho, more households in the treatment group than in the control group barter food from gardens; (32% vs 16%) at baseline, (36% vs 0%) in summer, with statistical significance ($p<0.05$), and (28% vs 18.1%) in winter. The proportion of treatment group households bartering food increased marginally from 32% (baseline) to 36% (summer), declining slightly to 28% (winter). Treatment households bartered food for other food items, mainly with neighbours who resided in urban areas, a few times a year and when there was a special need. The value of food bartered by treatment households is higher than that of control households; (ZAR410 vs ZAR180) at baseline, (ZAR143.7 vs ZAR0.0) in summer and (ZAR79.1 vs ZAR33.2) in winter, although these differences are not statistically significant. No clear trend is observed in the control group.

Figure 4.56: Barter of food from own gardens - Lesotho

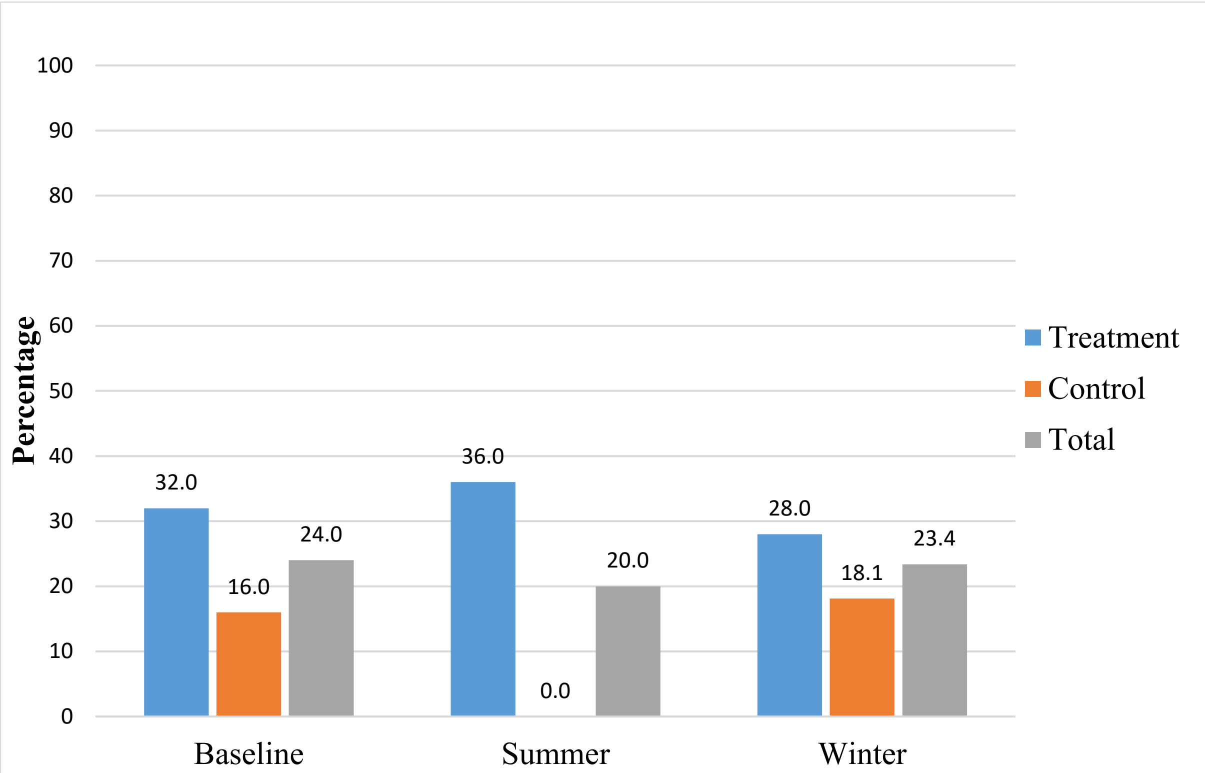
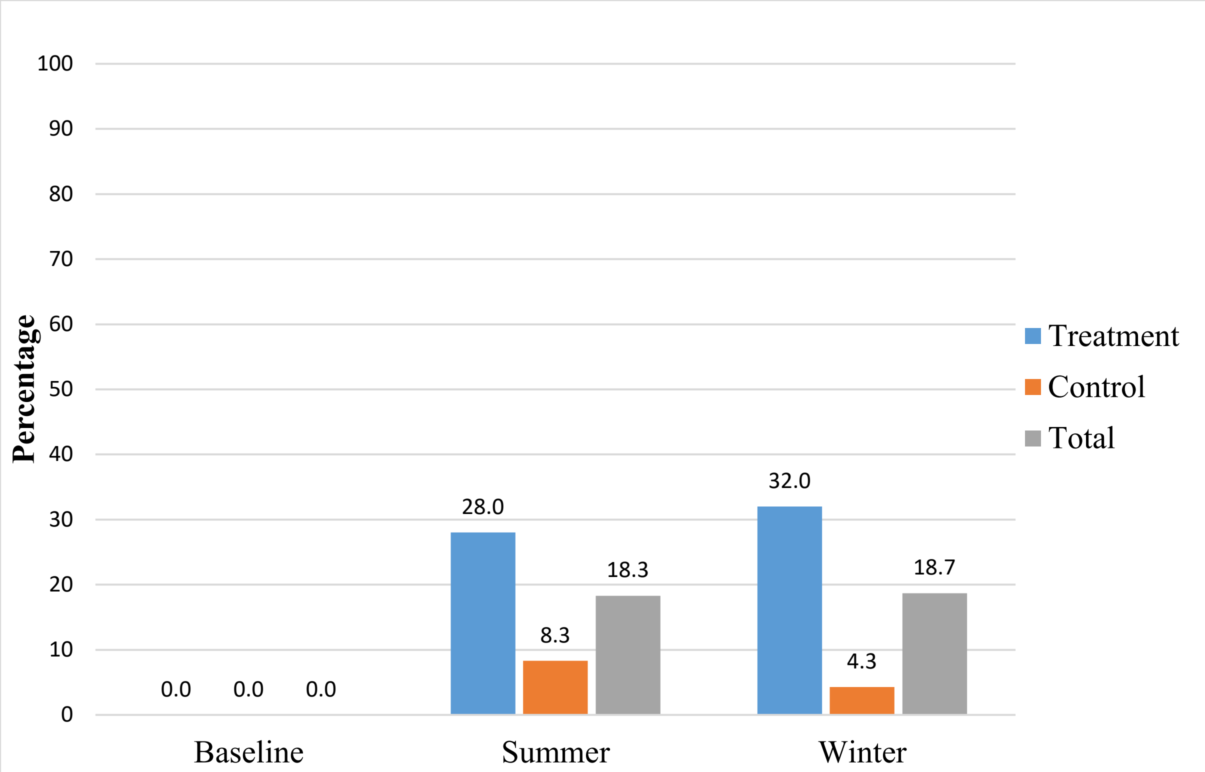


Figure 4.51 indicates that bartering is relatively uncommon in South Africa, with approximately only 20% of households using garden produce in summer and winter to exchange for other goods. The proportion of treatment households bartering food increases from 0.0% (baseline) to 28% (summer) to 32% (winter), with this increase being statistically significant ($p<0.01$). As expected, households in the treatment group are significantly more likely to barter garden produce than households in the control group, in both summer (28% vs 8.3%; $p<0.10$), and winter (32.0% vs 4.3%, $p<0.05$). Bartering occurs exclusively in urban areas, with friends and neighbours and when there is a special need in the treatment group. Households get food items such as beans and peanut butter in return. The value of bartered food for households in the treatment group is ZAR307.1 (summer) and ZAR108.1 (winter).

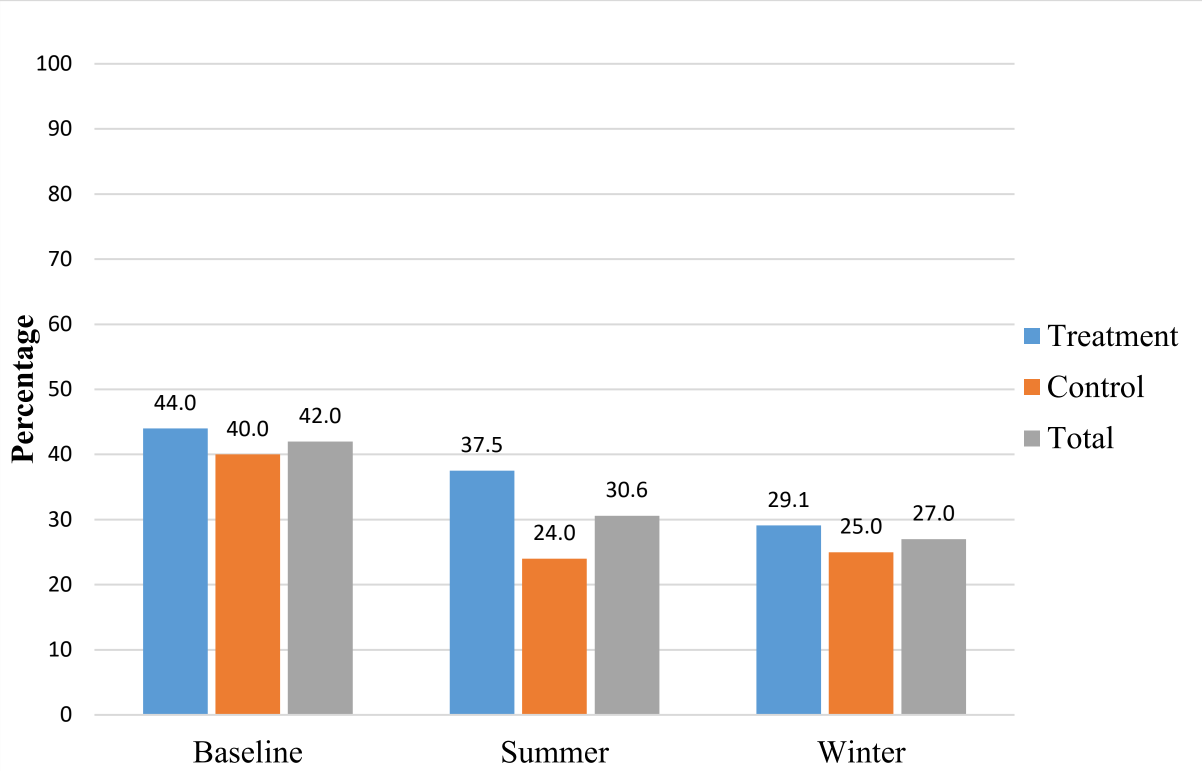
The value of bartered food was marginally statistically significantly higher in the control group than in the treatment group in summer (ZAR2050 vs ZAR307.1; p<0.10).

Figure 4.57: Barter of food from own gardens - South Africa



Of remitting, bartering and selling, bartering is the least common in Zimbabwe. However, as indicated in Figure 4.52 above, three to four in every ten households report trading household food garden produce for other goods, which is not a negligible proportion. Although not statistically significantly so, bartering is more common in the treatment group than control group in each season; (44% vs 40%) at baseline, (37.5% vs 24.0%) in summer, and (29.1% vs 25%) in winter. In summer, households in the treatment group barter more often with other urban dwellers, while households in the control group barter more often with rural villagers. In winter, both treatment and control group households barter more with those from urban areas. Bartering occurs mainly with friends and street vendors and households exchange garden produce for other food items, thus illustrating a secondary indirect impact of food gardens on dietary diversity. Bartering is less frequent, mainly a few times a year and when there is a special need. Treatment households barter food of higher value compared to control households; (ZAR264 vs ZAR 58.3) at baseline, (ZAR42.7 vs ZAR33.0) in summer and (ZAR105.1 vs ZAR32.4) in winter, with a weak statistically significant difference in winter (p<0.10). However, the value of bartering in the treatment group is higher in winter than in summer (ZAR105.1 vs ZAR42.7).

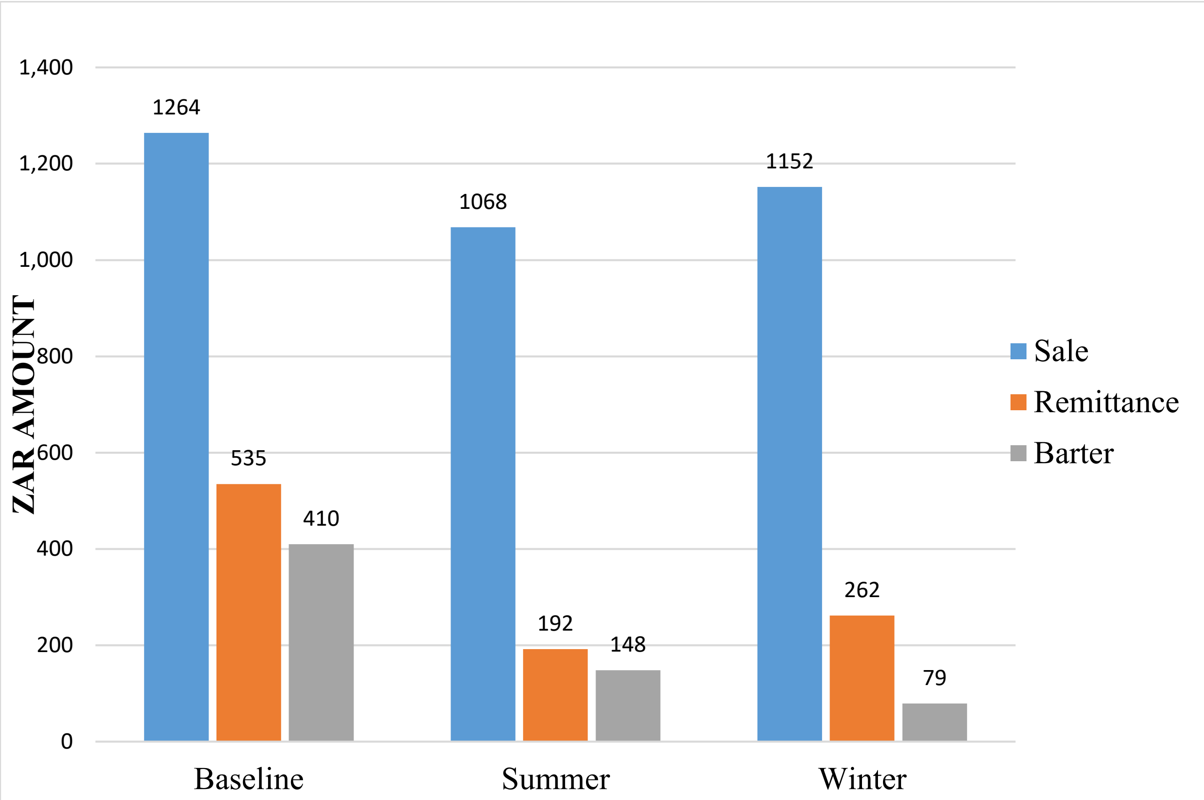
Figure 4.58: Barter of food from own gardens - Zimbabwe



In sum, treatment households are more likely to exchange their excess garden produce for other food with neighbours and friends. However, in each case study site, bartering is the least common way in which treatment households allocate their surplus garden produce, when compared to selling and remittances. In the focus group discussions with programme beneficiaries, bartering for food also emerged as one of the ways in which households utilised food from gardens. Households indicated that they bartered garden produce mainly for food and that the basis of this exchange was a preference for greater food diversity. As one respondent indicated; “I barter my vegetables for food that I don’t grow in my garden such as sugar beans, peanut butter, and potatoes.” The evidence for the exchange of excess garden produce for other household food items is in line with previous literature. Maroyi (2009), for example, found that food harvested from household food gardens was bartered with neighbours and friends for other foods. A study by Pillai *et al*. (2016) shows that besides selling surplus garden produce, households bartered the garden produce for vegetables or fruits they did not produce themselves. Puett *et al*. (2014) have reported that household food gardeners traded vegetables for beans and cooking oil. The discussion now turns to the comparisons of the three trade components, i.e. sale, remittance and barter, for treatment groups in each country. The results are discussed in turn: Lesotho, South Africa, and Zimbabwe

Results in Figure 4.53 show that when comparing the selling component of the food economy in Lesotho to the other two components of remitting and bartering, the income values from the sale of garden food exceeded the value of remittances and bartering by a considerable margin, particularly in the winter season in the treatment group (ZAR1152.1 vs ZAR262.3 vs ZAR79.1). The value of barter in the treatment households is lower than the value of remittances and sales in all seasons (Figure 4.53). Overall, Figure 4.53 shows that in terms of monetary values, sales were ranked 1st, remittances 2nd and barter 3rd.

Figure 4.59: Values of food sales, remittance and barter in treatment group - Lesotho



In South Africa's treatment group, Figure 4.54 shows that the income generated from the sale of food by treatment households in summer and winter exceeded the income values of remittances and barter (Figure 4.54). Values of remittances and barter fluctuate, with the remittances from treatment group households in summer being smaller in value than barter value (ZAR 230 vs ZAR307) and being higher than barter trade in winter (ZAR142.6 vs 108.1) (Figure 4.48).

Figure 4.60: Values of food sales, remittance and barter in treatment group - South Africa

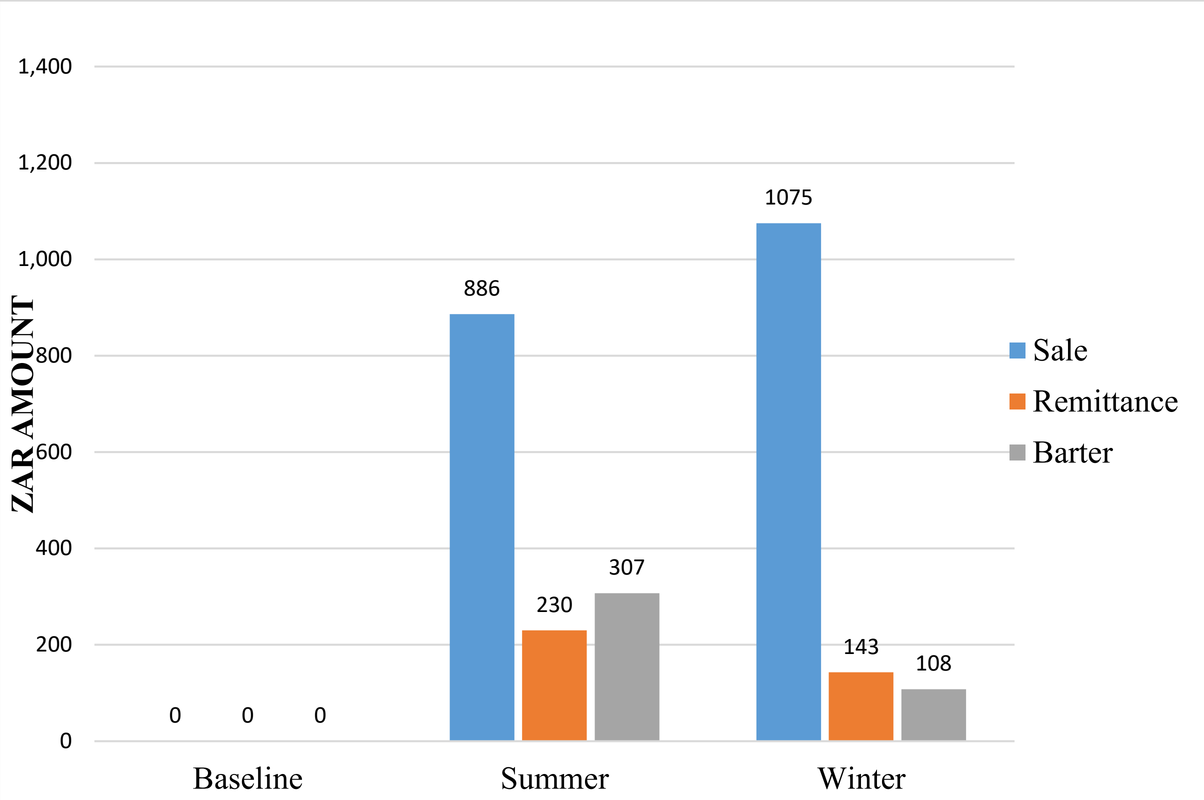
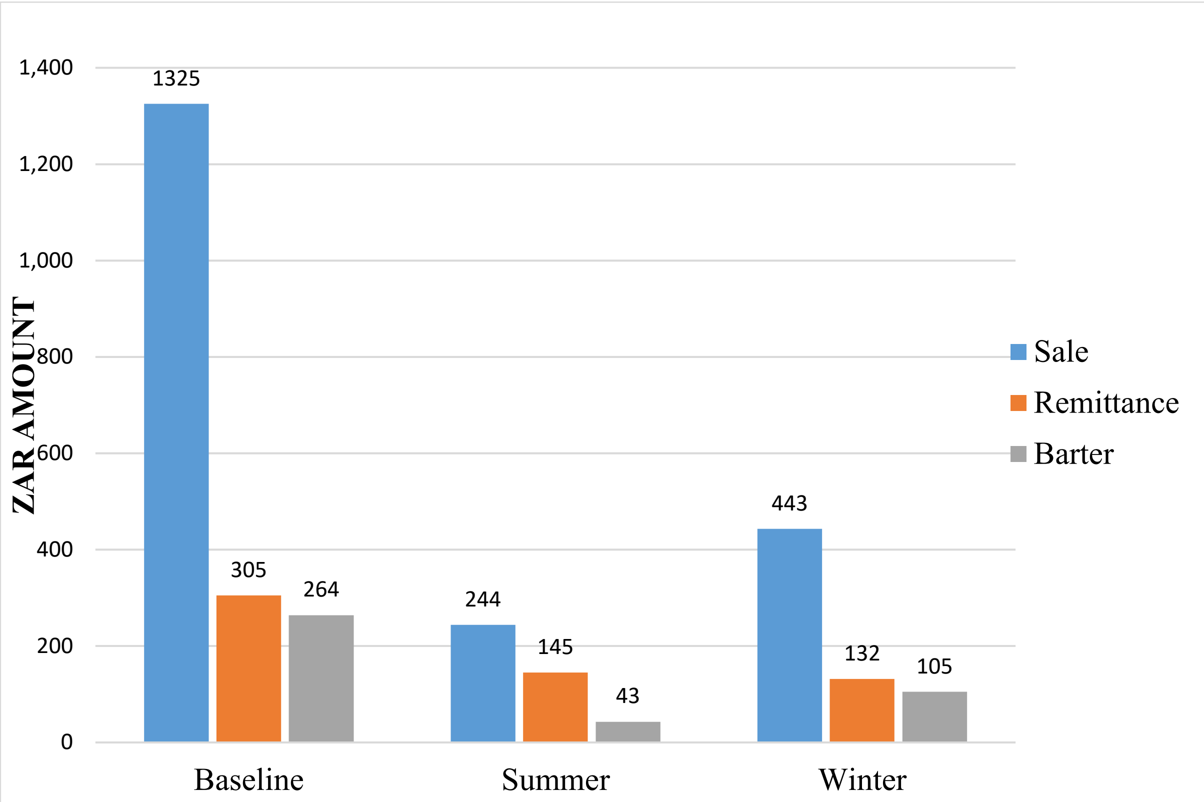


Figure 4.55 shows that the value of income earned from sale of garden produce by far exceeded the value of food bartered or remitted in the case of Zimbabwe's treatment group. In addition, within the treatment group, the value of food remittances is higher than barter values at baseline (ZAR304.7 vs ZAR264.0), in summer (ZAR145.4 vs ZAR42.7) and in winter (ZAR131.9 vs ZAR105.1) (Figure 4.55). Overall, in terms of monetary value, sales rank 1st, remittances 2nd and barter 3rd.

