OPPORTUNITIES FOR INCREASING HOUSEHOLD INCOMES THROUGH GARDENING: A CASE OF SEKE COMMUNAL AREA

by

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CERTIFICATION OF DISSERTATION

I certify that this dissertation is entirely my own effort except where otherwise acknowledged. The undersigned certify that they have read, and recommended to the Department of Agricultural Economics and Extension for acceptance, the thesis entitled;

OPPORTUNITIES FOR INCREASING HOUSEHOLD INCOMES THROUGH GARDENING: A CASE OF SEKE COMMUNAL AREA

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Abstract

Risk from climatic variability is a major limiting factor to agricultural production in Zimbabwe. Vegetable gardening has an important role in agricultural and economic development of Zimbabwe. Vegetable gardening has the potential to reduce the effects of prolonged dry spells, recurrent droughts and an early end to the rain season. The evidence of increasing unreliability of dry-land agriculture, and increasing popularity in gardening has prompted this research to look at the contributions of gardens to incomes of communal households. A sample of 100 communal households was used for the study. The first objective of the study was to determine the relationship between intensity of gardening and the wealth status of the households. The Principal component analysis, descriptive statistics, and correlation coefficient were used to answer the research question. The results revealed that there was no significant relationship between the wealth status and gardening intensity of a household. However, in the sampled community the contribution of garden income to the total household income was around 18%. The gross margin analysis was used to test the viability of the gardens and results showed that gardening is viable. Log-linear regression was used to determine the factors that affect profitability in the gardens. The age of the household head and the size of garden under crops affected profitability among households among other factors. Linear programming was used to test if increasing the size of the garden had an effect on the incomes of households hence welfare. Results show that increasing garden sizes had the potential of increasing incomes although there was a challenge of labour in the area interviewed. From the study it can be recommended that promotion of gardens can go a long way in increasing incomes and improving food security status of households hence their welfare.

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CHAPTER 1: INTRODUCTION

1.0 Background

Risk from climatic variability is a major limiting factor to agricultural production in Zimbabwe. This problem is more intense in the semi-arid regions where climatic extremes like droughts can lead to famine and result in acute food insecurity for millions of people. Climatic risk in crop production has been defined as a probability of occurrence of unfavourable weather conditions affecting crop performance (Rotter, 1993). Risk reduction options usually employed have included adjustment of tactical and operational decisions such as crop and income diversification, cultivar selection, fertilizer input and timing of activities.

The communal sector is the one of the main sectors after the land reform and is about 41.4% of total area of Zimbabwe (Utete, 2003). The majority of the farming communities are smallholder communal farmers and they reside in marginal agro-ecological areas, where rainfall is unpredictable and their crops are vulnerable to moisture stress and unavailability.

Gardening is food production on small plot adjacent to homesteads (RUDEP, 2004). Gardening has an important role in agricultural and economic development of Zimbabwe. The high yields obtained from irrigated land, coupled with other benefits such as increased food security, incomes, employment creation and drought relief savings are indications that irrigation can be a vehicle for long-term development.

In Zimbabwe, nearly every homestead (both urban and rural) cultivates a dry land vegetable plot or dambo (wetland), at least for its own food production during May to September. Zimbabwe being a semi-arid country, the contribution of vegetable gardening to the incomes and food security is very important to the communal households.

1.1 Statement of the problem

The majority of the farming communities are smallholder farmers who reside in marginal agro-ecological areas, where rainfall is unpredictable and are vulnerable to climate variability. Recent evidence has shown that there is now an increasing frequency of drought particularly in the semi-arid regions. In addition, the rainfall season in the past decade, has uncharacteristically started late and farmers are increasingly wary of establishing the effective planting period. The issue of increasing climate variability in recent years calls for action by farm communities, government, and other institutions to encourage households to engage in activities that can reduce these drastic effects.

With increased frequency of dry spells, changing climatic conditions and marginal soils, gardening can play an important role in reducing the effects. Gardening is food production on small plot adjacent to human settlements and it is an age - old survival strategy in the developing world (RUDEP 2004). Gardens make a substantial, though rarely appreciated contribution to the food security of the poorest segments of society. Gardening thus, can be part of the rural households' livelihood strategies for many rural households. Gardens can also be viewed as a source of income.

The evidence of increasing unreliability of dry land agriculture, and increasing popularity in gardening has prompted this research to look at the contribution of the gardens to the incomes and livelihoods of communal farmers. Despite the number of literature on importance of gardening worldwide, there are still some questions on the contribution of the gardening activities to the household incomes. This research intends to evaluate the contribution of vegetable gardening to the incomes focusing on Seke communal households.

The extent to which vegetable gardening contributes to rural household incomes is not clear. Therefore there is need to identify and develop economic viable livelihoods.

The study aims to quantify the contribution of vegetable gardening to rural households. This work is important as it will provide information on how best stakeholders can intervene for an improved food security status and a sustainable livelihood for the households.

1.2 Research questions

In light of the increase in the issues of climate change, the increase in chances of crop failure under rain fed agriculture in the communal sector, increased diversification by communal farmers and the prominence gardens have taken, a number of issues arise:

a) What is the relationship between wealth status and income from gardening?

b) Is gardening viable and what are the factors that determine its viability?

c) Are there any prospects for increasing incomes through expansion of gardens?

1.3 Research objectives

The overall objective of the study was to explore the prospects of increasing communal households' incomes and welfare through gardens. The specific objectives are:

a) Determine the contribution of intensity of gardening to the wealth status of a household

b) Determine the factors that affect viability of the gardens

c) To explore alternative of increasing garden size to increase household incomes

1.4 Research hypotheses

The research will answer the following hypothesis:

a) Intensity of gardening has a positive effect on the wealth status of a household.

b) Gardening is a viable activity.

c) Expansion in gardening has the potential to increase the incomes of the households.

1.5 Justification of the study

The study is important in that it gives insights on the contribution of gardening to the livelihood strategies in the district. This information would assist extension staff who works in these communities to enhance the food security status of the district. Results of this study can benefit various stakeholders in formulating policies and programmes that are suitable for the area and areas with similar characteristics.

The information generated can therefore be used in the formulation and implementation of relevant policies in agriculture and social welfare. The Government of Zimbabwe and in particular the Ministry of Agriculture, Mechanization and Irrigation Development and Ministry of Public Service and Social Welfare, has the mandate and social responsibility to formulate related policies. The responsible administrative structures can thus make and take informed decisions. The information can be useful in coordinating efforts by the government and Non Governmental Organizations (NGOs) so that rural households' livelihoods may be enhanced.

The World Bank (1993:63) reports that, "people are both the ends and means of development … healthy and educated human beings are also principal means of achieving development." In light of this, the study can sensitize and enlighten the government, non-governmental organizations, and other stakeholders to ensure better intervention methods as a means and way to bring about social and economic development to a country.

The research can also open up new avenues for future research. The research thus can acts as reference to future researchers, policy makers and NGOs who may have the desire to improve quality of rural livelihoods in Zimbabwe and anywhere else in the world.

1.6 Structure of the thesis

This study is organized into seven chapters. This chapter presented the concept of gardening, the research objectives to be achieved, questions to be answered and hypotheses to be tested, the rationale for the study and the delimitation of the scope of the study. Detailed literature review on the smallholder agricultural sector in Zimbabwe and on the contribution of gardening to the livelihoods of these communal farmers is presented in Chapter 2. It also looks at the history of gardening in Zimbabwe, the various types of gardens in the communal areas and their contribution to the incomes and food security to the households. The methodology employed in this study is presented in Chapter 3.

Chapter 4 presents the preliminary analysis; a characterization of households by intensity of gardening using primary data. Use of the principal component analysis (PCA) in the fourth chapter to find out the wealth ranking among the households was employed. Issues affecting profitability of the gardening activity are presented in Chapter 5. An estimation of the gross margin analysis and share ratio of the income from garden from the total household income to determine the contribution of gardens to the incomes of the households was done. A regression analysis was also done to determine the factors that affect profitability. Results from the linear programming in order to determine the

optimal resource use to inform policy whether to expand on gardening against other strategies are presented in Chapter 6. Finally, Chapter 7 presents the summary, conclusions and policy implications of the study.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This chapter gives a brief overview of the communal sector in Zimbabwe is laid down followed by the history of gardening in Zimbabwe and characterization of the most common gardens existing in the country. Horticulture marketing in Zimbabwe is also explored. Finally, the chapter reviews a number of empirical studies that have been done to test the conceptual model linking gardening activities to increased incomes and welfare thus food security.

2.1 Overview of the communal Sector in Zimbabwe

The communal lands are characterized by poor rural indigenous households whose main activity is subsistence farming, though some do supply local markets. Communal areas are home to the majority of small-scale farmers, where land is held under traditional and communal ownership. Communal farmers represent 51.4% of Zimbabwe's total population. The communal area is made up of about 1 million communal farmers on 16.3 million hectares (Utete Land Audit report 2003). The current average farm size in the communal area sub-sector is 5.0 hectares and of this, 3 – 5 hectares is arable (Rukuni, 2006). Communal areas represent 41% of all land in Zimbabwe, 74% of it in Natural regions 1V and V. The Zimbabwe's communal areas authority over land is exercised by chiefs with the help of councils of elders and under the customary tenure.

Nevertheless, smallholder agriculture plays a crucial role in most African economies, especially those of the SADC region. Most households derive their livelihood from agriculture in most parts of rural Africa (RUDEP 2004). Hence, the emphasis of most governments is placed on smallholder agricultural development.

Despite its importance, smallholder agriculture still face a number of constraints. According to the RUDEP report of 2004, smallholder agriculture continues to suffer from low and declining productivity. Productivity still remains far below that of the large-scale commercial farming sector and the majority of the farmers still produce traditional food crops from rain fed agriculture. Low productivity has been increased by the high frequencies of droughts. Production from rain fed agriculture has become unreliable and not dependable for smallholder farmers.

2.2 History of gardening in Zimbabwe

Gardening is a common practice among communal households usually at the end of the rainy season. Households with access to water often fence a small portion of land and produce vegetables during the dry season when labour demand is low. The vegetables produced are mainly for consumption and the excess is sold to the local market. In areas where there are perennial rivers these gardens are found along the rivers. Where there are boreholes the gardens are found near the boreholes. In some of the areas, the gardens are found in the vleis where the water table is very high. Examples of areas where vlei gardens are found in Zimbabwe include Chihota, Seke, Zimuto, Domboshava (Proctor *et al* 2000). These areas have high tables such that their source of irrigation water is shallow

wells during the dry season and sometimes raise their vegetable beds during the rainy season.

According to Proctor et al 2000, communal horticultural production is in Zimbabwe is usually located near major urban centres, along intercity roads that connect urban settlements, and along the main feeder roads linking rural areas to urban markets. This is largely because production of vegetables favours greater proximity to markets for ease of supply of inputs and extension services and ultimately for transportation and marketing of perishable produce. Extensive research carried out across Zimbabwe suggests that the most prominent small-scale horticultural regions are those close to Harare (Chihota, Domboshawa, and Seke) in the Mashonaland East Province, and around Mutare in Manicaland Province (Proctor *et al* 2000).

2.3 What are gardens?

According to RUDEP 2004 report home gardens are mixed cropping of fruits, vegetables, trees and condiments that serve as supplementary sources of food and income. These have a functional relationship with the homestead but are also found in pots, along fields and in wetlands, along rivers and dams. The report also points out that the function of gardens is largely shaped by their purpose for the "users". A home garden does not have to have a residence on it to qualify. The garden may be purely for subsistence or partially market orientated and it can consist solely of vegetable crops or mixtures of annuals and perennials.

