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**EVALUATION OF THE IMPACT OF BACKYARD GARDENS ON HOUSEHOLD
INCOMES IN SOUTHERN DISTRICT, BOTSWANA**

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**A Thesis submitted to the Graduate School in partial fulfilment of the requirements for the
award of a Master of Science Degree in Agricultural and Applied Economics of Egerton
University**

EGERTON UNIVERSITY

DECEMBER, 2016

DECLARATION AND APPROVAL

Declaration

This thesis is my original work and has not been submitted for an award of any degree in any other University.

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Approval

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DEDICATION

This work is dedicated to my family.

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ABSTRACT

Botswana is classified as an upper middle income country and despite having attained such economic growth, the country still faces socio-economic challenges such as poverty. The current poverty rate is 20.7% while rural poverty is 24.7% which is relatively higher for an upper middle income country. In order to address this problem, the government introduced the Poverty Eradication Programme. This study therefore, sought to assess the income, expenditure and consumption dimensions of households that have benefited from backyard gardens which form part of the Poverty Eradication Programme in Southern district of Botswana. The study areas were three sub-districts of Southern district, Botswana whereby cross-sectional data was used to evaluate the effects of backyard gardens on household incomes. The objectives were to: characterize households with and without backyard gardens; evaluate the factors that influenced the gross margin of backyard gardens, and evaluate the impact of backyard gardens on rural household consumption expenditure. A structured questionnaire was used to collect data from beneficiaries and non-beneficiaries of the backyard gardens program. Multi-stage sampling technique was employed to acquire proportionate sample of 247 respondents. Data was analysed using descriptive statistics, gross margin analysis, regression analysis and propensity score matching. Results showed that gardens were a viable activity as gardens had positive gross margins. Gross margins were affected by a number of factors including fertilizer application, market availability and area planted. Even though, backyard gardens were viable they are affected by a various production and marketing constraints and the major constraints were pests and diseases, lack of water, lack of market and poor prices. Propensity score matching revealed that average consumption expenditure of backyard garden program beneficiaries was P934.02 which was 8.07 % higher than that of non-beneficiaries (P841.34) of the backyard gardens indicating that backyard garden program has improved the livelihoods of rural households. Thus, the government can invest more on the program as one of the extreme poverty reduction tools and encourage beneficiaries to put more effort into making the gardens successful. This could be possible if the program leaders could develop policies aimed at enhancing productivity of backyard gardens through provision of workshops and seminars whereby beneficiaries would acquire more training on vegetable production. Therefore, it can be concluded that backyard garden program plays a crucial role in improving the living standards of Batswana.

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ACRONYMS AND ABBREVIATIONS

BCWIS	Botswana Core Welfare Indicator Survey
CEDA	Citizen Entrepreneurship Development Agency
EA	Enumeration Areas
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GM	Gross Margin
SDG	Sustainable Development Goals
MLGRD	Ministry of Local Government and Rural Development
MOA	Ministry of Agriculture
MOPAPA	Ministry of Presidential Affairs and Public Administration
PEP	Poverty Eradication Programmme
RDA	Rural Development Areas
SB	Statistics Botswana
SHHA	Self Help Housing Agency
SPSS	Statistical Package for Social Sciences
STATA	General Purpose Statistical Software Package
TVC	Total Variable Cost

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Botswana was classified as one of the ten poorest countries at the time of independence in 1966 and currently it is classified as an upper middle income country (Maipose, 2008). Though it has attained such economic growth, the country still faces socio economic challenge of poverty among others. The spread of poverty is geographical with some areas more profoundly affected than others. Results from the Botswana Core Welfare Indicator Survey (BCWIS) of 2009/10, revealed that poverty headcount rate stood at 20.7 % which is relatively high for an upper middle income country. Botswana's aspiration is to surpass the Sustainable Development Goal target of reducing extreme poverty by half by 2030 (Ministry of Presidential Affairs and Public Administration, 2015).

In order to achieve this goal, the government has introduced several initiatives aimed at improving the livelihoods of Botswana by addressing all aspects of poverty. These include among others the policy on environment such as the Environment Impact Assessment Act of 2005, Strategic Framework for Community Development in Botswana of 2010 and the establishment of sustainable economic empowerment projects under Young farmers CEDA fund which was established in 2004, Local Enterprise Authority established by the Small Business Act number 7 of 2004 and the Economic Diversification Drive (2010). Others include programs for orphans and destitute persons which falls under the Revised National Policy on Destitute Persons (2002), subsidized Self Help Housing Agency (SHHA) which falls under the National Policy on Housing (2000) and agricultural schemes which are under the National Policy for Agricultural Development of 1991 (MOPAPA, 2015). In addition to the above initiatives, a Poverty Eradication Programme that would aid in attaining food security and minimum sustainable livelihoods amongst disadvantaged individuals and/or families was introduced. The packages in the Poverty Eradication Programme include: Food items include; Jam, pickles, food catering, food packaging, backyard garden, bakery, small stock, poultry and bee keeping and non-food items include; kiosk, home based laundry, leather works, textiles, tent hire, landscaping, hair salon, backyard tree nursery, upholstery, handy crafts (basketry, wood carving, pottery), arts, craft, traditional dance and song.

The backyard garden program was introduced towards the end of 2009, as a government initiative through which individuals were identified and funded for a backyard garden (Basimane, 2014). Beneficiaries are given inputs such as irrigation systems (water

tank, drip irrigation pipes), seeds, fertilizer, tools (spade, garden fork, and rake), gum tree poles and net shade (Botlhoko, 2012; Keakabetse, 2013).

According to Torimiro *et al.* (2015) the types of vegetables that are mostly grown in the gardens are spinach (*Spinacea oleracea* L.), onion (*Allium cepa* L.), beetroot (*Beta vulgaris* L.), carrot (*Daucus carota* L.), rape (*Brassica napus* L.), chomolia (*Brassica oleracea* L.), green pepper (*Capsicum annum* L.) and tomato (*Solanum lycopersicum* L.). Challenges that backyard garden owners reported to face include lack of water, lack of finance, lack of market, pests and diseases, lack of technical knowledge on vegetable production and preservation and lack of encouragement from extension workers (Subair and Siyana, 2003; Torimiro *et al.*, 2015).

Backyard farming contributes to food security by assuring the provision of food in fresh form to satisfy the immediate calorie and nutritional needs of the household (Ojo, 2009). They are small pieces of land measuring approximately 30m by 10m in a residential area which is used to guarantee that the needs of immediate household members (Ojo, 2009). According to Ditedu (2015) backyard gardens were started with the aim of making sure that households were self-sufficient in fresh vegetables and they sell the surplus to their neighbours or through wet markets. Mostly these wet markets are found in front of retail supermarkets and the fresh vegetables are sold for a price lower than what the supermarket is offering for the same product.

1.2 Statement of the Problem

At the inception of the backyard gardening program, the government argued that these gardens would help poor households achieve food security and enhanced incomes through direct food provision and would enable households to earn income through sale of surplus produce. Though many households have been recruited into the program since its inception, the impact of these backyard gardens on household welfare have not been evaluated. Consequently evidence as to whether the socio-economic status of households that benefitted from backyard gardening has improved is largely unavailable. Likewise, direct impact of the program on access to food and household incomes remain largely un-documented. This study therefore sought to assess the income, expenditure and consumption dimensions of the backyard gardening program of households in Southern District of Botswana.

1.3 Objectives of the Study

1.3.1 General Objective

The aim is to contribute to improved household welfare of backyard gardens beneficiaries and food security in Southern District, Botswana.

1.3.2 Specific Objectives

- i. To characterize households with and without backyard gardens as per their socio economic indicators in Southern district, Botswana.
- ii. To evaluate the gross margins of the backyard gardens and factors that influence the gross margins of backyard gardens in Southern district, Botswana.
- iii. To evaluate the impact of backyard gardens on rural household consumption expenditure.

1.4 Research Questions

- i. What are the socio-economic characteristics of households in the study area?
- ii. Is there any difference in the gross margins of the backyard gardens?
- iii. What is the impact of backyard gardens on household consumption expenditure?

1.5 Justification of the Study

Considering the effort that the government is putting in making sure the programme is a success, there is need to assess how the backyard gardens are performing in terms of contributing to the standards of living of small scale vegetable farmers. Therefore the results will provide empirical evidence of the contribution of backyard gardens.

Secondly, findings will contribute towards the development of short and long term policy interventions aimed at fostering eradication of extreme poverty in the country. It will also add literature on the analysis of backyard gardens and poverty linkages specifically for smallholder farmers.

1.6 Scope and Limitations

The study used backyard gardens that are in the rural areas and are part of the poverty eradication programme. The limitation that this study had was that data collection was done during the period when most respondents were at the fields as it was harvesting time. To overcome this, the researcher made arrangements to interview the respondents in their preferred environment. Other respondents were unwilling to be interviewed no matter the level of assurance of anonymity and to address this limitation, those respondents were skipped. Most of the respondents did not keep records so they were not sure about some of

the feedback that they were giving therefore to overcome this limitation, follow up questions were asked to ascertain the answers given.

1.7 Definition of Terms

Backyard garden - is a small piece of land (10m by 10m, 20m by 10m or 30m by 10m) cultivated around the dwelling place which have been funded by the Botswana government.

Gross margin - compares the performance of enterprises that have similar requirements for capital and labour. It is given by total income less the variable costs associated with that enterprise.

Productivity – is a measure of efficiency in which inputs are utilized in production. It is the ratio of agricultural outputs to agricultural inputs.

Small scale vegetable farmer - refers to the beneficiary of the backyard garden scheme as funded by the government.

Welfare - this is the improvement in the household income level and livelihoods which leads to increase in consumption expenditure.

CHAPTER TWO

LITERATURE REVIEW

2.0 Concept of Backyard Gardens

Home gardens are found in both rural and urban areas in primarily small-scale subsistence agricultural systems (Nair, 1993). The very beginning of modern agriculture can be dated back to subsistence production systems that arose in small garden plots near the household. These gardens have tirelessly bore the test of time and continue to play an important role in providing food and income for the family (Marsh, 1998). Since the early studies of home gardens in the 1930s by the Dutch scholars Osche and Terra(1934) on mixed gardens in Java, Indonesia there have been comprehensive contributions to the subject amalgamating definitions, species inventories, functions, structural characteristics, composition, socio-economic, and cultural relevance. Home gardens are defined in multiple ways highlighting various aspects based on the context or emphasis and objectives of the research (Hoogerbrugge and Fresco, 1993).

Relying on research and observations on home gardens in developing and developed countries in five continents, (Nifiez, 1984) formulated the following definition: The household garden is a small-scale production system furnishing plant and animal consumption and utilitarian items either not obtainable, affordable, or enthusiastically available through retail markets, field cultivation, hunting, gathering, fishing, and wage earning. Household gardens tend to be situated nearby the dwelling place for security, convenience, and special care. They inhabit land marginal to field production and labor marginal to major household economic activities (*ibid*). Including ecologically adapted and complementary species, household gardens are marked by low capital input and simple technology (*ibid*).

Generally, home gardening refers to the farming of a small portion of land which may be around the household or within walking distance from the family home (Odebode, 2006). Home gardens can be described as a mixed cropping system that includes vegetables, fruits, plantation crops, spices and herbs, ornamental and medicinal plants as well as livestock that can serve as a supplementary source of food and income. While Kumar and Nair (2004), acknowledge that there was no standard definition for 'a home garden', they summarized the shared view by referring to it as 'an intimate, multi-story permutations of various trees and crops, sometimes in association with domestic animals, around homesteads', and added that

home garden cultivation is fully or partially dedicated for vegetables, fruits, and herbs primarily for domestic consumption.

Adding to this, Eyzaguirre and Linares, (2010); Sthapit *et al.* (2004) and Krishna, (2006) have defined a home garden as a well-defined, multi-storied and multi-use area near the family dwelling that serves as a small-scale supplementary food production system maintained by the household members, and one that encompasses a diverse array of plant and animal species that mimic the natural eco-system.

Home gardens are normally established on lands that are marginal or not suitable for field crops or forage cultivation because of their size, topography, or location (Hoogerbrugge and Fresco, 1993). The specific size of a home garden varies amongst households and normally their average size is less than that of the arable land owned by the household. However, this may not hold true for those families that do not own agricultural land and for the landless. New innovations and techniques have made home gardening possible even for the families that have very little land or no land at all (Ranasinghe, 2009). The home gardens may be delimited by physical demarcations such as live fences or hedges, fences, ditches or boundaries established through mutual understanding.

2.1 Backyard Gardens in Botswana

The backyard garden scheme was introduced towards the end of 2009, as a government initiative through which individuals are identified and funded for a backyard garden (Basimane, 2014). The Ministry of Presidential Affairs and Public Administration is the driver of the poverty eradication programme with the Ministry of Agriculture implementing the gardens after the Social and Community Development have identified people who qualify to benefit (MOA, 2008). The aims of backyard gardens are to economically empower individuals and/or families and enhance the self-esteem of beneficiaries.

To date, there are 3078 funded gardens nationwide; of which 1698 are operational, 1100 gardens are non-operational, 98 have failed and 182 are success stories (Ditedu, 2015). The maximum grants for backyard gardens is P12, 500 (P= Pula, Botswana currency P1= 0.096 USD). Torimiro *et al.* (2015) found out that small scale production beneficially impacted lives of respondents with increased profit margins, that is, for spinach (*Spinacea oleracea* L.) (P1, 140), onion (*Allium cepa* L.) (P276) and tomato (*Solanum lycopersicum* L.) (P684).

2.2 Benefits of Backyard Gardening in the Community

2.2.1 Ecological Benefits of Backyard Gardens

Private backyard gardens in cities, both food producing and non-food producing, have the ability to boost ecological function and connectivity (Byers, 2009). One study conducted in backyard gardens in Toronto found that natural conscription by all organisms was significant in 20 backyard study sites (Sperling and Lortie, 2010). Another study conducted in the United Kingdom found that the approximately 15 million gardens across the country performed as bio-havens for wildlife and played a substantial role in the preservation of biodiversity (Ryall and Hatherell, 2003).