Figure 4.61: Values of food sales, remittances and barter in treatment group - Zimbabwe



The earlier part of the section presented an analysis of the food economy based on treatment and control group comparisons, and this last part of the section shifts and analyses the food economy, utilising the garden and no-garden groupings as well as programme and non-programme garden groupings. For the garden and no-garden groupings, the sale, remittance and barter of food is discussed next, focusing only on households with gardens since households in the no-garden group are households without gardens, while the sale, remittance and barter of food is discussed for both the programme and non-programme gardens households.

Figure 4.56 shows that, among the households with food gardens, food remittances are relatively more important than food sales and bartering of food. Food remittances are mainly to close relatives, friends and neighbours who reside in urban areas, at varied frequencies. The value of remitted food fluctuates throughout the study period; (ZAR363.9) at baseline, (ZAR171.0) in summer and (ZAR208.6) in winter. Notably, the value is higher in winter compared to summer (Figure 4.57). The sale of food ranks second and fluctuates between baseline (65.2%), summer (64.1%) and winter (66.6%). Households sell their food in urban areas, almost every week, mainly to friends, neighbours and close relatives. The average income earned in winter (ZAR771.72) is higher than that earned in summer (ZAR359.69) (Figure 4.57). A high proportion of households report that they spend income earned from the sale of food on food; 90% (baseline), 86.7% (summer) and 88.8% (winter). Less than four in ten households report bartering food in each season, 34.7% (baseline), 29.2% (summer) and 29.6% (winter). Bartering occurs mainly with friends, neighbours and street vendors in exchange for other food items, a few times a year and when there is a special need. The value of barter declines throughout the study period, ZAR223.0 (baseline), ZAR132.7 (summer) and ZAR77.5 (winter) (Figure 4.57). Comparing the income values of remittances, bartering, and selling shows that sales values are higher than remittances values even though the proportion of households reporting sending food is higher than those who report selling garden produce in each season (Figure 4.57). This can be attributed to two reasons: either there was less volume of garden produce which was sold, or the more expensive items were sold while the lower value items were kept for bartering and remittances. Income values of sales are also higher than barter values in each season.

Figure 4.62: Households with gardens sale, remittance, and barter food from gardens

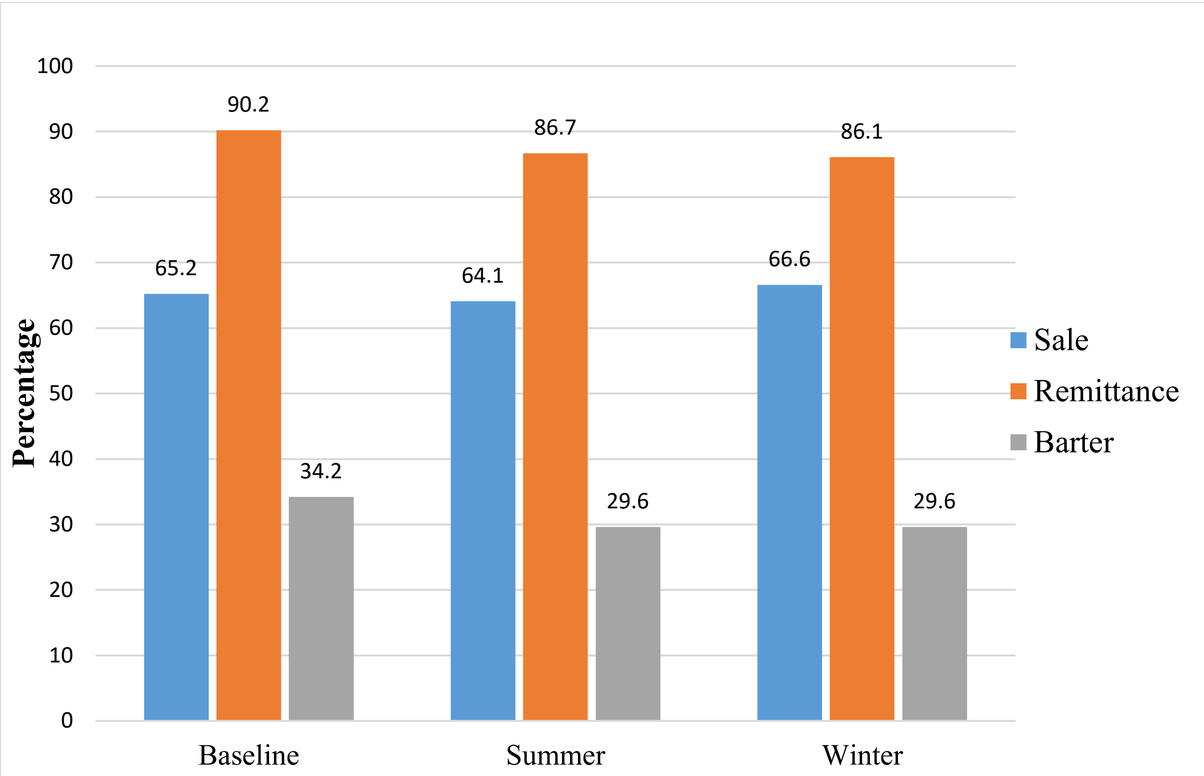
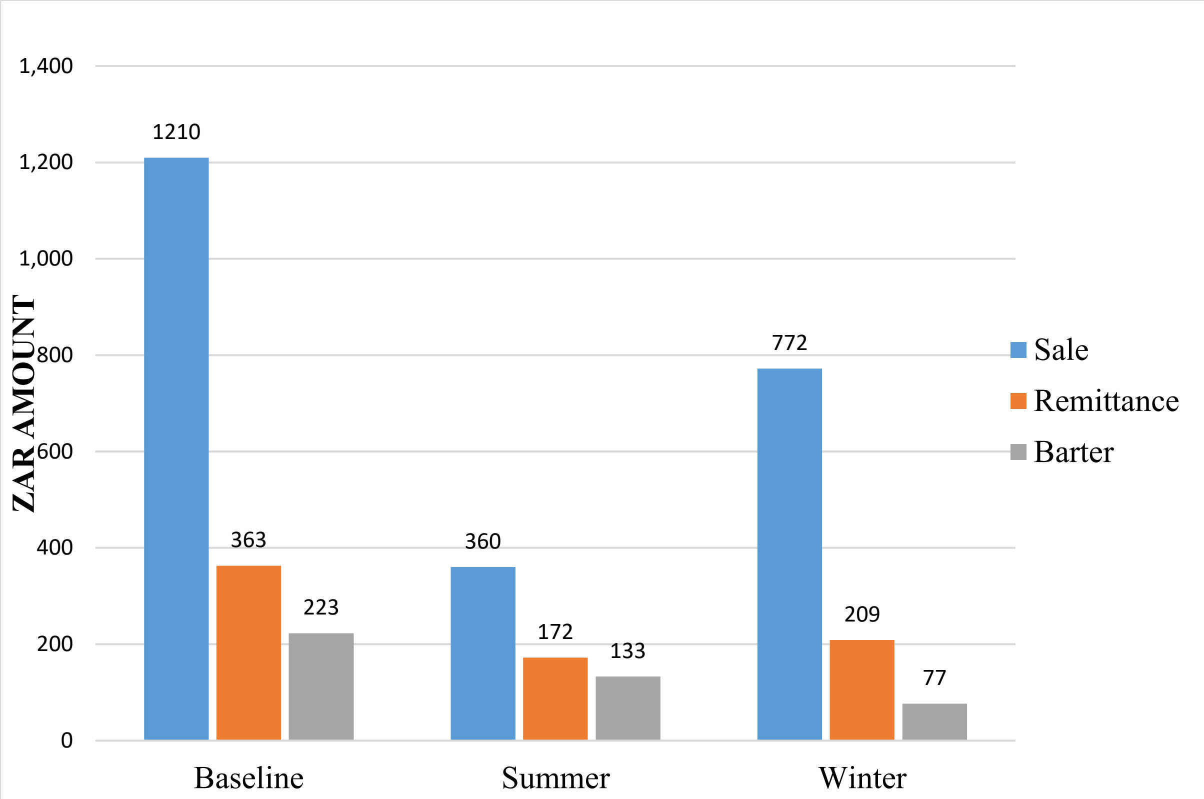


Figure 4.63: Values of food sales, remittances and barter and sales in the garden group



Comparisons based on programme garden and non-programme garden groupings show that in terms of the proportion of households selling food from gardens, there appears to be very little difference between households in the programme and non-programme garden groups (Figure 4.58). However, a slightly higher proportion of households in the programme garden group than households in the non-programme garden group sell food in summer (61.5% vs 54.5%), but the opposite is the case in winter (48.5% vs 57.8%). Sales are mainly in urban areas, to neighbours and friends at varied frequencies. In both seasons, households in the programme garden group sale food of higher value than households in the non-programme group; (ZAR376 vs ZAR325) in summer and (ZAR870 vs ZAR548) in winter. These differences are however statistically insignificant. A significantly higher proportion of households in the programme garden group households spend income from the sale of garden produce on food in summer (92.8% vs 84.3; $p<0.10$). Consequently, households in the programme garden group consider the income from sale of garden produce critical to their household food security (36.9% vs 0.0% $p<0.05$) and livelihood (39.1% vs 4.5%; $p<0.05$), as compared to households in the non-programme garden group.

Figure 4.64: Sale of food, by programme - non-programme garden status

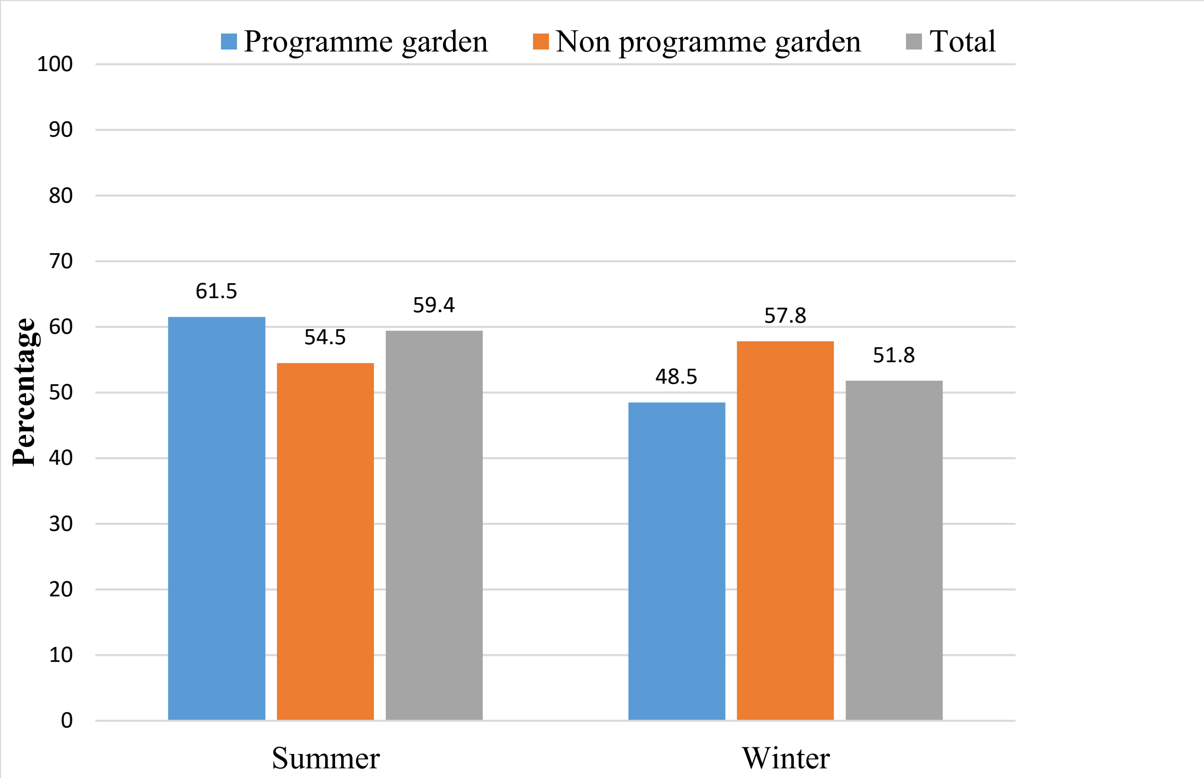


Figure 4.59 shows that a significantly higher share of households in the programme garden group than in the non-programme garden group remit food in both summer (91.7% vs 75.7%) and winter (90.0% vs 78.9%). These differences are statistically significant in summer, ($p<0.05$). Food remittances are sent mainly to close friends and neighbours who reside in urban areas at varied frequencies. In summer, households in the programme garden group remit food of higher value than households in the non-programme garden group (ZAR189 vs ZAR118), although the opposite was the case in winter (ZAR184 vs ZAR258), and both these differences are however not statistically significant.

Figure 4.65: Remittance of food by programme - non-programme garden status

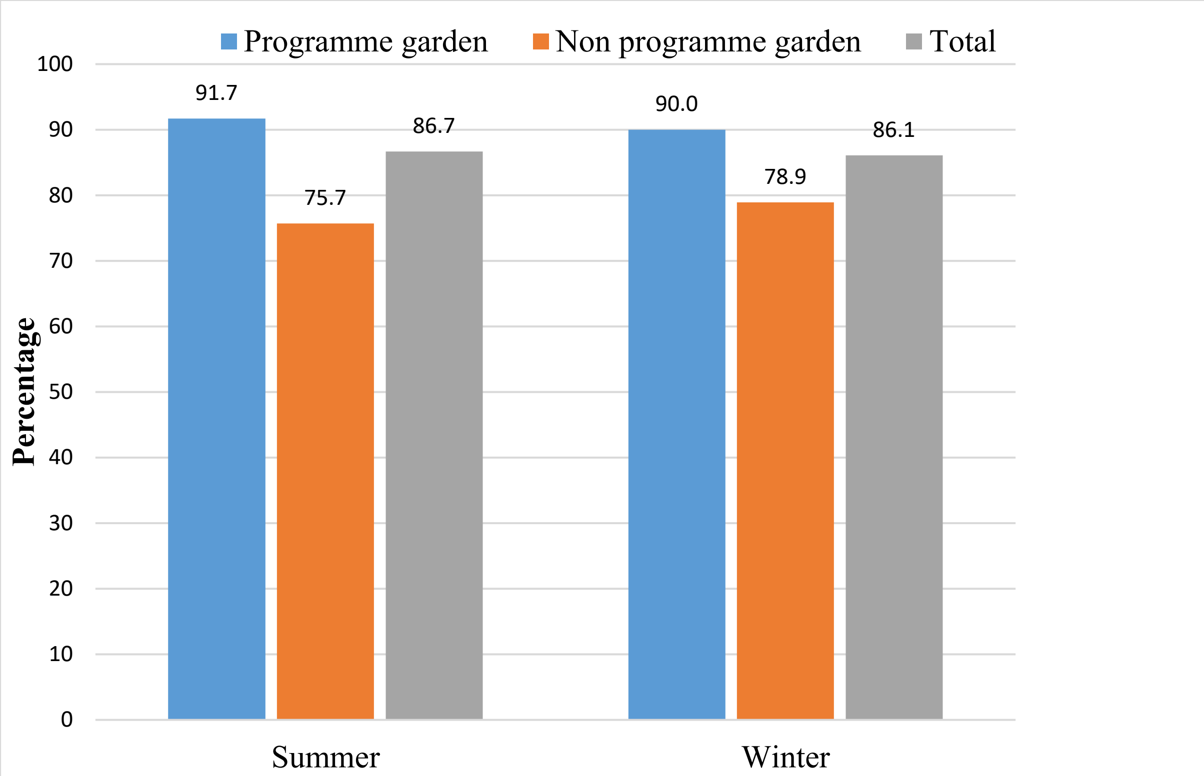
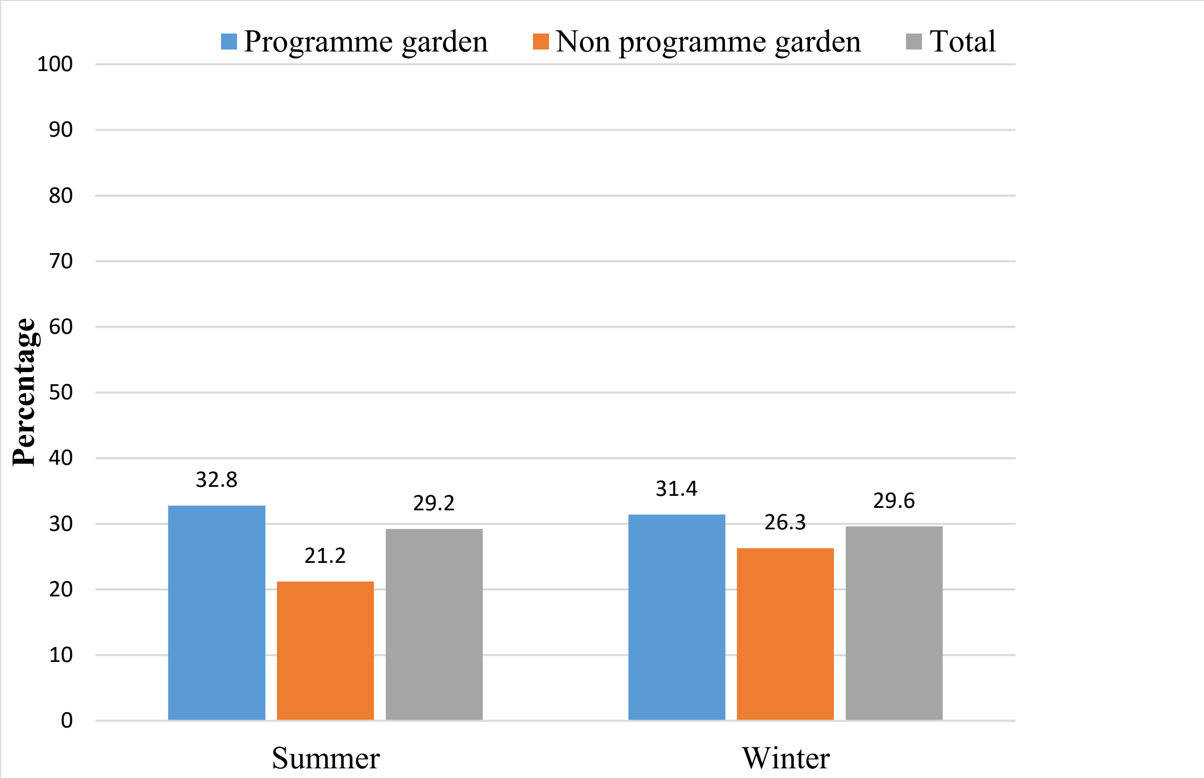


Figure 4.60 show that more households in the programme garden group barter food compared to households in the non-programme garden group in both summer (32.8% vs 29.2%) and winter (31.4% vs 26.3%), although these differences are not statistically significant. Food remittances are mainly urban, to friends and neighbours, almost every week and a few times a year. Households in the programme garden group barter food of more value in both summer (ZAR195 vs ZAR 42) and winter (ZAR99 vs ZAR33) than households in the non-programme garden group. These differences are statistically significant in winter ($p<0.05$).