2.4 Why gardens

Development policymakers in favour of field-based commercially oriented agriculture have overlooked small-scale home gardening as a food production strategy (RUDEP 2004). However, few have benefited from large-scale production orientated programs biased towards landowners and dependent on costly industrial inputs.

According to RUDEP 2004 the following are the reasons why gardens are important in the small holder agriculture.

•Homestead or underutilized marginal land is often the only resource available to landless and near -landless groups and urban slum dwellers. Intensive gardening can turn this land into a productive source of food and economic security. There are few, if any, barriers to adoption of intensive household production using organic manure, regenerative agricultural practices and locally adapted societies. The technology entails very little capital investment land and because of the marginal nature of resources used and variety of crop grown, carries very little risk. Thus gardening reaches even those poorest in the villages.

• Family gardens may constitute the only source of certain nutrients to less well off households and the major or only source of food between harvests or when harvest fails. They provide critical sources of energy and protein especially for weaning - age children. Habitat destruction and migration to urban areas mean that wild foods are no longer available to the poorest groups. The commercialization of agriculture has displaced many indigenous crops that ensured a balanced rural diet. Year -round, readily available and continuously harvested garden production can be a source of

nutritious and pesticide-free fresh vegetable and fruits for the poorest families who may otherwise have no access to them.

• As an efficient user of soil, water, sunlight and household waste to realize high and sustained yields, home gardens exemplify the relationship between intensification of land use and higher yield. In semi arid areas where low and erratic rainfall has made the introduction of vegetables into existing farms a difficult task, water conserving garden systems that recycle water used in the home can achieve substantial production.

- Gardens generate income through the marketing of surplus produce and from the savings created by producing items that were formerly purchased. The small amounts of cash income that home gardens provide can make the vital difference between relative well being and hardship, crippling debt and starvation in cash poor societies.

  • Limited access to resources means that land-poor women are more likely to be under-employed. Home gardening offers women an important means of earning incomes without overtly challenging cultural and social restrictions on their activities. Since women are frequently the principal providers for family diets, enhancing their purchasing power and food production capacity has a direct impact on household nutrition and health.

  • Home gardens can be ecologically sound land management systems. Multi-cropping prevents depletion of soil nutrition; the combination of trees, shorter plants, creepers and tubers enhances soil conservation. An advantage of poly-cropped, intensively managed gardens planted with locally adapted species is their primary reliance on cultivation practices rather than toxic chemicals to control weeds, pests and diseases.

Household food production will rarely poison people or the environment - a serious problem in agrochemical intensive field based agriculture. Traditional-style home gardens are also crucial repositories of diverse plant genetic resources.

• Among low-income households the factors of production, including time, energy, money, and land are available in small discrete increments through time and space. Accumulation of these factors to make larger investments can be difficult. Home gardens are a very efficient way to use these resources without competing with staple crop production or other productive activities. Labour inputs effectively utilize small amounts of the spare time of family members, especially women, children and the elderly, and can be conveniently combined with childcare and domestic tasks.

• Gardening can contribute vitamin A through production of vegetables. Vitamin A deficiency contributes not only to xerophthalmia and blindness, but to high child mortality rates as well. Lasting long-term solutions to vitamin A deficiency rest on increasing the availability of vitamin A- rich foods to the most vulnerable groups. Household cultivation of vegetable and fruits can be an effective solution to vitamin deficiency.

In short, support for small-scale family food production can provide improve health and economic benefits to the most deprived sectors of the developing world population at a relatively low cost while safeguarding the environment.

2.5 Types of gardens in Zimbabwe

Gardening is a specialized form of farming that demands a wet climate, good soils, relatively low temperatures and a consistent water supply throughout the year (Muir, 1994 as cited by Aragrande 1997). Vegetable gardening is traditional practices using water from a range of different sources, including where they exist, sand river, ephemeral rivers, streams, and boreholes. Mostly they are defined by the type of water source. The main types of crops grown in the gardens are the horticultural crops. The production of horticultural crops (on both large and small-scale farms) tends therefore to be concentrated in Natural Regions I, II and III, which receive in excess of 500mm of rainfall per year.

2.5.1 Wetland/ dambo gardening

Dambos (termed vleis by European farmers in Zimbabwe) are defined by Bell and Hotchkiss (1989) as shallow, grassy depressions at the head of drainage basins, which retain moisture during the dry season. They are about 1.28 million hectares in Zimbabwe and are concentrated on the high veld forming an arc along the watershed between the Zambezi, Limpopo and Sabi rivers (Bell and Hotchkiss, 1989). About 263 000 ha of dambo land are found in the communal areas (Bell and Hotchkiss, 1989). It is estimated that about 20,000 ha of land in Zimbabwe is under vlei vegetable production (Aragrande 1997). Vleis tends to become waterlogged in the wet season. However, this land can retain moisture well into the following dry season.

Dambo gardens are gardens in areas of marsh, fen feat land, or water, whether natural or artificial, permanent or temporal with water that is static or flowing. These may be found

situated along river channels, lakeshores, and estuaries or in isolated catchments (Chenje and Johnson 1996 as cited by Chirinda et al 1999. The land and water resources in the dambos have multiple uses for rural communities. Land can be used for activities such as garden cultivation and the water is used for irrigation (Bell and Hotchkiss, 1989).

The key to successful cultivation under vleis lies in the farmer's ability to adapt to and deal with the varying soil moisture requirements. Raised beds may be constructed and shallow drainage channels dug to drain excess moisture and prevent water logging of crops during wet years. During the dry season and in drought years irrigation becomes necessary (Bell and Hotchkiss, 1989). Wells are dug inside the gardens and by means of simple technology such as watering cans and buckets, oil drums and hosepipes the crops are watered. By careful adaptation to changing environmental conditions during the agricultural year, households can grow a sufficient and continuous supply of crops to feed themselves and to sell (Bell and Hotchkiss, 1989). They may also grow rice and maize as staple crops in their garden with a harvest in January, which is usually when nutritional levels are at their lowest. Thus, dambo farming complements dry land agriculture, the main harvest for which is in AprIl. As Bell and Hotchkiss (1989), suggests dambos can benefit those household without gardens as they can access crops from their neighbour's.

2.5.2 The Shallow well gardens

The presence of a sufficiently high static water level enables one to develop a shallow well. Shallow wells consist of a well point driven into the soil until it penetrates the water

table. Generally, shallow wells draw on water passing into them from shallow groundwater resources (Batchelor, *et al* 1994).

The characteristics of groundwater reserves and the chemical composition thereof are determined by hydro-geological conditions. Almost everywhere in Zimbabwe the groundwater mode can be characterized by the tendency for a high water table, thus it is not the amount of water but rather its quality, which is the important factor in this case. Under this scenario household irrigate their gardens from these shallow wells (Batchelor *et al,* 1994). As the season progresses the water levels goes down also and thus gardening becomes very difficult.

2.5.3 The deep well/ borehole gardens

These are gardens where water for irrigation is being derived from very deep wells. In Zimbabwe, deep tube wells and boreholes are usually equipped with hand pumps, such as the bush pump to draw the water (Mugabe *et al,* 2003). The key issue from a multiple use perspective is the yield of boreholes, in relation to the use of the water. This is the intrinsic amount of water, which can be extracted from the borehole, until overdraft occurs. This may be different from the yield of a hand pump. For example, a borehole may have a high potential yield (i.e. high water resources availability) but be limited by the extraction capacity of the pump.

2.5.4 The River gardens

These are gardens usually done at the end of the rain season. Households fence gardens along the riverbeds and get water from the rivers for irrigation. The rivers may be perennial or seasonal. In Zimbabwe, surface water from (perennial) streams and springs is being captured through small-piped systems for domestic supply or irrigation. These are either at community level, or even individually owned systems. Because of water resources availability, these systems are mainly limited to the wetter mountainous area in the eastern part of the country.

In these types of gardens, irrigation is done using buckets and watering cans. A survey carried out by the Mvuramanzi Trust in 1999 revealed that almost 90% of the irrigators are using buckets and watering cans. This leads to relatively a large amount of time spent on collecting water from the source and in applying it to the land at relatively high water losses. This limits the amount of land to be cultivated. Having additional lifting devices may help reduce time spent. However, there are other technologies such as pumps, which enable the distribution from the point of water collection to the point of use.

2.5.5 The Keyhole garden

A keyhole garden is a round raised garden, supported with stones (Agritex 2010). They are round gardens of about two metres (6.5 feet) in diameter and raised to waist-height to make them easy to work. Underneath, the first layer of soil has been dug out, leveled and covered with multiple layers of locally-made compost (manure, organic waste, scrap metal, wood ash, plant waste, yard sweepings, etc). A central basket made with sticks and filled with grass and leaves serves for irrigation purposes: water is poured in it, allowing

for its dispersal through the completely enclosed garden. A small pathway leading to the central basket allows a person to easily work the garden without bending and the soil surface is sloped to allow runoff. Keyhole gardens are built in places where it is difficult to build normal gardens (rocky areas, shallow arid/or compacted soils, etc), near the entrance of dwellings to facilitate their watering with household wastewater.

Keyhole gardens are made with low-cost locally available materials. Compared to regular vegetable gardens, keyhole gardens require less labour (ideal for elderly, children or sick persons), less water and no costly fertilizers or pesticides (Agritex 2010). A keyhole garden also has important comparative advantages: its structure ensures soil fertility for 5 to 7 years; it can produce food all year round even under harsh temperatures; it can support the production of at least 5 varieties of vegetables at a time - thus supporting dietary diversity; and it is so prolific that its produce is more than enough to feed a family of 8 persons (Agritex, 2010).

2.6 The importance of the horticultural sector in Zimbabwe

Horticultural production is important in Zimbabwe because of the nutritional benefits of fruit and vegetable consumption to the general population as well as the economic benefits of horticultural crop production and marketing (Horticultural Promotion Council, 1998). Production of horticultural crops for sale is a major source of income for many peri-urban farmers in Zimbabwe. The horticultural sector is considered strategic in terms of high employment opportunities since most production systems are labour intensive. On average a project creates an additional 25 to 30 jobs per hectare (Heri, 2000). Thus with

local gardening this has also an opportunity of creating forward and backward linkages thus creating employment. Communal farmers in Zimbabwe usually target Mbare Musika. However, their produce sometimes finds its way to processors through the presence of middleman.

There are also high employment opportunities for women, who tend to be the most underprivileged in the Zimbabwean society (Horticultural Promotion Council, 1998). Experiences have shown that women are more productive than men in harvesting, grading, and sorting of products. The sector is also a significant earner of foreign currency thereby improving the country's terms of trade in addition to numerous downstream benefits in the packaging, processing, input suppliers and transport industries (Horticultural Promotion Council, 1998).

The Zimbabwean horticultural export industry continues to experience phenomenal growth since inception in the mid-1980s and is now the third largest agricultural commodity after tobacco and livestock. In addition, horticulture is acknowledged as the second largest foreign exchange earner after tobacco and accounts for approximately 3.5 to 4.5% of GDP (Horticultural Promotion Council, 1998). Foreign exchange earnings increased by an average of 30% per annum up to 1986. However, in terms of export volumes the sector declined at an average of 21% per year since 1986 (Zimtrade 2011). Home gardens are an important source of cheap but fresh vegetables for most families in both rural and urban areas (Horticultural Promotion Council, 1998).