2.2.2 Psychological and Cultural Aspects of Backyard Gardens

Lewis (1993) described gardens as a work of art, and an expression of culture by being a purely human paradigm with intrinsic value for the gardener and can be viewed as a diagnostic artefact, reflecting the characteristics of the gardener. For example, the food plants within a garden reflect the gardener's cultural traits and culinary preferences. Kiesling and Manning (2010) noted that gardening lies at the juncture of nature and culture, personal values and public expectation. Gardens are products of social, physical and symbolic ordering of private living space (Kimber, 2004) and any place where people garden, be it associated with a house or a community garden, is a place of social, cultural and religious significance (Francis and Hester, 1990; Kimber, 2004; Sinclair, 2005).

Food gardening provides a number of personal and cultural benefits and uses. Local food production benefits cities by: 1) providing socio-educational functions, 2) contributing to urban employment, and 3) reducing social inequality (Aubry *et al.*, 2012). Wilhelm (1975) studied gardening within a southern black community in USA and found that residents identified both the tangible (trees, flowers, fruits and vegetables) and intangible (a connection with the land) benefits from their dooryard gardens. Study participants identified curiosity, personal satisfaction, social recognition, beauty and amazement by the mysteries of nature as some reasons for gardening. Although intangible benefits were important, gardening was done primarily to raise the homeowner's standard of living and to provide food. Essential to gardening success and passage to younger generations, local plant experts played an esteemed role within the community.

2.2.3 Physical Health Benefits from Backyard Gardens

As the number of people living in cities continues to increase, dependency on large-scale and distant agriculture will only grow. With the increasing population densities, community leaders have identified food insecurity and food deserts, places where little fresh

or quality food is available for purchase, as growing problems in inner-city neighbourhoods. In these areas, access to healthy and affordable food can be limited. Inadequate access to fresh and nutritious food has been linked to higher rates of diabetes, obesity, cardiovascular disease, certain types of cancers and chronic illnesses (Aubry *et al.*, 2012; Corrigan, 2011; McCormack *et al.*, 2010). Hendrickson *et al.* (2006) summarized the many definitions of “food desert” used by different researchers. These varied definitions share the common idea that a food desert is a condition where people living in poor urban communities have few or no choices to purchase affordable, healthy food because of a lack of money, a lack of retail outlets or the low nutritional quality of food offerings (Koh and Caples, 1979; Lang and Rayner, 2002; Hendrickson *et al.*, 2006). Because people living in food deserts may have inadequate diets, they have a higher risk for health problems (Resnicow *et al.*, 2001). Unfortunately, the availability of affordable and quality fresh fruits and vegetables is a problem in some communities, particularly in inner-city and minority neighbourhoods.

In a study of low-income residents living in urban and rural Minnesota communities, the price of fresh fruits and vegetables were significantly higher in markets in poor areas, and selection and quality were lower (Hendrickson *et al.*, 2006). These conditions reduce residents’ access to fresh, healthy and nutritious food. Besides food deserts, another problem that affects many city dwellers is food insecurity. Anderson (1990) described food insecurity as the inadequate availability of nutritional and safe food to meet the person’s needs, or the uncertain or limited ability to acquire food in socially acceptable ways. Factors that contribute to food insecurity include limited income, lack of home ownership and education, ethnicity and household size (Eikenberry and Smith, 2005; Nord and Brent, 2002; Rose, 1999). Urban agriculture, such as community and backyard gardens, offers an inexpensive means to alleviate some of the problems of food deserts and food insecurity by positioning food production in the areas of greatest need.

Numerous studies examined the relationship between the availability of fresh vegetables, vegetable consumption and attitudes toward eating fresh vegetables. Several studies found that convenience, as related to the ease of obtaining fresh vegetables, was related to the amount consumed (Nijmeijer *et al.*, 2004; Steptoe *et al.*, 1995; Worsley and Skrzypiec, 1998). Household participation in a community garden may increase fruit and vegetable consumption among urban adults. For example, Alaimo *et al.* (2008) found that adults with a household member who participated in a community garden consumed fruits and vegetables 1.4 more times per day than those who did not participate, and they were 3.5 times more likely to consume fruits and vegetables at least 5 times daily.

Studies have suggested that the presence of farmers markets, community gardens and backyard gardens improve community nutrition and diet (McCormack *et al.*, 2010). This could be related to a greater ease of obtaining fresh fruits and vegetables, as suggested by Steptoe *et al.* (1995), Worsley and Skrzypiec (1998) and Nijmeijer *et al.* 2004).

2.2.4 Economic Benefits of Backyard Gardens

The economic benefits of home gardens go beyond food and nutritional security and subsistence, especially for resource-poor families. Bibliographic evidence suggests that home gardens contributed to income generation, improved livelihoods, and household economic welfare as well as promoting entrepreneurship and rural development (Calvet-mir *et al.*, 2012; Trinh *et al.*, 2003).

Through the review of a number of case studies, Mitchell and Hanstad (2004) assert that home gardens can contribute to household economic well-being in several ways: garden products can be sold to earn additional income (Ezygguire and Linares 2010, Torquebiau 1992 and Ninez 1985); gardening activities can be developed into a small cottage industry and earnings from the sale of home garden products and the savings from consuming home-grown food products can lead to more disposable income that can be used for other domestic purposes.

Studies from Nepal, Cambodia, and Papua New Guinea report that the income generated from the sale of home garden fruits, vegetables, and livestock products allowed households to use the proceeds to purchase additional food items as well as for savings, education, and other services (Iannotti *et al.*, 2009 and Vasey 1985). Families in mountain areas of Vietnam were able to generate more than 22 % of their cash income through home gardening activities (Trinh *et al.*, 2003).

Home gardens are widely promoted in many countries as a mechanism to avert poverty and as a source of income for subsistence families in developing countries. Although home gardens are viewed as subsistence-low production systems, they can be structured to be more efficient commercial enterprises by growing high-value crops and animal husbandry (Torquebiau, 1992). A number of research studies have focused on evaluating the potential or real economic contribution to the household and local economy as well as social development (Kehlenbeck and Maass, 2004). A study from South-eastern Nigeria reported that tree crops and livestock produced in home gardens accounted for more than 60 % of household income (Okigbo, 1990). In many cases the sale of produce from home gardens improves the financial status of the family providing additional income, while contributing social and cultural amelioration (Wilson, 1995). The fact that home production is less cost-intensive and requires

fewer inputs and investment is extremely important for resource-poor families that have limited access to production inputs. It has been assessed that moderately rigorous crop and livestock production in home gardens can generate as much revenue per unit area as field crop production (Marsh, 1998 and Danoesastro, 1980). Where land constraints exist, innovative tools have been used to make efficient use of limited space (Ranasinghe, 2009). Also, livestock housed in gardens diversify risk due to crop losses and provide a cash buffer and asset to the household (Devendra and Thomas, 2002).

2.3 Impact of Backyard Gardens on Household Welfare

Torimiro *et al.* (2015) in a study conducted in Kweneng District of Botswana found that the participants of backyard gardens either moderately or highly benefited from small scale vegetable production. Food, income, payment of bills, purchase of clothing and furniture were identified as benefits derived and this is supported by observations made by Rahman *et al.* (2008) that homestead vegetable production can play an important role in changing social and livelihood issues. The increased purchasing power can be used for non-vegetable food items. Subair and Siyana (2003) concluded in study done in Mochudi village in Botswana that the joy derived from backyard gardening and the physical exercises involved could help to keep the body in shape.

Batchelor *et al.* (1994) concurred with Rahman *et al.* (2008) that gardening has the potential to improve the household welfare by providing continuous supply of vegetables throughout the dry season and years of drought. Gardens offer crop security as compared to field crops as they are prone to drought. Yields in gardens are high and farmers are able to produce three crops in a year thus giving a relative high income as crops grown in gardens are high value crops hence this can increase the income of communal farmers. Gardens can significantly increase household income (Rahman *et al.*, 2008).

Produce from backyard gardens can be used for household consumption or for sale. Income from the sale of garden produce provides for other household needs as well. The fact that small but steady income comes from gardens, they are considered as dependable socio-economic safety nets for household food security and other requirements (Chirinda *et al.*, 2002).

Qualitative impact assessments have shown that the encouragement of vegetable gardens in particular keyhole gardens to improve access to a variety of food, even during the winter months, attests to being successful (FAO, 2000). Participating households noted the increase in the availability of food, wider diversity of their diet and surplus in vegetables,

which they are able to sell to generate income. Thus, households that participate in vegetable production are able to reduce both the direct and trade entitlements failures. According to Mwabumba (2015), direct entitlement failures refer to a situation where the food producers fail to produce enough and are unable to feed themselves either by self-supply or by trade.

Irrigated farming can create economic backward and forward linkages (FAO, 2000). A backward linkage takes the form of creating and enhancing business activities for those dealing in farm inputs. This is because of the fact that the crops grown under irrigation rely heavily on recommendations of improved purchased inputs. Forward linkages occur if irrigation leads to cash cropping. This will promote the growth of the agro- industry.

2.4 Theoretical Framework

The theory adapted in this study is the theory of agricultural household model. The model of household behaviour presented below describes a semi-commercial family farm with a competitive labour market (Singh *et al.*, 1986). It has been noted that the major part of world agriculture is consistent with this genre of model which is located intermediately on a continuum between a wholly commercial farm employing only hired labour and marketing all output and a pure subsistence farm using only family labour and producing no marketed surplus. Further, there is an active labor market for agricultural and other types of labor and all households participate in the labor market either as buyers or sellers of labor. Thus the use of labor time and the disposal of output are determined with reference to market wages and prices, and the average farm is aptly described as semi-commercial. Finally we note that land is rented by means of fixed charges and there are no sharecropping or other contractual arrangements which might lead to non-standard profit maximizing conditions.

With these points in mind, the household model can be formulated as follows:

$$U = U(L, C, M; a_i), i = 1 \dots \dots \dots 1$$

$$F = F(D, d_j; A), j = 1 \dots \dots \dots 2$$

$$T = H + L + D \dots \dots \dots 3$$

And

$$qM + pC = wH + R + pF - \sum w_j d_j \dots \dots \dots 4$$

Where L = leisure, C = own-consumption of agricultural output, M = consumption of market-purchased goods, a_i = household characteristics (for example, number of dependents), F

=total output of C, D = total labor input (both family and hired) used in i; production, d_j =other variable inputs used in F production, A =area of land used in F production, T = total household time available for labour, H =net quantity of labor time sold if $H \sim 0$ and net quantity of labor time purchased if $H < 0$, R =non-wage, non-crop net other income, q =price of M, p =price of C, w = wage- rate, and W_j = prices of other variable factors.

The household is assumed to maximise its utility function [eq. (1)] subject to a production function [eq. (2)] and time and income constraints [eq. (3) and (4)]. The planning horizon is assumed to be one agricultural cycle. As a result, decisions relating to the total supply of household factors of production are treated as given. Thus migration, which affects total available household labor supply, is omitted from the analysis, as is the rent decision, which affects the total available household land supply. Land may, therefore, be treated as a fixed factor. Rent payments or receipts, however, are captured in the definition of R, non-wage, non-crop net other income. Other long term decisions are also omitted from the analysis. In particular, it is assumed that the household has already made some decision about its desired level of saving and that this quantity is included in the definition of R. Finally, the analysis ignores risk, again on the grounds that, while risk may play a crucial role in the migration decision or the rent decision, it plays a less important role in the short term when it may be assumed that the longer term decisions have already been made and the household is, at least to some extent, committed to a fairly well-defined course of action for the duration of the agricultural cycle.

Maximising eq. (1) subject to eqn (2) through (4) and eliminating the Langrangian multipliers, yields the following first order equations:

$$\frac{U_c}{U_m} = \frac{p}{q} \dots\dots\dots 5$$

$$\frac{U_l}{U_m} = \frac{w}{q} \dots\dots\dots 6$$

$$pF_d = w \dots\dots\dots 7$$

$$pF_d = w_j, j = 1 \dots\dots\dots 8$$

and

$$qM + pC + wL = \pi + R + wT \dots\dots\dots 9$$

where,

$$\pi = pF(D) - wD - \sum w_j d_j \dots\dots\dots 10$$

Eqs. (5) and (6) express the traditional first-order condition of welfare economics: that is, the marginal rate of substitution in consumption must equal the marginal rate of transformation in production. Eqs. (7) and (8) are the profit-maximising conditions for the allocation of labor and 01-3 x variable factors. Eq. (9) combines the income and time constraints as well as the technological constraint described by the production function. The left- hand side of eq. (9) includes the ‘expenditure’ on leisure and the right-hand side is an augmented version of Becker’s (1965) concept of ‘full income’ which in this case includes the net profit (π) from household production.

Labor is singled out for separate treatment in eq. (7) to emphasize that the level of labor input is determined solely by the profit maximizing condition. In the absence of labor market participation the dichotomy between the production and consumption side would not be as complete. In this cast the quantity of labor used in production would be affected directly by the subjective evaluation of work to the household. However, with an active labor market the subjective evaluation of work determines the level of labor supplied by the household but not the household’s total demand for labor in production. Instead total labor demand is determined by the profit maximizing condition and the production and consumption segments of the model can be estimated separately.

Given an independent estimate of the production function, eqn. (7) and (8) can be used to determine the variable inputs into F production, and since the land input is determined exogenously, the total output of F. The solutions for the variable inputs and F can then be used to derive π , net farm profit. Eqn. (7) and (8), therefore, represent the production side of the model, and the impact of production on the consumption side is then transmitted through the value of π in the income constraint. Turning to the consumption segment, if we assume that the second order conditions are satisfied, eqn. (5), (6) and (9) can be solved for demand functions for the three consumption goods, C, M and L, in terms of the three prices, q, p and w, the household characteristics, a_i , and total household expenditure, E, which is defined as the sum of π , R and wT.

2.4 Conceptual Framework

The conceptual framework adapted in this study is built on the relationship between backyard gardening and an improvement in farm household welfare. The production decision

of a household is affected by internal and external factors. The internal factors are the household characteristics such as age, education level, household size, farming experience, income level and gender while the external factors are the institutional factors such as transaction costs, extension services and land tenure.

The production decision will include what to produce, how much to produce and how to produce which is constrained by the amount of inputs that are available and the size of land. After production, the household is faced with the problem of how much to sell and for how much and also how much should be consumed by the household. Overall impact will be got from the profit from the sale of the produce and the utility from the consumption of part of the produce.