Figure 4.66: Barter of food by programme - non-programme garden status



To sum up, the food economy analysis has revealed that household food gardens play a role in income generation, answering one of the study's main research questions. The analysis also unveiled the various pathways in which household food gardens influence the two dimensions of household food security, namely availability and access. After household consumption, households distributed the produce from their gardens by either selling, bartering, or remitting it to others, which all stand to increase household food security in the community at large as well as the variety of food consumed by households in the community. The fact that income generated through sales was spent mostly on food suggests that gardening strengthens the ability of households to access food. In addition, the fact that garden income was mainly used to purchase nutritious foods such as fish, meat, beans, and eggs also suggests an improvement in the quality of food accessible to the households. Moreover, with bartering, households increase the variety of their diets in a way that is resourceful and cost-effective. In this sense, gardens contribute more to food security than just the food harvested from the gardens. Added to that, the finding that excess food from household gardens was remitted to friends, neighbours, and family suggests that the food provisioning benefits of gardens extend beyond gardening households. In other words, this flow of food from gardens between households may be significantly reducing vulnerability to food insecurity in the broader community. This may also highlight the importance of social capital in enhancing household food security in these poor urban communities. Overall, these findings suggest that household food gardens can be credited with improving not only the availability of food to households but also the ability of households to access diverse foods, and therefore, their overall food security. The forthcoming section discusses the impact of food gardens on household food security.

4.6 Food security

This section emphasises the role of food gardens in enhancing household food security**.** The first sub-section discusses changes in the food security indicators over the study period. The second sub-section addresses the question whether household food gardens impact food security in a formal regression framework setting. The study uses the linear OLS panel data regression models and the propensity score matching (PSM) analysis to assess the impact of gardens on household food security. In both the linear panel data models and PSM analysis, results for the household garden versus no-garden comparisons are reported first, followed by findings from the programme household food gardens versus non-programme household food gardens comparisons.

4.6.1 Descriptive analysis

In this sub-section, the study descriptively analyses the household food security indicators (the household dietary diversity score (HDDS) and the months of adequate household food provisioning (MAHFP).

Results from Lesotho, in Figure 4.61, indicate that the households' diets are not highly diverse, with all households consuming an average of 4.2 unique food groups, which falls in the low category according to the FAO (2007) proposed thresholds of household dietary diversity (6+: high = good dietary diversity; 4.5 - 6: medium dietary diversity; <4.5: low dietary diversity). Dietary diversity increases marginally over time in the treatment group from 4.4 (baseline) which is initially in the low category, to 4.5 (summer) and to 4.7 (winter), which now falls into the medium category. This increase over time in dietary diversity in the treatment households is however statistically insignificant. Control group households' dietary diversity scores fluctuate over time, dropping in summer (from 4.2 to 3.6) and rising again in winter season (from 3.6 to 4.0). When comparisons are drawn between treatment and control households, though, dietary diversity scores are higher among households in the treatment group than in the control group in each case: (4.4 vs 4.2) at baseline; (4.5 vs 3.6) in summer, and (4.7 vs 4.0) in winter, these differences, however, are only statistically significant in summer and then only weakly ($p<0.10$). In terms of individual food categories consumption, there are few differences between treatment and control households. Treatment households significantly more frequently reported consuming vitamin A rich vegetables than control households (20% vs 0.0%, $p<0.05$) in summer and significantly more frequently reported consuming meat in winter (28% vs 4.5%, $p<0.05$). These results are consistent with that of Akrofi *et al*. (2010), who found that households maintaining household food gardens had a higher dietary diversity score of 6.8 compared to 6.0 of households who did not manage a garden. Similar results were reported by Cabalda *et al*. (2011), who indicated that households with gardens had a higher dietary diversity score of 5.8 compared to 5.3 of households without gardens. Olney *et al.* (2009) reported an improvement in the household dietary diversity scores from 3.3 to 4.3 among households who had adopted improved household food gardens in Cambodia.

Figure 4.67: Household dietary diversity - Lesotho

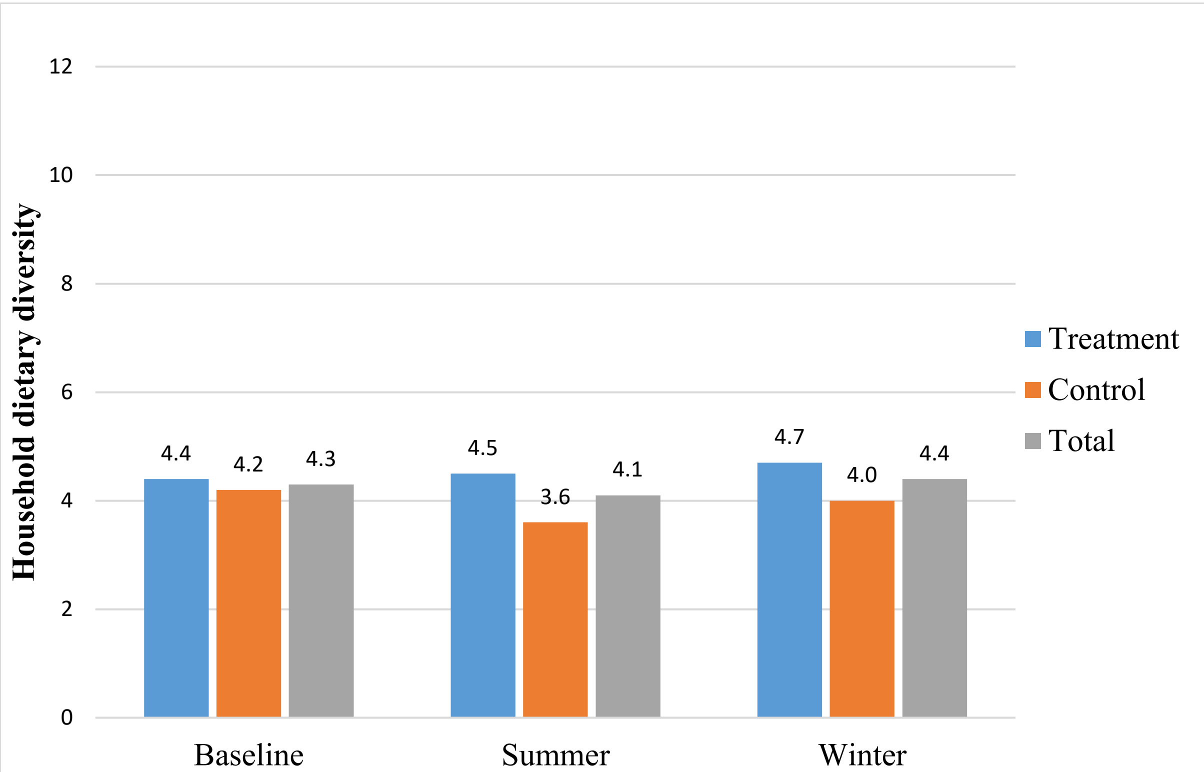


Figure 4.62 shows that in South Africa, household dietary diversity is moderately diverse in summer and winter, falling into the high category of FAO's (2007) guidelines for household dietary diversity. Dietary diversity increases over time for both groups compared to baseline. In the treatment group, dietary diversity fluctuates throughout the study period, increasing markedly between baseline and summer from 4.7 (baseline) to 6.6 (summer) and declining marginally between summer and winter from 6.6 (baseline) to 6.4 (winter). The increase over time in the treatment households' dietary diversity score is statistically significant ($p<0.01$). Compared to the treatment group, a clear upward trend is notable in the control group over all three points in time, where dietary diversity increases from 4.4 (baseline) to 6.2 (summer) to 6.6 (winter), an increase over time is statistically significant ($p<0.01$). Dietary diversity, except for the winter season, is slightly higher in the treatment than control group, but not statistically significant. A single difference is noted when individual food categories are considered. In summer, treatment households are significantly more likely to consume dark green vegetables than control households ($p<0.05$).

Figure 4.68: Household dietary diversity - South Africa

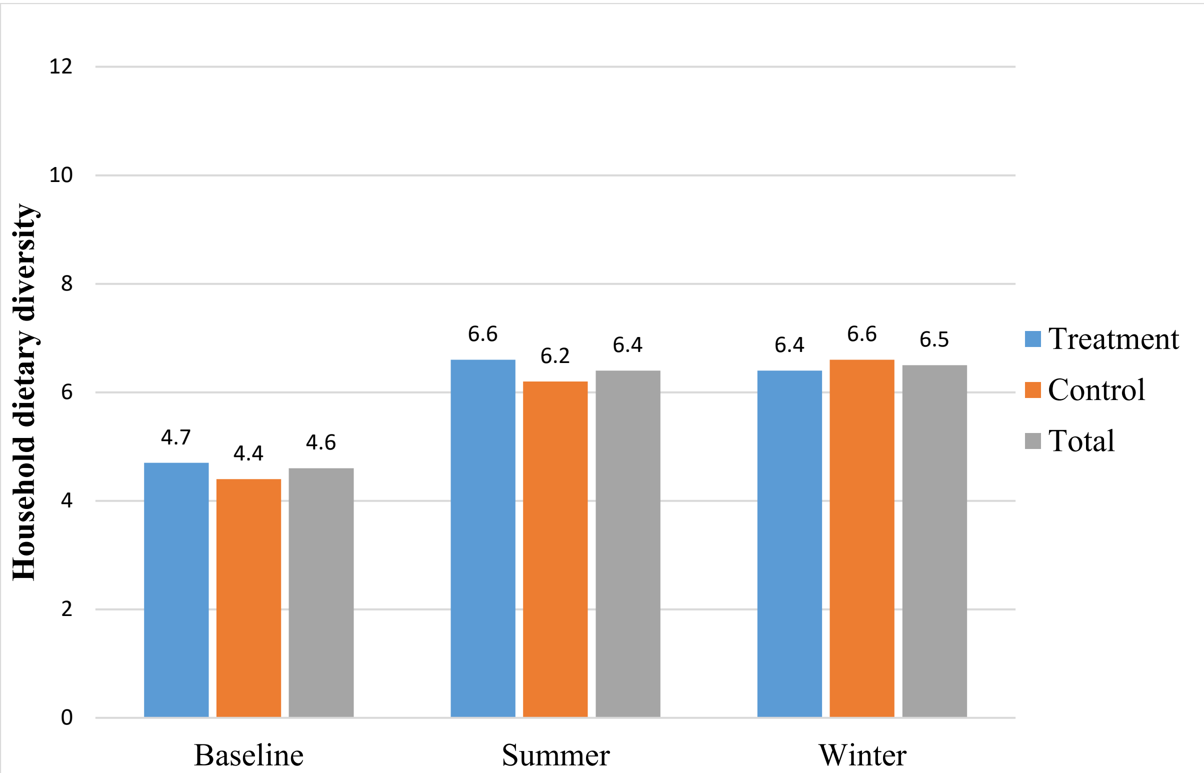


Figure 4.63 above indicates that in Zimbabwe, as in South Africa, households' dietary diversity in summer and winter is moderately diverse and falling into the high category of FAO's (2007)

guidelines of household dietary diversity. Between baseline and summer seasons, improvements in dietary diversity are observed, from 5.2 (baseline) to 6.3 (summer) but dropping marginally to 6.2 in winter. The increase over time in the household dietary diversity scores in the treatment group is marginally statistically significant ($p<0.10$). Compared to the treatment group, a clear upward trend is observed in the control group, where the household dietary diversity score increases from 5.7 (baseline) to 6.2 (summer) to 6.5 (winter), though this increase over time is statistically insignificant. The dietary diversity score is slightly higher in the control groups at baseline (5.7 vs 5.2), with the same picture depicted in winter (6.5 vs 6.2), though this is statistically insignificant. In summer, the dietary diversity score is marginally higher in the treatment households than control households (6.3 vs 6.2). No statistically significant differences are observed between the treatment and control groups in terms of consumption of individual food categories.

Figure 4.69: Household dietary diversity - Zimbabwe

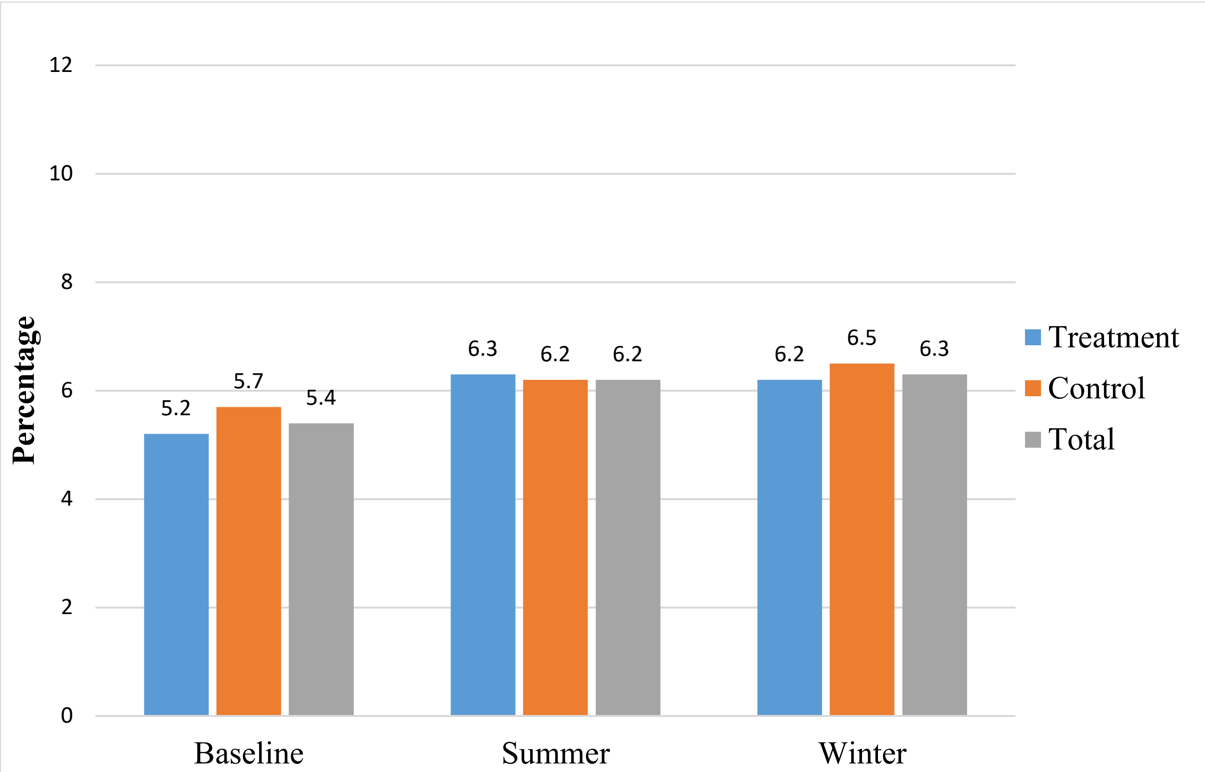


Figure 4.64 shows that household dietary diversity increased in both the garden and non-garden group between baseline and winter. The increase over time in the dietary diversity score in the garden group of 4.9 (baseline) to 5.9 (summer) to 5.9 (winter) is statistically significant ($p<0.01$). Like the garden group, the non-garden group's household dietary diversity score

increases over baseline-summer-winter, from 4.6 (baseline) to 4.7 (summer) to 5.3 (winter). The increase over time of the household dietary diversity in the no-garden group is however statistically insignificant. At baseline, households in the garden group have higher dietary diversity scores (4.9 vs 4.6) than households in the no-garden group, although this difference is not statistically significant. As expected, household dietary diversity scores are statistically significantly higher among households in the garden group than in the non-garden group, both in summer (5.8 vs 4.7; p<0.01) and winter (5.9 vs 5.3; p<0.10). It appears that household food gardening contributed to increased dietary diversity among households in the garden group in the respective countries, although dietary diversity increased marginally from baseline to winter for the Lesotho treatment group.

Figure 4.70: Household dietary diversity, by garden status

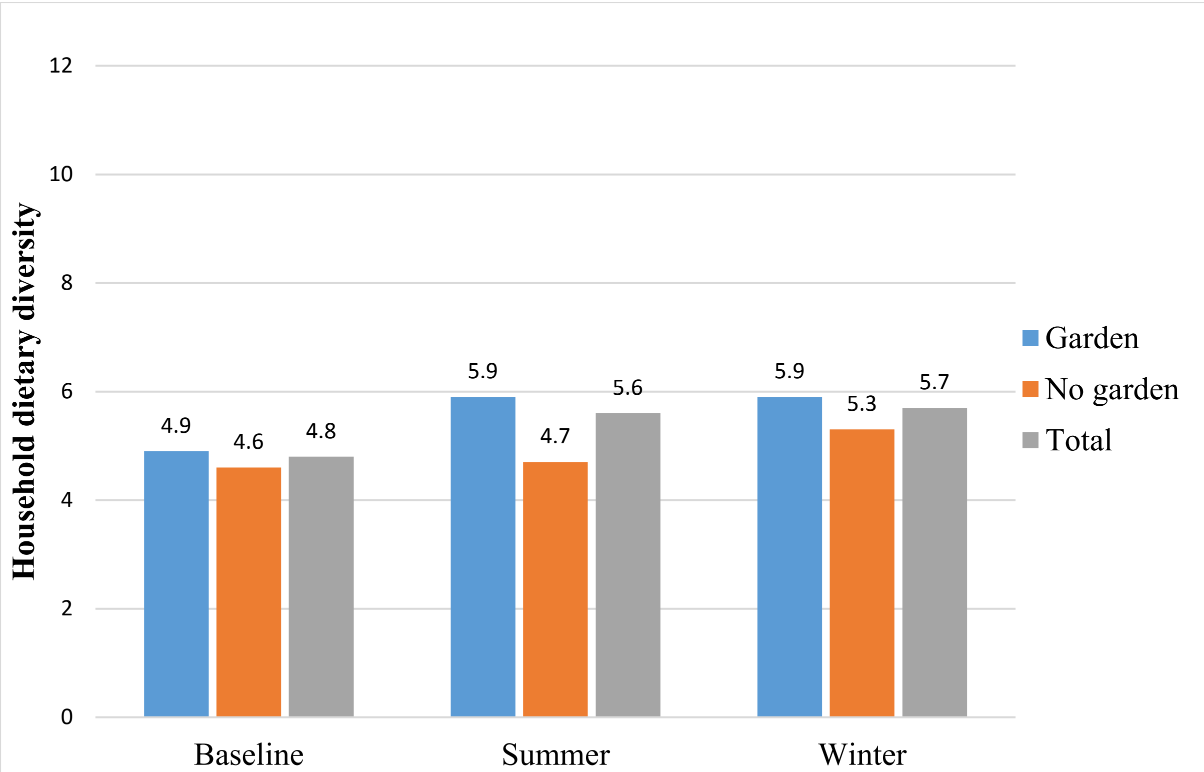


Figure 4.65 shows that households in the programme garden group had higher dietary score than households in non-programme gardens in summer (6.6 vs 5.9; p<0.10). This trend is however reversed by winter, so that the household food diversity scores were identical in both programme and non-programme garden group (5.9 vs 5.9).

Figure 4.71: Household dietary diversity, by programme - non-programme garden status

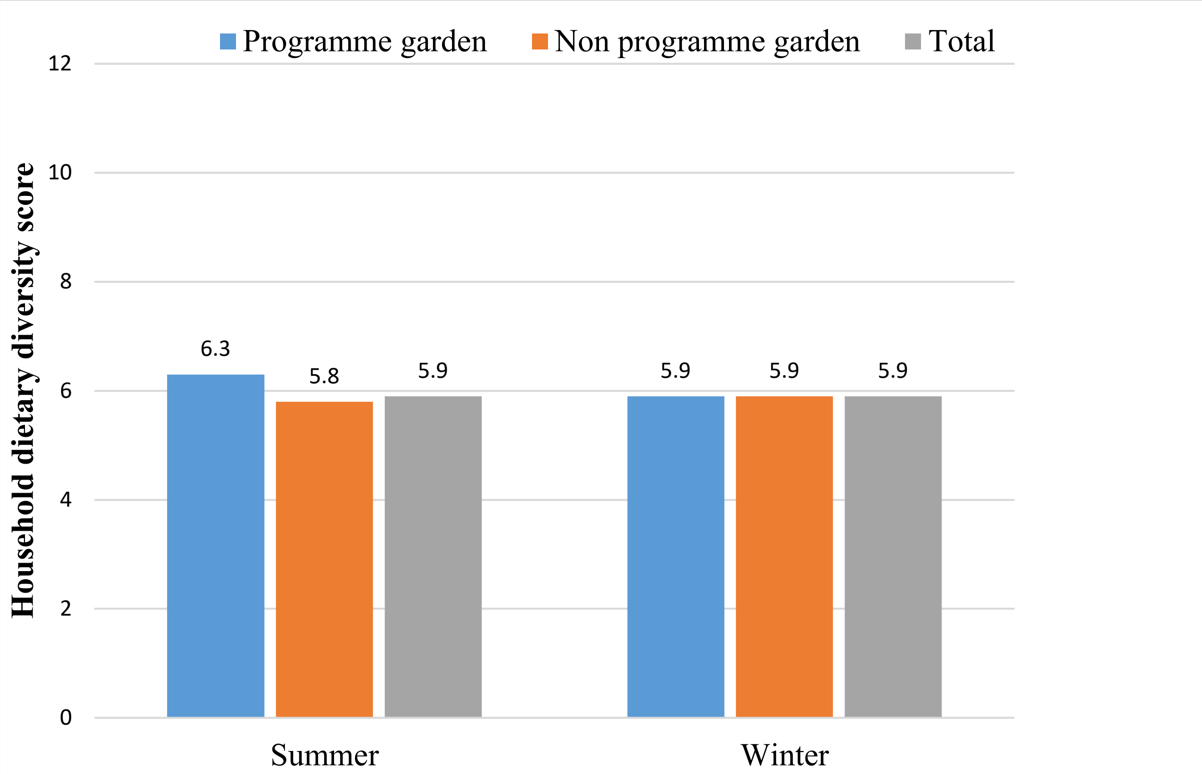


Figure 4.66 shows that at baseline, in Lesotho, control households had higher MAHFP than intervention households, though the difference is not statistically significant, but which may reflect the fact that the NGO targets poorer, food insecure households as part of their programme. By summer, intervention households were enjoying more months of adequate food provisioning, with these gains sustained till winter. The upward trend noticed in the treatment group, 8.7 (baseline) to 10.8 (summer) to 11.0 (winter), mirror the trend in the HDDS. This improvement over time in MAHFP in the treatment group is statistically significant ($p<0.05$). MAHFP fluctuates in the control group, increasing between baseline and summer (10.3 to 10.9) and falling again between summer and winter (10.9 to 10.3), which is the opposite to the trend in HDDS. No statistically significant differences are observed between treatment and control groups in terms of the overall MAHFP.