The horticultural sector is not only an important employer in terms of (rural, peri-urban) labour demands on large and small-scale farms, but also provides employment in terms of the upward and downward linkages to other industries. For example, it creates employment in those industries involved in input provision (e.g. seed and agro-chemicals), agro-processing, and in the marketing and distribution of produce to local, regional and international markets

2.7 Evidence of the contribution of gardening to incomes and food security

Poor distribution of rainfall during a rainy season is often the main cause of crop failure even in years of close to average or above average rainfall (Mugabe *et al*, 2003). The biggest threat to rural livelihoods is drought, which has a chance of occurring 1 to 3 years out of every 10 years (ZIMVAC, 2005). As a result, it is becoming increasingly obvious that dry land communal farming on its own rarely provides enough means of survival in many areas of rural Zimbabwe. In reality, most rural households depend on a diverse portfolio of activities and income sources.

Hussein (1987) pointed out that about two-thirds of the communal area population in Zimbabwe lives in Natural Regions (NR) IV and V, both of which are characterized by low and erratic rainfall. These areas are recommended for extensive and semi-extensive livestock production. Drought resistant cash crops are the types of crops recommended in these areas. Nevertheless, communal area farmers, either do not own enough cattle or have insufficient land to engage in commercial ranching, and hence all grow food crops on subsistence and occasionally sell surplus. The hazards of crop production failure in

these semi-arid areas are emphasized when one considers the probability of a 'normal' season[1] occurring in these regions is of the order of 35 per cent in NR IV and 40 per cent in NR V (Hussein, 1987). Thus, the issue of gardening can play a vital role to these communal areas in terms of food security is there is a source of water.

Gardening has the potential to reduce the chances of crop failure as the irrigation is regular and systematic. Vegetable gardening has many potential nutritional, economic, social and ecological benefits. Informal garden irrigation using ground water and other water sources is more appropriate for communal areas for which it has been part of their traditional component of farming system (Batchelor *et al,* 1994). This posse an opportunity for households to grow more vegetables, both for consumption and to diversify and increase farm income. Given the increases in the incidences of droughts, gardens offer household's opportunities to harvest something.

As Batchelor *et al* (1994) pointed out, gardening has the potential to improve the household welfare by providing continuous supply of vegetables throughout the dry season and years of drought. They went on to comment that gardening can reduce the need for households to rely on unsustainable agricultural practices such as cultivation of marginal lands and overgrazing which are the two main causes of dry land degradation. Thus, 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. In addition crops grown in gardens are high value crops

[1] One in which rainfall is adequate to sustain plant growth

hence this can increase the income of communal farmers. Gardens can increase significantly household income.

To the communal farmer the advantages of vegetable gardening over the field crops is that for those that buy the produce, they pay for it immediately irrespective of what they want to use it for. Thus, the income from vegetable gardening can provide for other needs. Mugabe *et al* (2003) also pointed out that gardens provide an additional source of nutrition and income from produce sold.

Vegetable sales form the major income contributor to the Seke communal households (ZimVac interim rural food security assessment May 2009). Principal livelihood activities in the district's communal areas are crop production (food and cash crops), animal husbandry, and employment on commercial farming estates and sometimes off farm economic activities. Major food crops are cereals (maize, wheat, sorghum and millet), and vegetables; major cash crops are cotton, sugar, tobacco, and horticultural produce (tomatoes, leaf vegetables and onions).

2.8 The link between gardening and food security

Food security has spatial and temporal dimensions. Spatial dimensions can be addressed when farmers are encouraged to engage in gardening. With increased frequency of dry spells, changing climatic conditions, and marginal soils, gardens can play an important role in address both chronic and transitory food shortages. Vegetables can form a part of the rural households' food security strategies for many rural households.

Income mainly comes from the livelihood strategies that a household engages in. According to the ZIMVAC (2005) report, the selling of cash crops and garden vegetables is a major income generating activity for most households in Seke district, especially for middle and better off households.

In a communal household, income available to a household is the sum of income from the rain fed agriculture, (fields), from the garden and other non-farming activities. Food security is a function of income. Food security is the availability, accessibility, and affordability of food. Therefore, the higher the amount of money a household has access to, the higher are the chances of increased food security, as they will be able to purchase that is the affordability aspect. In addition, they will be able to access food even from distant areas. The availability aspect comes from production, accessibility, and affordability. Gardening can lead to availability of food at household level through increased productivity, stable production and increased incomes.

Mbiba (1994) suggests that low-income families who grow food crops for domestic consumption and sale primarily conduct the peri-urban cultivation-taking place around Harare . The latter are not only involved in the production of crops, but furthermore in the sale of fruits and vegetables at roadside stalls, via door-to-door sales or within informal urban markets (Horn, 1997; Mbiba, 1994). Thus, smallholder irrigation can lead to availability of food at household level through increased productivity, stable production and increased incomes.

2.9 Review of Empirical Studies

Garden produce can be used for household consumption, or for sale. Income from sale of the garden produce provides for other household needs as well. The fact that small but steady daily income comes from gardens, they are considered as dependable socio-economic safety nets for household food security and other requirements (Chirinda *et al*, 1999).

Qualitative impact assessments have highlighted that the promotion of vegetable gardens in particular keyhole gardens to improve access to a variety of food, even during the winter months, proved particularly successful (FAO, 2000). Participating households noted the increase in the availability of food, the wider diversity of their diet and the surplus in vegetables, which they were able to sell to generate income. Thus, households into vegetable production are able to reduce both the direct and trade entitlement failure. Direct entitlement failure; is a situation in which a household fails to produce enough to eat and they do not have the ability to trade. Trade entitlement failure is when for those who normally purchase a sufficient amount to feed the household, the failure may be caused when a livelihood activity is offset or there are increases in prices. This is because from gardening they will generate both food and income for purchasing food staffs.

According to FAO (2000), irrigated farming can create economic backward and forward linkages. 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 crops grown under irrigation rely heavily on recommendations for improved purchased inputs. Forward

linkages occur if irrigation leads to cash cropping. This will promote the growth of the agro –industry.

2.10 Summary

This chapter has highlighted a number of literatures in gardening. Firstly, an overview of the communal sector in Zimbabwe was discussed. The history of gardening activities in Zimbabwe was also explored. The different types of gardens found in Zimbabwe were also discussed and advantages of each type of garden highlighted. The chapter went on to explore the importance of the horticultural sector in Zimbabwe, especially its contribution to the household and economy as a whole. It went on to look at the evidence of the contribution of gardening to incomes and food security. Finally, the linkages between garden and food security and a summary of empirical studies on gardening were explored. Chapter three, which follows, presents the appropriate research method and the analytic framework for the study.

CHAPTER 3: METHODOLOGY

3.0 Introduction

The purpose of this chapter is to develop the methodological framework that will be used to test the hypotheses that are suggested in chapter one. This chapter first lays out the conceptual framework linking gardening and incomes. Consideration is taken of the data requirements, the analytical framework and empirical model specification. The chapter then discusses the linear programming model that was used to estimate the optimal garden size.

3.1 Conceptual Framework of contribution of gardening to food security

The conceptual framework adapted in this study is built on the relationship between the gardening and improvement in well-being of household. A garden can be regarded as a prime land; because it is usually fenced and has a source of water supply hence its chances of success are high. Production is all year round and is not affected by moisture stress.

Given the increase in the frequencies of droughts, it is expected that household with gardens have more incomes, are more food secure, better endowed but on the other hand, they need more labour to work in the gardens. Thus the profitability of the garden is influenced by the types of crops, output levels of the different crops, the prices of produce as well as the cost of production.

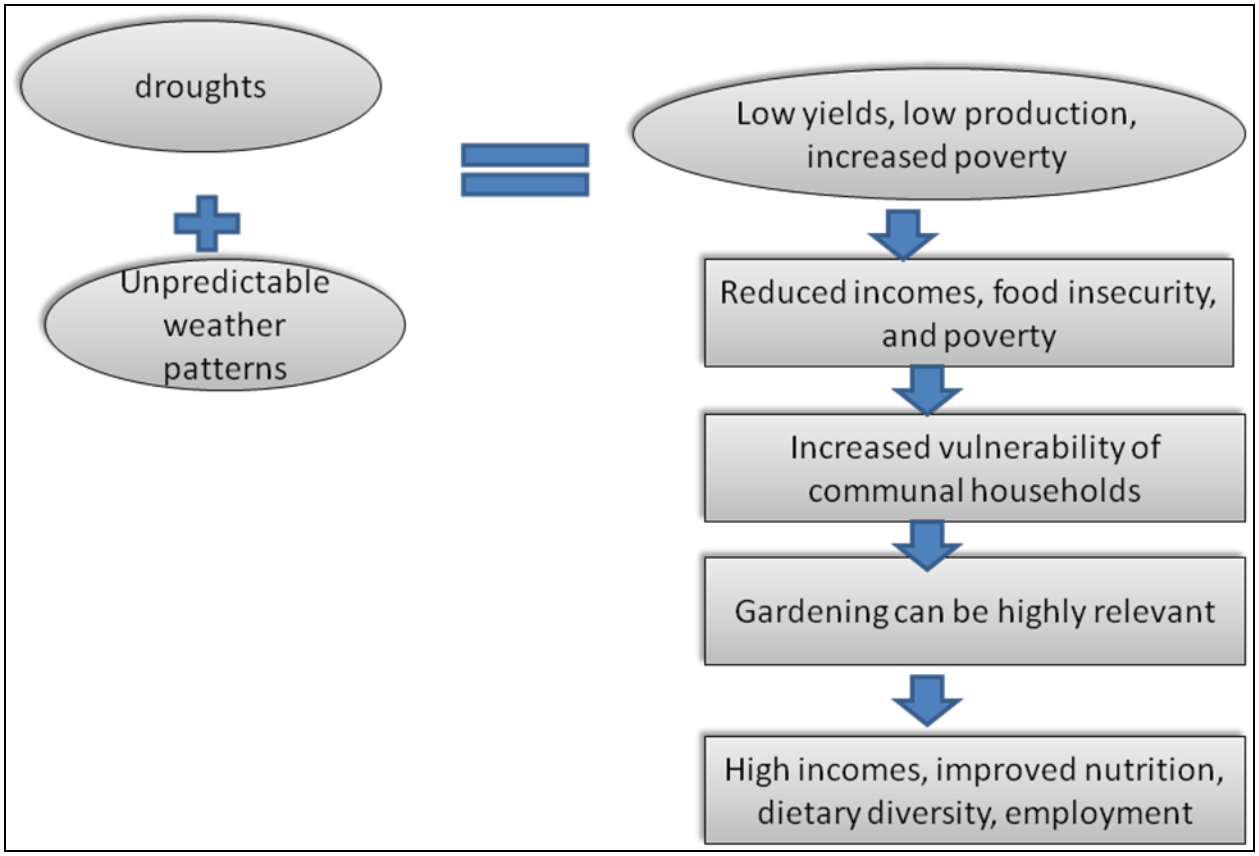


Figure 1: The Conceptual Framework

3.2 Research Design

The study used the survey research design because it is regarded as the best method to collect original data for the purpose of describing phenomena which is too large to observe directly (Best and Kahn, 1993). The population of the communal households in Seke is very large (N=9458); therefore the survey research design would enable the researcher to complete the study in a short time by choosing a manageable number

sample to represent the rest. To survey basically means to see over or observe things in their natural setting in order to derive meaning (Best and Kahn, 1993).

Furthermore, as Leedy (1997) explains, the survey design is the most suitable method to gather and obtain information where little is known about the phenomenon. The research would aim at investigating the prospects for increasing household incomes and improving livelihoods in Seke communal area. The survey research would therefore be the most ideal since it entails gathering raw information from a representative sample of communal households in Seke. Bogdan and Biklen (1992) thus conclude that the survey design is good in original data collection.