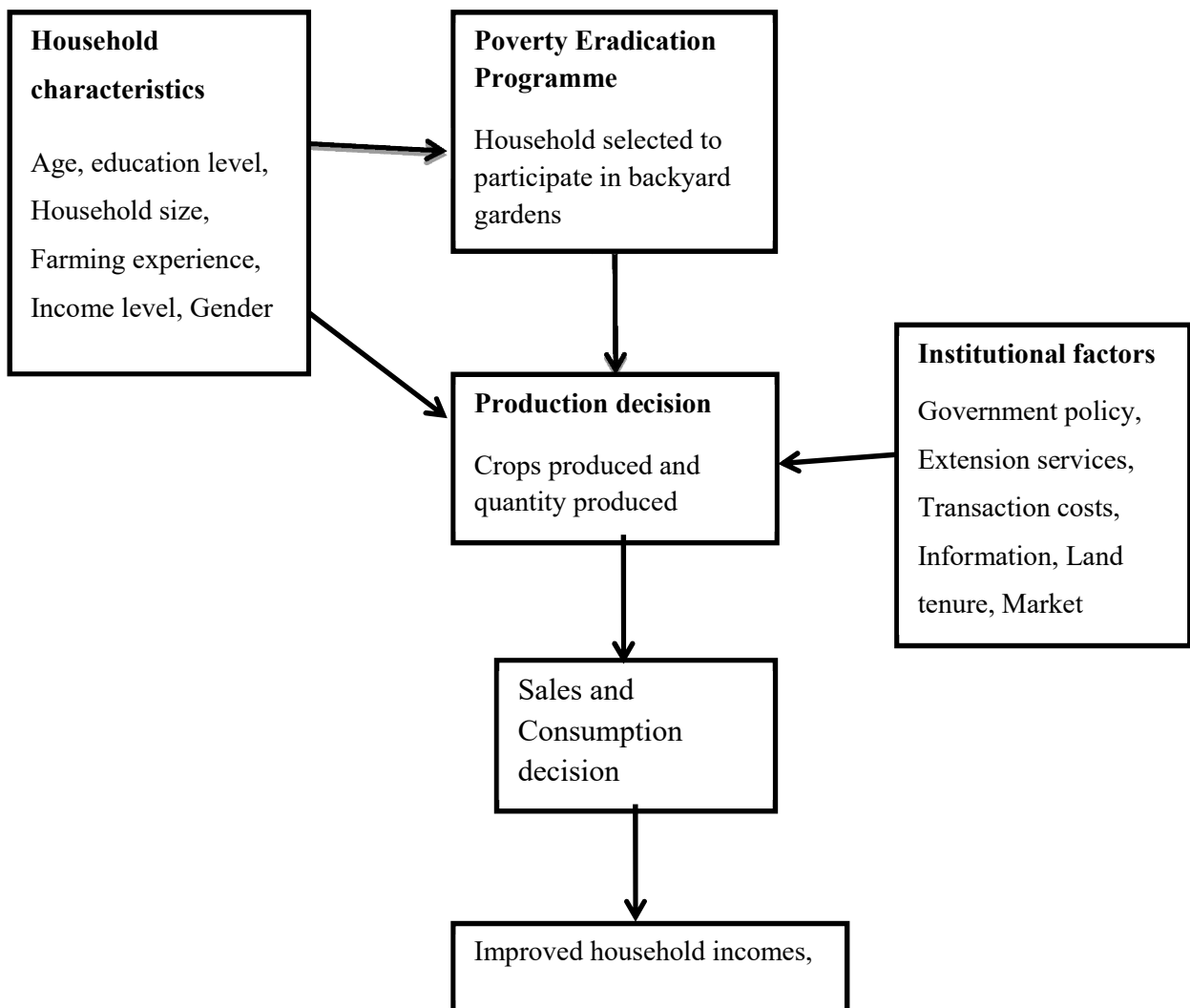


Figure 1: Conceptual Framework

CHAPTER THREE

METHODOLOGY

This chapter describes the study area, the sampling procedure and determination of the sample size from the target population. The section on the method of data collection explains the tools that were used.

3.1 Study Area

This study was conducted in Southern District in Botswana because this is where the largest number of backyard gardens is found. The district is bordered by the North West Province of South Africa in the South, South East district in the East, Kweneng district in the North and Kgalagadi district in the South-west. Figure 2 below shows the Southern district which lies approximately between latitudes 24° and 25° South and longitudes 24° and 25° East. Southern district has an area of 28470 km² with a population of 186 831 and the population density of 6.6/ km² (Statistics Botswana, 2011). The capital of Southern District Kanye Village and the other large villages in the district are Moshupa and Goodhope.

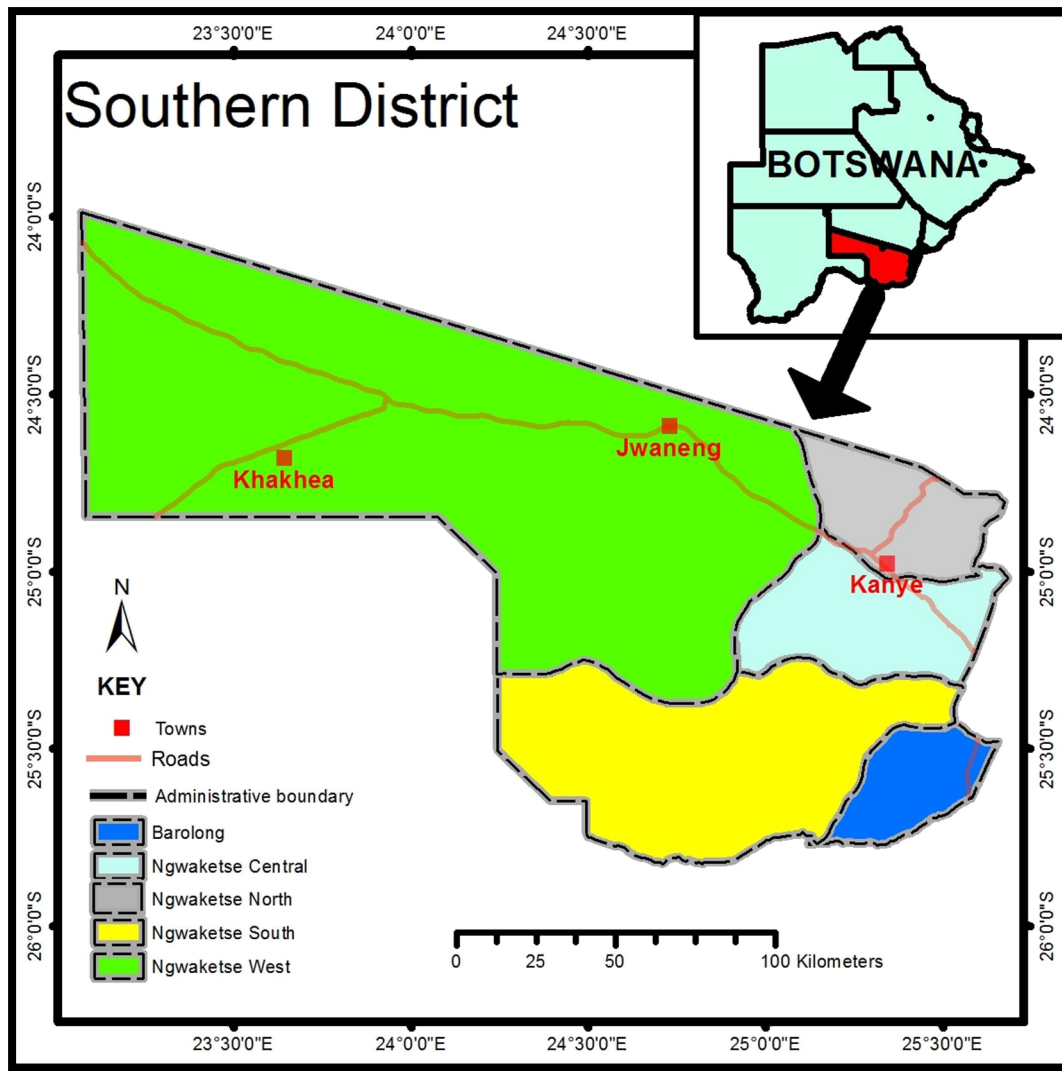


Figure 2: Map of Study Area

Source: Google maps

3.2 Sampling Procedure

The study targeted beneficiaries of the backyard garden program and non-beneficiaries who have the same characteristics as the beneficiaries. In order to control selection errors, an up-to date population source list was obtained from the Office of the President and the local extension officer in the department of Crops.

Multi-stage sampling was used to select the sample whereby in the first stage:- the region was purposively divided into three sub-districts which are Ngwaketse Enumeration Area (EA) (10617), Ngwaketse West Enumeration Area (10618) and Barolong sub-district Enumeration Area (10619). In the second stage, the population was stratified into two groups (beneficiaries and non-beneficiaries) and then random sampling was used to get a representative sample size from each strata.

3.3 Sample Size

Yamane (1973) suggested that since the population number (number of targeted population) is known in the study area, the following can best provide the required sample size for this study.

$$n = \frac{N}{1 + N(e)^2} \dots\dots\dots (1)$$

Where n is the desired sample size, N is the population size and e is the allowable margin of error (level of precision) ranging from 0.05 to 0.1. Margin of error shows the percentage at which the opinion or behaviour of the sample deviates from the total population. The smaller the margin of error the more the sample is representative to the population at a given confidence interval. Therefore, for this study allowing the smallest possible margin of error ($e = 0.05$), the total sample size became:

$$n = \frac{648}{1 + 648(0.05)^2} = 247 \text{ respondents}$$

The proportions to size sample for each enumeration area are given in Table 1.

Table 1: Household Population and Sample Size for Study Areas

Enumeration Area code	Enumeration area	Number of households	Sample size
10617	Ngwaketse EA	323	123
10618	Ngwaketse- West EA	54	21
10619	Barolong EA	271	103
	Total	648	247

3.4 Data Collection Instrument

A structured questionnaire was used to collect data. The kind of information required was on the socio-economic characteristics such as age, gender of the respondent, education level, household size and farming experience, consumption expenditure of households and amount of time allocated to garden work. However, pre-testing of the questionnaire was done on 25 respondents with similar characteristics in Kweneng District before data was collected in order to test the validity and reliability of the questionnaire and a final questionnaire was prepared using responses from the respondents. Pre-testing revealed that the economic

benefits of the backyard program were missing in the first questionnaire and should therefore be included in the final questionnaire.

To support the data collected from the field, secondary data which was collected from different published and non-published research journals and reports of Poverty Eradication Programme office were used.

3.5 Data Analysis Techniques

3.5.1 Characterizing Households With and Without Backyard Gardens as per their Socio-economic Indicators

Descriptive statistics was applied where mean, standard deviation, frequency distribution, and percentages were used to compare participants and non-participants of backyard garden scheme.

Variables included garden size, employment, age, marital status and gender of family head, education level of household head and possession of durable goods (variables obtained from the Botswana Core Welfare Indicators Survey, 2010).

3.5.2 Evaluating the Gross Margin of the Backyard Gardens and Factors Influencing the Gross Margins of the Backyard Gardens

Households are involved in various livelihood activities. These activities contribute to the income and food security status of a household. In this section the productivity and viability of the gardening activities were calculated. Gross margin analysis was used to determine the viability of the gardening activities. Gross margin is the difference between the value of output and the total variable costs. It is used to evaluate the performance of different enterprises.

Gross margin analysis was carried out for the garden crops; leafy vegetables, green pepper, tomatoes, and onions. This was used to test the hypothesis that gardening activities are profitable. The model for calculating the gross margin can be specified as:

$$GM = Q_i P_i - X_i P_{xi} \dots \dots \dots (2)$$

Where GM is the gross margin, Q_i is the quantity of output of crop i produced, P_i is the price of output, X_i amount of input i used and P_{xi} price of input i .

Even though the gross margin is an important analytic tool to assess the profitability of different farming enterprises, it has a number of disadvantages (Forestry, 2009). These are:

- i. There is no inclusion of fixed costs in the analysis. This incomplete analysis may lead to wrong conclusions.

- ii. Gross margin analysis does not take into account the possible environmental and social effects that may arise due to different types of technology or crops grown.
- iii. The results of a gross margin analysis are valid for the season under consideration; therefore, they may be not useful for other recommendations.

The ratio of income from backyard gardening to total income was calculated to get the contribution of gardening to the total household incomes. A regression analysis was run to relate the profitability of the gardens to the different socio- economic characteristics.

Gross margin is a function of price and output. Assuming a constant price, it is expected that output will cause the variation in gross margins of backyard gardens across households. Output is affected by household characteristics, input usage and soil characteristics. In order to assess the effects of different variables on yield, productivity analysis was done using a log-linear (translog) model specified as follows:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + \beta_{14}X_{14} + e_i$$

Where Y represents yield of vegetables produced, β_0 = constant, β_i = estimated coefficients of the explanatory variables, X_i = explanatory variables and e_i = disturbance term.

The explanatory variables hypothesized to have a relationship with the dependent variable and their expected signs are presented in Table 2:

Table 2: Description of the Independent Variables Used in the Productivity Model

Variables	Coding system	Category	Expected sign
X ₁ = Age of the beneficiary	Number of years	Continuous	-
X ₂ = amount of fertilizer applied	Number of kilograms	Continuous	+
X ₃ = area planted	Number of hectares	Continuous	+
X ₄ = Alternative income source	1 if available, 0 if unavailable	Dummy	-
X ₅ = Major constraint	1 if available, 0 if unavailable	Dummy	-
X ₆ = Livelihood threat	1 if available, 0 otherwise	Dummy	-
X ₇ = Labour source	Man days	Continuous	+

X ₈ = Market constraint	1 if available, otherwise	0	Dummy	-
X ₉ = Production constraint	1 if available, otherwise	0	Dummy	-
X ₁₀ = Market availability	1 if available, otherwise	0	Dummy	+
X ₁₁ = Garden size	Number of hectares		Continuous	+
X ₁₂ = Education level of the beneficiary	1 if literate, illiterate	0 if	Dummy	+
X ₁₃ = Household size (family labour)	Man days		Continuous	+
X ₁₄ = Problem index	1 if available, otherwise	0	Dummy	-

Increase in the farmer's age was expected to negatively affect the profitability of vegetable production. Nwaru and Iwuji (2005) stated that entrepreneurship gradually becomes less as age of the entrepreneur increases because creativity and confidence of the entrepreneur as well as his mental capacity to cope with challenges of his business activities decrease with age. Education is thought to be important as it informs farmers on how best to strategize and adapt to better marketing conditions therefore a positive relationship was expected between education and profitability.