Figure 4.72: Months of adequate household food provisioning - Lesotho

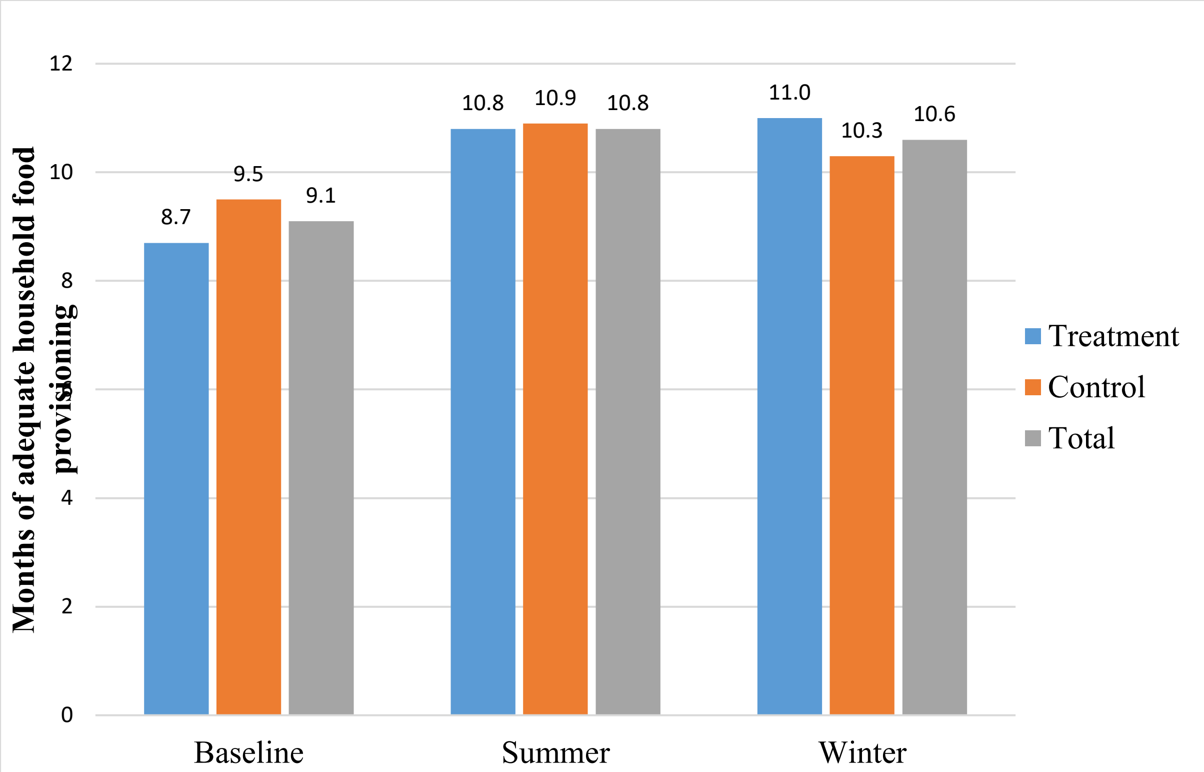
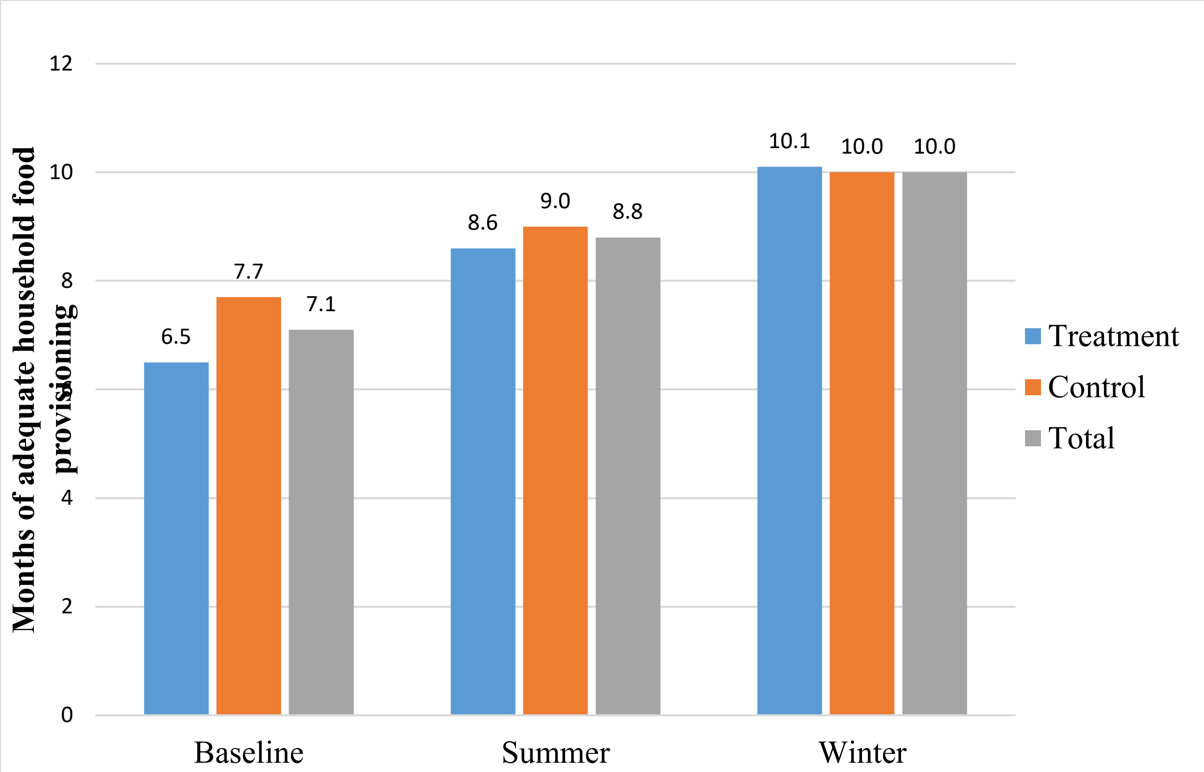


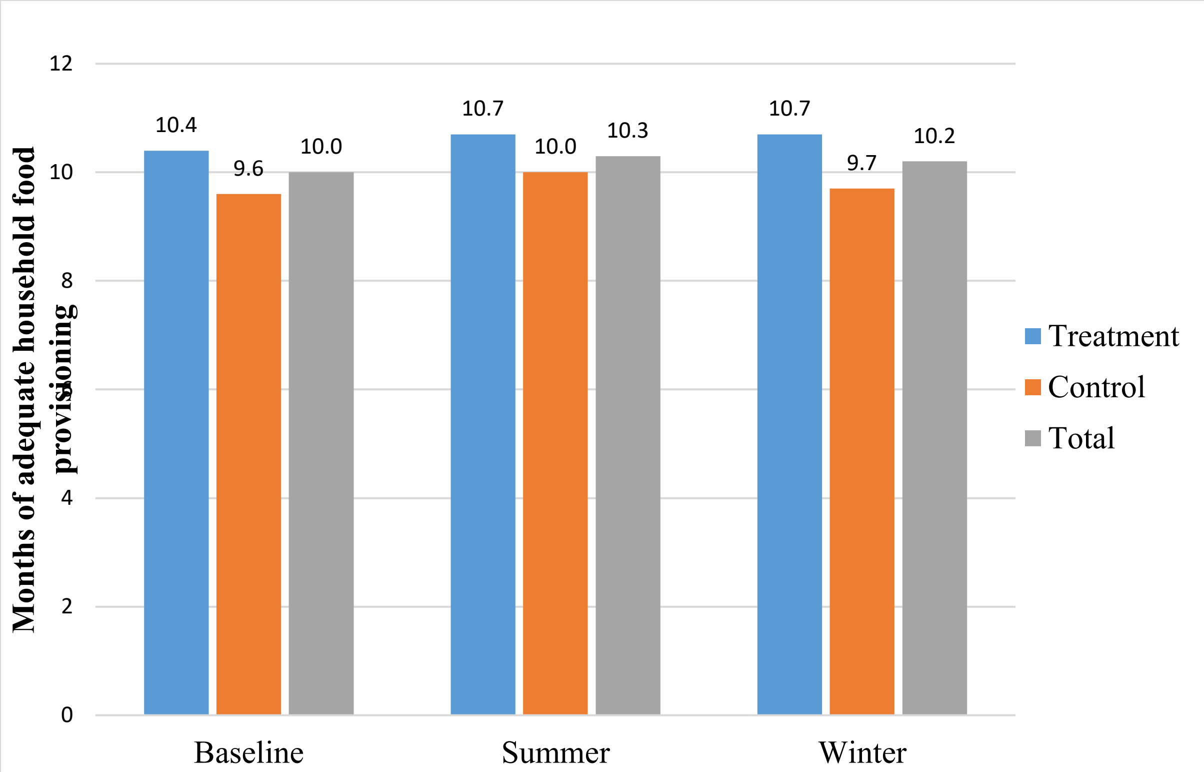
Figure 4.67 illustrates that on aggregate, the number of months in which households did not have enough food to eat declined throughout the study period in South Africa. MAHFP however increased in both the treatment group and control group. The increase over time of MAHFP in the treatment group is statistically significant ($p<0.01$), which may suggest that household food gardens contributed to household food security improvement among the treatment households. For the control group, an increase over time in MAHFP is observed; 7.7 (baseline) to 9.0 (summer) to 10.0 (winter), although this increase is statistically insignificant. MAHFP scores, however, did not differ between treatment and control households at baseline, summer and winter.

Figure 4.73: Months of adequate household food provisioning - South Africa



As shown in Figure 4.68, in Zimbabwe, MAHFP increase between baseline and summer (from 10.0 to 10.3) and fell marginally between winter and summer (from 10.3 to 10.2). MAHFP increase in the treatment group from 10.4 (baseline) to 10.7 (summer) to 10.7 (winter), though the increase over time was not statistically significant. No clear pattern is observed in the control group: 9.6 at baseline; 10.0 in summer; and 9.7 in winter. MAHFP scores are not statistically different between the treatment and control groups in all seasons, although MAHFP is higher in the treatment than control group in all cases: (10.4 vs 9.6) at baseline, (10.7 vs 10.0) in summer and (10.7 vs 9.7) in winter. This may possibly hint at the potentially greater productivity of programme gardens compared to non-programme gardens in the control group, a research question to which the thesis returns in the econometric analysis.

Figure 4.74: Months of adequate household food provisioning - Zimbabwe



Cross-country comparisons based on treatment groups indicate that improvements in MAHFP are greatest in South Africa's treatment households compared to Lesotho's and Zimbabwe's treatment households. This might suggest that gardening made a huge impact in terms of food provisioning for South African households. These results may also suggest that households in treatment groups used their garden produce in ways that enhanced their diets, as well as their overall household food security. Aggregating the data across garden and no-garden groups and across the three countries gives the following results:

Figure 4.69 indicates that on aggregate, the average number of months with adequate food increased over time from 9.0 (baseline) to 10.0 (summer) to 10.3 (winter). Marginal increases in MAHFP are observed in the garden group from 9.8 (baseline) to 10.1 (summer) to 10.4 (winter), though the improvement was not statistically significant. For the no-garden group, statistically significant increases in MAHFP are observed over time, from 7.6 (baseline) to 9.7 (summer) to 10.1 (winter) ($p<0.01$). MAHFP does not differ between garden and non-garden group in summer (10.1 vs 9.7) and winter (10.4 vs 10.1), although it is higher in the garden group, but differs between the two groups at baseline (9.8 vs 7.6) and is also statistically significantly so ($p<0.01$).

Figure 4.75: Months of adequate household food provisioning, by garden status

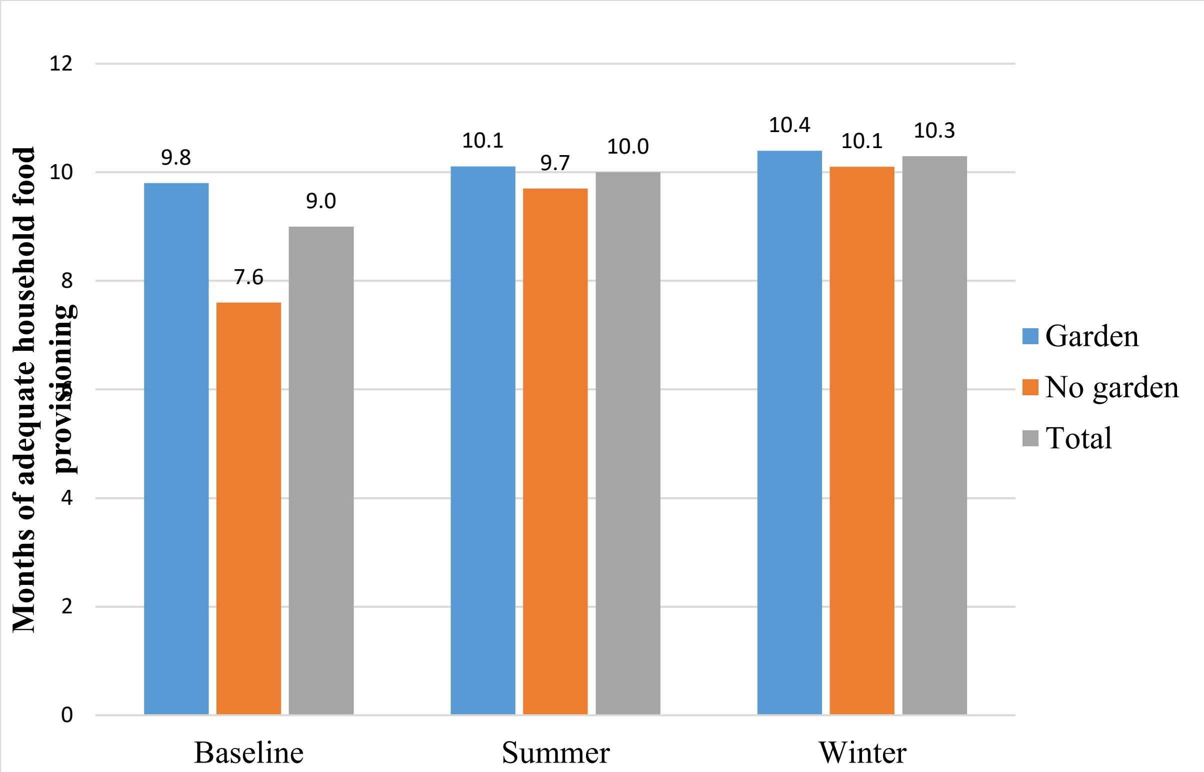
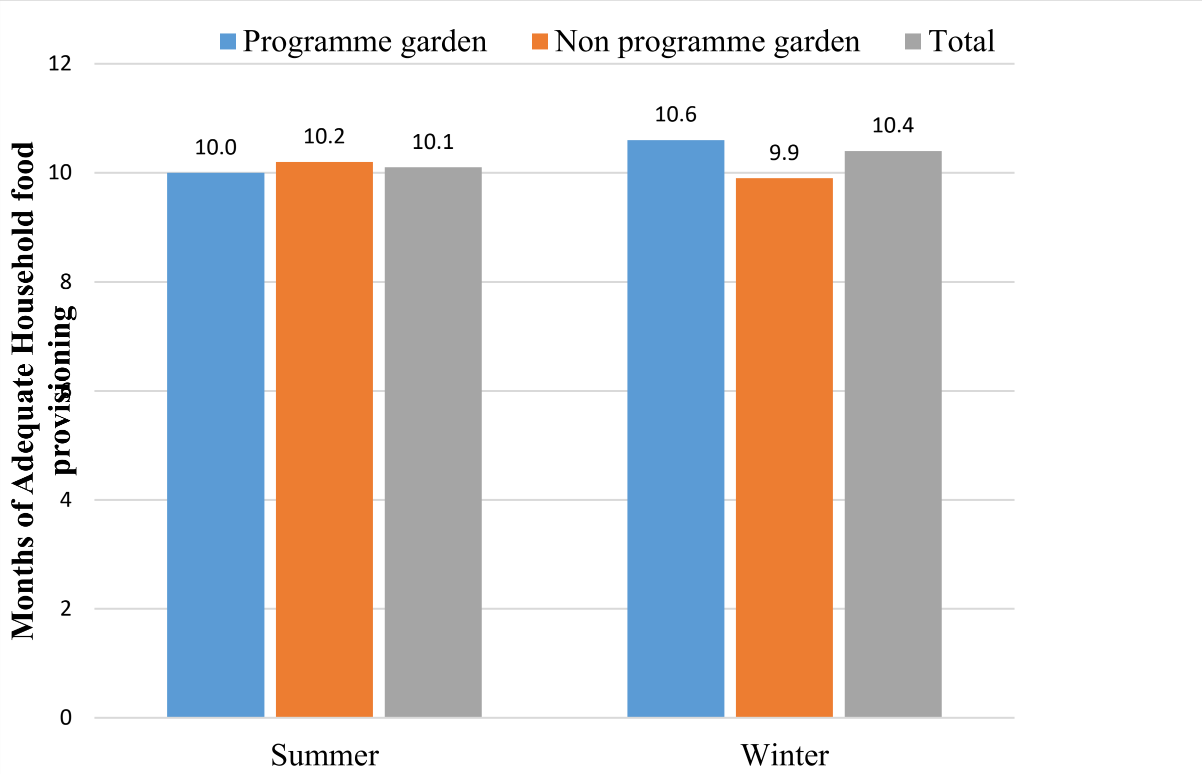


Figure 4.70 show results based on programme and non-programme garden groupings. Results show that in summer, households in the non-programme gardens had a slightly higher MAHFP (10.2 vs 10.0) and this difference was not statistically significant. In winter, the trend is reversed so that the households in programme garden group statistically significantly enjoy more months of adequate household food provisioning (10.6 vs 9.9; $p<0.10$) than households in the non-programme garden group.

Figure 4.76: Months of adequate household food provisioning, by programme - non-programme garden status



4.6.2 Econometric analysis

(a) Panel data analysis

The estimation methods applied in this section are the linear panel models, namely Pooled Ordinary Least Squares (POLS), Random Effects (RE), Fixed Effects (FE), and First Differencing (FD). Results are calculated for different estimation methods, to enable comparison and to choose the best method. As indicated in Chapter 3, two measures of household food security are used in this study, namely, the household dietary diversity score (HDDS) and months of adequate household food provisioning score (MAHFP) (see Chapter 3, Section 3.9.1, page 62). To assess the impact of gardens on household food security, two garden dummy variables are used: (i) the garden dummy which takes the value of one when a household has a food garden and zero otherwise, and (ii) the programme garden dummy, taking a value of one when a household has a project garden and zero when a household has a non-programme garden. To account for country unobservables, country fixed effects are included through 2 dummy variables, representing the 3 countries in our sample. Seasonal variations in the provisioning of household food gardens are also accounted for using 2 dummy variables, representing 3 seasons in the sample data. For each independent variable, HDDS and MAHFP, there are two regressions presented, which differ on the indicator used for the garden dummy variable. See Table 3.10 (see Chapter 3, Section 3.10.2, page 96) for the description of the variables used in the regression. First, the effect of gardens in general on household food security is estimated. The impact of programme gardens on household food security is estimated thereafter.