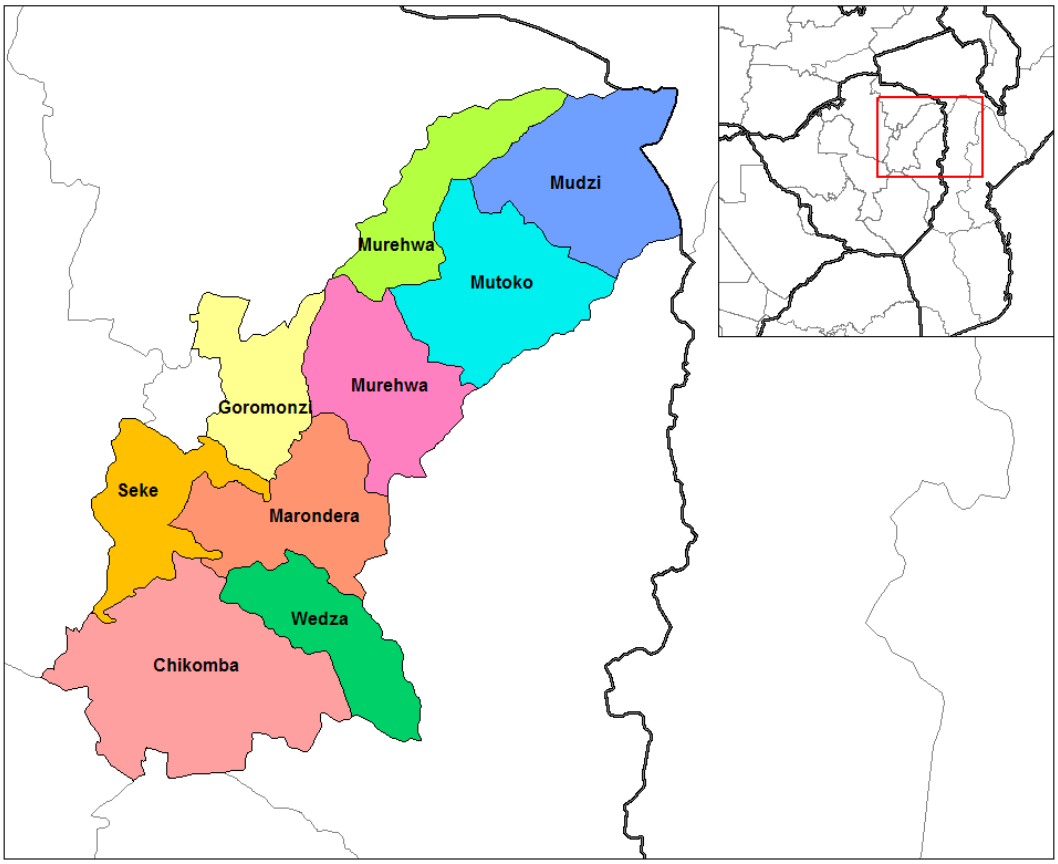
At the same time, the survey research design is strong in that it does not influence the research respondents (Bogdan, and Biklen, 1992). This means that it does not control the respondents. Instead, it observes and describes the opinions and perceptions of this defined group. The results from the sample would then be generalized to the entire population. The research design is therefore fairly cheap and information can be collected from a large population in a relatively short period of time.

3.2.1 Sampling design and Site selection

Primary data was collected in Seke district. Seke district is one of the nine district in Mashonaland East province and lies in Natural regions IIA of the agro ecological zones of Zimbabwe. Rainfall pattern in this district is diverse and sometimes limit dry land agricultural production. Seke communal is a peri urban to the capital city, Harare, and is

rich in wetlands. Seke farmers carry out main field as well as gardening activities throughout the year. These activities contribute so much in terms of food and income. The farmers have to carry out these gardening activities to augment the total household income. These farmers are close to urban Harare and Chitungwiza, which makes gardening a lucrative business.

The district has 22 wards. Of these only 8 wards are communal, the rest are large scale, old resettlement, urban areas, A1 and A2 models.



Source: Wikipedia

Figure 2: Location of Seke District

A large sample was ideal but not sufficient in itself since the principles that underlay the selection of the participants were equally important. The researcher used probability procedures to make up the sample. Cohen and Manion (1997) defines probability sampling as a method in which each all members of the population have an equal chance or a non-zero probability of being chosen.

Multi stage sampling was done. Initially, Seke district was purposively selected to its proximity to the researcher's location and the presence of communal gardening in the area. A purposive sampling of two wards out of the 8 communal wards was done on wards that are intensively into gardening activities. Ten villages were randomly selected in each ward. A total of 10 households were randomly selected in each village making the total of 100 households from the 20 villages. Ten random numbers were generated for each village and using the village registers the households whose numbers tallied with the generated numbers were interviewed.

For the purposes of this research, the population comprises the total number of communal households in the district. This information was sought from AGRITEX district office. According to the Second Round Crop and Livestock Assessment (2011), the district has an estimate of 9458 communal households in the eight communal wards.

Best and Kahn (1993) define population as, any group of individuals who have one or more characteristics in common that are of interest to the researcher. The population of Seke communal area was ideal since their social and economic background is consistent.

In addition, the farmers concerned are all communal who face similar environmental, economic, and social challenges.

The entire population (**N=9458**) was too large and therefore too costly to cover adequately for the purposes of the research. Best and Kahn (1993) argues that it is impracticable if not impossible to study a whole population in order to arrive at generalizations. It was therefore too expensive and impractical to collect data from all the communal farmers within a realistic period. Bell (1993) even believes that it is not worth the time and effort to investigate every one when statistically useful data can be equally drawn from a representative portion of the same population.

In this study, a representative sample (n) was chosen from the entire population (N) of communal farmers in Seke. A sample of 100 households was taken from the population. A sample can be visualized as a small part of the universal population which is selected for observation and from which certain valid and reliable inferences can be made of the population (Best and Kahn, 1993; Borg and Gaul, 1996).The features of the sample should match that for the population to warrant any economical but statistical deductions to be made. A sample should be large enough to serve as an adequate representation. Best and Kahn (1993) contend that samples of more than 30 members are generally large while Van Dalen (1979) recommends descriptive samples of between 10 and 20% of the whole population.

3.2.2 The Research Instrument

The information was collected using structured questionnaires. A questionnaire is a document consisting of items to solicit information from a participant that is suitable for research analysis (Best and Kahn, 1993). A questionnaire was designed to get the information about communal farmers and how gardening has contributed to their incomes. Questionnaires are useful in that vital information can be obtained from many participants within a short time frame (Cohen and Marion, 1997). Information would be collected by enumerators hence response is assured. In addition, the questionnaires would guarantee participant anonymity; hence, the respondents would be free to give correct responses.

The questionnaires have an added advantage of being filed therefore they provide a permanent and verifiable record of the collected data (Leedy, 1997). The researcher used only one questionnaire. The research combined closed-ended and open-ended questions. Best and Kahn (1993) argue that closed questions are particularly useful when high levels of data specificity are required. The participants are instructed to choose one response from a given set therefore there is no room left for them to waffle or to give unintended answers. The collected data would therefore be easier to compare and analyze.

Tuckman (1994) concludes aptly that closed questions reduce the tendency by respondents to include petty details, which may complicate data analysis and comparison of the data. Although the free response questions were few, their inclusion was worthwhile since Cohen and Marion (1997) posit that fixed response items have a

tendency to suffocate or restrict the respondents. The questions were however fewer because they encourage respondents to waffle which way complicate the interpretation of the data.

To test for validity, the tools were pre-tested with 10 communal households before the actual research since Borg and Gaul (1989) argue that a smaller number is enough to evaluate the effectiveness of the instrument. The questionnaires were also given to the supervisor and some colleagues for editing and rephrasing. Reliability was ensured by the use of at least two items on each objective or question. A reliable instrument is one, which is able to consistently measure what it was meant to measure (Mhlanga and Ncube, 2003). Furthermore comparable items were set for both the questionnaires and the interviews which meant that responses were easier to assess. In addition open-ended items where repeated in the closed items to see whether or not there was any notable variance. The various repetition of items was important because gave ample room for the researcher to capture their responses from different angles. The comparison of results from these different items improved the reliability of the data and therefore its usefulness.

3.3 Analytical framework

Data analysis was done in three parts. The first part, Chapter 4 looks at the descriptive analysis of the households using survey data collected from surveyed area. Chapter 5 uses gross margin to assess the viability the gardens. The final part Chapter 6 looks at the

household optimization problem. Various options in gardening were explored to increase incomes hence food security.

3.3.1 Characterization using Primary data

This is the initial analysis chapter. The section is purely descriptive in its approach. The principal objective here is to confirm or refute the findings in the preliminary analysis of secondary data. To determine the wealth status of households the Principal Component Analysis (PCA) was used. Households' endowments by given assets vary tremendously making it difficult to compare them on a wealth ranking scale. To compare different forms of assets so that ranking households can be objective, the assets have to be normalized. Normalizing households' assets involves constructing indices by rescaling the assets' values to between 0 to 1. The indices are then aggregated to obtain a composite index that is used for ranking the households widely differing value ranges. The PCA was run on the selected rural wealth status indicators using the Statistical Package for Social Scientists (SPSS). Seven components were extracted in the first stage of PCA, but only the first seven were significant (based on the criterion of an Eigen value greater than 1. A comparative analysis on the households' characteristics was done using the degree of intensity in gardening.

3.3.2 The gross margin analysis and regression analysis

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 are calculated. Gross margin analysis was used to determine the viability of the gardening activities whilst the regression analysis was used to determine the factors that affect viability.

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, leaf vegetables, 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:

$GM = Q_iP_i - X_iP_{xi}$

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

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. These are:

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

- 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.
- 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 the income from vegetable gardening to total income was calculated get the contribution of gardening to the total household incomes. A regression analysis is also run to relate the profitability of farmers to the different socio economic characteristics.

The regression model

The following is the specification of the regression model.

$$\text{Ln } Y = ß_o + ß_1 \text{Ln HHage} + ß_2 \text{Ln topdress} + ß_3 \text{Lnarea} + ß_4 WI + ß_5 MEU + ß_6 GDW + ß_7 PIG + \mu$$

Where Y is the yield, HHage is the age of the household head, topdress is the amount of topdressing fertilizer that was applied, area is the area under the crop, WI is the wealth index of the household, MEU is the man equivalent unit of the household, GWD is the distance of water source of garden and PIG is people involved in gardening.

3.3.3 Linear programming

Linear programming was used to come up with optimal garden size that will improve the welfare of the households. This is an operational research technique based on matrix algebra whereby the stated objective is either maximized or minimized while satisfying a number of linear constraints (Johnson, 1990).

Specification of a linear programming model

1. Objective function

   The objective function is either maximized or minimized. The objective of the household is to maximized the household farm income. In this case the objective function of the household is to maximize household income.

2. The objective function is maximized or minimized subject to a number of binding constraints. The constraints that the household are subjected are land, labour, capital and the food security constraints. These can be stated as follows;

   $a_{11}x_1 + a_{21}x_2 \ldots\ldots <=> d_1$

   $a_{21}x_1 + a_{22}x_2 \ldots\ldots <=> d_2$

   $a_{31}x_1 + a_{23}x_2 \ldots\ldots <=> d_3$

   In this case the constraints are land, labour, capital and attaining food security.