The amount of land cultivated under vegetables was expected to be positively allied with profitability, because the more land put under production, the higher would be the profitability of the crop because of possible economies of scale. Garden size was assumed to have a positive relationship with profitability as the bigger the garden, the more land household have to plant more vegetables hence increasing their profits. Market constraint and production constraint were set as dummy variables, where a farmer either having marketing and production constraints took the value one or no constraint took a value of zero. Both marketing and production constraints were assumed to have a negative influence on profitability of backyard gardens.

Distance between the production area and the market is expected to reduce the probability of households in participating in commercial vegetable production hence poor profits because of associated high transport costs. Therefore it is expected that market availability would positively affect profitability. Household size is assumed to have a positive

relationship with profitability because households with large family sizes may cultivate more land. This is because family labour that is cheap is guaranteed therefore labour constraints will not be a problem.

Fertilizer quantity was measured in kilograms and was anticipated to positively affect the profitability of backyard gardening. It was assumed that the more fertilizer applied on vegetable crops up to a certain level, the more the quantity of vegetables produced. Problem index was assumed to have a negative relationship with profitability and this is because a household would spend more in-order to solve the problems that they are facing hence cutting the amount of profits realized.

Availability of alternative sources of income is also another factor that may affect the profitability of backyard gardens thus was given a value of one if alternative sources of income are available and zero otherwise. Therefore a negative relationship is expected between availability of alternative sources of income and profitability of the gardens. Major constraint to improving livelihood and threats to livelihood of the household were given value of one if they are available and zero if unavailable. Therefore, a negative relationship is expected between major constraint to improving livelihood, threats to livelihood and profitability.

3.5.3 Evaluating the Impact of Backyard Gardens on Household Consumption Expenditure

In order to evaluate the impact, the outcome variable that was used was consumption expenditure per day per adult equivalent. The average change in the outcome variable was estimated using Propensity Score Matching (PSM). PSM method improves on the ability of regression to generate accurate causal estimates by virtue of its non-parametric approach of balancing of covariates between the “treatment” and “control” group.

When usual methods of assessing the impact of an intervention using “with” and “without” method, has been hindered by a problem of missing data, the impact of intervention cannot be accurately estimated by simply comparing the outcome of the treatment groups with the outcomes of control groups (Heckman *et al.*, 1998). Rosenbaum and Rubin (1985) developed an alternative technique to assess the impact of discrete treatment on an outcome by using propensity score matches. This was achieved by grouping households from treated individuals and non-treated individuals which show a high similarity in their explanatory variables. Thus, to support results obtained from regression analysis the impact of having a backyard garden on household consumption expenditure was examined using econometric PSM method.

This study considered households that participate in backyard gardens as the treatment group and the non-participants as the control group. Ideally, the aim is to compare the level consumption expenditure, socio-economic and institutional factors of the backyard gardens participants to that of the non-participants. This ensures that the average treatment effect or effect of choice to participate in the backyard gardens on household consumption expenditure can be accurately estimated.

First, logistic regression of treatment status (1 if a household participate in backyard gardens, 0 if a household is a non-participant) was specified. This was run for the households on observables and exogenous variables that included: gender, level of education, household size, distance to market, price of output, price of information, farming experience, crops quantity output and extension services.

The major concern of this regression was to predict the probability of a household participating in backyard gardens. That is, to predict propensity scores based on which, the treatment and control groups of households was matched using the matching algorithms. As such according to Gujarati (1995), the functional form of logit model is specified as follows:

$$P_i = E(Y = 1/X_i) = \frac{1}{1+e^{-(\beta_0+\beta_1X_1)}} \dots\dots\dots (3)$$

Equation (4) can also be written as:

$$P_i = \frac{1}{1+e^{-z_i}} \dots\dots\dots (4)$$

The probability that a given household participates in backyard gardens is expressed by (5) while, the probability for non-participants in backyard gardens scheme is given by:

$$1 - P_i = \frac{1}{1+e^{z_i}} \dots\dots\dots (5)$$

Therefore it can be written that:

$$\frac{P_i}{1-P_i} = \frac{1+e^{z_i}}{1+e^{-z_i}} \dots\dots\dots (6)$$

$\frac{P_i}{1-P_i}$ is the odds ratio in favour of participating in backyard gardens that is, the ratio of the probability of participating in backyard gardens to that of the probability of not participating in backyard gardens. Lastly, taking the natural logarithms of equation (7) we obtained:

$$L_i = \ln \left[\frac{P_i}{1-P_i} \right] = Z_i = \beta_0 + \beta_1X_1 + \dots + \beta_nX_n \dots\dots\dots (7)$$

Where P_i is probability of participating in backyard garden scheme and it ranges from 0 to 1 and Z_i is a function of n explanatory variables (X_i) which is expressed as:

$$Z_i = \beta_0 + \beta_1X_1 + \dots + \beta_nX_n \dots\dots\dots (8)$$

Where β_0 is intercept, β_1, \dots, β_n are the slope parameters in the model, L_i is the log of the odds ratio, which is not only linear in X but also linear in parameters and X_i is vector of the relevant sampled household's characteristics. If the disturbance term U_i is introduced to the logit model it will become:

$$Z_i = \beta_0 + \beta_1 X_1 + \dots + \beta_n X_n + U_i \dots \dots \dots (9)$$

Table 3: Variables used in the logistic regression

Code Variable	Variable	Measurement of variable	Expected sign
Dependent variable			
BGPART	Household choice to Participate in export market	(1=participants, 0=non-participants)	+
Independent Variables			
Age	Age of household head	In years (Continuous)	+
Gender	Gender of household head	Dummy (1=Male, 0=Female)	+/-
Educl	Education Level of household head	(1=No education, 2=Primary, 3=Secondary, 4=Tertiary)	+
HHsz	Household size	Size of the household (Continuous)	+
FrmE	Farming experience	In years(continuous)	+
MrktI	Market information	Dummy (yes=1, No=0)	+/-
MrktD	Market Distance	Kilometers	+/-
OutputP	Output Price	Pula	+
OutputQ	Output Quantity	In kilograms (continuous)	+/-
ExtS	Extension Services	Number of contacts with extension	+/-

However, estimation of the propensity score is not enough to estimate the ATT of interest. This is due to the fact that propensity score is a continuous variable and the probability of observing two units with exactly the same propensity score is, in principle, zero. Therefore, after obtaining the predicted probability values on the observable covariates (the propensity scores) from the binary estimation, matching was done using a matching algorithm that is selected based on the data at hand. Some of the various matching algorithms that have been proposed in literature differ from each other with respect to the weights they attribute to the selected controls when estimating the counterfactual outcome of the treated. However, they all provide consistent estimates of the Average effect of treatment on the

Treated (ATT) under the Conditional Independence Assumption (CIA) and the overlap condition (Caliendo and Kopeinig, 2008).

Nearest Neighbour matching (NNM): Here an individual from a comparison group is chosen as a matching partner for a treated individual that is closest in terms of propensity score (Caliendo and Kopeinig, 2008). It can be done with or without replacement options. The problem this technique faces is that where the treatment and comparison units are very different, finding a satisfactory match by matching without replacement can be very problematic (Dehejia and Wahba, 2002).

Checking overlap and common support

Imposing a common support condition ensures that any combination of characteristics observed in the treatment group can also be observed among the control group (Bryson *et al.*, 2002). The common support region is thus the area which will contain the minimum and maximum propensity scores of treatment and control group households, respectively. However, comparing the incomparable must be avoided. This can be avoided by checking the overlap and the region of common support between treatment and comparison group. One way of determining the region of common support more precisely is by comparing the minima and maxima of the propensity score in both groups. The basic criterion of this approach is to delete all observations whose propensity score is smaller than the minimum and larger than the maximum in the opposite group. As such, observations which lie outside this region are discarded from analysis (Caliendo and Kopeinig, 2008).

Impact of backyard garden participation on household consumption expenditure

The impact of farmer’s participation in backyard gardens on household consumption expenditure were further investigated by letting Y_i^T and Y_i^C be the amount of consumption expenditure for participants and non-participants respectively. As such the difference in outcome between treated and control groups can be seen from the following mathematical equation:

$$\partial_i = Y_i^T - Y_i^C \dots\dots\dots (10)$$

Where Y_i^T = Outcome of treatment (income of i^{th} household, when they participate in backyard garden scheme), Y_i^C = Outcome of the untreated individuals (income of i^{th} household, when they do not participate in backyard garden scheme) and ∂_i = Change in outcome as a result of treatment or change in consumption expenditure for participating in backyard gardens.

Equation (11) is then expressed in causal effect notational form, by assigning $D_i = 1$ as a treatment variable taking the value 1 if individual received the treatment (participates in backyard garden) and 0 otherwise. Then the Average Treatment Effect of an individual i can be written as:

$$ATE = E(Y_i^T | D_i = 1) - E(Y_i^C | D_i = 0) \dots \dots \dots (11)$$

Where ATE , Average Treatment Effect: is the effect of treatment on household consumption expenditure, $E(Y^T | D_i=1)$: Average outcomes for individuals with treatment, if they choose to participate in the backyard garden, ($D_i=1$) and $E(Y^C | D_i = 0)$: average outcome of the untreated individual, when they do not choose the backyard garden is ($D_i =0$). Furthermore, the Average Effect of Treatment on the Treated (ATT) for the sample can be expressed as:

$$ATT = E(Y_i^T - Y_i^C | D = 1) = E(Y_i^T | D = 1) - E(Y_i^C | D = 1) \dots \dots \dots (12)$$

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Socio-economic Dimensions of Beneficiaries and Non-beneficiaries of the Backyard Garden Programme

4.1.1 Demographic Characteristics of Households

The combined results of beneficiaries and non-beneficiaries in Southern district (Table 4) shows the average age for household head was 47 years with no significant difference between the beneficiaries and non-beneficiaries. The mean age for beneficiaries and non-beneficiaries was 48 and 46 years respectively.

Persons between the ages of 25 and 45 dominated small scale vegetable production. Within that age bracket, households are providing for their children and must engage in activities that provide food and incomes as well (Subair and Siyana, 2003). Oluwasola (2015) also found that the majority of participants were in their active year which means that these farmers are young adults who are physically active and are able to contribute significantly to agricultural production thus positively affecting farm size and earnings.

The mean household size was 6 people. The mean household size for beneficiaries was 5 people while for non-beneficiaries it was 6 people per household and this was significant at 10%. Large family size implies that the farmers have access to family labour that can assist on the farm and hence reduce cost of farm operations. Household size has an influence on production as it affects consumption and production (Randela, 2005). A large household size discourages selling of produce because the farmer has to supply household consumption before selling.

The household's perception toward the backyard garden scheme was significant at 1% between the beneficiaries and non-beneficiaries. How people perceive situations is important as it influences the choices they make. If they think that backyard gardens are a vital social safety net, then they would make efforts for the success of the gardens. These findings are corroborated by Lake *et al.* (2011) that increases in perceptions of behavioural control, attitudes and subjective norms would increase the intention to participate in edible gardening which would then lead to increases in actual participation.

Table 4: Demographic Characteristics of Beneficiaries and Non-beneficiaries of Backyard Gardens

Variables	Beneficiaries		Non-beneficiaries		Total		t test	p-value
	Mean	SD	Mean	SD	Mean	SD		
Age	47.45	13.00	46.28	13.06	46.75	13.02	-0.70	0.488
Household Size	5.41	3.24	6.15	3.59	5.85	3.47	1.65	0.100*
Perception index	6.52	2.33	4.31	2.94	5.19	2.92	-6.34	0.000***

Note, *, **, ***: refers to significance at 10%, 5% and 1% respectively while SD denotes standard deviation.

4.1.2 Gender and Marital Status

Results in Figure 3 show that about 28 % of the households were male headed and 72% female headed for combined households. However, when the two groups were separated, 71% of beneficiary households were headed by females compared to 72% for non-beneficiaries. Female headed households dominated those participating in the program as they are responsible for their household food security and this is also a deliberate policy action by the government to make sure that more women are participating in the backyard gardens as they are the more vulnerable to food insecurity than men. Samantaray *et al.* (2009) established that vegetable cultivation is dominated by women and that they manage the vegetable production system up to harvesting and marketing stage.

When compared to non-beneficiaries, single parents (57%) dominate the program. This might be because they do not have a partner to help them support their families such that all responsibilities befall them. Widowed and divorced people accounted for 23% and 1% respectively and this might be because they take a long time to remarry and sometimes they do not have that opportunity thus they are responsible for their household welfare. Married people accounted for 19% and they were mature adults saddled with marital responsibilities hence their involvement in backyard gardening. These were regarded to have more labour force compared the unmarried. This is corroborated by Oladele (2011) that farm labour required by the married vegetable farmers was supplied by their spouses.