Table 4.3 shows the summary statistics of the two food security indicators used in the study. The overall and within variation for both HDDS and MAHFP are calculated over 436 observations. The between variation is calculated over the 150 unique households, and the average number of times a household was observed in the data is 2.90. Results from Table 4.3 reveal that HDDS varied between 0 and 12. For each household, the mean HDDS varied between 2.5 and 10.33 and the HDDS score within varied between 1.73 and 11.06. The standard deviation shows that the variation in HDDS across households as expected is greater than that observed within a household. Like HDDS, the MAHFP varied between 0 and 12, with the average MAHFP for each household varying between 3 and 12. The within variation of the MAHFP varied between 1.7 and 11.10, with the standard deviation indicating that there is more variation within than between households, unlike for the HDDS measure.

Table 4.15: Summary statistics for HDDS and MAHFP

Variable		Mean	Std. Dev.	Min	Max	Observations
HDDS	**overall**	5.399	1.906	0	12	N=436
	Between		1.472	2.5	10.333	n=150
	Within		1.218	1.732	11.065	T-bar =2.906
MAHFP	**overall**	9.772	2.757	0	12	N=436
	Between		1.880	3	12	n=150
	Within		2.028	1.772	17.106	T-bar =2.906

Tables 4.4 and 4.5 show the results of the effect of food gardens on household food security based on the four estimation methods. Using the HDDS as the food security indicator, results in Table 4.4 reveal that the POLS, RE, FE, and FD models all show a significant and positive effect of gardens on household food security. For HDDS, Hausman test result, ($\chi^2 = 21.88$

with a p-value =0.025), suggests a rejection of the null hypothesis in favour of the FE estimator, indicating that the FE model should be used, and implying that the RE model is inconsistent (Table 4.4). The F-test for the overall fitness of the FE model (with F-value = 5.96 and a p-value <0.01), suggests that all the coefficients of our explanatory variables are jointly different from zero. In other words, the explanatory variables included in the FE model are jointly significant at 1% error probability, implying that our FE regression model fits well. The FE result indicates that household food gardening increases HDDS by 1.027 points. Thus, in line with our hypothesis, the study found a positive effect of food gardens on household food security. In addition to the food garden variable, among the control variables included in the regression model, only marital status is significant in predicting household food security, and only for married households. The dummy variable for married households' heads is positively related to household food security and this means that households headed by married households' heads are more food secure compared to their counterparts. This, therefore, may indicate that marriage is protective of household food security. This is consistent with other studies that find that being married increases the likelihood of households being food secure (Wilde & Nord, 2005; Yusuf *et al*., 2015). This result however is interpreted with caution as it could still be the case that households that are food secure are more likely to have a married head (i.e. dual causality). Time dummies are significantly positive as well. This shows that the household dietary diversity score, compared to baseline, is higher in summer and winter by 0.696 and 0.866, respectively.

When MAHFP is used as a dependent variable, the positive and significant food garden effect remains positive in all models as shown in Table 4.6. However, the Hausman test, ($\chi^2 = 9.12$ with a p-value =0.610) shows that the preferred method is the RE model. Among the variables, which are hypothesised to influence food security, only education of the household head is a significant determinant of household food security, and only for the household heads with a secondary level of education, although negatively. In other words, food security is lower in households with heads with secondary education compared to households with heads with no education, a result that is contrary to the a priori expectation of the study. This result therefore shows that households headed by people with secondary education attainment are less food secure, compared to their illiterate counterparts. This might be attributed to selection bias resulting from targeting, i.e., gardening programmes targeting poorer households with heads with lower levels of education, hence resulting in greater food security in households with heads with less education. The country dummy also indicates that there is a significant difference between countries concerning the level of household food security. Being in Zimbabwe and South Africa is associated with lower levels of food security than Lesotho, when MAHFP is used as a measure of household food security. However, only the South African country dummy is negatively and significantly related to household food security. The result indicates that months of adequate household food provisioning (MAHFP) is lower by -1.514 in South Africa compared to Lesotho. The time dummies are also positive and statistically significant. This shows that MAHFP scores are higher in both summer and winter than at baseline, by 0.990 and 1.185 respectively.

The positive and significant coefficients on the garden dummy variable when both HDDS and MAHFP are used implies that households with food gardens tend to be more food secure than their counterparts with no garden. This is possibly because, according to descriptive evidence provided above, household food gardens provide supplementary food and additional income that enables households to spend more on other food items, thus enhancing their food security. These results are in line with those of previous studies. For instance, in South Africa, Baiyegunhi and Makwangudze (2013) show that home gardening had a positive and significant impact on household food security. In Uganda, Linderhof *et al*. (2016) found a positive impact of gardens on household food security, while Puett *et al*. (2014) have shown that gardens are an important determinant of household food security in Zimbabwe.

Table 4.16: Impact of household food gardens on household dietary diversity score (HDDS)

	Pooled OLS		Random Effects		Fixed Effects		First Difference	
	Coefficient	**S.E.**	**Coefficient**	**S. E.**	**Coefficient**	**S.E.**	**Coefficient**	**S.E.**
Independent variables								
Garden	0.789***	(0.201)	0.853***	(0.199)	1.027***	(0.251)	1.203***	(0.278)
Household head variables								
Gender (1=female, 0= male)	0.507**	(0.262)	0.522*	(0.296)	0.659	(0.447)	0.604	(0.533)
Age	0.077**	(0.038)	0.047	(0.036)	0.001	(0.040)	0.012	(0.058)
Age-squared	-0.001	(0.000)	-0.000	(0.000)	0.001	(0.000)	0.000	(0.000)
Marital status[a]								
Living together	0.753**	(0.389)	0.760	(0.480)	0.872	(0.738)	1.008	(0.821)
Married	0.906***	(0.260)	0.831***	(0.288)	0.759**	(0.362)	0.403	(0.456)
Education level[b]								
Primary education level	0.487	(0.318)	0.450	(0.323)	0.311	(0.496)	0.519	(0.561)
Secondary education level	1.262	(0.343)	1.137***	(0.352)	0.584	(0.588)	0.577	(0.617)
Household variables								
Household size	-0.081**	(0.036)	-0.050	(0.039)	0.092	(0.067)	0.093	(0.078)
Household dependency ratio	0.333	(0.357)	0.146	(0.377)	-0.411	(0.565)	-0.181	(0.594)
HIV and AIDS affected	-0.188	(0.287)	-0.198	(0.290)	-0.090	(0.426)	-0.027	(0.450)
Country[c]								
South Africa	1.668***	(0.232)	1.702***	(0.270)				
Zimbabwe	1.340***	(0.251)	1.326***	(0.305)				
Season[d]								
Summer	0.683***	(0.195)	0.696***	(0.169)	0.719***	(0.168)	0.701***	(0.178)
Winter	0.860***	(0.194)	0.866***	(0.163)	0.893***	(0.169)	0.845***	(0.257)
Constant	-0.042	(0.987)	0.690	(0.937)	2.566**	(1.029)		

Number of observations	416	416	416	254
F statistic (P)	15.35 (0.000)		5.96 (0.000)	4.23 (0.000)
Within R^2		0.1957	0.2152	
Between R^2		0.3880	0.0447	
Overall R^2	0.321	0.3184	0.1083	0.171
LR /Wald Chi2 statistic (P)		188.65 (0.000)		
Hausman test χ^2(P)			21.88 (0.025)	

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$. Reference categories: [a] is unmarried, [b] is no formal education, [c] is Lesotho and [d] is baseline.

Table 4.17: Impact of household food gardens on months of adequate household food provisioning (MAHFP)

	Pooled OLS		Random Effects		Fixed Effects		First Difference	
	Coefficient	**S.E.**	**Coefficient**	**S. E.**	**Coefficient**	**S.E.**	**Coefficient**	**S.E.**
Independent variables								
Garden	0.683**	(0.337)	0.872**	(0.341)	1.100***	(0.407)	1.042**	(0.426)
Household head variables								
Gender (1=female, 0= male)	0.082	(0.417)	0.021	(0.457)	-0.265	(0.602)	0.691	(0.825)
Age	0.061	(0.066)	0.078	(0.072)	0.160*	(0.090)	0.125	(0.115)
Age-squared	-0.001	(0.001)	-0.001	(0.001)	-0.001*	(0.000)	-0.001	(0.001)
Marital status[a]								
Living together	0.683	(0.748)	0.732	(0.975)	1.185	(1.677)	3.09**	(1.428)
Married	-0.081	(0.443)	-0.175	(0.519)	-0.568	0.852	-0.159	(0.906)
Education level[b]								
Primary education level	-1.030***	(0.347)	-1.138***	(0.430)	-1.469**	(1.677)	-1.737*	(1.004)
Secondary education level	-1.001**	(0.422)	-1.094**	(0.488)	-0.568*	(0.852)	-2.042	(1.116)
Household variables								
Household size	0.037	(0.058)	0.029	(0.062)	0.024	(0.115)	0.056	(0.139)
Household dependency ratio	0.079	(0.511)	0.191	(0.590)	0.721	(1.159)	-0.035	(1.1645)
HIV and AIDS affected	-0.291	(0.578)	-0.484	(0.415)	-0.758	(0.480)	-0.518	(0.514)
Country[c]								
South Africa	-1.514***	(0.394)	-1.541***	(0.472)				
Zimbabwe	-0.540	(0.361)	-0.594	(0.459)				
Season[d]								
Summer	1.003***	(0.323)	0.990***	(0.281)	1.020***	(0.259)	0.984***	(0.269)
Winter	1.180***	(0.309)	1.185***	(0.295)	1.206***	(0.297)	1.132***	(0.359)
Constant	8.904***	(1.658)	8.723***	(1.727)	6.613***	(2.310)		

Number of observations	416	416	416	254
F statistic (P)	3.51 (0.000)		3.14 (0.000)	2.39 (0.004)
Within R^2		0.149	0.157	
Between R^2		0.109	0.002	
Overall R^2	0.132	0.131	0.064	0.169
LR /Wald Chi2 statistic (P)		64.93 (0.000)		
Hausman test χ^2(P)			9.12 (0.610)	

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$. Reference categories: [a] is unmarried, [b] is no formal education, [c] is Lesotho and d is baseline.

To further examine the impact of gardens on household food security, the same regression models and food security indicators are used, but with a different independent dummy variable (programme-garden dummy) of primary interest. Estimation results of the impact of programme gardens on household food security are shown in Tables 4.6 and 4.7. Using the two food security indicators, programme gardens are shown to have a mixed impact on household food security. Estimation results from Table 4.6 show that programme gardens are not a significant predictor of household food security in all models as measured by HDDS. This suggests that in terms of contribution to HDDS, gardens provided by the intervention are just as good as the non-programme gardens, i.e., programme gardens do not outperform general gardens maintained by households not support by NGO programmes. Since the Hausman tests strongly rejects the fixed estimates ($\chi^2 = 14.46$ with a p-value =0.144), the focus of the discussion is on the RE model. Among the other variables hypothesised to affect food security, consistent with our expectations, only marital status significantly predicts household food security, for married household heads. Household food security is positively and significantly associated with households headed by married heads, and this means that households headed by married household heads enjoy higher levels of food security compared to those headed by unmarried household heads. This could be attributed to the fact that married household heads are likely to have more household members who engage in income generating activities, therefore, contributing more to household income compared to households headed by single persons or those living together. This again suggests that marriage is protective of household food security, a finding like the one reported by Kumba *et al*. (2015) and Wilde and Nord (2005).

Results from Table 4.7 show that in all four methods, the parameter estimate of the programme gardens dummy has the expected sign and is statistically significant when MAHFP is used as the dependent variable, albeit at different levels of significance, indicating that participating in programme gardening has a positive and significant impact on household food security as expected. Since the Hausman test statistic ($\chi^2 = 33$ with a p-value =0.000) show that the FE model is appropriate, the discussion of results centres on the FE model. The results show that programme food gardens increase MAHFP by 1.235 units, indicating a positive and significant impact on household food security. This finding lends support to the idea that programme gardens enhance household food security more than normal non-programme supported gardens. This positive impact of programme gardens on household food security is consistent with results of similar programme household food gardening impact studies in Africa and Asia. For instance, Bushamuka *et al*. (2005), Olney *et al*. (2009), Schreinemachers *et al*. (2016), and Talukder *et al*. (2010) have reported a positive and significant effect on household food security of programme gardens. Findings of this study are, therefore, consistent with past empirical findings.

Among the variables included in the regression model, marital status is again a significant determinant of household food security, but only for married household heads. Household size carries a negative sign and has a significant effect. The negative estimated coefficient corresponding total household size in general suggests that large household size is among the underlying causes of food insecurity. This indicates that households with more household members tend to be food insecure compared to households with fewer household members. Probably the reason behind the negative impact of household size is that a larger household size puts pressure on household income for food and other non-food consumptions, such as clothing, education, and health. Put differently, there are more mouths to feed, which ends up with existing food supply in the household failing to meet the family food demands, and this may finally result in food insecurity. The finding is in conformity with the previous findings of Abafita and Kim (2014), Feleke *et al*. (2005) and Gebre (2012). Likewise, the household dependency ratio has a negative and significant coefficient, implying that, as the dependency ratio, which indicates household composition, increases, the household's ability to meet its food needs decreases. This also indicates that as the ratio of dependents (only consuming individuals) to adult household members (producing and consuming individuals) increases, household food security will decline since the need for food is higher than labour contribution and production. This result confirms the findings of Mutisya *et al.* (2016), Abafita and Kim, (2015) and Kumba *et al*. (2015), who show a negative link between household dependency and household food security. The variables of household head age, household head education, household head gender, and the HIV and AIDS affected dummy are not important in explaining the variations in household food security.

Table 4.18: Impact of programme gardens on household dietary diversity

	Pooled OLS		Random Effects		Fixed Effects		First Difference	
	Coefficient	**S.E.**	**Coefficient**	**S. E.**	**Coefficient**	**S.E.**	**Coefficient**	**S.E.**
Independent variables								
Programme garden	0.036	(0.2535)	-0.040	(0.250)	0.110	(0.352)	0.116	(0.451)
Household head variables								
Gender (1=female, 0= male)	0.599*	(0.327)	0.768	(0.384)	1.283**	(0.875)	0.540	(0.753)
Age	0.100**	(0.045)	0.049	(0.043)	-0.005	(0.060)	-0.005	(0.070)
Age-squared	-0.0008*	(0.0004)	-0.0002	(0.0004)	0.001	(0.001)	0.0003	(0.0007)
Marital status[a]								
Living together	0.537	(0.538)	0.398	(0.618)	-0.798	(1.367)	-1.365	(1.311)
Married	1.046***	(0.314)	1.014	(0.344)	0.950**	(0.485)	0.222	(0.590)
Education level[b]								
Primary education level	0.520	(0.399)	0.409	(0.397)	0.494	(0.729)	1.078	(0.901)
Secondary education level	1.093**	(0.425)	0.870*	(0.467)	0.546	(1.014)	0.850	(1.078)
Household variables								
Household size	-0.065	(0.045)	-0.028	(0.050)	0.044	(0.074)	0.028	(0.077)
Household dependency ratio	0.010	(0.455)	-0.217	(0.488)	-0.337	(0.810)	-0.288	(0.776)
HIV and AIDS affected	-0.409	(0.427)	-0.209	(0.417)	0.082	(0.522)	-0.279	(0.311)
Country[c]								
South Africa	1.879424***	(0.309)	1.983***	(0.350)				
Zimbabwe	1.398916***	(0.294)	1.349***	(0.362)				
Season[d]								
Summer	0.672**	(0.284)	0.663***	0.255	0.522*	(0.294)	0.532	0.381
Winter	0.694**	(0.291)	0.727***	0.237	0.634**	(0.276)	0.642	0.427
Constant	0.480	(1.261)	1.560	(1.247)	3.016	(2.104)		

Number of observations	296	296	296	157
F statistic (P)	11.50 (0.000)		2.26 (0.010)	1.62 (0.086)
Within R^2		0.113	0.153	
Between R^2		0.375	0.001	
Overall R^2	0.319	0.311	0.020	0.121
LR /Wald Chi2 statistic (P)		129.46 (0.000)		
Hausman test χ^2 (P)			14.67 (0.1446)	

Notes: Robust standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.001. Reference categories: [a] is unmarried, [b] is no formal education, [c] is Lesotho and d is baseline.

Table 4.19: Impact of programme gardens on months of adequate household food provisioning (MAHFP)

	Pooled OLS		Random Effects		Fixed Effects		First Difference	
	Coefficient	**S.E.**	**Coefficient**	**S. E.**	**Coefficient**	**S.E.**	**Coefficient**	**S.E.**
Independent variables								
Programme garden	0.545*	(0.297)	0.811**	(0.365)	1.235**	(0.489)	0.981*	(0.585)
Household head variables								
Gender (1=female, 0= male)	0.277	(0.449)	0.360	(0.528)	0.282	(0.718)	0.332	(0.889)
Age	0.115	(0.069)	0.120	(0.120)	0.142	(0.091)	0.092	(0.113)
Age-squared	-0.001*	(0.0007)	-0.001	(-0.001)	-0.001**	(0.0008)	-.0001	(0.001)
Marital status[a]								
Living together	0.341	(0.718)	0.827	(0.946)	1.980	(2.564)	2.001	(2.606)
Married	-0.482	(0.491)	-0.696	(0.602)	1.960**	(0.825)	-1.940***	(0.927)
Education level[b]								
Primary education level	-0.886**	(0.411)	-0.857*	(0.493)	-0.752	0.716	-0.885	(0.750)
Secondary education level	-0.967**	(0.471)	-1.157*	(0.621)	-1.408	1.018	-1.584	(1.132)
Household variables								
Household size	0.068	(0.065)	-0.013	(0.079)	-0.189*	(0.105)	-0.151	(0.107)
Household dependency ratio	-0.286	(0.522)	0.347	(0.598)	-1.983**	(0.954)	1.597	(1.125)
HIV and AIDS affected	0.808	(0.839)	0.039	(0.439)	-0.596	(0.371)	-0.422	(0.346)
Country[c]								
South Africa	-0.817*	(0.477)	-1.029*	(0.564)				
Zimbabwe	-0.551	(0.372)	-0.539	(0.448)				
Season[d]								
Summer	0.229	(0.375)	0.121	(0.360)	-0.099	(0.392)	0.098	(0.471)
Winter	0.290	(0.387)	0.165	(0.373)	-0.138	(0.403)	0.093	(0.537)
Constant	7.708***	(1.663)	8.725***	(1.726)	9.396***	(2.561)		

Number of observations	296	296	296	157
F statistic (P)	1.44 (0.023)		2.08 (0.019)	1.75 (0.056)
Within R^2		0.235	0.294	
Between R^2		0.012	0.000	
Overall R^2	0.087	0.069	0.024	0.257
LR /Wald Chi2 statistic (P)		24.03 (0.064)		
Hausman test χ^2 (P)			33.5 (0.000)	

Notes: Robust standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.001. Reference categories: [a] is unmarried, [b] is no formal education, [c] is Lesotho and d is baseline

In summary, the findings of this section consistently support the hypothesis that food gardens have a positive and significant impact on household food security. When the HDDS is used to assess the effects of gardens in general on household food security, a comparison between the RE model and the FE model revealed that fixed effects are statistically significant. In the case of MAHFP, the RE model is preferred. The pooled OLS and FD models both show a significant and positive effect of food gardens on household food security, regardless of the food security indicator. When the same estimations are performed with the programme garden dummy variable, the effect is not statistically significant when the HDDS is used as a measure of household food security. Programme gardens, however, did have a positive and significant impact on MAHFP in accordance with the FE model. Empirical results also show that household food security is influenced by the marital status of the household head, the gender of the household head, household size, and household dependency ratio. The forthcoming section employs Propensity Scoring Matching (PSM) to further evaluate the impact of food gardens on household food security.

(b) Propensity Score Matching

In this section, the study examines the impact of food gardening on household food security using the Propensity Scoring Matching (PSM) method. The section presents an estimation of the propensity scores, assesses the common support region, conducts balancing tests, and reports and interprets the ATT estimates. As in the previous section, the analysis uses HDDS and MAHFP as the indicators of household food security. For this analysis, the inclusion of the country dummy in both participating models was difficult because, as indicated in Chapter 3 (see Chapter 3, Section 3.4, page 46), there was inadequate variation in the groupings of households for some countries. For example, in Zimbabwe, because of the high prevalence of gardening in the communities, both control and treatment households had household food gardens at the inception of the study. Results for the household garden versus no-garden comparisons are reported first, followed by programme gardens versus non-programme gardens analysis.

(i) Food gardening

- **Propensity score**

The first step in PSM analysis is the estimation of the propensity score, and a probit model is used to estimate the propensity score using vector *X* of independent variables. The variables used in the probit estimation are described in Chapter 3 and are based on empirical evidence of factors that affect the outcomes of interest (household food security) but are not affected by participating in the household food gardening (Faridi & Wadood, 2010; Onuche & Edoka, 2013; Wilde & Nord, 2005). Results of the probit estimation of the propensity score are presented in Table 4.8.