3. Values of Xi are non-negative

   $X_i >= 0$

Basic Assumptions of linear programming

Linear programming is based on the following assumption

a) Linearity of the objective function and constraints

   $f(KX) = K f(X)$

b) Non-negativity of the X_i terms

$X_i > 0$

c) Additivity i.e. there is no interactive effects among Xi terms

$f(X_1, X_2, X_3 \ldots\ldots X_n) = f(X_1) + f(X_2) + f(X_3) + \ldots\ldots + f(X_n)$

Households make joint decisions over consumption, production and work time allocation. The household seeks to maximize the whole farm gross margin. The agricultural household model addresses issues such as net selling versus net buying households, complete versus incomplete markets and the backward supply curve. The key assumptions about the agricultural household models are that leisure time is better termed 'home time" and includes family maintenance (cooking and cleaning), reproduction (kid tending), social obligation (religious and cultural) sleep and leisure, unified decision-making and a household generally includes those living in one abode. The features of an agricultural household model includes utility maximization, product market but no perfect labour market, household trades off consumption against disutility of labour, and demographic factors dominating the outcome.

Table 1: Relationship between research objectives, hypothesis, and method of analysis

Objectives	Hypotheses	Method of analysis	Data used
Relate the wealth status of the household to the level of gardening intensity	Wealth status of a household has a positive effect on the intensity of gardening a household engages in.	Summary statistics, PCA, correlation analysis	Primary data analysis
Determine the productivity and viability of gardening activities	Gardening is viable	Regression analysis and Gross margin analysis	Primary data analysis
To explore alternatives for increasing household incomes	Expansion in gardening has the potential to increase the incomes of the households.	Linear programming.	Primary data

3.4 Data Analysis Packages

The collected data was used to validate the research questions and objectives. The validation process entails the confirmation and disconfirmation of each of the research

questions and objectives as portrayed by the results. Data collected was analyzed using Excel, SPSS, Stata and Lingo.

3.5 Limitations of the Study

This study was constrained in terms of the availability and accessibility of the needed secondary data, which forms the basis of preliminary analysis done to inform important aspects of the study. Most of the papers on the issues are reports by intervening organizations that assisted communities in developing community gardens.

Farmers had challenges in recalling past production and income data. They were also not willing to share some of their farm production data such that they sometimes under reported. This problem was addressed by fully explaining to the sample farmers the purpose of the study, by ensuring maximum confidentiality and by respecting the respondent's right to privacy.

3.6 Summary

The chapter has highlighted the appropriated research method. The survey research methodology has been described and its relevance has been explained and justified. The target population has been delimited to include communal farmers in Seke. The rationale for including the target population and for excluding the other people has been given. The sample size has also been outlined. The research instruments, which are the questionnaires, have been discussed with particular emphasis on their relative strengths

and weaknesses. Chapter four, which follows, presented and analyzed the research outcomes.

CHAPTER 4: HOUSEHOLD CHARACTERIZATION AND INTENSITY OF GARDENING

4.0 Introduction

This Chapter presents a comparative analysis of the study findings using results of a survey done in Seke communal area. The preliminary analysis aims at characterizing the typology of farmers in Seke and assessing if there are any significant differences in land sizes, access to key resources and the level of production. The chapter also intends to test the hypothesis that says there is no significant relationship between wealth status and gardening intensity.

4.1 General Socio-economic characteristics of the sample

From the sampled households 75% were two parent type whilst 20% were female headed as husbands were away most of the time. From table 2, it can be seen that some of the households are male-headed single households, which are rare cases, as most men tend to remarry after a divorce or death of the spouse.

Table 2: Proportion of the types of households existing in the area

Type of household	% (N)
Two parent type of household	76.7
Male headed	80
Female headed, husband away most of the time	2.2
Female headed, widowed	16.7

The mean age of the sampled community was 57 years, with an average of three members per household. However, the average man equivalent unit (MEU) for each household was 2.74. The MEU was calculated following Runge-Metzger (1988) and Langyintuo et al (2005). Each household member was converted to a man equivalent unit (MEU) with the postulation that individuals in different age groups could not perform normal farm operations at similar rates of efficiency. For instance, under normal circumstances, a 5-year old cannot weed a farm with the same efficiency as a 30-year old, but there would hardly be any difference between 20- and 40-year olds. Therefore, the development of MEU takes into consideration the differences in labour use efficiencies among different age categories. The estimated [2]MEUs ranged from 1 to 5.7 with a mean of 2.74, being somewhat lower in a communal area.

About 95% of the both categories of household heads had some form of education (Table 3). Nevertheless, for the female-headed households none of the heads had attained post-secondary education.

[2] MEU was calculated after Runge- Metzer (1988) as follows: Households members less than 9 years =0; 9 years to 15 years and or above 49 years= 0.7; and 16 years to 49 years =1

Table 3: Education level by gender of household head

	Male headed (%)	Female headed (%)
none	5	5
Primary	38.18	55
Secondary	38.18	40
Post-secondary	17.5	0

4.1.1 Distribution of wealth status among households

The wealth index was calculated using the Principal Component Analysis (PCA) method. The wealth indices of households ranged from -11.8 to around 4.5. It was observed that 45% of the whole sample was poorly endowed (negative wealth index), relative to the communities' measure of wealth (Figure 3). The well-off households had a mean wealth index of 2.57 while the poorly endowed ones had a mean wealth index of -2.68.

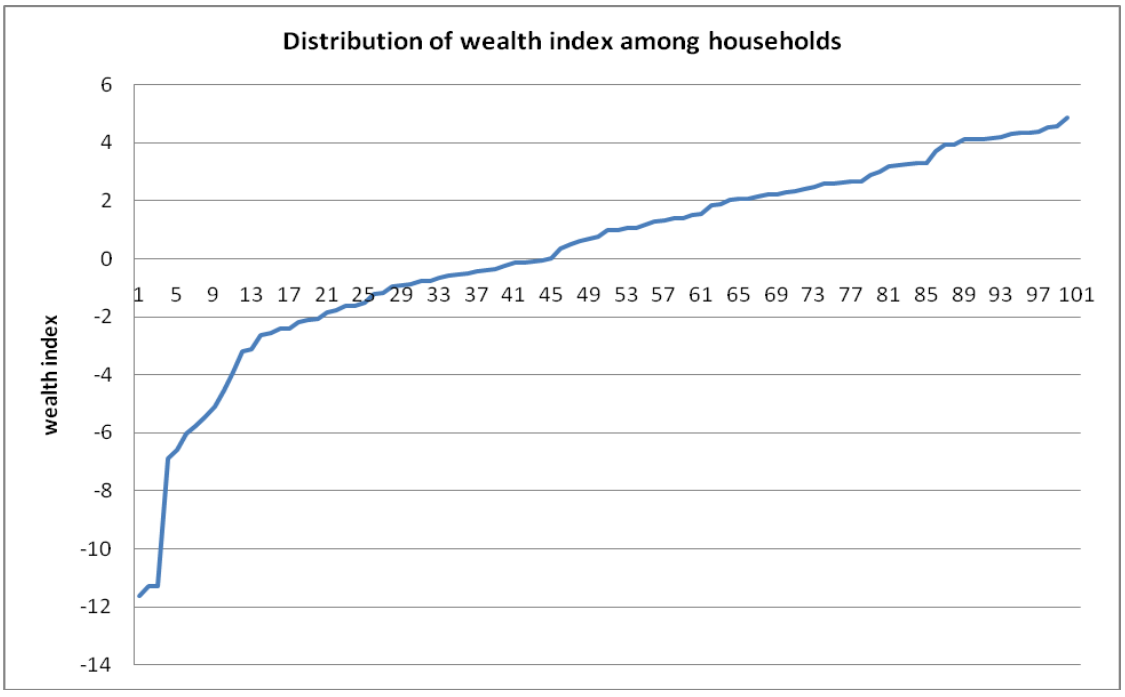


Figure 3: Distribution of wealth index

The sampled households were then differentiated into three groups, well off, average and worse off. The three groups were calculated as follows: firstly, the mean of those with the wealth index above zero and below zero were calculated. The three groups were then differentiated as well off – those above the average of the wealth index above zero and the worse off those below the average of mean of the below zero and the average is the remaining middle group. Twenty six percent (26%) of the sampled households fell in the well-off category while 13% fell in the worse off category. Figure 4 presents a summary of the distribution of households by category.

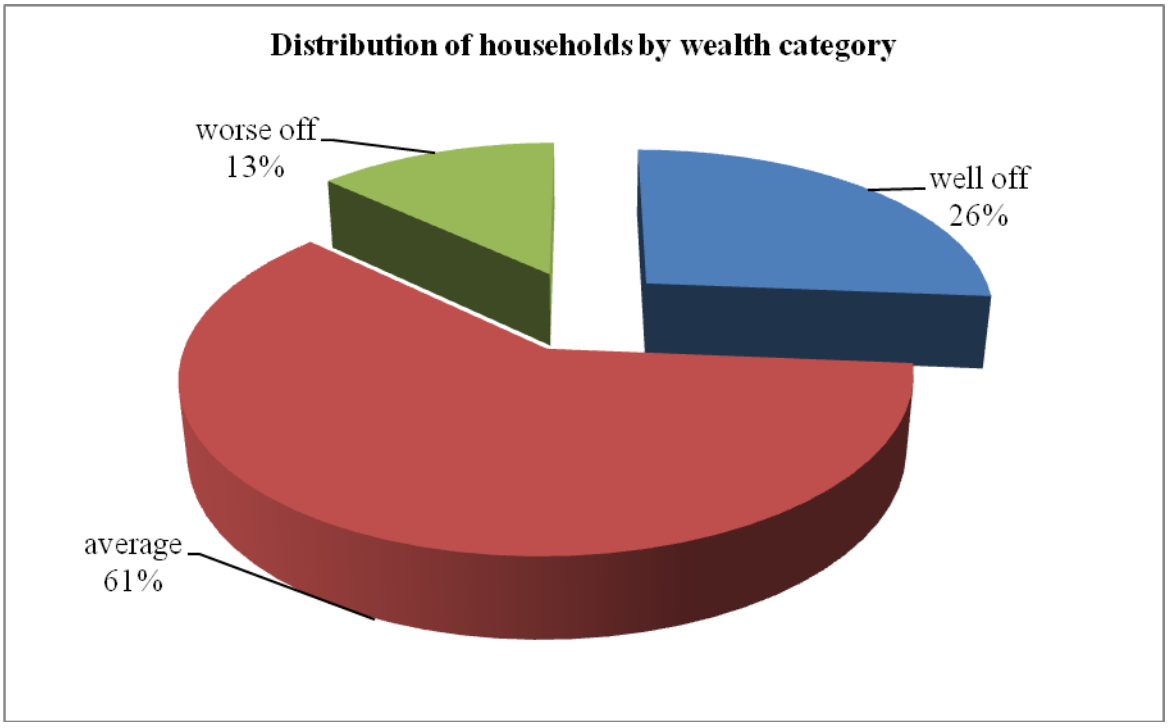


Figure 4: Distribution of households by wealth category

4.1.2 Land holding and land cultivation

The area under investigation is a communal area. Under the customary tenure system found in Zimbabwe's communal areas authority over land is exercised by chiefs with the

help of councils of elders. Rights of usufruct are allocated to an individual, usually a male, by a chief for as long as he may need it or is cultivating on it. The rights of usufruct in an area the individual lives also include the right to graze livestock, fetching fuel wood, thatching grass, wild fruit and vegetables and hunting game. There are no controls to rights of access to these things as they are considered "free" goods.