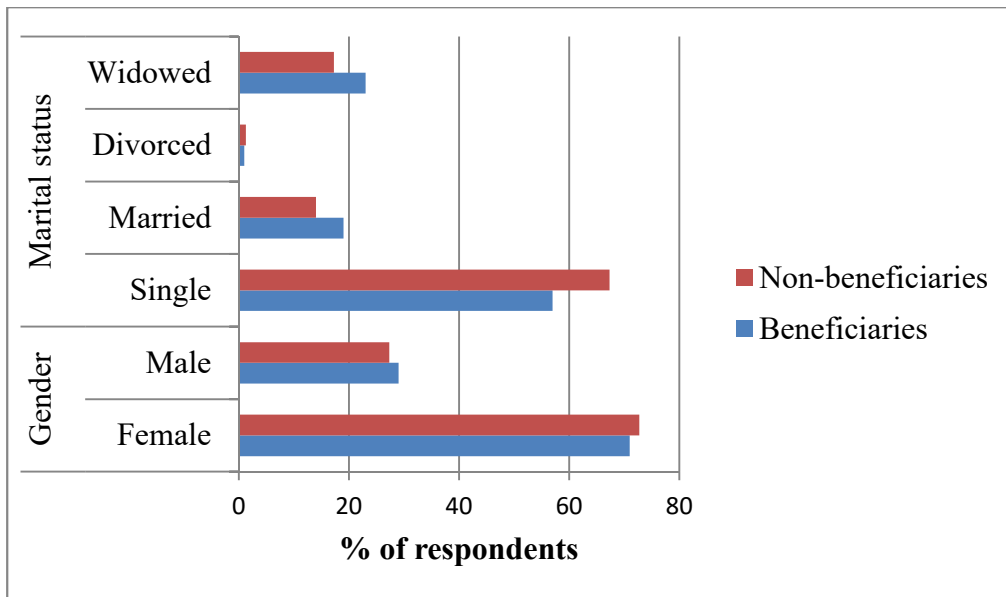


Figure 3: Distribution of Households by Gender and Marital Status

4.1.3 Educational Level

In this study, the level of education was included to ascertain the farmers' ability to use and interpret information than those who have less education or no education at all (Marther and Aldelzadeh, 1998). The results (figure 4) show that 25% of the households had no formal education at all whilst 75% had formal education. For those who had formal education, 47% had gone up to primary level whilst 16% attained junior secondary school, 9% had senior secondary school and 3% had tertiary education. These findings are supported by those of Subair and Siyana (2003) that most of the participants of backyard gardens have primary education and little to no skills to perform optimally in backyard gardens. Such farmers are imbued with the ability to access and appreciate the use of improved technology and best practices in their enterprises.

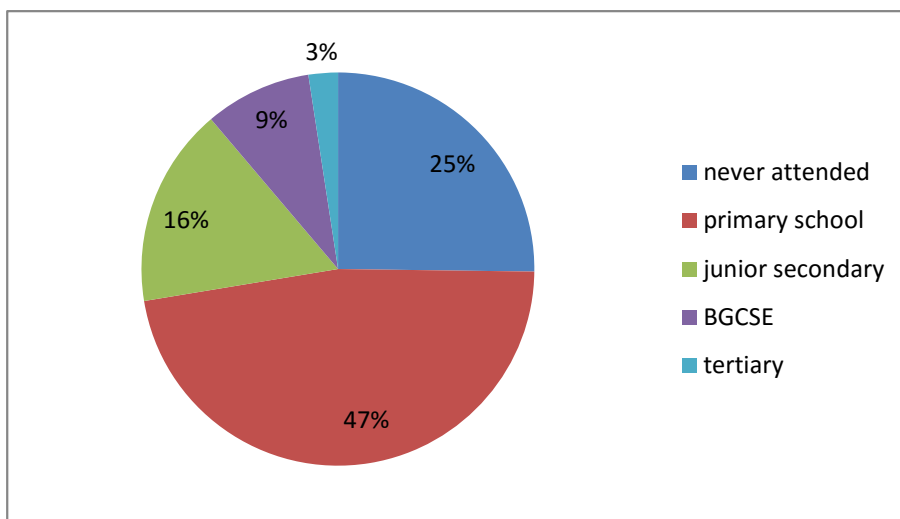


Figure 4: Educational Level

4.1.4 Asset Ownership

Asset ownership is an indicator of welfare in the sense that the households which owns such assets are assumed to be better in terms of poverty level as compared to those who cannot afford to purchase such items (Statistics Botswana, 2003). Results in Figure 5 reflect ownership of durable assets for production such as tractors, handhoes and ox drawn ploughs. Assets for production were handhoe, ox plough and wheelbarrows. Compared to non-beneficiaries where 70% had wheelbarrows, 80% of the beneficiaries had the equipment. About 48% of the beneficiaries had hand hoes compared to 46.7% of the non-beneficiaries while 10% of the beneficiaries had an ox plough compared to 6.7% of the non-beneficiary households. These are the most commonly used implements in backyard gardens.

Rural households for beneficiaries that had tractors was 4% compared to 3.3% for non-beneficiaries. This might be because of the fact that tractors are expensive to purchase, own and run. The low numbers of farmers using tractors was because they are expensive to hire and run and not readily available (Betek and Jumbam, 2016). About 10% of the beneficiaries had bicycles when compared to 6% of the non-beneficiaries. This is because they are a convenient way of easily accessing input and output markets in the village given the lack of transport due to poor roads. However, bicycles are not efficient as farmers spent most of their time and energy riding it to the market instead of utilizing that time for production (Phanith and Phnom, 2011).

There was no distinct difference in cellphone ownership since 82% of beneficiaries and 81% non-beneficiaries had them. Both groups indicated that they used the cellphone to keep in touch with the outside world. Rural beneficiary household indicated that they needed the cellphone in order to communicate with the suppliers of manure and also their customers. Krone *et al.* (2014) found that the increasing use of mobile phones resulted in positive contributions to the economic activities of horticultural farmers as it facilitated a diversified knowledge access and led to better informed farmers.

When compared to non-beneficiary households, beneficiary households had a higher number of fridges (26%) to 17.3% for non-beneficiaries. Majority of the both groups indicated that they did not have fridges because they do not have access to electricity. However, for beneficiary households that had fridges they indicated that they have fridges so as to store some of their left over produce to be sold the next day.

A good number (52%) of beneficiaries owned radios when compared to 40.7% non-beneficiaries and about 38% of the beneficiaries compared to 28% of the non-beneficiaries had televisions. They indicated that they needed the radios and televisions to access information on better crop production techniques and major inputs such as high-yielding seeds and pesticides so that they can improve their gardens. These results are substantiated by Ali (2011) that the use of mass media (radios and television) methods of information transfer has the potential to greatly help the farming community.

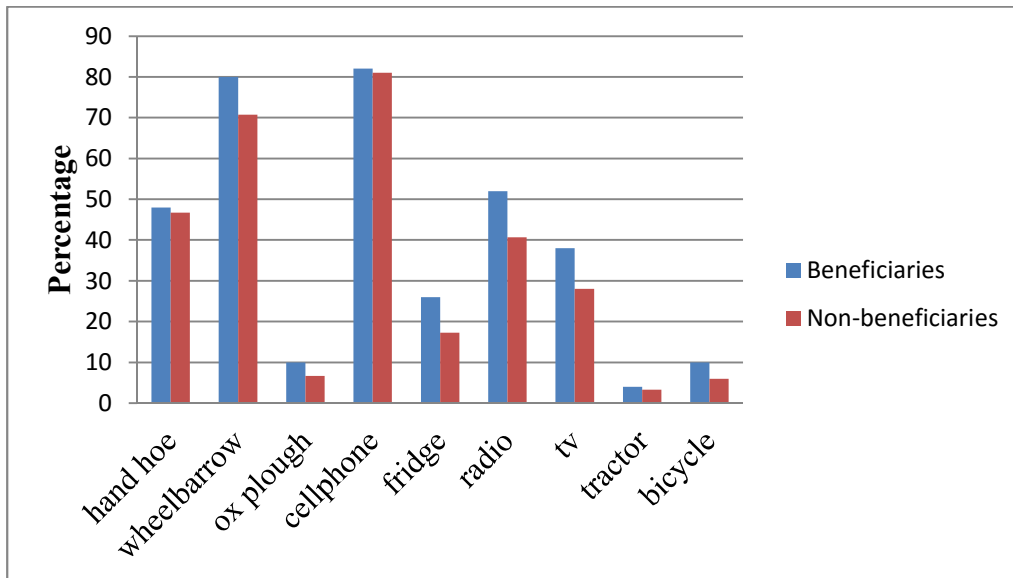


Figure 5: Household Assets

4.2 Backyard Gardening Response rate

Backyard gardening is a government program as such most beneficiaries and non-beneficiaries were unwilling to respond to the questionnaire. Despite the impact that backyard gardens might be having towards improving the incomes of rural households, the uptake of the program remains low in some places such as Southern District. Out of the total sampled respondents, about 39% were beneficiaries of the backyard garden program while 61% were non-beneficiaries of the program and this is presented in Figure 6.

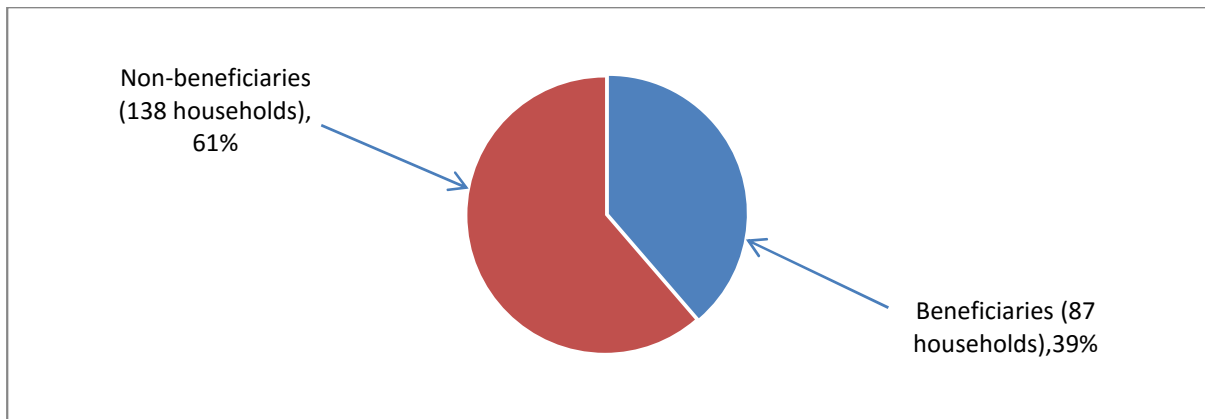


Figure 6: Response rate

4.3 Backyard Garden Productivity

Apart from outputs from gardens, farmers would also be interested in producing crops that would minimize cost of production to save on the limited financial resources they have. Therefore gross margin analysis was used to analyse the returns beneficiary rural households were getting from the different garden crops.

4.3.1 Garden Income Share Ratio

The study also analysed the contribution of gardening activities to household income. Since gardening seemed to be the main livelihood activity in the area, there was an interest to what proportion of the household incomes was coming from the gardening activities. To analyse the contribution of gardening income to the household, the garden income share ratio was used. The proportion of the income from the garden was calculated from the household income.

In order to calculate the garden share ratio the following formulae was used;

$$\text{Garden income share ratio} = \frac{\text{Income from garden sales}}{\text{Total household income}}$$

The summary of the garden income share ratio is presented in Table 5. On average, the income from gardening activities of beneficiary households was contributing about 36% of the total household income. Twenty five percent of the households had 18% or less of their income from gardening activities which might be of little significance to the welfare of the household. About 75% of the households had income from the garden contributing 49% or less to the total household income. This analysis shows that the income from the gardening activities is relatively small as compared to the whole household income. This can reveal that households had other sources of income besides gardening.

Table 5: Summary Statistics of the Garden Income Share Ratio

		Value
Mean		0.36
Standard Deviation		0.251
Standard Error		0.025
Percentile	25	0.18
	50	0.32
	75	0.49

4.3.2 Gross Margin Analysis

Table 6 summarises the yield, cost of variable inputs and gross margins per hectare by gardening activities. In these calculations, household level margins per hectare were extrapolated from farmed area. Gross margins are calculated by deducting costs (fertilisers, chemicals, seed and labour) from the value of total production of each individual household then averages are taken for each factor. The unit of currency is the Botswana Pula (BWP).

Table 6: Gross Margin Analysis of Garden Crops

	Leafy vegetables	Onions	Tomatoes	Green Pepper
Yield (t/ha)	7.95	14.26	7.11	33.29
Average area under crop	0.294	0.046	0.109	0.034
Gross income per ha (BWP/ha)	119668.44	64139.74	65620.53	66588.24
Total variable Costs (TVC) per ha (BWP/ha)	33179.08	39301.31	49239.23	48588.24
Gross margin per ha (BWP/ha)	86489.36	24838.43	16381.30	18000
Gross margin per TVC	2.61	0.63	0.33	0.37

Exchange rate is P1= US\$0.097

All the garden crops analysed had positive gross margins. However, of the four main crops analysed the leafy vegetables had the highest gross margin as well as the highest return on Pula spent. The fact that leafy vegetables are in high demand both locally and urban markets can be used to explain this. With tomatoes, onions and green pepper, they are additives to the relish dish such that in case of financial crises one can forgo them.

From the results, gardening is viable as indicated by the gross margins. The mean gross margin per hectare for the leafy vegetables was P86489.36 or US\$ 8380.78, onions was P24838.43 or US\$ 2406.83 and P16381.30 or US\$ 1587.34 for tomatoes. On average, the area under leafy vegetables was 0.294 whilst for onions it was 0.0458 and 0.1091 for tomatoes. Larger areas could significantly increase the contribution of income from the garden to the total household income.

4.3.3 Factors Affecting Gross Margin per Hectare

Gross margin is a function of price and yield. Assuming a constant price, it is expected that yield will cause the variation in the gross margins across rural beneficiary households. Yield is affected by household characteristics, input usage and garden size among other factors. The results of log-linear analysis of these relationships are presented in Table 7.

Table 7: Factors Affecting Gross Margin per Hectare

Variable	Coefficient	Std. Err.	t	p> t
Age	-0.07	0.30	-0.23	0.753
Fertilizer applied	0.70	0.14	5.10	0.000***
Area planted	0.34	0.18	1.87	0.066*
Income source	-0.03	0.05	-1.70	0.484
Livelihood constraint	-0.08	0.07	-1.30	0.196
Livelihood threat	0.003	0.03	0.09	0.931
Labour source	0.001	0.63	-0.00	0.998
Market constraint	0.05	0.03	1.31	0.195
Production constraint	0.17	0.06	3.06	0.003***
Market availability	0.63	0.22	2.79	0.007***
Education level	0.11	0.11	1.06	0.295
Household size	-0.05	0.03	-1.79	0.078*
Problem index	-0.29	0.27	-1.11	0.273
Constant	0.50	1.97	0.25	0.801
Number of obs	= 83			
R-squared	= 0.5456			
Adjusted r-squared	= 0.4521			

*, **, ***: refers to significance at 10 %, 5 % and 1 % level, respectively

Out of the 14 factors that were hypothesized to have an effect on the household gross margin, three (fertilizer, production constraint and market) had a significant effect on gross margin.