Table 4.20: Probit estimates for participating in household food gardening

	Coefficient	S. E	Z	P>|z|
Household head variables				
Age	0.107	0.029	3.65	0.000 ***
Age squared	-0.001	0.001	-3.02	0.003 ***
Female	0.317	0.198	1.60	0.109
Marital status[a]				
Living together	-0.436	0.285	-1.53	0.126
Married	0.111	0.210	0.53	0.594
Education[b]				
Primary education level	0.179	0.312	0.58	0.565
Secondary education level	0.235	0.328	0.72	0.474
Household variables				
Household size	0.089	0.034	2.59	0.010**
Household dependency ratio	-0.483	0.295	-1.64	0.102
HIV and AIDS affected	0.727	0.232	3.12	0.002***
Constant	-3.565	0.823	-4.33	0.000***

Number of observations = 416
LR chi2(10) = 73.79
Prob > chi2 = 0.0000
Pseudo R2 = 0.1476

Notes: Dependent variable equals one if household has a garden, and zero otherwise. *=p<0.10; **=p<0.05; ***=p<0.01. Reference categories: [a] unmarried, [b] is no formal education, Propensity score within common support range is (0.0916, 0.9456).

The major aim of the propensity score model is to find a propensity score that balances treated and control cases; hence we do not use this model for causal inference of the probit model (Heckman & Navarro-Lozano 2004)[3]. The regression shows that having an older household head negatively predicts participation in household food gardening. Household size has a positive and significant effect on the probability of household food garden participation: larger households will certainly require more food and may therefore tend to cultivate food gardens, for food self-sufficiency and income generation. Being an HIV and AIDS affected household is significant and positively associated with household food gardening participation. This is probably explained by the targeting of HIV and AIDS affected households by the NGOs implementing the various gardening programmes (see Chapter 3, Section, 3.2 page 42). It may also be the case that poorer households are more likely to garden because they do not have other options for food security.

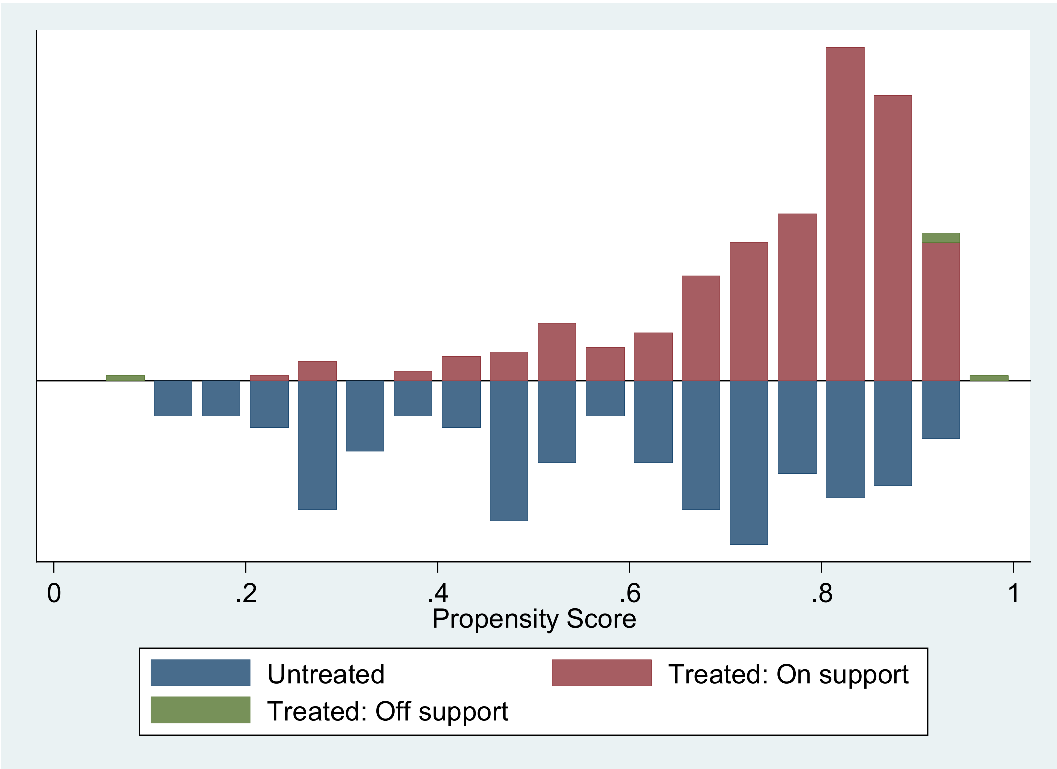
A crucial step in investigating the validity or performance of PSM is to verify the common support or overlap condition. Assuming that the probability of participating in the household food garden programme conditional on observed characteristics lies between 0 and 1 (implying participation is not perfectly predicted, that is, $0 < P(garden = 1 | X) < 1$. This assumption is critical to estimation as it ensures that households with the same *X* values have a positive probability of belonging to both the gardening group and no-gardening group.

Verification of the overlap or area of common support between households in the gardening group (treatment) and those in the no-garden group (control) can be done with straightforward methods. One approach proposed by Caliendo and Kopeinig (2008) is through a visual inspection of the propensity score distributions for both the treatment and control group. Figure 4.71 shows the distribution of propensity scores among the treatment and control groups before matching. In the treatment group, the predicted probability ranges from 0.0916 to 0.9529 with a mean of 0.7640. In the control group, the predicted probability of belonging to the household food gardening programme ranges from 0.1100 to 0.9456 with a mean of 0.5810. Therefore, using minimum and maximum comparison, the common support assumption is satisfied in the region of 0.0916–0.9456. Thus, the zone in which there is no common support given by the control group is above 0.9456 and below 0.0196.

[3] Significant predictors for participating in household food gardening include age of household head, the household size and household being HIV and AIDS affected.

In the next step, the overlap condition of propensity score before and after matching of both groups is examined. To show the overlap of the propensities, both densities of the treatment and control groups are depicted in one graph. Figure 4.71 shows the distribution of propensity scores after matching. Visual analysis of the density distribution of the propensity scores suggests that the densities of propensity scores are much similar after matching. The histogram also reveals that there is clear overlap in the propensity score distributions of the treated and untreated, which implies that common support is achieved. The histogram shows that both untreated and treated scores are concentrated in the upper quartile of the distribution. There is common support of treated and non-treated households throughout the distribution as shown by Figure 4.105. The histogram also shows that only a few treated households (4) were off common support, indicating that most households in the gardening group found a suitable match among those in the no-garden group. Accordingly, the treated households whose estimated propensity score is above the maximum or below the minimum propensity score for the comparison group did not have "common support" in the comparison group and are dropped from the matched sample (Smith & Todd, 2005).

Figure 4.77: Region of common support and propensity score distribution



Note: Treated on support indicates the households in the gardening group who find a suitable match, whereas treated off support indicates the households in the gardening group who do not find a suitable match.

The distributions of the propensity scores, before and after matching, are plotted in Figure 4.72 and 4.73. Visual inspection suggests that the densities of the propensity scores are more similar after matching. The plots also reveal a clear overlap of the distributions of the propensity scores.

Figure 4.78: Distribution of propensity scores before matching

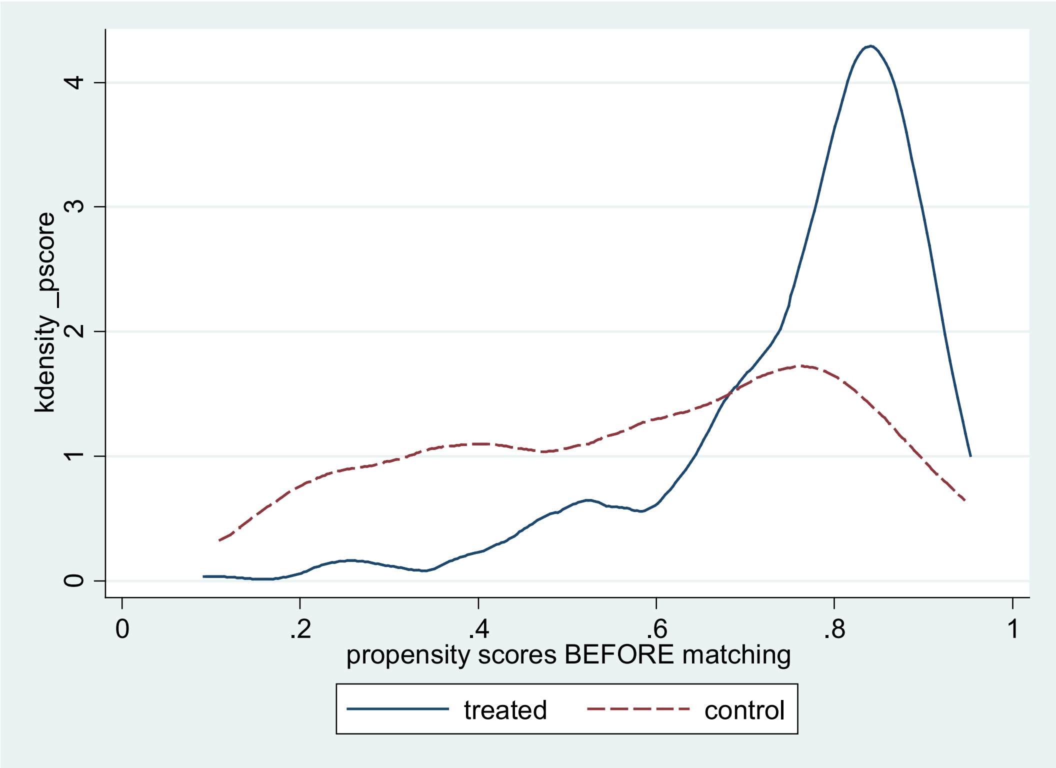
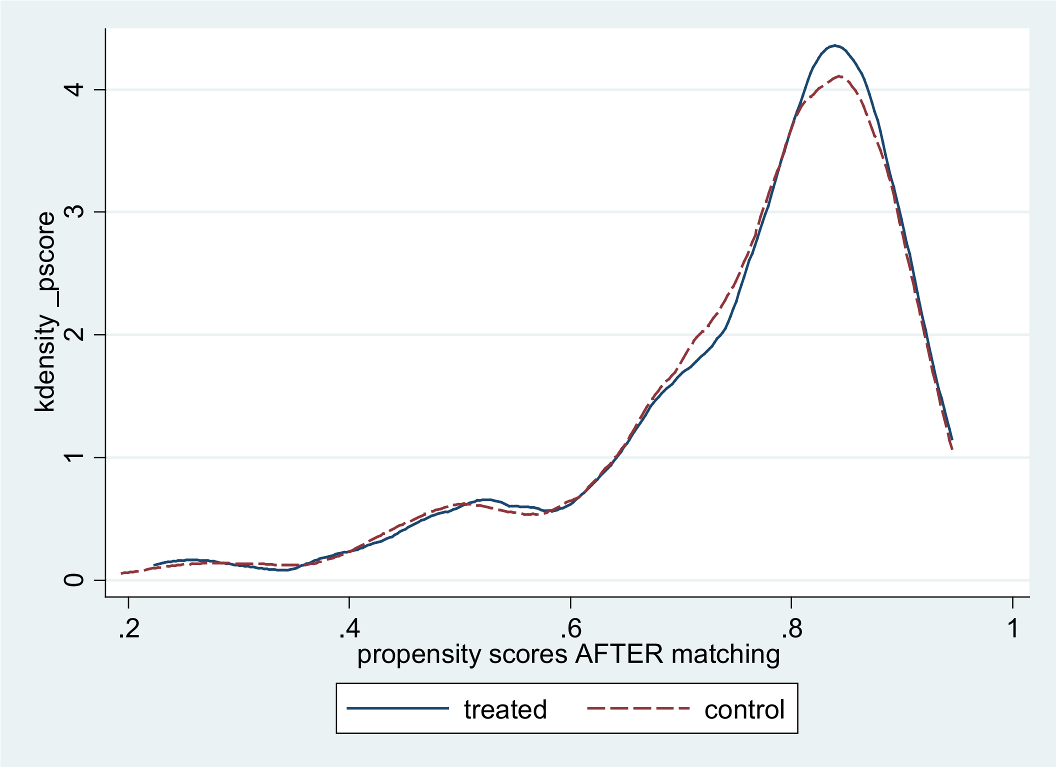


Figure 4.79: Distributions of propensity scores after matching



- **Matching**

Once the propensity score model is estimated and a propensity score is computed for each household, the next step consists of performing the actual matching after choosing a matching algorithm. As discussed in the methods section, matching algorithms differ not only in the way the neighbourhood of each treated household is defined, but with respect to the weights assigned to these neighbours. The matching quality depends on the closeness of the match or the distance measured to determine whether a household is a good match. The kernel matching algorithm is used for this study. Kernel matching uses the weighted average of the households in the comparison group to construct the counterfactual (Caliendo & Kopeinig, 2008).[4] The advantage of the kernel matching algorithm is that it uses more (all) non-participants for each participant, thereby reducing the variance, although possibly increasing the bias (Caliendo & Kopeinig, 2008). This choice is particularly appropriate in this study, because the numbers of non-treated observations (n = 130) are relatively few compared to the numbers of treated observations (n= 306).

[4] The Epanechnikov kernel function and the default bandwidth of 0.06 is used for the kernel algorithm using psmatch2 software.

- **Tests of covariate balancing**

The next step in assessing the quality of matching is to perform tests that determine whether the propensity score adequately balances the characteristics between treatment and comparison groups (Diprete & Gangl, 2004; Leuven & Sianesi 2003; Rosenbaum & Rubin 1985). Formally, the objective of these tests is to verify that treatment is independent of characteristics after conditioning on observed characteristics (as estimated in the propensity score model). Four methods of assessing covariate balance discussed in the methods section are employed: (i) the standardised bias method, (ii) the t-Test, (iii) the pseudo-R^2 method, and (iv) the likelihood ratio (LR) test.

Figure 4.74 shows the covariate balancing test for household food garden participation using the standardised bias method. Overall, the quality of the match is good, based on the distance of the standardised bias of the covariates before and after matching. The mean standardised bias of 29.4% before matching is reduced to 4.2% after matching. The reduction in aggregate bias by more than 20% is an indication that matching successfully reduced selection bias from observables (Rosenbaum & Rubin, 1985). Figure 4.74 shows the distance before and after matching and the distance of the marginal distributions of characteristics in both groups is reduced after matching.

Figure 4.80: Covariate balancing - food gardening

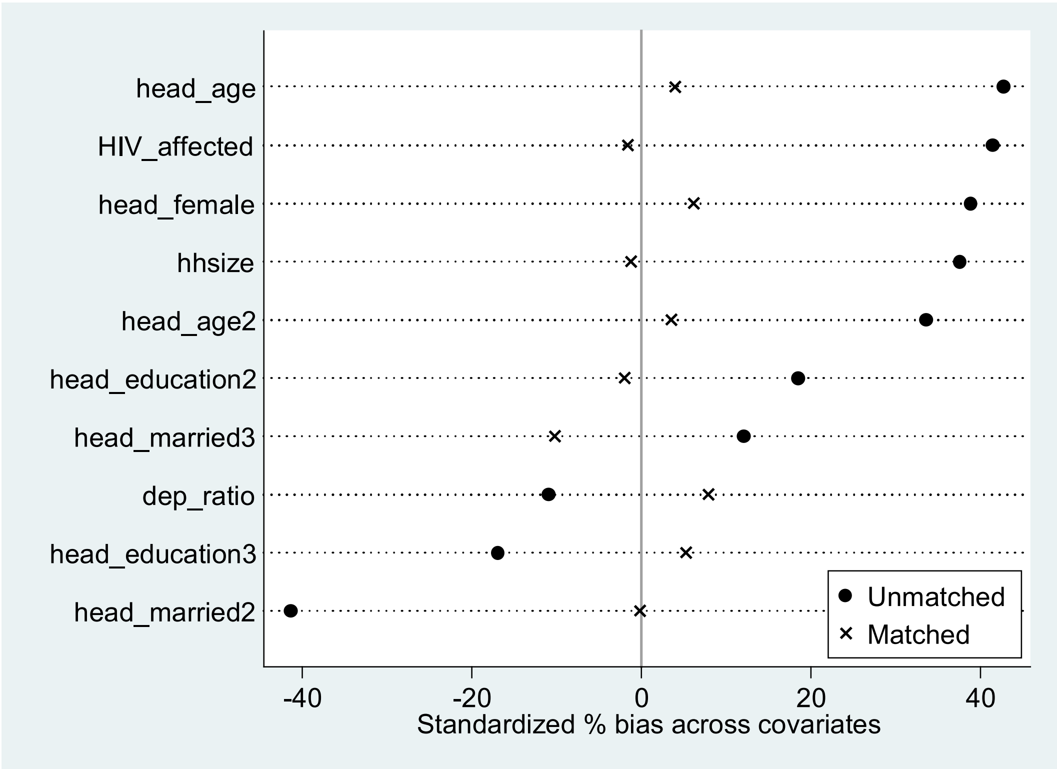


Table 4.9 shows the results from the t-Test method on the equality of means for each covariate included in the probit model. None of the covariates remain significantly different between the two groups after matching, implying that the treated and comparison groups are comparable.

Table 4.21: T-test for equality of means of covariates after matching – food gardening

Covariate	Sample	Mean		T test differences in means	
		Treated	Untreated	T stat	p value
Household head variables					
Age	Unmatched	51.476	44.958	4.14	0.000
	Matched	51.466	50.868	0.53	0.596
Age squared	Unmatched	2831.7	2302.8	3.24	0.001
	Matched	2830.5	2776.3	0.46	0.647
Female	Unmatched	0.574	0.383	3.58	0.000
	Matched	0.571	0.541	0.73	0.463
Marital status					
Living together	Unmatched	0.047	0.175	-4.34	0.000
	Matched	0.044	0.045	-0.04	0.968
Married	Unmatched	0.347	0.291	1.10	0.270
	Matched	0.352	0.400	-1.19	0.233
Education[b]					
Primary education level	Unmatched	0.533	0.441	1.70	0.089
	Matched	0.537	0.547	-0.24	0.810
Secondary education level	Unmatched	0.415	0.500	-1.57	0.116
	Matched	0.410	0.385	0.64	0.524
Household variables					
Household size	Unmatched	4.611	3.783	3.45	0.001
	Matched	4.575	4.603	-0.15	0.882
Household dependency ratio	Unmatched	0.397	0.427	-1.03	0.304
	Matched	0.398	0.377	1.03	0.305
HIV and AIDS affected	Unmatched	0.942	0.808	4.29	0.000
	Matched	0.945	0.950	-0.29	0.770

Further tests of the quality of matching also confirm that the balancing property is satisfied as shown in Table 4.10.

Table 4.22: Further tests of covariate balancing – food gardening

Sample	Pseudo R^2	LR $\chi2$	P $>\chi2$
Unmatched	0.148	73.79	0.000
Matched	0.006	4.83	0.902

The low pseudo-R^2 and the insignificant likelihood ratio test for joint significance tests further supports the hypothesis that both groups have the same distribution in covariates X after matching. The examination of the results of the four methods shows that the matching procedure successfully balanced the characteristics in the treated and the matched comparison groups. Through PSM, it was possible to generate a comparison group which is similar enough to the treatment group to be used for ATT estimation. Therefore, PSM was used to evaluate the impact of household food gardens on household food security.

- **Food gardening - Average treatment effects on the treated (ATT)**

After assessing the quality of matching based on propensity score graphs and covariate balance, the next step is to analyse the ATT estimates. However, the interpretation of ATT depends on the standard errors. When the propensity score is estimated before the treatment effect, as in our case, uncertainty from the estimation of the propensity score estimation produce biased standard errors on the treatment effect (Garrido *et al.,* 2014). Ignoring and not correcting this bias leads to conservative or overly generous standard errors for ATT estimates (Abadie & Imbens, 2006a; Austin, 2011). The bootstrapping method is used to correct for variation arising from the separate estimation of the propensity score, i.e., to obtain the adjusted standard errors (Garrido *et al.,* 2014; Lechner, 2002).

Table 4.11 shows the ATT matching estimates of household food gardening on the household food security indexes, i.e., the HDDS and MAHFP. The estimates from the matching procedure indicate a significant and positive impact of household food gardens on household food security. Gardening households have significantly higher dietary diversity and months of adequate household food provisioning scores than the comparison households. These results, which confirm the findings from the panel data analysis reported above, reveal that household food gardening increased household dietary diversity of gardening households by 0.919 index points and MAHFP by 1.398 index points. These results are comparable to those from the panel data analysis which show that food gardening increased households dietary diversity by 1.027 index points and MAHFP by 0.872 index points. Based on this, the results confirm the postulated hypothesis of a positive impact of household food gardening on household food security. These results are in line with those found by several studies in different contexts. In the Eastern Region of Ghana, Akrofi *et al.* (2010) report that household food gardens had a positive impact on household food security, since the household dietary diversity of gardening households was higher (6.8 vs 6.0) than that of non-gardening households. Roberfroid *et al.* (2011) in their study in Chipinge, Zimbabwe, also report a positive impact of household food gardens on household food security, as intervention households had higher dietary diversity scores (6.6 vs 5.7), and higher food consumption scores (40.5 vs 36.1) compared to control households. Baiyegunhi and Makwangudze (2013) in KwaZulu-Natal, South Africa also report a similar positive impact of household food gardens on household food security.