All the interviewed households' had access to a dry land plot. Nevertheless, 88.8% of the male-headed households had access to a garden whilst it was 85% for the female headed. Gardens are a major source of livelihood in the sampled communities

Table 4: Land ownership by gender of household head

	Male headed	*Female headed*
Owning a dry land plot	100	100
Owning a garden	88.8	85

4.1.3 Crop Production

In Seke district, crop production is generally done at subsistence level, complemented by limited semi-commercial and commercial farming. The major crops grown are maize, sugar beans, groundnuts, millet, tobacco, and sweet potato while minor ones include cowpeas and sunflower. Vegetables (such as leaf vegetables, tomatoes, onion, and carrots) also are a major part of the livelihood activity in the communal part of the district. Tobacco production has also increased in the area, particularly because of the attractive prices that often arise at the auction floors during the selling season

4.1.3.1 Field production

Maize is the major staple crop in most parts of Zimbabwe. Results of this survey show that in total, maize constitutes the single largest cultivated crop. About 97% of the sampled households had grown the crop in the previous season and the crop occupies, about 60% of the cultivated area in Seke district. The surveyed households cultivate hybrid maize varieties.

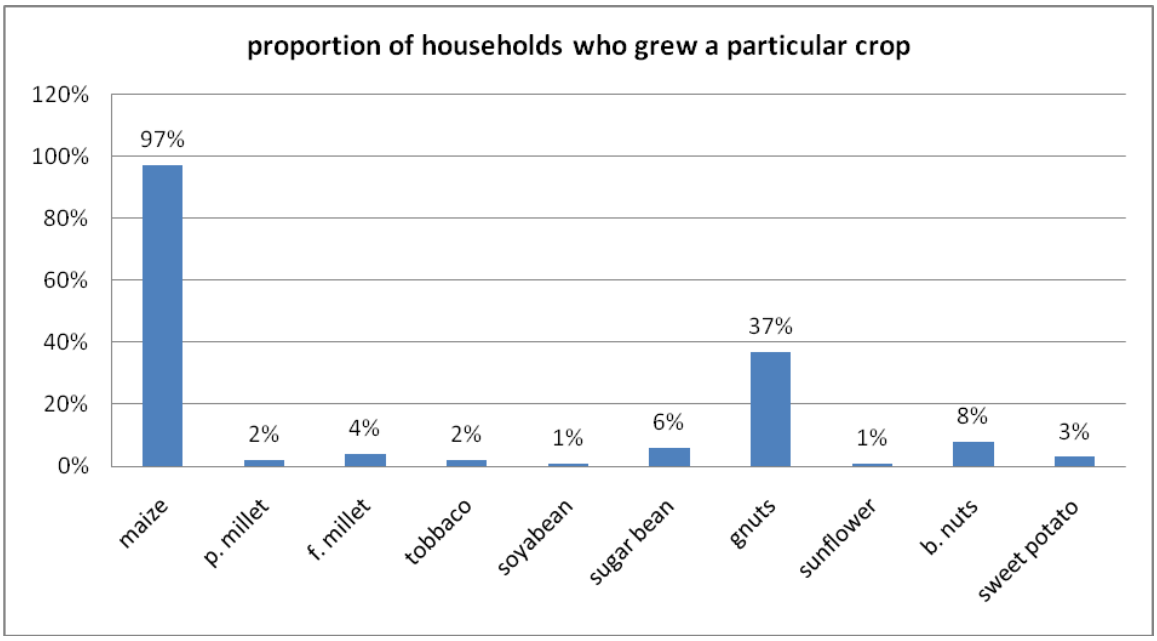


Figure 5: Proportion of households who grew a particular crop

4.1.3.2 Garden production

The main horticultural crops grown in Seke district are leaf vegetables, onions and tomatoes follow the carrots. The leafy vegetable mainly grown is the perennial covo, locally known as viscose. Viscose is a perennial crop that is grown from cuttings and can grow up to a height of 1metre. Households prefer this type of vegetable, because one can

continue to harvest the crop for over a number of years. Farmers also say it saves on costs particularly the planting material and labour during the planting period as one harvests continually for many years. From the survey it can be seen that the households are biased towards the leafy vegetables leaving out other prime vegetable crops that might give them higher returns. Figure 5 below presents the different types of horticultural crops the households had grown and the proportion of households who had grown it.

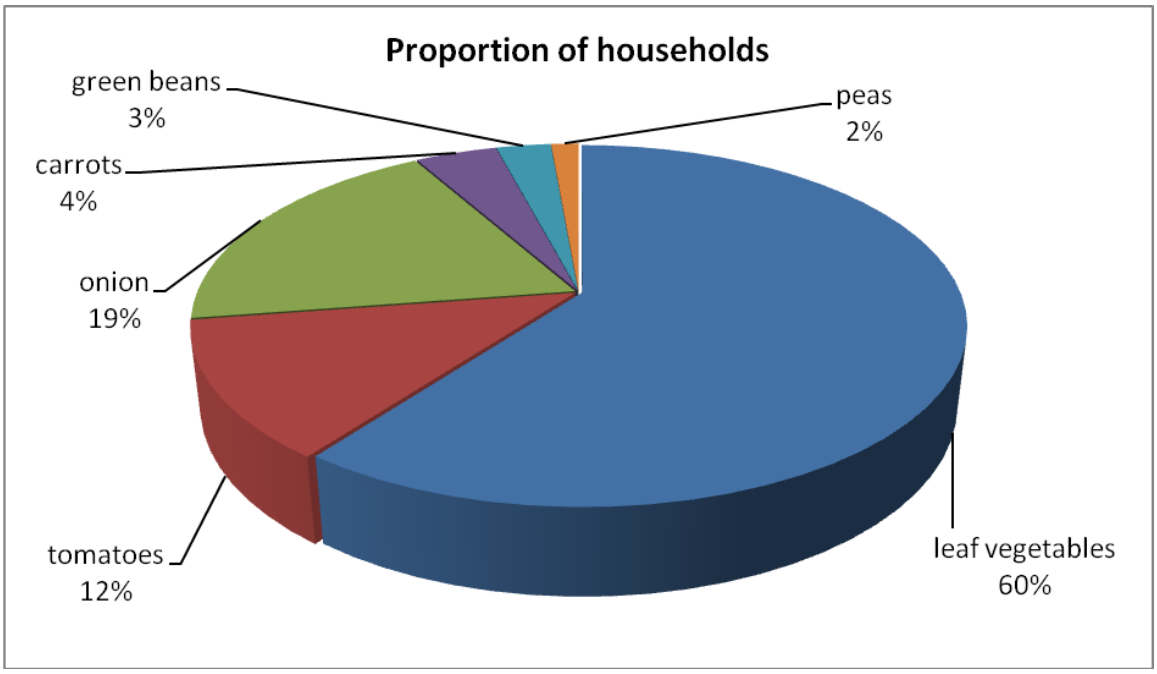


Figure 6: Proportion of households who grew a particular garden crop

4.1.3.3 Gardening activities and resources

Four types of fences were mentioned in the area. These were the wire, the branches, live fencing and grass fencing. The most common fence around the gardens was the wire fence (44%). However, the proportion of households that had fenced their gardens using wire was nearly the same as to those who had fenced their gardens using branches. Figure

6 below show a diagrammatic presentation of the different types of fences in the area and the proportion of households who were using the particular fence.

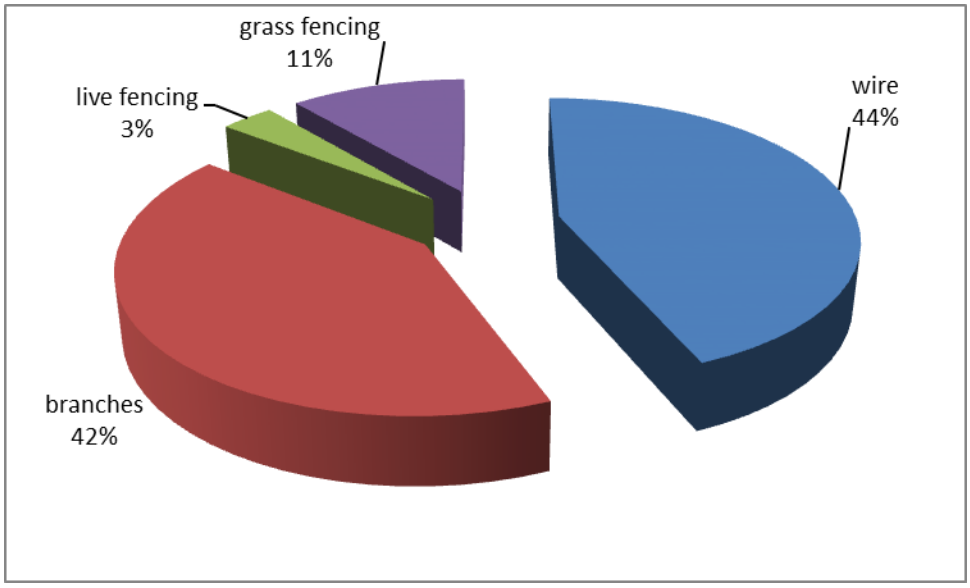


Figure 7: Types of garden fences

For the water sources for the garden, the majority of the households were using water from the shallow wells. This is in line with literature as the area is said to have a very high water table. Figure 7 below shows the proportions of the households using a particular water source.

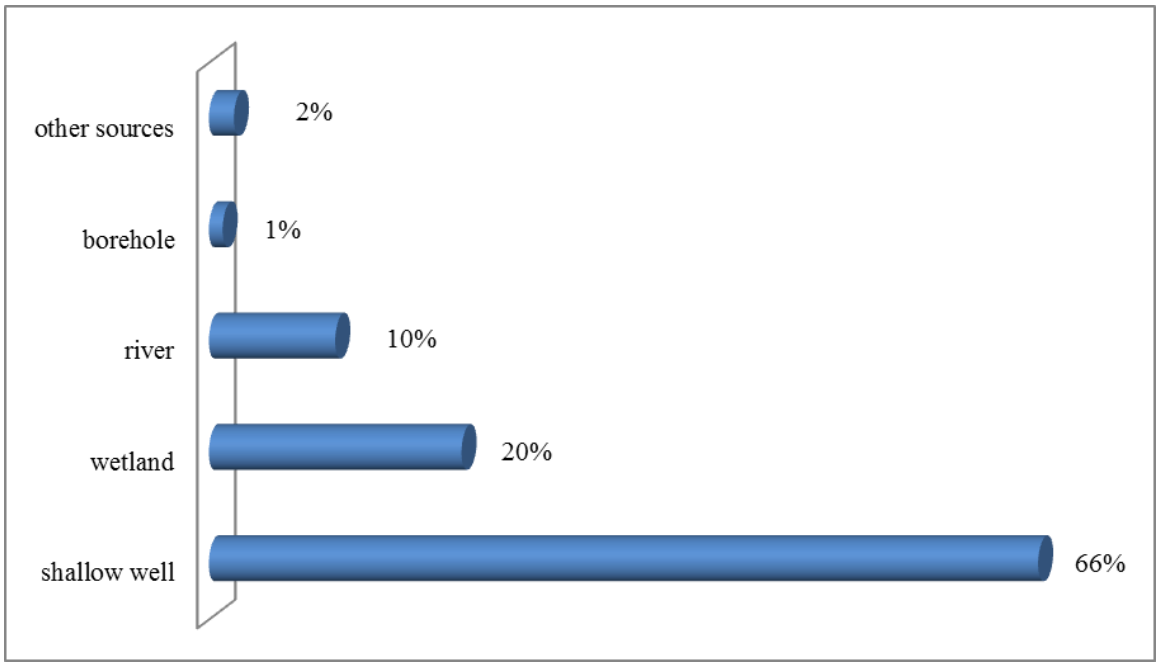


Figure 8: Different water sources for the gardens

For the distance of the garden from the homestead, the majority of the households 96.6% had their gardens at most a kilometre away. Only a small proportion had a distance of more than a kilometre. However, none of the households travelled more than 2km to the garden. Table 5 below shows the cumulative frequency of the proportion of households and the distance they have to travel to their gardens.