The amount of fertilizer applied was significant at 1%. Fertilizer is an agent for increasing yields and when optimum levels are applied, more output is realized and thus gross margins. Results showed that a one unit increase of fertilizer raises yield of vegetables by 70%. This is corroborated by Chellemi and Pierce (2002) that supplemental use of fertilizers significantly impact marketable yields as fertilizer application increased the marketable yield of the first harvest.

The head of a household is assumed to be responsible for the coordination of the household activities therefore, age of the household head is often indicative of farming experience as well as the ability to comprehend new technologies. The results in Table 6 show that age has a negative relationship with vegetable yields. When the age of the household head increases by one unit then yield will be reduced by 7%. This is because the innovativeness, buoyancy of the farmer and mental abilities to deal with challenges that arise decrease with age. The age of the head of the household is also important since it determines whether the household benefits from the experience of an older person, or has to base its decisions on the risk-taking attitude of a young farmer (Makhura, 2001).

Market availability has to be determined by the farmers before they start production so as to answer the question of what to plant, how much to plant, where and to whom the produce will be sold to. Nichols and Hilmi (2009) found that availability of market research enables smallholder farmers to become more knowledgeable about prices, what vegetables are wanted and the quantities of the vegetables markets require. Availability of the market was significant at 1% and the positive coefficient can be construed to mean when farmers have a particular preference they get motivated to increase yields and thus increasing profits. There is often preference for retail markets because they tend to provide higher prices as observed by Oxouzi and Papanagiotou (2010).

The results suggest a positive relationship between the yield and area devoted to vegetable production due to economies of scale. Area planted was significant at 10% which can be inferred to mean that a unit increase in the area planted will increase yield and consequently gross margins by 34%. Given good management practices, increase in area under vegetable production would increase output. Erbaugh *et al.* (2008) found that farm size negatively influenced gross margins and this contrasted the results found by Sulumbe *et al.* (2010) who found positive relationships between gross margins and farm size.

The alternative income source of a household is another factor that was found to affect profitability of the gardens negatively. When a household has an alternative source of income, it reduces gross margins by 3%. With existence of other sources of income, there is tendency of less concentration on the gardens leading to lower yields assuming constant prices, low output leads to low margins.

A large household size indicates availability of labour to garden activities and thus labour constraints would not be a problem. In addition a large household size could be an indication of a household's ability to have several sources of information that might have a positive impact on yield. Even though the source of labour dummy was not significant in explaining the observed gross margins, household size was significant at 10% and showed a negative relationship between household size and yield. The observed relationship may be due to the fact that in some instances, despite the relatively large household size, most members spend their time on other activities and thus may not represent a readily available labour source. Despite a large household size, profitability may be negatively impacted in that some family members may not take part in production activities or due to diminishing marginal returns to labour (Ahuja, 2000).

4.3.4 Analysis of Production Constraints for Rural Beneficiary Households

Farmers were asked using Focus Group Discussion (FGD) about main limitations they face during farming operations. Households were requested to list the three most important constraints they face in the gardens. Figure 6 shows the strength of each constraint in the garden. Pests and diseases seem to be the greatest challenge that 27.7 % of households were facing. Farmers indicated that the problematic pests were aphids thus they were using soapy water to control them. Soapy water does not always work so households that can afford to buy pesticides were using Malathion. Households indicated that they rely on the government to supply them with pesticides but often, there are delays which leads to a build-up of pests. This is substantiated by Ellis-Jones *et al.* (2008) that pests and diseases have been identified as major constraints to vegetable production as they cause both economic and health problems for vegetable farmers.

A small number of households (4.3 %) had insufficient knowledge on what to produce and when to produce for higher returns. However farmers pointed out that they grow leafy vegetables because they are perennial in nature and easy to manage. It is possible for farmers to get information by their own effort but they are facing problems due to absence of market information as most of the time they become aware of the price upon arrival at the market. Farmer's know-how of product sorting, grading, packing and transporting is traditional,

which severely affects the quality of horticultural products supplied to the market (Kiros, 2008).

Lack of water is also a major production constraint that 23 % of the farmers were facing as most of them rely on rain water. Since the gardens were situated in places where access to piped water is not available, government supplies using bowsers and sometimes they go for a month without water thus disrupting vegetable production. For farmers (4 %) who pointed out that they use piped water for irrigation, their water bills exponentially increased and they could not afford to pay the bill hence their water was be disconnected. Rahman *et al.* (2008) identified shortage of irrigation water in the dry season, lack of quality seeds, lack of knowledge on vegetable production and preservation, insect/pest problems on vegetables as major constraints to homestead vegetable production for sale.

Damage of gardens by domestic animals affected 3.3 % of the farmers. Goats and donkeys could damage the net shading and eat the vegetables inside. As a way of preventing animals from damaging their gardens, farmers have put up fences to surround the gardens. About 2.3 % of the farmers had a problem of vandalism and crime as their gardens were destroyed and the thieves took the poles thus leaving the net shading sagging. These findings are supported by Chowdhuri *et al.* (2014) that farmers pointed out they have a problem of vegetable damage by domestic animals and loss of production due to theft.

Low quality of materials supplied (variable inputs included) was identified by 15.7 % of the farmers as a production constraint. For example, farmers indicated that they were given pipes for drip irrigation that were blocked and were never checked thus the farmers have never used them and some were given leaking water tanks so they could not store water in them until they could fix the leaks. The farmers indicated that though they would like to fix the leaks themselves it is not possible as they cannot afford to do so. Chowdhuri *et al.* (2014) found that inadequate supply of good quality seeds was also a vegetable production problem faced by farmers.

Transport was a production constraint to 2 % of the farmers as they did not have reliable transport to the market or even to places where they can purchase inputs they needed. (Kiros, 2008) found that the issue of transport brings into focus the inadequacy of farm roads and the poor condition of existing ones as most of the production sites are in rural areas. Because soil testing was not done before the farmer was given the backyard gardens, 4.3 % of the farmers indicated that where the gardens were constructed was not suitable for growing vegetables and thus gardens failed. Soil properties and its water permeability should be

known as they are important aspects of vegetable growth and quality (Nichols and Hilmi, 2009).

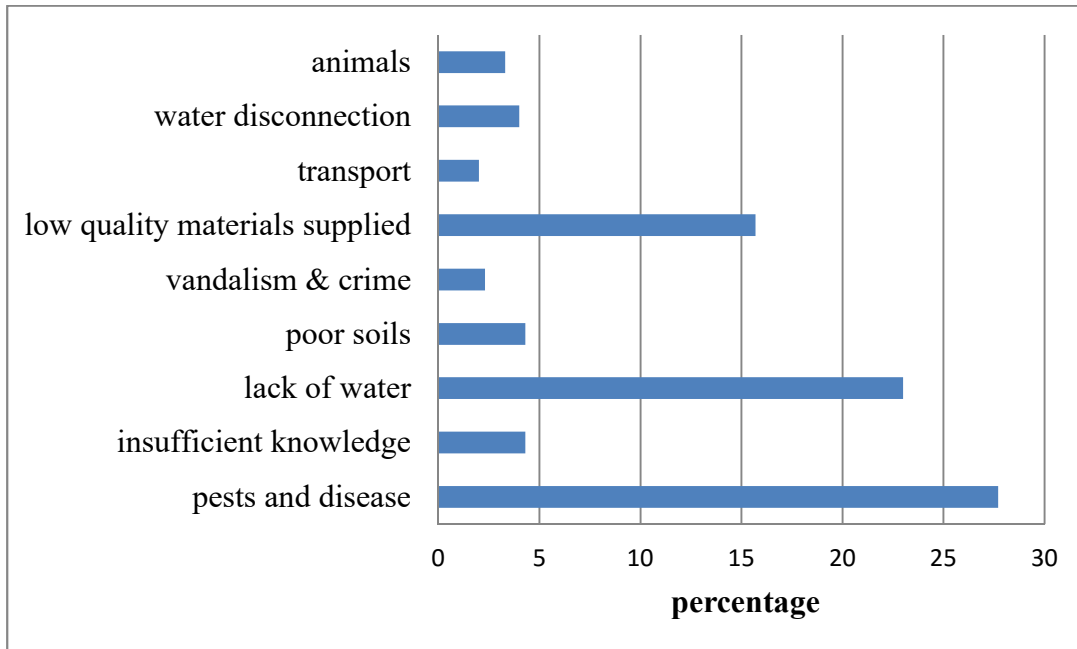


Figure 7: Production constraints

4.3.5 Analysis of Marketing Constraints

Results of marketing constraints facing backyard gardens are presented in Figure 7. In marketing of horticultural produce, lack of market was identified by the majority (26%) as the main constraint. The primary markets for various vegetable products from the gardens were neighbourhood households who buy for consumption. Likewise, vendors who bought in bulk for re-sale in open markets served as another outlet. Xaba and Masuku (2013) found out that some vegetables produced by farmers in Swaziland were spoiled due to lack of markets.

Lack of storage facilities was a problem faced by 11 % of the farmers as sometimes they produced excess vegetables which they could not consume. Large amounts of vegetables were lost due to wastage as farmers had no technical knowledge of preservation and lack of facilities. This led to high post-harvest losses because of large amounts of left overs. Lack of market facility was identified by 20 % of the farmers as a constraint because they sold their vegetables in the local market as they were dependent on word of mouth to market their gardens. As a result, they did not get good prices. Poor prices were encountered by 15.7 % of the farmers. The main cause is that farmers produce at the same time leading to low demand because there might not be enough market to sell (Antwi and Seahlodi, 2011; Kiros, 2008).

Salami *et al.* (2010) stated that road systems are the most serious infrastructural bottleneck facing agricultural development. The results in figure 7 further show that about

4.7% of farmers were constrained by the lack or poor access roads. These may have limited transportation of vegetables to better or other markets. However, it may have also delayed quick distribution of produce after harvesting hence the vegetables deteriorated. Lack of rural roads impedes the marketing of agricultural commodities, preventing farmers from selling their produce at reasonable prices and leads to spoilage of farm produce (Oluwasola, 2015).

Access to transport by farmers plays a significant role in their ability to access markets. Since vegetables are highly perishable, there is a sense of urgency in marketing these products as quickly and efficiently as possible in order to maintain their farm fresh value. About 6.7 % of the farmers did not have access to convenient modern transportation system to ship their products to the market thus they were forced to hire transport from other people or use public transport. This findings are supported by Louw *et al.* (2004) that most small scale farmers have no means of transport to carry their produce to markets, therefore, transportation problems results in loss of quality and late delivery, which in turn lead to lower prices and this is the greatest problem faced by emerging farmers. The problem of marketing constraints arise due to many factors such as limited knowledge, lack of access to reliable markets and lack of appropriate and affordable means of transport (Chanimuka *et al.*, 2008).

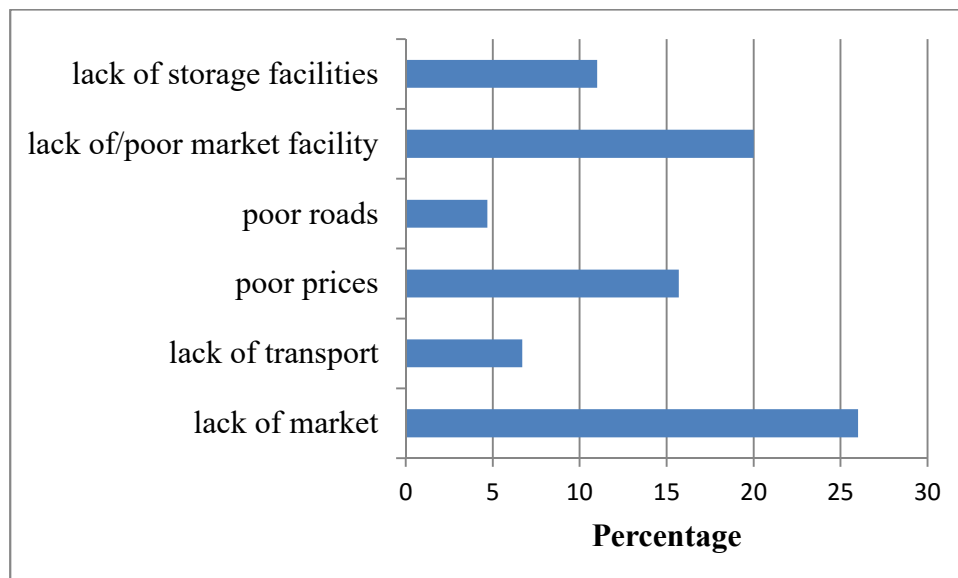


Figure 8: Marketing constraints

4.4 Impact of Backyard Gardens and Factors that Affect Consumption Expenditure

Prior to discussion of the impact of backyard gardens on household consumption expenditure, it was imperative to explain the factors that affect consumption expenditure.

Factors that affect consumption expenditure explain why some household spend more than others.

4.4.1 Factors Affecting Household Consumption Expenditure

The OLS model results of factors affecting household consumption expenditure are presented in Table 8. The dependent variable was average household expenditure and variable of interest were household size, marital status, education, gender, age, perception index, income perceptions, source of income, threats to livelihoods constraint to improving livelihoods, number of meals a household has each day and total income.

The results in Table 8 show that the significant variable were gender and education level of household head, income perception, total income, threats to household livelihood, number of meals the household have each day and income source were found to be significant.