When interpreting the results, it is important to evaluate the robustness of the estimates by changing the matching algorithms or by altering the parameters of a given algorithm. Robustness checks help to increase the reliability of the results by showing that the estimations do not depend crucially on the chosen matching algorithm. To ascertain that these findings are not driven by the selection of a specific matching algorithm, i.e., are robust to the matching algorithm employed in the analysis, coefficients are estimated using different matching algorithms. The results are reported in Table 4.12. The following matching algorithms are used: Kernel Matching, Nearest Neighbour, Radius, Caliper, and Local Linear Matching. The results from these algorithms generally indicate that the impact found on household dietary diversity and months of adequate household food provisioning of household food gardening does not depend on the algorithm choice since both the value of the coefficients and its significance are very similar when using alternative matching algorithms.

Table 4.23: The impact of household food gardening on household food security – food gardening

	Sample	Treated	Control	Difference	Std Error	T-Statistic	P-value
HDDS	ATT	5.644	4.745	0.919	(0.259)	3.54	0.000 ***
MAHFP	ATT	10.222	8.824	1.398	(0.451)	3.10	0.001***

Notes: *=p<0.10; **=p<0.05; ***=p<0.01. Standard errors in parentheses for the ATT are computed using a bootstrap with 100 replications. Matching algorithm is Epanechnikov kernel with bandwidth of 0.06.

Table 4.24: Food gardening average treatment effects, by matching algorithms

Outcome	Kernel	Kernel trim (2.5%)	NN (1)	NN (3)	Radius (0.047)	Caliper (0.047)	Local linear
HDDS							
Treated	5.644	5.644	5.644	5.644	5.644	5.644	5.644
Control	4.745	4.752	4.650	4.724	4.748	4.650	4.860
Differences in average outcomes ATT	0.919*** (0.206)	0.911*** (0.250)	1.013*** (0.271)	0.939*** (0.252)	0.915*** (0.209)	1.013*** (0.271)	0.984*** (0.231)
MAHFP							
Treated	10.222	10.217	10.222	10.222	10.222	10.222	10.222
Control	8.824	8.817	8.675	8.875	8.835	8.657	8.915
Difference in average outcomes ATT	1.398*** (0.405)	1.400*** (0.388)	1.565*** (0.403)	1.347*** (0.423)	1.387*** (0.395)	1.565*** (0.457)	1.307*** (0.366)

Notes: *=p<0.10; **=p<0.05; ***=p<0.01. Standard errors in parentheses for the ATT are computed using a bootstrap with 100 replications. NN-Nearest Neighbor matching.

- **Sensitivity analysis to hidden bias**

Since PSM does not correct for bias due to unobserved characteristics, sensitivity analysis to unobserved heterogeneity was conducted. This is achieved by determining the strength or level of unobserved heterogeneity that would change the statistical significance of the ATT estimates. To determine whether the PSM results are sensitive to hidden bias due to unobserved factors, the bounding approach proposed by Rosenbaum (2002) is applied. Following Rosenbaum (2002), the study uses the value of gamma, at which upper bound p-value is >0.05, to perform the sensitivity analysis. The study also follows Rosenbaum and Rubin (1985), who state that a gamma value greater than 1 indicates a more robust estimate against hidden bias. Tables 4.13 and 4.14 present the results of the Rosenbaum bounds sensitivity analysis for the two respective indicators of household food security.

The results in Tables 4.13 indicate that when HDDS is used as a measure of household food security, a Γ value of 2.3 is required before an upper bound of 0.05 is reached. For MAHFP, the results in Table 4.14 show that a gamma value of 4.1 is required before an upper bound of 0.05 is reached. Because both values of gamma are greater than one, as recommended by Rosenbaum and Rubin (1985), unobserved difference would not change our inference. In other words, the findings of a positive effect of household food gardening on household food security are robust to unobserved characteristics. Caliendo *et al*. (2008) mention that these values or bounds represent "worst-case scenarios" and hence do not indicate the presence of selection bias, but only reflect how strong the selection bias should be to invalidate any conclusions. As such, based on the result from Tables 4.13 and Table 4.14, we can conclude that the ATT estimates reported in Table 4.11 are a robust indication of the impact of household food gardens on household food security. Overall, the sensitivity analysis demonstrates that the PSM results are robust to the presence of unobserved heterogeneity.

Table 4.25: Rosenbaum bounds for household dietary diversity score (HDDS)

Gamma	Lower bound	Upper bound
1	<0.0001	<0.0001
1.1	<0.0001	<0.0001
1.2	<0.0001	<0.0001
1.3	<0.0001	<0.0001
1.4	<0.0001	<0.0001
1.5	<0.0001	<0.0001
1.6	<0.0001	0.0002
1.7	<0.0001	0.0010
1.8	<0.0001	0.0010
1.9	<0.0001	0.0033
2	<0.0001	0.0087
2.1	<0.0001	0.0199
2.2	<0.0001	0.0401
2.3	**<0.0001**	**0.0722**

Notes: Matching algorithm is Epanechnikov kernel with bandwidth of 0.06. Gamma is log odds of differential assignment due to unobserved factors.

Table 4.26: Rosenbaum bounds for months of adequate household food provisioning (MAHFP)

Gamma	Lower bound	Upper bound
1	<0.0001	<0.0001
1.5	<0.0001	<0.0001
2	<0.0001	<0.0001
2.5	<0.0001	<0.0001
3	<0.0001	0.0006
3.5	<0.0001	0.0087
4	<0.0001	0.0497
4.1	**<0.001**	**0.0654**

Notes: Matching algorithm is Epanechnikov kernel with bandwidth of 0.06. Gamma is log odds of differential assignment due to unobserved factors.

(ii) Programme gardens

Propensity score

When programme gardens and non-programme gardens are compared, the following findings come to light: to calculate the propensity score for each observation, the propensity score model is re-estimated using the same covariates and a dependant variable which takes the value of 1 for programme gardens and 0 indicating non-programme gardens. Results of the probit model are shown in Table 4.15.

Table 4.27: Probit estimates for participating in the household food garden programme

	Coefficient	S. E	z	P>|z|
Household head variables:				
Age	-0.017	0.035	-0.50	0.615
Age squared	0.000	0.000	0.92	0.358
Female	0.261	0.226	-1.16	0.247
Marital status[a]				
Living together	0.547	0.400	1.37	0.172
Married	0.027	0.233	0.12	0.907
Education[b]				
Primary education level	0.375	0.368	1.02	0.308
Secondary education level	0.316	0.381	0.83	0.407
Household variables:				
Household size	0.041	0.036	1.15	0.249
Household dependency ratio	-0.788	0.326	-2.42	0.016**
HIV-affected	0.285	0.325	0.88	0.380
Constant	-0.446	1.038	-0.43	0.668
Number of observations = 296				
LR chi2(10) = 17.86				
Prob > chi2 = 0.0574				
Pseudo R2 = 0.0437				

Notes: Dependent variable equals one if household has a garden, and zero otherwise. *=p<0.10; **=p<0.05; ***=p<0.01. Reference categories: [a] unmarried, [b] is no formal education, Propensity score within common support range is (0.258-0.809).

The regression results in Table 4.15 shows that the household dependency ratio negatively predicts participation in household food gardening. Although larger households will certainly require more food and may therefore need to cultivate food gardens, for food self-sufficiency and income generation, the negative relationship between household dependency ratio and participation in household food gardening does not support that. This may be attributed to the fact that larger households may contain more infants and the very old who cannot provide labour needed in garden cultivation. Results also indicate that HIV and AIDS affected households are not significantly more likely to be programme participants. This may be attributed to the fact that households in the sampled communities are in general affected by HIV and AIDS as shown in Section 4.3.1, page, 99. In other words, communities in general are affected by HIV and AIDS, explaining why there is no differences between programme participants and non-programme participants.

- **Matching**

Before discussing the causal effects of programme gardening participation on household food security, the quality of matching is investigated. After estimating the propensity scores for the programme food gardens and non-programme food gardens, the common support condition is assessed and all households were on common support. Based on the results in Figure 4.75, the predicted propensity score for programme food gardens ranged from 0.258 to 0.783 and from 0.198 to 0.809 for non-programme food gardens. Thus, using a minimum and maximum comparison, the common support assumption is satisfied in the region of 0.258-0.809. This region of common support for the propensity scores is also clear from the density distribution for the two groups of programme and non-programme household food gardens (Figure 4.75). A visual inspection of the density distribution of the estimated propensity scores for the two groups indicates that the common support condition is satisfied: there is substantial overlap in the distribution of the propensity scores for programme and non-programme household food gardens (Figure 4.75).

Figure 4.81: Region of common support and propensity score distribution - programme gardening

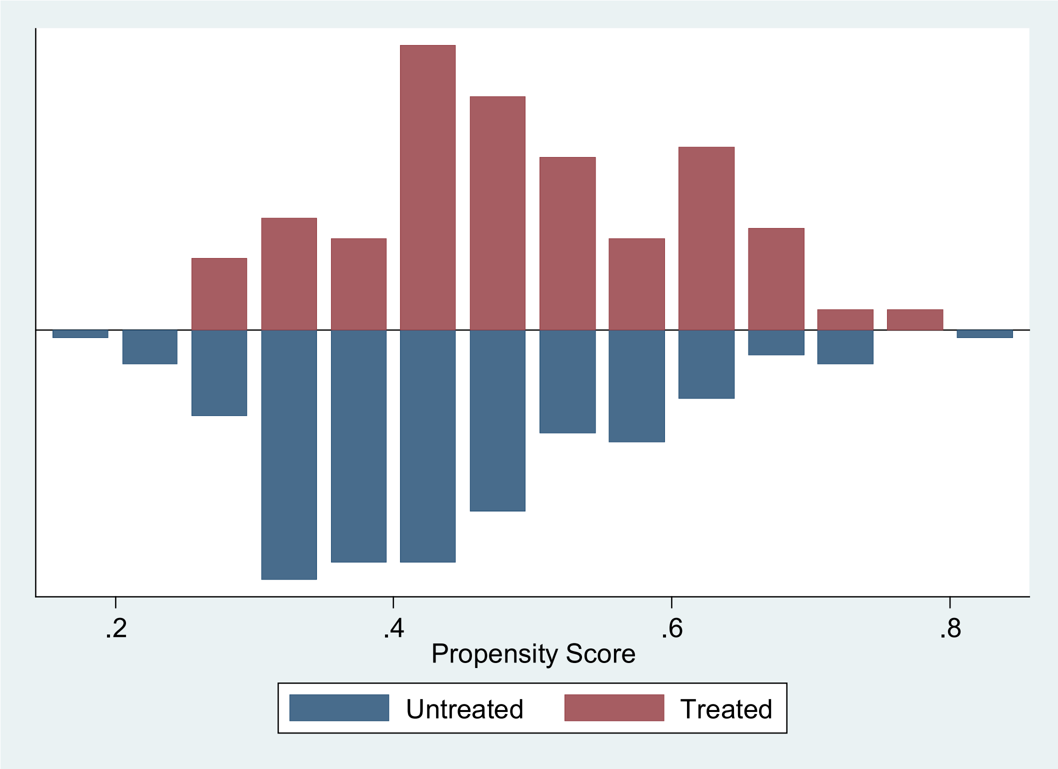


Figure 4.82: Distribution of propensity scores before matching - programme gardening

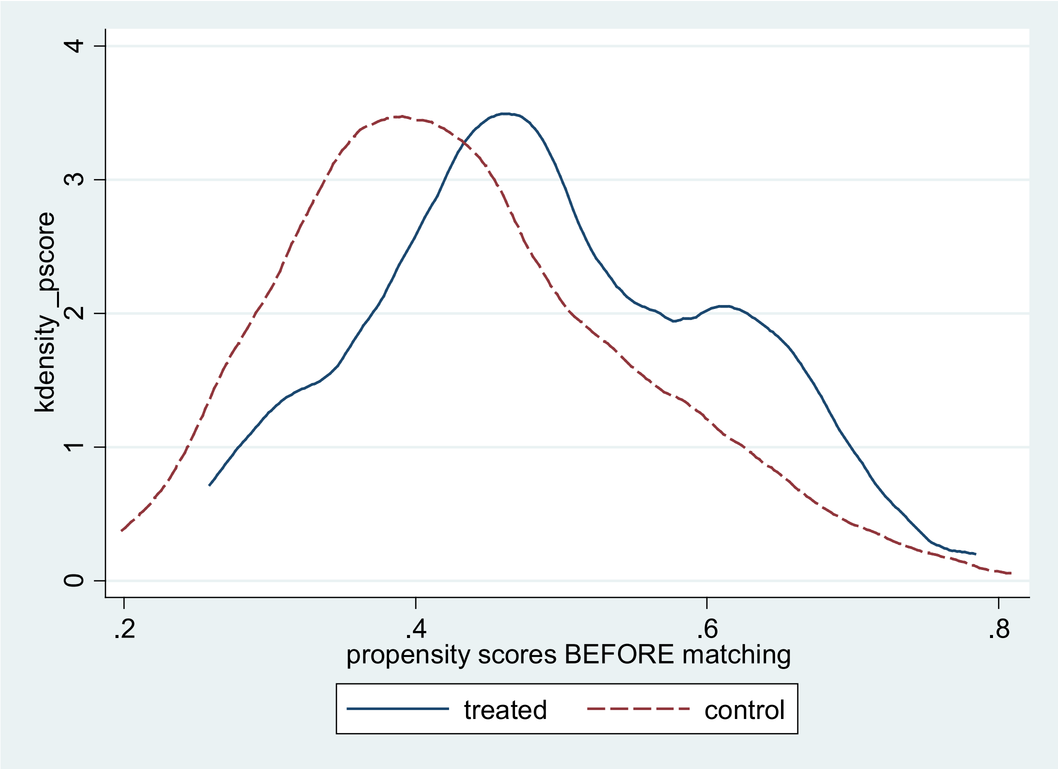
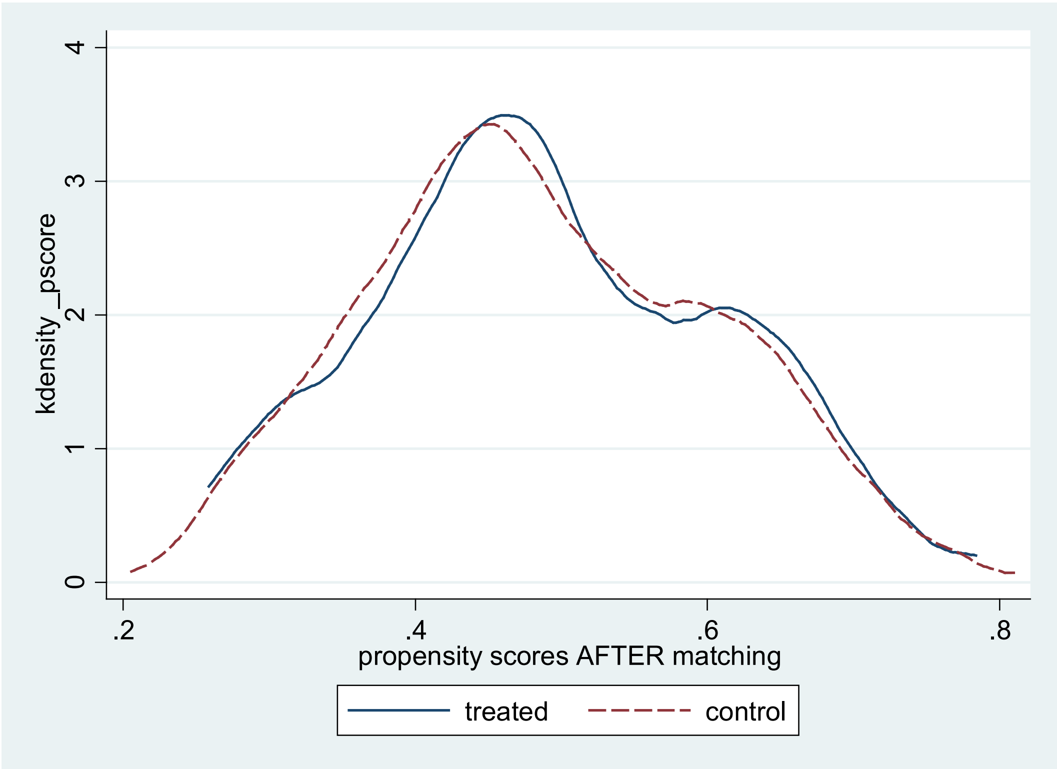


Figure 4.83: Distribution of propensity scores after matching - programme gardening



- **Tests of covariate balancing**

Using the standardised method, the mean standardised bias of 14.2% is reduced to 1.2% after matching (Figure, 4.78), which falls well below the acceptable range of 3% -5%. Table 4.16 presents the results from covariate balancing tests based on the t-Test, which shows that no significant differences are observed for all covariates after matching. Furthermore, further tests of covariate balancing are presented in Table 4.17 and indicate the following: the insignificant *p*-values of the likelihood ratio tests after matching show that covariate balance was successful. The low pseudo-R^2 after matching indicate that there are no systematic differences in the distribution of covariates between both groups after matching. The low pseudo-R^2, low mean standardised bias, insignificant p-values of the t-Test, and insignificant *p*-values of the likelihood ratio test after matching suggest that the PSM process is successful in balancing the distribution of covariates between programme and non-programme food gardens. The study therefore uses matching to evaluate the effects of programme gardens on household food security. To compute the ATT, Kernel matching was used, because based on the balancing tests, particularly the mean standardised bias of 1.2% after matching, the Kernel algorithm was more successful than other matching algorithms. The results are shown in Table 4.18.

Figure 4.84: Covariate balancing - programme gardening

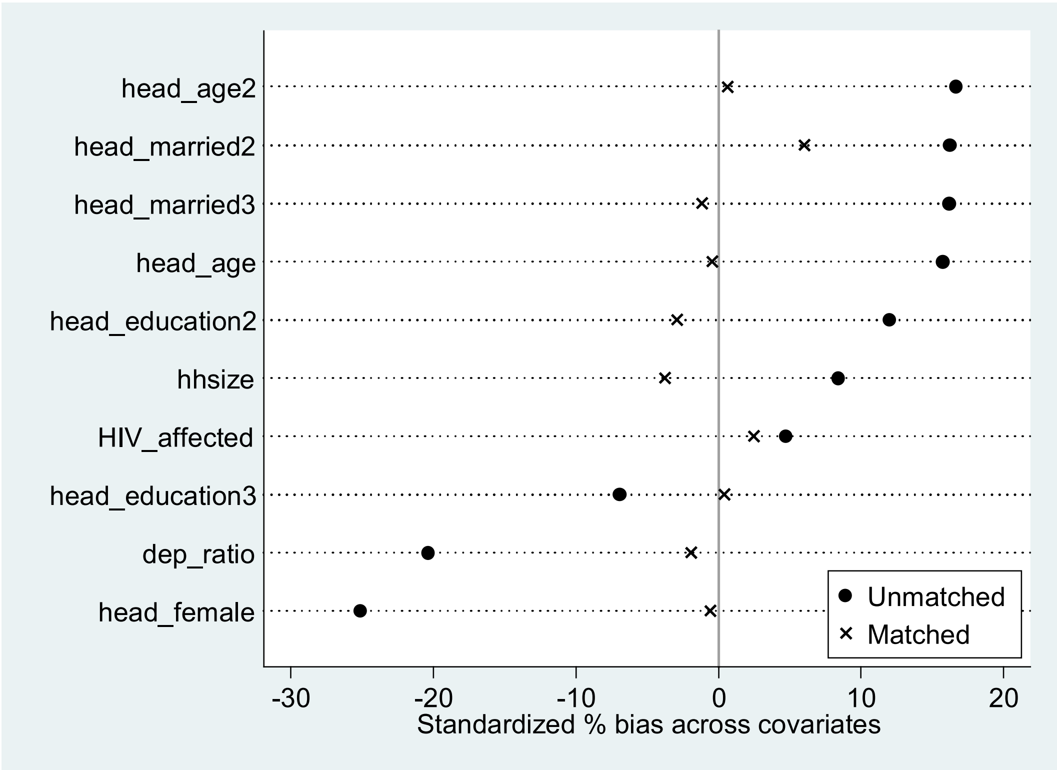


Table 4.28: T-tests for equality of means of covariates after matching – programme gardening

Covariate	Sample	Mean		T test differences in means	
		Treated	Untreated	T stat	p-value
Household head variables					
Age	Unmatched	52.625	50.500	1.35	0.178
	Matched	52.625	52.637	-0.01	0.994
Age squared	Unmatched	2958.8	2723.7	1.43	0.153
	Matched	2958.8	2948.7	0.06	0.954
Female	Unmatched	0.507	0.631	-2.16	0.032
	Matched	0.507	0.511	-0.07	0.948
Marital status[a]					
Living together	Unmatched	0.066	0.031	1.41	0.159
	Matched	0.066	0.058	0.27	0.788
Married	Unmatched	0.389	0.312	1.39	0.166
	Matched	0.389	0.389	0.01	0.994
Education[b]					
Primary education level	Unmatched	0.566	0.506	1.03	0.305
	Matched	0.566	0.575	-0.16	0.874
Secondary education level	Unmatched	0.397	0.431	-0.59	0.554
	Matched	0.397	0.399	-0.05	0.961
Household variables					
Household size	Unmatched	4.713	4.525	0.72	0.470
	Matched	4.713	4.705	0.03	0.977
Household dependency ratio	Unmatched	0.368	0.421	-1.75	0.081
	Matched	0.368	0.371	-0.10	0.920
HIV and AIDS affected	Unmatched	0.948	0.937	0.41	0.686
	Matched	0.948	0.942	0.20	0.839

Table 4.29: Further tests of covariate balancing – programme gardening

Sample	Pseudo R^2	LR $\chi 2$	P $>\chi 2$
Unmatched	0.044	17.86	0.057
Matched	0.002	0.76	1.000

- **Programme food gardening - Average treatment effects on the treated (ATT)**

Results of the PSM analysis presented in Table 4.18 indicate that programme food gardens had higher HDDS and MAHFP, indicating a positive impact of programme gardens on household food security. The added contribution of participating in programme household food gardening towards HDDS and MAHFP was 0.503 and 0.512 respectively. Thus, the estimation result provides supportive evidence that there were increments in household food security because of participation in the programme food gardening project. This finding agrees with other studies that evaluated the impact of programme food gardens on food security. Kabunga *et al.* (2015), for example, assessed the impact of household food gardens on household food security, employing the PSM method and the household food insecurity access score (HFIAS) as an indicator of household food security in Uganda. Their results indicate that gardening production had a positive impact on household food security, i.e. it reduced food insecurity by 0.09 index points and severe food insecurity by 0.10 index points. Schreinemachers *et al.* (2016) use a difference in difference (DID) estimator and found a positive and significant impact of food gardens on household food security.