Table 5: Distance of garden from homestead

Distance to garden	*Cumulative frequency (%)*
< 0.1 km	27.0
Up to 0.5 km	82.0
Up to 1 km	96.6
Up to 2 km	100

The majority (53.4%) of the households indicated that everyone in the household was involved in the gardening activities. About 38.6% of the households indicated that only female members of the households were involved in the gardening activities. Figure 8 below presents household members' participation in the gardening activities.

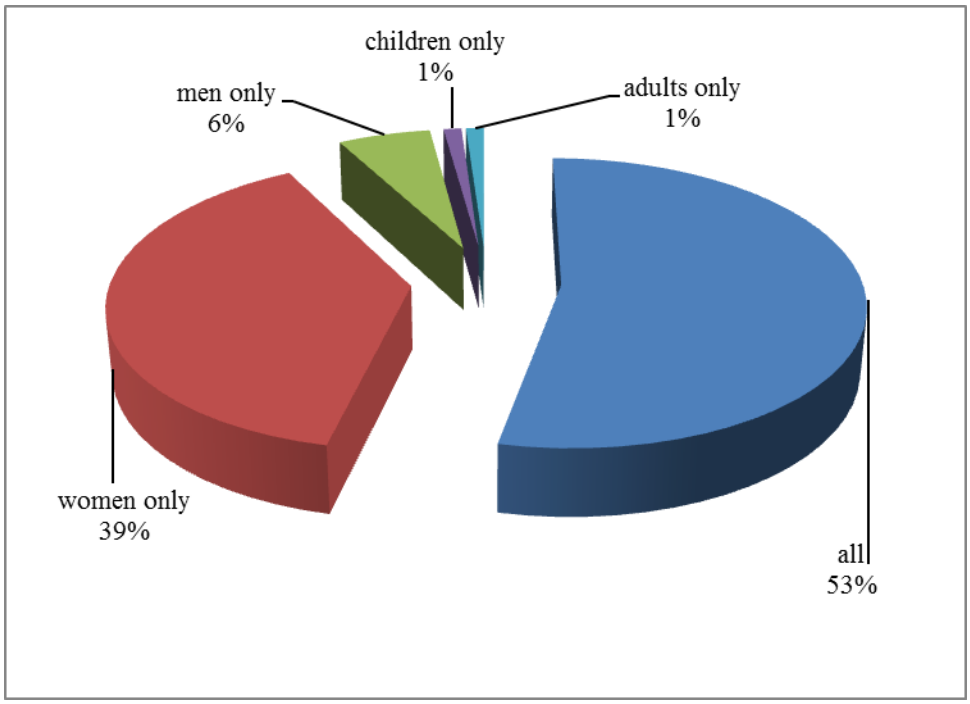


Figure 9: Participation of household members in gardening activities

4.1.4 Access to Key Resources

Households are endowed with different levels of assets. Table 6 shows the percentage and mean number of farmers owning agricultural equipment. The table shows the percentage of households owning the particular type of implements and the mean, mode, minimum, and maximum number of implements the household own. The proportion of farmers owning agricultural equipment is significantly higher as for the listed implements; around 50% or more of the households owned these agricultural assets.

Table 6: Implements ownership by households

Asset	*% of HH owning*	*Mean number of asset owned*	*Mode number of asset owned*	*Mini*	*max*
implements					
Ox-drawn plough	52	1	1	1	4
scotch carts	44	1	1	1	2
Wheel barrow	63	2	1	1	4
bicycles	49	1	1	1	4

In addition to investment in agricultural implements, an analysis was also made of the extent to which farmers make fixed investments like fencing, protected and unprotected water sources and fruit trees. With fruit trees about 84% of sampled households said they had at least a tree on their homesteads, and 65% had their homes fenced. About 57% of the household had protected water source, 17% unprotected water source and 2% had boreholes at their homesteads. Figure 10 presents a summary of these assets in agricultural owned by household.

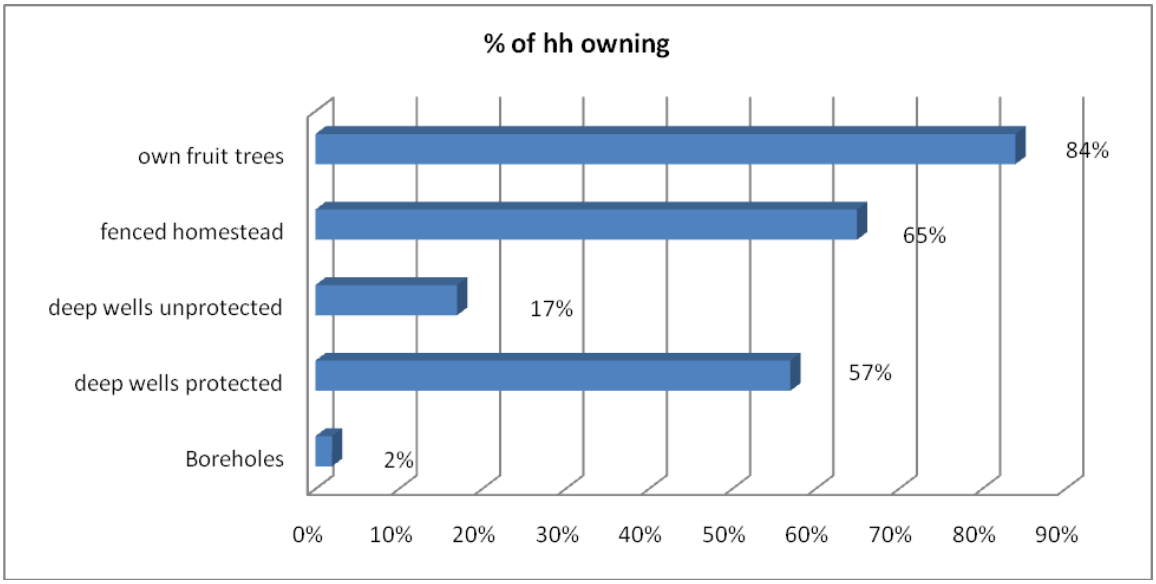


Figure 10: Percentage of household owning different assets

4.1.4 Analysis of limitations constraining agricultural activities

Farmers were asked about main limitations faced during farming operations. The graph below shows a combination of quantitative information from the survey. Household were requested to list the three most important constrains in the field and in the garden. Figure 10 below shows a comparative analysis of the strength of each constraint in the open field and in the garden. Inputs seem to be of greatest challenge both in the field and in the garden. Household indicated that inputs were very expensive and sometimes they bought fake chemicals from the market where they sold their produce. It was indicated that dealers at the market took advantage of unsuspecting farmers and they would buy chemicals in large quantities and repackage to small amounts. In the process of repackaging some of the dealers were adding water to increase the volumes of chemical. Farmers indicated that they had to buy these chemical as they will be readily available at the market place where they would be selling their produce.

Households also pointed out that labour was a big challenge. Given the fact that the district is a peri-urban many of the able bodied people preferred to go and work in the cities and for those available their rates were relatively a bit on the higher side; an average of $5/labour day was being charged by those who were offering labour. Comparing with what farm employees are getting this is a bit on the higher side. On average farm workers are getting $50 per month.

In marketing of horticultural produce market flooding was pointed out to be the main challenge. Households in the community grow similar crops and usually at the same time. The survey revealed that the community lacked market information on what to produce and when to produce for higher returns. The flooding resulted in low prices encountered at the market and something high post-harvest losses because of large amounts of left overs. The majority of the household indicated that they would give away the left produce otherwise it would be very expensive to carry it back and process it. However household pointed out that they grew the leaf vegetable, viscose, because it was a perennial crop and easy to manage. An interesting point to note was the higher proportion of farmers in gardening who pointed the challenges of unpredictable rainfall. This is due to the fact that the majority of the households rely on wetland gardening as such the varying levels of water in their gardens is of major concern.

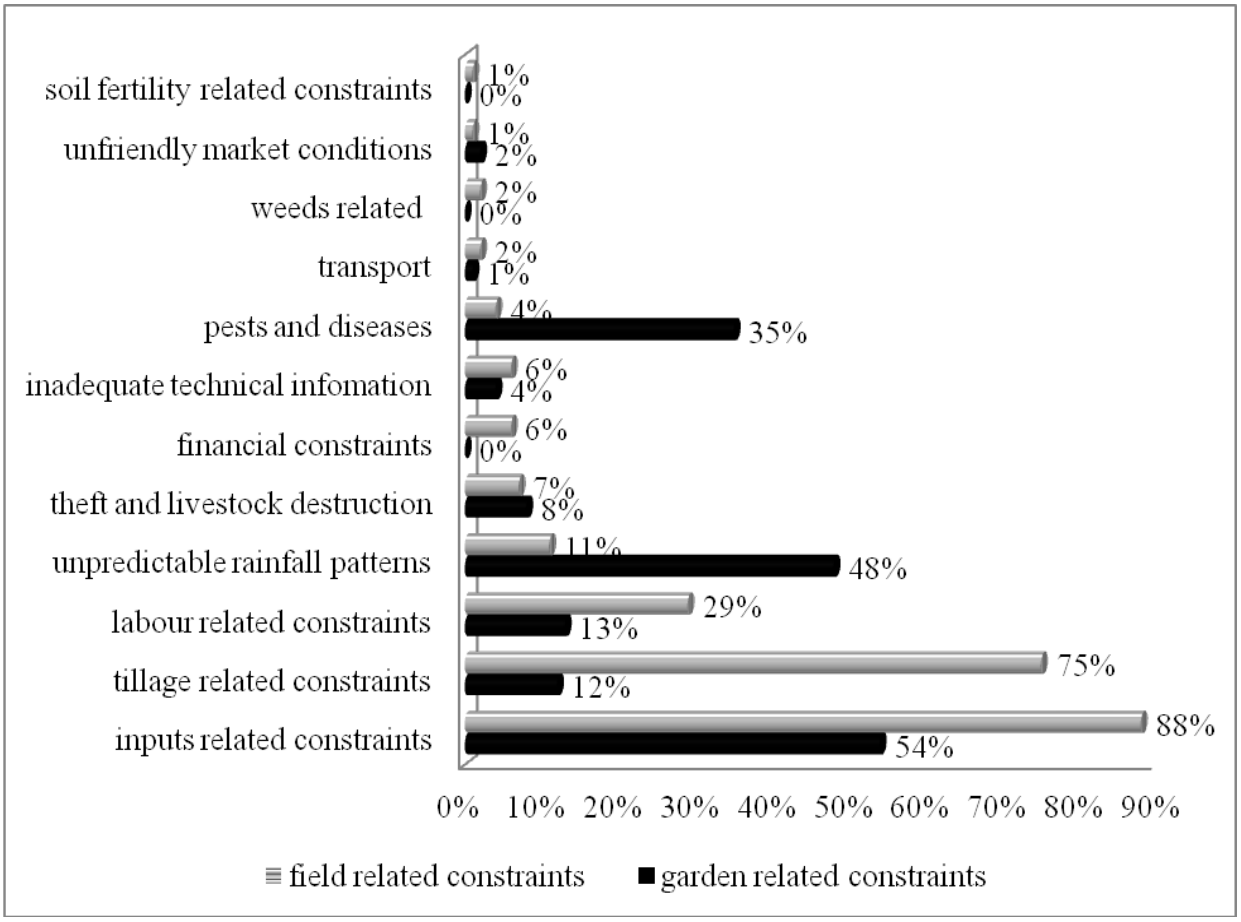


Figure 11: Field and garden constraints faced by households

4.1.5 Livestock Ownership

Table 7 shows the proportion and mean livestock ownership. For easy of interpretation, the percentage of household owning is shown also, the mean and mode livestock ownership is shown, and the minimum and maximum numbers owned. Using the ranking method the mostly held types of livestock, in order of decreasing importance, are poultry, goats, cattle, pigs and donkeys. The proportion of farmers owning the first 3 types of livestock types is significant. With chickens some household have ventured in to the poultry business as such they are raising broilers for sale.