Table 8: Factors Affecting Consumption Expenditure

Average expenditure	Coefficient	SE	t	p> t
Age	1.63	2.50	0.65	0.514
Gender	-145.74	66.84	-2.18	0.030**
Marital status	9.67	25.87	0.37	0.709
Household size	1.27	8.64	0.15	0.883
Education level	108.28	31.58	3.43	0.001***
Farming experience	0.13	9.46	0.01	0.989
Livestock ownership	0.004	0.003	1.18	0.239
Perception index	-8.74	10.30	-0.85	0.397
Income perception	61.98	15.55	3.99	0.000***
Total income	0.07	0.03	2.21	0.028**
Livelihood threat	-17.04	7.31	-2.33	0.021**
Major constraint	-6.56	16.75	-0.39	0.696
No of meals	157.76	47.35	3.35	0.001***
Income source	-35.09	12.16	-2.88	0.004***
Kanye	-8.97	61.22	-0.14	0.885
Mabutsane	-22.16	107.15	-0.21	0.836
_Const	-11.22	218.50	-0.05	0.959
Number of obs	= 238			
Prob> F	= 0.0000			
R- squared	= 0.3347			
Adjusted R-squared	= 0.2766			

** , ***: refers to significant level at 5 and 1% level, respectively

The relationship between gender of the respondent and consumption expenditure was negative. It implies that being male reduces the consumption expenditure by BWP145.74.

This is explained by the fact that men tend to spend the income on non-household items like alcohol and tobacco. This is corroborated by Muriithi (2015) who found that a significant share of income managed by men was used to purchase adults goods such as beer and other expenditures that do not benefit the family.

Education level had a positive relationship with consumption expenditure as a unit increase in the level of education of the household head by one year will increase the consumption expenditure of that household by BWP 108.28 and was significant at 1%. This is because household heads are the decision makers in matters concerning expenditure and education exposes them to a wide range of consumer possibilities. Mignouna *et al.* (2015) found that farm households expenditure increases with education which suggests that the more educated the household head are, the higher their household expenditure when compared to their less educated counterparts.

Money increases the willingness of households to consume more. Therefore a household that perceives more income will increase its consumption expenditure. Results in Table 7 show a positive relationship between income perception and consumption expenditure. This results are supported by Jappelli and Pistaferri (2010) who found that a one dollar anticipated rise in income increases non-durable consumption by approximately 20 cents. There is a positive relationship between total income that the household has and consumption expenditure. This is because it expected that the rich will spend more than the poor hence rural households that are rich will consume more goods and services than their counterparts. Ruel *et al.* (2005) found that income growth contributed to greater consumption in the long run.

The major threat to livelihoods that rural households were facing was drought/irregular rains and prolonged dry spells. This might lead to a severe loss of employment as 80% of rural population is engaged in agriculture and allied activities (Udmale *et al.*, 2014). The results in Table 7 show that rural households that are faced with this threat toward their livelihoods would reduce their consumption expenditure by 17%.

There is a positive relationship between the number of meals per day that a household consumes and the consumption expenditure. This might be because the more meals per day a household consumes, the more they have to spend on buying food to take care of their dietary needs. Therefore, if there are concerns by households about job security and future expected income, they will reduce their consumption expenditure. Results in Table 7 show that when households are worried about their income source, their consumption expenditure reduces by 35.1%.

4.4.2 Impact of Backyard Gardens on Farm Household Consumption Expenditure

Table 9 presents the logit model results which were used to create the counterfactuals for matching and the outcome variable was consumption per equivalent adult. Matching of beneficiaries to non-beneficiaries was based on household size, marital status, education, gender, age, perceptions, income perceptions, source of income, threats to livelihoods and constraint to improving livelihoods. These are the variables which both groups had similar characteristics suitable for matching. The average treatment effect of the program was then calculated as the mean difference in outcomes between these two groups.

The results in Table 9 show that the significant variables were perception index, income perception, source of income, major threat to livelihood of the household, major constraint to improving household livelihood, household size, being located in Mabutsane and farming experience.

Table 9: Psmatch2 Logit Results

Variable	Coefficient	Std. Err.	Z	P> Z
Age	-0.003	0.003	-1.00	0.320
Gender	-0.010	0.092	-0.11	0.910
Marital status	0.048	0.350	1.36	0.172
Household size	-0.021	0.011	-1.87	0.061*
Education	0.005	0.043	0.11	0.915
Farming experience	0.136	0.078	1.74	0.082*
Livestock	0.014	0.010	1.37	0.172
Perception index	0.069	0.015	4.57	0.000***
Income perception	0.072	0.025	2.90	0.004***
Total income	-0.057	0.045	-1.29	0.198
Livelihood threat	-0.025	0.011	-2.27	0.023**
Major Constraint	-0.047	0.024	-2.00	0.046**
No of meals	-0.039	0.065	-0.61	0.545
Income source	-0.069	0.017	-4.04	0.000***
Kanye	0.052	0.085	0.61	0.543
Mabutsane	-0.170	0.101	-1.69	0.090*
Constant	-1.077	1.956	-0.55	0.528
Number of obs	= 225			
LR chi2	= 78.48			

Prob> chi2	= 0.0000
Pseudo R2	= 0.2614
Log likelihood	= -110.885

*, **, ***: refers to significance at 10, 5 and 1% level, respectively

Perception index is important because when one's overall perception increases, the probability of participating in the backyard garden scheme increased by 6.9 %. This findings are supported by Sirivongs and Tsuchiya (2012) who found that there is a strong relationship between positive perceptions, attitudes and participation. The resident's positive perceptions affected their attitudes while positive attitudes strongly influenced their participation.

Money increases the willingness of the households to participate in programs that they perceive to give higher returns. Therefore a household that perceives backyard gardening as an income source and also has alternative source of income has a 7.3% chance of participating in gardening. Northrop *et al.* (2013) found that several consumers perceived store-bought organic foods as high-priced and therefore, they preferred to have gardens as an affordable means of obtaining organic food.

The severe threat that households indicated to be facing was drought/irregular rains and prolonged dry spells. This might lead to a reduction in crop production and a severe loss of employment as 80% of rural population is engaged in agriculture and allied activities (Udmale *et al.*, 2014). The results in Table 8 show that rural households that are faced with this threat toward their livelihoods, the chances of them participating in the backyard gardens are reduced by 2.5 %.

Production constraint was the most serious problem that households faced to improving the household livelihoods as it reduced the probability of the household participating in backyard gardens by 4.7%. This might be because vegetable production as a livelihood strategy is a distress-push because its share in total earnings reduces as income increases. The almost constant income share of off farm income activity may be taken as an indication of a stagnant off farm economy therefore, farmers should integrate on-farm with off farm activities especially those that have complementarity with farming activities and also adopt a livelihood diversification strategy that combines multiple portfolios (Udmale *et al.*, 2014).

Household size in this context was used to describe the dependency of the household rather than labour availability. An increase in the number of household members was negatively related to the probability of that household participating in the backyard garden

scheme. This may be because household size is not a good indicator of labour availability as it includes not only active and inactive members of the household but the number of mouths to be fed. This is supported by Mustafa-Msukwa *et al.* (2011) who found that an increase in the number of household members was negatively related to the adoption of compost manure in Malawi therefore having a large family *per se* does not necessarily mean all family members are available for the farm work.

If a farmer increased farming experience by one year then the probability of them participating in backyard gardens would increase 13.6%. This might be because the experience of farmers in vegetable production is positively associated with net income from vegetable farming. As farmer's experience in vegetable production increases, their efficiency at utilizing resources to achieve higher levels of output increases as they understand the dynamics in demand and pricing of vegetables to be able to take full advantage in order to increase earnings and/or minimize loss (Oluwasola, 2015).

A person from Mabutsane has a probability of 17% that they might participate in the backyard garden scheme when compared to the person from Goodhope. This is because of the location. Mabutsane is a remote village without proximity to any urban area and therefore if a household was to participate in backyard gardens, they were likely to be running a profitable small scale vegetable production unit. The reason is that the anticipated customers will not be willing to travel long distances to the nearest town to buy garden produce.

4.4.3 Average Treatment Effects on Consumption Expenditure

To identify the impact of backyard gardens on consumption expenditure, the average monthly consumption expenditure was compared for beneficiaries and non-beneficiaries. The result obtained are presented in Table 10 and indicate that, there was no significant difference ($p < 0.73$) between the consumption expenditure of the beneficiaries and non-beneficiaries but the average monthly consumption expenditure of backyard garden scheme beneficiary household was P934.02 which is equivalent to US\$90.60, was higher than non-beneficiaries, P841.34 or US\$81.61. This implies that backyard garden scheme increases the per capita consumption expenditure of scheme members by P92.69 or by 9.9%. This agrees with Beshir (2012) who found that households who are members of irrigation scheme for vegetable gardens have better annual incomes when compared to non-members and this extra income allows households to meet daily expenses.

Table 10: Average Treatment Effects on Household Consumption Expenditure

Variable	Sample	Treated	Controls	Difference	S.E	T-stat
Consumption expenditure	Unmatched	934.02	766.52	167.52	67.76	2.47
	ATT	934.02	841.34	92.69	127.13	0.73

Region of common support ensures that treatment observations have comparison observations nearby in the propensity score distribution (Heckman *et al.*, 1998). Results in Table 11 indicate that there were no cases that were out of the region of support. (Bryson *et al.*, 2002) noted that when the proportion of lost individuals is small, this poses few problems. Therefore, this means that only individuals between the treatment and control group in terms of observed characteristics unaffected by participation were compared as only in the area of common support can inferences be made about causality.

Table 11: Region of Common Support

Treatment assignment	Off support	On support	Total
Untreated	0	138	138
Treated	0	87	87
Total	0	225	225

After matching, the covariate imbalance was checked and a ps-test command was used. The ps-test shows the percentage reduction in bias which is the standardised biased. A good bias reduction is supposed to be below 5 %, however 10 % is also reasonable (Rosenbaum and Rubin, 1985). The variables after matching are not supposed to be significant. Results in Table 12 indicate that after matching there was less bias in the covariates which were below 10 %. U represents unmatched and M represents matched.

Table 12: Ps-test for Covariates

Variable	Unmatched Matched	Mean		% bias	% reduction bias	t	p> t
		Treated	Control				
Perception index	U	6.49	4.34	81.3		5.83	0.000
	M	6.49	6.82	-12.8	84.2	-0.89	0.377
Total income	U	6.37	6.42	-4.4		-0.33	0.742
	M	6.37	6.29	8.2	-87.0	0.52	0.601
Income perception	U	7.06	6.72	17.0		1.23	0.220
	M	7.06	6.61	22.4	-31.4	1.48	0.140
Livestock	U	4.71	3.64	26.5		1.93	0.055
	M	4.71	3.90	20.0	24.5	1.33	0.186
Age	U	46.99	46.30	5.3		0.38	0.701
	M	46.99	47.12	-1.0	81.7	-0.07	0.945
Gender	U	0.29	0.27	4.3		0.31	0.754
	M	0.29	0.30	-2.6	40.3	-0.17	0.869
Education	U	2.17	2.07	10.5		0.77	0.441
	M	2.17	2.09	8.4	19.5	0.55	0.580
Household size	U	5.45	6.18	-21.2		-1.53	0.128
	M	5.45	5.10	10.0	52.9	0.61	0.544
Marital status	U	1.87	1.69	15.8		1.16	0.247
	M	1.87	1.86	1.0	93.8	0.06	0.952
Farming experience	U	1.33	1.18	25.0		1.80	0.073
	M	1.33	1.13	34.8	-39.0	2.19	0.030
No of meals	U	2.26	2.22	6.2		0.45	0.650
	M	2.26	2.16	16.2	-160.45	1.19	0.236
Income source	U	3.80	5.33	-59.6		-4.36	0.000
	M	3.80	3.91	-4.0	93.2	-0.28	0.781
Livelihood Threat	U	3.08	4.43	-37.4		-2.66	0.008
	M	3.08	2.46	17.2	54.2	1.51	0.132
Major Constraint	U	2.76	2.89	-7.6		-0.55	0.581
	M	2.76	2.74	1.3	82.7	0.09	0.928
Kanye	U	0.52	0.47	9.2		0.67	0.502
	M	0.52	0.43	18.3	-98.9	1.21	0.227
Mabutsane	U	0.07	0.11	-13.9		-1.00	0.321
	M	0.07	0.02	16.1	-15.7	1.45	0.149
Sample	Pseudo R2	LR chi2	p>chi2	Mean bias	Med bias		
Unmatched	0.261	78.22	0.000	14.9	14.9		
Matched	0.081	19.56	0.358	9.2	11.4		

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This section presents summary of the major findings in the study, conclusions drawn and recommendations.

5.1 Summary

The main aim of this study was to assess the impact of backyard gardening on household incomes. To select respondents for the study, Southern District was selected because this is where the largest number of backyard gardens was found. Accordingly, primary data was collected from 247 respondents of which 100 were beneficiaries and 147 were non-beneficiaries of the backyard garden program.

In order to examine the impact of backyard gardening on household income, the study assessed gross margins of backyard gardens, factors affecting gross margins, factors affecting consumption expenditure and the impact of backyard gardens on household consumption expenditure. Descriptive statistics were also employed for analysis. During analysis, different software's such as SPSS and Stata were used.

In relation to gross margins of the backyard gardens, the results revealed that backyard gardening was viable as leafy vegetables had gross margins of P86 489.36, onions had P240838.43, tomatoes had P16 381.30 and green pepper had P18 000. Factors that affect gross margins were fertilizer application, market availability, area planted, household size and production constraint. Household size negatively influenced gross margins while the remaining four factors influenced gross margins positively. The gender of household head, education level, income perception, total household income, livelihood threat, income source and number of meals per day had significantly influenced the average consumption expenditure of both the beneficiary and non-beneficiary households. Propensity score matching revealed that backyard gardening increased beneficiary household's monthly average consumption expenditure by P92.69.

5.2 Conclusion

Although gardening was prominent in the area, some households were seasonal gardeners, some did very little gardening because of water challenges. The income from the garden was not contributing much to the total household income and this would affect the amount of effort households are willing to put into gardening. In order to generate income, the rural households must also incur costs, which may be a heavier burden in the first few years. Beneficiaries should have been informed that their gardens may not be profitable for

the first few years and therefore they should maintain their other forms of employment if possible.

Farmers faced various production and marketing constraints but the major constraints were pests and diseases, lack of water, low quality materials supplied, lack of market, lack of storage facilities, lack of market facilities and poor prices. Government should have a comprehensive value chain for backyard gardens so as to avoid some of the production and marketing challenges that the beneficiaries are facing. As for the lack of water constraint, it is important that another source of water be identified and used instead of relying on rainfall. Unreliable rainfall and insufficient water for crop production is a major constraint to improving the welfare of households as it results in low productivity. The uncertainty of rain fed agriculture results in low yields, thus most of the households might fail to meet their minimum food requirement.