To assess the robustness of the findings, the treatment impacts are estimated using alternative matching algorithms. According to Becker and Ichino (2002), a combination of matching approaches is adequate to reach a reliable conclusion on the relative effect of an intervention. For this analysis, the Kernel Matching, Nearest Neighbour, Radius, Caliper, and Local Linear Matching algorithms are used and treatment estimates are compared across the different algorithms. The results from Table 4.19 indicate that all the matching algorithms yielded similar results and show that the treatment effects are not dependent on the matching algorithm used in the analysis when HDDS is used. However, for MAHFP, treatment effects are not statistically significant when Local linear matching and Nearest Neighbour (3) is used, indicating that these results are not robust across all matching algorithms and that the ATT obtained in the baseline Kernel analysis should be interpreted with some caution.

Table 4.30: The impact of programme gardens on household food security

	Sample	Treated	Control	Difference	Std Error	T-Statistic	P-Value
HDDS							
	ATT	5.897	5.393	0.503	(0.234)	2.15	0.016**
MAHFP							
	ATT	10.514	10.002	0.512	(0.259)	1.97	0.024**

Notes:*=p<0.10; **=p<0.05; ***=p<0.01.Standard errors in parentheses for the ATT are computed using bootstrap with 100 replications. Matching algorithm is Epanechnikov kernel with bandwidth of 0.06.

Table 4.31: Average treatment effects of programme gardens, by matching algorithm

Outcome	Kernel	Kernel trim (2.5%)	NN (1)	NN (3)	Radius (0.030)	Caliper (0.030)	Local linear
HDDS							
Treated	5.897	5.917	5.897	5.897	5.911	5.911	5.897
Control	5.393	5.381	5.389	5.443	5.376	5.385	5.364
Differences in average outcomes ATT	0.503** (0.231)	0.535** (0.227)	0.507** (0.295)	0.453* (0.259)	0.534** (0.276)	0.525* (0.306)	0.532* (0.310)
MAHFP							
Treated	10.514	10.500	10.514	10.514	10.503	10.503	10.514
Control	10.002	10.079	9.661	10.105	10.048	9.651	9.914
Difference in average outcomes ATT	0.512** (0.229)	0.420* (0.267)	0.852** (0.393)	0.409 (0.291)	0.455** (0.254)	0.851** (0.403)	0.600 (0.420)

Notes: *=p<0.10; **=p<0.05; ***=p<0.01. Standard errors in parentheses for the ATT are computed using a bootstrap with 100 replications. NN-Nearest Neighbor matching.

- **Sensitivity analysis to hidden bias**

To test the robustness of the results against possible hidden bias, sensitivity analysis of the matching procedure was conducted. Table 4.20 and Table 4.21 provide results of the tests for unobserved heterogeneity. The test for the significant impact on HDDS suggests that at a level of Γ =1.2, causal inference of the significant effect of programme gardens would have to be reviewed critically. Specifically, the value implies that if households who have the same *X* vector differ in their odds of adoption by a factor of 20%, the significance of the effect on household food security may be questionable. For MAHFP, a critical level of Γ= 1.7 is reported. This implies that, for the hidden bias to overturn the statistical significance of programme gardening effects, households with the same *X* vector variables should differ in their odds of participation by a factor of 70-100 percent. Thus, the critical level of hidden bias for HDDS is 1.2, whereas that for MAHFP is 1.7. According to Rosenbaum and Rubin (1985), a critical level greater than 1.00 indicates a more robust estimate against hidden bias, and based on these results, it can be concluded that the estimates of programme gardens effects reported in Table 4.18 are insensitive to hidden bias, and thus are a reliable indicator of how the participation in programme gardens has effects on household food security.

Table 4.32: Rosenbaum bounds for household dietary diversity score (HDDS)

Gamma	Lower bound	Upper bound
1	0.0035	0.0035
1.05	0.0016	0.0071
1.1	0.0007	0.0133
1.15	0.0003	0.0230
1.2	0.0001	0.0372
1.25	**0.0000**	**0.0569**

Notes: Matching algorithm is Epanechnikov kernel with bandwidth of 0.06. Gamma is log odds of differential assignment due to unobserved factors.

Table 4.33: Rosenbaum bounds for months of adequate household food provisioning (MAHFP)

Gamma	Lower bound	Upper bound
1	<0.0001	<0.0001
1.1	<0.0001	<0.0001
1.2	<0.0001	0.0002
1.3	<0.0001	0.0008
1.4	<0.0001	0.0026
1.5	<0.0001	0.0069
1.6	<0.0001	0.0155
1.7	<0.0001	0.0304
1.8	**<0.0001**	**0.0537**

Notes: Matching algorithm is Epanechnikov kernel with bandwidth of 0.06. Gamma is log odds of differential assignment due to unobserved factors.

Summarily, this section examined the impact of household food gardens; food gardens in general and programme food gardens; on household food security, using PSM, and two food security measures (HDDS and MAHFP). The key result from the matching estimates is that gardening has a significant and positive average effect on household food security. The results are largely consistent with previous literature (Puett *et al*., 2014; Kabunga *et al*., 2015; Schreinemachers *et al*., 2016).

4.7 Conclusion

This chapter examined the role of household food gardens in HIV/AIDS impact mitigation in poor urban communities in Lesotho, South Africa and Zimbabwe using household survey data. Descriptive analyses show that household food gardens are an important informal food source that potentially contribute to improving food access and availability. To assess the impact of gardens on household food security econometrically, the chapter employed linear panel data regression models and propensity score matching. The empirical results are largely consistent and indicate that household food gardens, whether gardens in general or programme gardens, have a significant positive impact on household food security. The results not only show that household food gardens are important in enhancing food security, but also show descriptive evidence of the income generating potential of household food gardens. Households generated income through the sale of garden produce and the savings realised when garden produce is consumed instead of buying food from the market. Given that food access in urban areas largely depends on cash incomes, an increase in household income may assist households to spend more on nutritious food, which is vital for HIV and AIDS affected household members. Results also indicate that the income raised from the sale of garden produce was mainly controlled by women, enabling women to control what the household eats. Women, moreover, participated in informal savings groups with the use of the generated income, further enhancing households' food security.

Overall, this study has shown that household food gardening and food garden programmes can play an important role in increasing household food security and household income. This study, therefore, supports vital investments in household food gardening. Improving food gardening practices in poor urban communities can be an important strategy for mitigating the impacts of HIV and AIDS. As such, policies that enhance diffusion and adoption of household food gardens in poor urban communities as well as the adoption of better food gardening practices and technologies should be central to food security strategies in Southern Africa, especially for those affected by HIV and AIDS.

Chapter 5: Conclusion

5.1 Introduction

This chapter presents the summary, conclusion, and recommendations of the study. The chapter is structured in five sections. The first section summarises the descriptive and econometric findings with reference to the main study objectives. The second section outlines the conclusion and the policy implications of the study. The third section presents the limitations of the study, while the fourth section describes the recommendations and suggestions for future research. The final section is the conclusion.

5.2 Main findings

In relation to the context of the study, the findings confirm that households in the poor urban communities included in the study are heavily impacted by HIV and AIDS and experience high levels of morbidity. The aim of the study therefore was to assess the contribution of household food gardens to HIV and AIDS impact mitigation. To do so, three key research questions were addressed: (a) investigating the role of household food gardens in the informal urban food system, (b), determining the role of food gardens in the household food economy, and (c) assessing the impact of household food gardening on household food security.

Within the informal food system, results show that household food gardens are a prevalent food source in poor urban communities of Lesotho and Zimbabwe, though not in South Africa. Through the frequent utilisation of household food garden produce, households get direct access to food, and this makes household food gardens, whether programme gardens or food gardens in general, an important food source, particularly for the treatment groups. The evidence also suggests that the consumption of vegetables was more frequent in households with food gardens. In addition, the results also show that food remittances received from food gardens enable households to benefit from food gardens in terms of the supply of food. Food gardens, therefore, fulfil an important role in the informal food system.

According to the findings, the food economy analysis unveiled the various pathways through which the direct economic benefits of household food gardens influence the two dimensions of household food security, namely availability and access. First, through the sale of surplus garden produce, gardens contributed to household income. Extra income from the gardens eased pressure on household incomes and contributed to household food security through improving the access of households to foods such as meat, eggs and beans, in a way increasing food consumption, providing better quantity and quality of nutrients, and thus diversifying household diets. Thus, the sale of surplus produce from the garden indirectly increased households' access to food. The income from household food gardens, moreover, allowed women's participation in social saving schemes aimed at the provision of food, while simultaneously enhancing social capital. Moreover, through food garden earnings, women controlled what their households ate, in what quantity and how often, resulting in better diets and greater household food security. As such, gardening income had a positive impact on household food spending, food preparation, and food choices.

Second, the food economy analysis shows that gardening households remitted some food garden produce to neighbours, friends, and relatives. The sharing of food produce from the garden through remittances indicates that the benefits of household food gardens are not limited to improving the food security of gardening households only, but also accrue to those who receive remittances from food gardens, thus benefiting communities at large. Moreover, this sharing of food can strengthen relationships and create social networks which contribute to household food security, indicating the potential of household food gardens to contribute to the social capital of households; an important livelihood asset in the SLF.

Third, the study's results showed that, apart from selling surplus garden produce for cash and remitting garden produce to neighbours, friends and relatives, households also engaged in bartering with friends, neighbours, and vendors. The evidence shows that bartering was used as a strategy to further diversify household diets.

These findings suggest that gardens offer multiple pathways for increasing household food security and diversifying household diets, thus suggesting that household food gardens are a potential intervention for reducing macro and micronutrient deficiencies. Moreover, household food gardens contribute to local food systems beyond the household through the sale, remittance and barter of produce.

The study also assessed the impact of food gardens in general and that of programme gardens on household food security. The results from the linear panel data regression models show that the uptake of household food gardens in general increased household food security. Household Dietary Diversity Scores (HDDS) and Months of Adequate Household Food Provisioning (MAHFP) (the two metrics of household food security employed in this study), were 1.027 and 0.872 points higher respectively in gardening households than in household with no food garden, a difference that is statistically significant. Based on the evidence of the Propensity Score Matching (PSM) analysis, gardens increased household food security by 0.919 index points for HDDS and by 1.398 index points for MAHFP, indicating a positive and statistically significant effect of household food gardens on household food security. These results imply improved food access and nutrition in gardening households.

When the impact of programme gardens on household food security is examined using linear panel data regression models, the results are mixed. Programme-gardens are no better than non-programme gardens when HDDS is used as a measure of household food security. This implies that programme gardens did not contribute more to household dietary diversity than non-programme gardens. This contrasts with the finding of Bushamuka *et al.* (2005), who found that programme gardens contributed more to household food security. However, programme gardens increased MAHFP by a significant 1.235 index points compared to non-programme gardens, indicating that programme gardens households had a higher food security level than non-programme gardens households. Based on the findings of the PSM analysis, programme gardens exhibited a significantly higher HDDS (by 0.503 index points) and significantly higher MAHFP (by 0.512 index points), indicating that programme gardens contributed more to household food security than non-programme gardens, thus supporting recent data on the effect of programme household food gardening on household food security (Kabunga *et al*., 2015; Kumar & Quisumbing, 2011, Schreinemachers *et al*., 2016). The PSM results of programme households with a higher MAHFP than non-programme garden households are consistent with the one observed in the linear panel regression analysis. Thus, when MAHFP is used as a food security indicator, in both the PSM and regression analyses, there was strong evidence that programme gardens resulted in significant increases in household food security compared to non-programme gardens. The study therefore finds evidence of increased household food security as a result of participation in household food gardening (whether in programme gardens or gardens in general).

Overall, the conclusion of this study is that household food gardens have the potential to mitigate the impact of HIV and AIDS on affected households. Household food gardens appear to boost household incomes, food availability, accessibility, and consumption, thus potentially reducing the risk of malnutrition and possibly enhancing adherence to HIV and AIDS treatment among infected household members and improving their health. Food gardens also appear to empower women in ways that boost their control over household resources, an important variable in HIV and AIDS prevention, care and treatment, and impact mitigation

However, despite the very positive results of household food gardening, the study participants revealed that they faced many challenges in managing their gardens. Households mentioned that limitations in accessing water for gardening was a big limiting factor and that this problem potentially could constrain gardening activities. Participants also identified access to suitable and sufficient land to establish larger household food gardens, together with the lack of gardening equipment, as important constraints to their gardening activities. In addition, participants also reported that some of their garden produce had been stolen by people around them or eaten/destroyed by foraging livestock and other animals. Many participants also mentioned limitations in accessing adequate extension services. These challenges may hinder tapping into the potential benefits of household food gardens.

5.3 Policy implications

Arising from the results and discussion above, important policy recommendations can be drawn from the findings of the study. First, the results show that gardens can be a strategy for enhancing food security in poor urban communities and given the increased recognition that food security is a fundamental element of the health of PLWHA, it is important that household food gardening be encouraged among the urban poor affected by HIV and AIDS. Furthermore, in the wake of dwindling HIV and AIDS funding, combined with fiscal constraints in most Southern African countries, promotion of food security and nutrition interventions like household food gardens that promote food production by households can be more reliable and sustainable than food security and nutrition interventions that rely on government goodwill and financial support. In light of this, it is essential that decision makers make concerted efforts to promote and scale-up household food garden programmes within the context of HIV and AIDS impact mitigation programmes. Thus, this study supports investments in household food gardening in HIV and AIDS programmes.

Second, results from this study suggest that food gardens' income provided the means with which women boosted household food expenditures. Given that women are the principal caregivers in most homes and that income in women's hands is correlated with improved household food security and health outcomes (Doss, 2006; Duflo, 2003; Kennedy & Peters, 1992), enabling women to generate income through household food gardening is important in the context of HIV and AIDS impact mitigation. As such, the results of this study can be used to advocate for household food garden programmes to target women, which can form part of a viable public health strategy. Together, these two recommendations could improve the lives of many poor urban households affected by HIV and AIDS and thereby mitigate the impact of the epidemic.

5.4 Limitations

This study has several limitations. First, the study followed a quasi-experimental design, where selection of participants into the household food gardening programme was not randomised. Given the non-randomisation of study participants, there was a need to correct for selection bias and endogeneity of the household food gardening programme using econometric methods. However, the use of panel regression models and PSM is fraught with its own limitations. PSM depends on observable differences, where unmeasured confounding or latent heterogeneity may remain, leading to biased treatment effects (Hill, 2008). PSM may be sensitive to the number of observations available for analysis, and its efficiency is especially limited with small samples (Bryson *et al*., 2002). PSM also does not estimate the local average treatment effect (LATE), which is the average impact of the programme on those whose participation status is affected by a targeting criterion (Bryson *et al*., 2002). The use of panel data suffers from missing data resulting from attrition and issues of sample selection biases and heterogeneity (Baltagi, 2005). In addition, tests such as the Hausman test may be biased in small samples and depend much on the correct specification of the underlying model (Baltagi, 2005). Nevertheless, the econometric strategy can be considered to have enhanced the extent to which some causal inferences can be drawn from the longitudinal, quasi-experimental data.

Second, since this was a pilot study informing a larger scale impact evaluation, the study used a relatively small sample in each country (n=50), which could lead to imprecise estimates and difficulty in detecting differences in some endpoints and thus limit the generalisability of the results. While the descriptive analysis does include country-specific comparisons, the econometric analyses include no country-level data analysis, because of the lack of statistical power resulting from the small sample sizes in the relevant sub-groups. As a result, the study does not make any country-specific recommendations, but rather draws on the aggregated analysis in terms of documenting the study's main findings.

Third, the high prevalence of household food gardening in Zimbabwean communities made it impossible to recruit both control and treatment households without gardens at baseline and to an extent reduced the ability to determine the impact of the intervention on key study outcomes.

Fourth, the study used different recall periods: 12 months for baseline and seasonal for follow-ups, which hampered comparisons across time.

Lastly, the valuation of garden output can be very difficult and the use of self-reported values of garden produce in this study could have affected the estimation of the true economic value of gardens.

These limitations would need to be addressed in future studies. It is therefore critical that more studies are conducted on the developmental impacts of household food gardens in the context of HIV and AIDS mitigation.

5.4 Further research

In light of the above limitations, the study assists in identifying some important research gaps and future work that need to be given attention in order to provide a clearer picture of the HIV and AIDS impact mitigation potential of household food garden programmes. The study recommends that larger samples be used as this would strengthen the nascent body of evidence on this subject matter. More evidence based on larger samples would not only satisfy academic interests but provide valuable information and insights for policy makers and programme implementers. Furthermore, rigorous impact assessments of household food garden programmes is important for informed and evidence-based policy making; for instance, to develop and implement appropriate support policy measures for improving targeting, access and adoption of household food gardens.

The study also recommends that future studies should recruit households that have never had a household garden as well as measure the volume and price of garden produce. Recruiting households who had never had gardens may provide a clearer baseline against which progress can be assessed or comparisons made. Measuring garden produce may give more concrete information on how much gardens contribute to household food and nutrient availability as well as the garden micro-economy. The results in Chapter 4 indicate a positive impact of household gardens on dietary diversity at a household level. However, this does not necessarily indicate that household food gardens have a positive impact on dietary diversity at the individual level. This is so because, food security at the household level may not ensure food security for all household members for two reasons: first, the ability to acquire sufficient food may not convert into actual food acquisition, because the preferences of the household or its decision maker may not prioritise food acquisition over the acquisition of other goods and services. Second, the intra-household allocation of the food may not comply with the physiological requirements of each individual household member (Pinstrup-Andersen, 2009). The data used to assess the impact of food gardens on food security was collected at the household level, so the study was unable to assess individual food security status. As a result, the study recommends that future studies that intend to assess the impact of household food gardening on household dietary diversity should collect data at the individual level to enable comparison of food security outcomes at that level.

In addition, there are several questions which future research can clarify. First, "Do household food gardens have different food security impacts for different subgroups, e.g., female and male headed households?" Second, "do household food gardens have nutritional impacts on PLWHA?", which requires collecting individual-level data on HIV status and other nutritional outcomes in treatment and comparison households. Finally, because governments, donors, and policy practitioners are always faced with resource limitations, they need to understand better how to allocate resources to ensure good value for resources, and as such worry about whether household food gardening is cost-effective relative to other interventions. Since such analysis was beyond the scope of this study, additional research is needed on the cost-effectiveness of household food garden programmes.

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ANNEXURES

ANNEXURE A.1: HOUSEHOLD SURVEY QUESTIONNAIRE

ANNEXURE A.2: FOCUS GROUP DISCUSSION (FGD) GUIDE

SADC Urban Food Garden Study

Focus Group Discussion (FGD) Guide – Beneficiary (Intervention) Households

18 March 2014

A. Pre-garden focus group discussion (FGD)

Welcome

Overview of study – informed consent [insert] – date and (start and finish) time

Introductions

Question 1:

How do you think having a garden will help your family?

Question 2:

Prompts (where these themes are not mentioned to then be elaborated on in further discussion):

2.1 Do you think the garden will help the health of your family?

2.2 Do you think the garden will have any economic benefit to you and your family?

2.3 How do you think the garden will impact the lives of women?

2.4 How do you think the garden will impact the lives of people living with and affected by HIV/AIDS?

B. Post-garden focus group discussion (FGD)

Welcome

Overview of study – informed consent [insert] – date and (start and finish) time

Introductions

Question 1:

What has the gardening programme meant for you and your family?

How do you think having a garden has helped your family?

Question 2:

Prompts (where these themes are not mentioned to then be elaborated on in further discussion):

2.1 Do you think the garden helped the health of your family?

2.2 Has the garden had any economic benefit to you and your family?

2.3 How do you think the garden has impacted the lives of women?

2.4 How do you think the garden has impacted the lives of people living with and affected by HIV/AIDS?

Question 3:

How has the education programme been helpful to your gardening?

What skills training has been the most helpful?

Question 4:

What are the major constraints and difficulties you face in maintaining your garden?

How do you think those people implementing the programme can help address these challenges?

Question 5:

Would you encourage other households to start a food garden?

Probe: Explain why or why not.