Based on the results many households in Southern district are operating and selling their produce locally as gross margin analysis of the different garden crops revealed that gardening activity is viable. The impact of the backyard garden in terms of consumption expenditure of households was higher for beneficiaries indicating a positive impact of the backyard garden program towards their incomes.

Hence it can be concluded that backyard garden program plays a crucial role in improving the living standards of Batswana as it has the potential to increase household incomes.

5.2 Recommendations

There is need for the government to re-design the backyard garden program in Botswana due to the significant contribution of this program in alleviating extreme poverty especially the consumption expenditure of the households who are beneficiaries of the program. As part of re-designing the backyard garden program, beneficiaries should be taught about rain water harvesting technology and be encouraged to form groups in order to access financing for drilling boreholes because irrigation is an alternative way to improve and sustain food production hence consumption expenditure of rural households.

Program leaders must recognize the production and marketing constraints themselves as well as plan for the possibility that continual financial support may be necessary particularly in the first few years of operation as beneficiaries may need assistance for purchasing inputs and for garden upkeep. Even though there was increase in consumption expenditure, there is dire need for setting up a comprehensive structure to engage all stakeholders to improve the implementation of the program. This could start with identifying

the aims of the program because as of yet it is not clear what the aims of the program are and stakeholders should be identified and they could be potential beneficiaries, social workers, *dikgosi*, councillors, extension officers, office of the president officers and ministry of agriculture officers.

Program leaders should come up with policies that would improve productivity of small scale vegetable farmers through provision of seminars and workshops where farmers would acquire more training on vegetable production. This would enable them to increase the average yield of vegetables produced per hectare, hence profitability.

There is an urgent need to develop a complete value chain for produce from backyard gardens. This policy will ensure a wholistic approach of rural development in the agricultural sector.

5.3 Areas for Future Research

The conclusions drawn in this study were based on the cross-sectional data of the year 2015/2016. However, the impact of the currently significant variables as well as the non-significant variables should also be checked using time series data. It is also recommended that a study should be conducted on market analysis for the community so that the community can be able to plan their cropping programs effectively such that issues of market flooding are avoided. There is also a need for a study which will focus on the sustainability of all backyard gardens in Botswana.

Another issue to be looked at would be opportunities for exploring other markets as well as value addition of the produce before going to the markets. Finally it is recommended for future researchers to consider SWOT analysis of the backyard garden program as it was introduced without carrying out SWOT analysis and also interrogate how Agricultural Extension Agents can assist beneficiaries of the program.

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APPENDIX
HOUSEHOLD QUESTIONNAIRE

A questionnaire for research titled: Evaluation of the role of backyard gardens on household incomes in Southern District, Botswana.

My name is Taboka Kealeboga Sekgopa, a master's student from Egerton University. The purpose of this questionnaire is to collect data that will assist me in my research objective (goal), so your participation is vital. The outcome of this research will enhance knowledge on the role that backyard gardens play in improving household incomes thus contributing to household welfare.

I would appreciate it if you could please assist me by answering the following questions. I assure you that your information will be kept confidential as your name will not be documented in any of the pages of this questionnaire.

Household level survey: Questionnaire for Farmers

1. Enumerator _____
2. Date of interview _____
3. Sub-district _____
4. Village _____
5. Time started: _____ Time finished: _____

A. GENERAL INFORMATION

[The respondent must be the head or de-facto head of the household]

1. Gender of respondent:

1. Male []
2. Female []

2. Age of respondent

1. 21 – 25 []
2. 26 – 30 []
3. 31 – 35 []
4. 36 – 40 []
5. Above 41 []

3. Marital status

1. Single []
2. Married []
3. Divorced []

4. Widowed []

4. Educational level

- 5. Never attended []
- 1. Primary school []
- 2. Junior secondary []
- 3. BGCSE []
- 4. Tertiary []
- 5. Other(specify)_____

5. Household size (*number of people living and eating together*)_____

6. Farming experience

- 1. < 9 months []
- 2. 9 – 12 months []
- 3. > 12 months []

B. HOUSEHOLD RESOURCES

(We would like to know a little bit about the resources your household owns)

7. What type of dwelling do you live in?

- 1. Mud hut and grass thatch roof []
- 2. Mud hut and asbestos/iron roof []
- 3. Brick house and grass thatch roof []
- 4. Brick house and asbestos/iron roof []
- 5. Block house and grass thatch roof []
- 6. Block house and asbestos/iron roof []
- 7. Pole and dagga and grass thatch []
- 8. Other(specify)_____

8. Family household assets

ASSETS	NO. OWNED CURRENTLY	UNIT VALUE	NET VALUE
Chickens			
Goats			
Draft animals			
Total livestock			
Car			
Tractor			
Hand hoe			
Trailer			
Truck			

Animal scotch cart			
Animal plough			
Wheel barrow			
Bicycle			
Urban house			
Fridge			
Television			
Radio			
Telephone-landline			
Cell phone			
Other(specify)			

C. AGRICULTURAL GARDEN PRODUCTION AND MARKETING ACTIVITIES

9. Are you part of the backyard garden scheme? (If **YES** continue to question 10, if **NO** go to question 23)

- 1. Yes []
- 2. No []

10. What is the total size of the garden you have/own?

- 1. 100m² []
- 2. 200m² []
- 3. 300m² []

11. What is the source of water for your garden?

- 1. Stand pipe []
- 2. Borehole []
- 3. River []
- 4. Shallow well []
- 5. Other (specify).....

12. What type of fence is around your garden?

- 1. Wire []
- 2. Branches []
- 3. live fencing []
- 4. Grass fencing []
- 5. Net shading []
- 6. Other (specify)

13. Who are the main people involved in the gardening activities in your household?

1. All []
2. Women []
3. Men []
4. Children []
5. Adults []
6. Other (specify).....

14. What were the types, quantities, source and the cost of inputs and outputs used in the garden during the past season (2015/2016)?

		Garden crops					
	Crop/area (m ²)						
Inputs	Qty(kg)						
	Source						
seed	Unit price (P)						
Fertilizer	Qty						
	Source						
	Unit Price						
	Qty						
	Source						
	Unit price						
Labour	Qty(labour days)						
	Source						
	Unit price(P)						
	Type of labour						
chemicals	Qty						
	Source						
	Unit price (P)						
output	Qty						
	Qty consumed						
	Qty sold						
	Mrkt						
	Reason for mkt						
	Unit price(P)						

Types of garden crops [1]-Leaf vegetables [2]-Tomatoes [3]-Onions [4]-Carrots [5]-green beans [6]-peas [7]-cucumber [8] - other(specify)

Source input [1]-local shop [2] - town [3] - other

Market type code [1]- local [2]-roadside [3] -middlemen [4]-horticultural companies [5] other _____(specify)

Reason for that choice of market? 1- Near 2- high prices 3- cheap transport 4-variety of customers 5- other

Labour source [1]- hired [2]- family [3] other- specify

Type of labour [1] –family [2] - hired [3]- seasonal [4] - contract [5] - permanent [6]-other- specify

15. What are the 3 main production constraints limiting productivity in the garden

i

ii

iii

Production Constraint [1]pests and diseases [2]high temperatures [3]insufficient knowledge of small scale production [4]insufficient financial support [5] no water [6] poor soils [7] vandalism and crime [8] low quality materials supplied [9] transport [10] water disconnection [11] animals [12] other (specify)

16. List the 3 main constraints you face when marketing the horticulture produce?

i.....

ii

iii.....

Marketing constraint [1] lack of market [2]lack of competition/few traders [3]poor transport [5]poor prices [6]unreliable traders [7]poor roads [8]lack of/poor market structures [9]lack of storage facilities [10] inadequate communication[11]lack of marketing institutions [12] other (specify)

17. How do you handle the produce that fails to sell on the market?

1. Process it []
2. Throw it away []
3. Give it away []
4. Other (specify).....

18. Would you classify the following problems as either **major** or **minor** in association with your garden? Tick the correct answer

Problem	1. Major	2. Minor
Pests and diseases		
High temperature		
Insufficient knowledge of small scale production		
Insufficient financial support		
Lack of market		
No water		
Poor soils		
Vandalism and crime		
Low quality materials supplied		
Transport		
Water disconnection		
Animals Lack of support from extension services		
Competition		

D: SOCIAL IMPACTS OF THE BACKYARD GARDEN PROGRAMME

19. Please indicate how your participation in the backyard programme has affected you in the following social aspects

Social impact	Experienced change						
	1	2	3	4	5	6	7
Your way of life							
How you live							

How you work							
How you play							
How you interact with other people							
Your culture							
Your beliefs							
Your customs							
Your values							
Your language							
Your community							
Its cohesion							
Its stability							
Its character							
Its services							
Its facilities							
Your political systems							
The extent to which you participate in decisions that affect your life							
The level of democratization that is taking place							
The resources provided for this democratization							
Your environment							
The quality of air you breathe							
The quality of the water you use							
The availability of the food you eat							
The quality of the food you eat							
The level of hazard or risk you are exposed to							
The level of noise you are exposed to							
The adequacy of sanitation							
Your physical safety							
Your access to resources							
Your control over resources							
Your health and wellbeing							
Physical well being							
Mental well being							
Social well being							
Spiritual well being							
The absence of disease or infirmity							
Your personal and property rights							
Whether you are economically affected							
Whether you experience personal disadvantage							
Your fears and aspirations							
Your perceptions about your safety							
Your fears about the future of your community							

Your aspirations for your future							
The future of your children							

1= extreme negative 2=moderate negative 3=slight negative 4=no impact 5=slight positive 6=moderate positive 7=extreme positive

ECONOMIC IMPACTS OF THE BACKYARD GARDEN PROGRAMME

20. Please indicate how the backyard garden programme has affected your community in the following aspects

Basic economic indicator	Experienced change						
	1	2	3	4	5	6	7
Unemployment level							
The quantity of jobs in a community							
The quality of jobs in a community							
Income level							
Wealth level							
Poverty level							
The presence of major industrial sectors							
The level of business activity							
Aesthetic quality of the community							
Secure livelihoods							
Self-reliance							
Economic diversification							
Access to finance							

1= extreme negative 2=moderate negative 3=slight negative 4=no impact 5=slight positive 6=moderate positive 7=extreme positive

ATTITUDE TOWARDS THE BACKYARD GARDEN PROGRAMME

21. State whether you agree or disagree with the statements below

Statement regarding backyard garden programme	Rating of extent of agreement with the statement				
	1	2	3	4	5
The backyard garden programme is effective in alleviating poverty					
The backyard garden programme is okay as it is designed currently					
The backyard garden programme should be reviewed					
The backyard garden programme is sustainable					
The backyard programme helps the poor people					
The backyard programme is a source of employment					
The backyard garden programme wastes national resources					
The backyard garden programme should be terminated					
The backyard garden programme is a vital social safety net					

The backyard garden programme should be continued					
1=strongly disagree	2=disagree	3=undecided	4=agree	5=strongly agree	

22. What changes can be made to improve the effectiveness of the backyard garden programme?

E: Monthly food requirements, Income and Expenditure requirements for the family

23. How important are the following sources of income to your household on the following scale?

SCALE
<i>1 not important</i>
<i>2 less important</i>
<i>3 neutral</i>
<i>4 important</i>
<i>5 very important</i>

Source of income	Importance
1-Field crop sales	
2-Garden sales	
3-Petty trading	
4-Formal employment	
5-Casual farm work	
6-Self-employment	
7-Other(specify)	

24. Sources of income 2015/2016 season

Category	Amount (P)	Category	Amount (P)
Crops (grains/seeds) sales		Self-employment	
Garden sales		Remittances	
Petty trading		Other (specify)	
Formal employment			

25. What are the three most serious threats for livelihoods of your household? (E.g. Droughts, food insecurity, etc.)

[1] -----

[2] -----

[3] -----

Codes	Cause of food shortage
1	Drought/irregular rains, prolonged dry spells
2	Death of bread winner
3	Serious illness of bread winner
4	Loss of employment of breadwinner
5	Reduced income of a bread winner
6	Unusually high prices of food
7	Unusually high level of human disease [state]
8	Theft of productive resources [state]
9	Relocation of family
10	Cut off remittances for relatives not staying in homestead
11	Floods
12	Other [specify]

26. What are the three most serious constraints for improving the livelihoods of your household? (e.g. production, output marketing, input markets, health, soil conditions, transportation, etc.)

[1] -----

[2] -----

[3] -----

27. What is the number of meals you have per day?

1. 1 []

2. 2 []

3. 3 []

4. Other (specify) _____

29. Last season how much months of cereal did you produce

30. What was your main source of income to purchase the balance?

1. Field (crop) sales []

2. Vegetable sales []

3. Petty trading []

4. Fruit sales []

5. Formal employment []

6. Casual farm work []
 7. Self-employment []
 8. Other (specify) _____

31. What is your main market for purchasing the balance cereal?.....

*Market type code [1] - local [2]-roadside [3] -middlemen [4]-horticultural companies [5]
 other _____ (specify)*

32. How did you spend on the following items?

	WEEKL Y	MONTHL Y	YEARLY		WEEKL Y	MONTHL Y	YEARLY
Staple food (maize)				Traditiona l healing			
				Burial and wedding expenses			
				School fees			
				Electricity			
Non staple food (other food items apart from maize)				Firewood			
				Water			
				Airtime			
				Newspape r			
Household items	cleaning			Furniture			
	Appliance s			Insurance	Life		
					Car		
	Utensils			Club subscriptio ns	Jet		
	Bedding				Ackerman s		
	Toiletry				DSTV		
	Make-up				Motshelo		
			Burial society				
Fruits				Entertain ment			
Crop production inputs				Other(spec ify)			
Livestock production							

inputs							
Transport							
Clothes	Men						
	Women						
	Children						
Beer and tobacco							
Hospital bills and Medical Aid							

33. Are there any chronically ill people in the household?

1. Yes []
2. No []

34. In the past 3 months has there been a death in the family?

1. Yes []
2. No []

35. If yes what was the cause of the death?

Thank you for your cooperation!!