Table 7: Livestock ownership by households

Asset	% of HH owning	Mean number of asset owned
Chickens (local & exotic)	82	18
goats	32	3
cattle	40	5
pigs	4	20

4.1.6 Garden income share ratio

The study went on also to analyze the contribution of gardening activities to household income. Since gardening seemed to be the main livelihood activity in the area, there was to an interest to what proportion of the household incomes was coming from the gardening activities. To analyze 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 total household income.

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

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

The summary of the garden income share ratio is presented in Table 8 below. On average, the income from the gardening activities is contributing about 18% of the total

household income. Twenty five percent of the households had 0.4% or less of their income coming from the gardening activities which might be of little significance to the welfare of the household. About 75% of the households have the income from the garden contributing 25% or less to the total household income. This analysis shows that the income from the gardening activities is relatively very small as compared to the whole household income. This can reveal that households had other sources of income besides gardening.

Table 8: Summary statistics of the garden income share ratio

		Value
Mean		0.18
Standard Deviation		0.263
Standard Error		0.0263
Percentile	25	0.004
	50	0.054
	75	0.253

A further analysis of the garden income share ratio shows that the majority of the households fall far below the average line. A summary of the distribution of the garden income share ratio is presented in Figure 12 below.

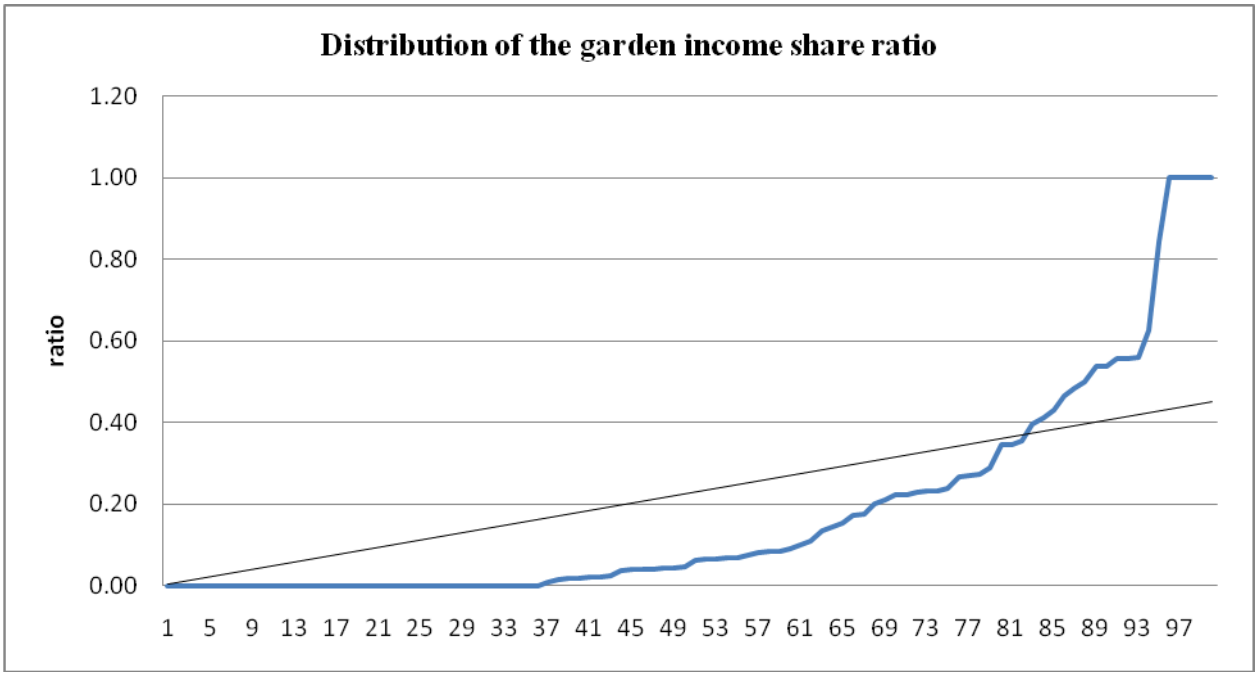


Figure 12: Distribution of the garden income share ratio

4.2 Measures of intensity of gardening

A number of issues will be discussed in trying to define the intensity of gardening by households. From the study, three issues can be used out to measure intensity. Intensity of gardening can be measured by the amount of revenue that is derived from the gardening activity, the number of crops being grown in the garden, the size of the garden, and proportion of area being utilized in the garden. From the sampled households 90% of the households indicated that they had a garden. In order to determine the level of gardening intensity among households the issues highlighted above were explored.

4.2.1 Intensity of gardening as measured by income from gardening

From the households that had gardens (90%) of the whole sample, income from the garden ranged from zero to thousands of United States Dollars. A plot of the incomes against the households is presented in Figure 13 below. There is high variability in

income from gardening activities. Income from gardening activities ranged from none to about US$2,400.

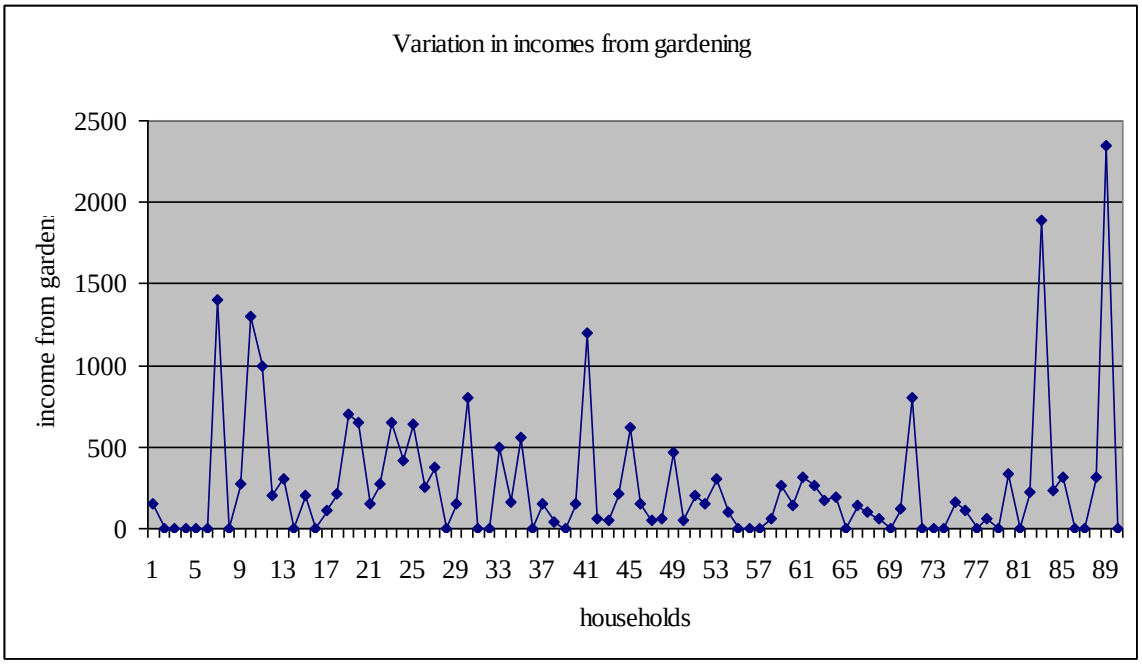


Figure 13: Comparison of income from gardening

From the summary statistics the mean income from garden is US$ 337.81 see Table 9, below.

Table 9: Summary statistics of the income from gardening

Statistics	**Value**
Mean	US$ 337.81
Standard deviation	US$440.42

To rank the households in terms of intensity, households with incomes that are equal to the mean plus half of the standard deviation (US$337.81+US$220.21=US$598.03) are

regarded as involved in high intensity gardening (HIG). Those with incomes equal to the mean less half of the standard deviation (US$337.81-US$220.21=US$157.60) are regarded as involved in low intensity gardening (LIG). Household with incomes between US$157.60 and US$598.03 were placed in the medium intensity group (MIG). Below is table 10 showing the proportion of households who have gardens and their level of intensity in terms of income from gardening.

Table 10: Intensity in gardening as measured by income from garden activities

	N	*% of households*
Low intensity gardening (LIG)	50	55.6
Medium intensity gardening (MIG)	25	27.8
High intensity gardening (HIG)	15	16.7

4.2.2 Intensity of gardening as measured by number of garden crops

When measuring intensity of gardening by the number of garden crops grown, only six crops where highlighted to being grown by the households. The crops mainly grown by the households are the leafy vegetables, tomatoes, onions, carrots, and very little peas and green beans. Only 1.1 percent of the sampled household grew five vegetable crops. The table 11 below shows a summary of the level of intensity by the number of crops grown. About 71.9% of the farmers fell into the low gardening intensity group whilst only 10.1% were in the high intensity group. Around 41.6% of households had a garden and during the time of study had nothing in their gardens.

Table 11: Intensity of gardening as measured by number of crops grown

Level of intensity	Number of crops being grown	Proportion of households growing the number of crops (%)	Total % for the level of intensity
LIG	0	41.6	71.9
	1	30.3	
MIG	2	18.0	18.0
HIG	3	5.6	10.1
	4	3.4	
	5	1.1	

4.2.3 Intensity of gardening as measured by the size of the garden

The size of gardens ranged from 0.001 to 1ha with a mean area of 0.2ha. Using the size of the garden as a measure of gardening intensity reveal that the higher proportion of household had gardens in the more than 0.1 ha category. Table 12 below shows a summary of the level of intensity by the size of garden the household owns.

Table 12: Intensity of gardening as measured by size of garden

	Size of garden	***Proportion of households under the category (%)***
LIG	Below 0.005 ha	5.62
MIG	0.005 to 0.1 ha	20.22
HIG	More than 0.1 ha	74.16

4.2.4 Intensity of gardening as measured by size of garden being used

Using the proportion of garden being used as a measure of gardening intensity reveal that a large proportion of households fall in the low gardening intensity. About 63% of the households are using at most about 0.005 ha out of the whole garden. Only about 16.85% are using more than 0.1 ha of their garden area. Table 13 below summarizes the level of gardening intensity as measured by the proportion of the garden that is being utilized.

Table 13: Intensity of gardening as measured by size of garden being used

	Size of garden being used	*Proportion of households under the category (%)*
LIG	Below 0.005 ha	62.92
MIG	0.005 to 0.1 ha	20.22
HIG	More than 0.1 ha	16.85

A further analysis shows that only 13.5% of the households were utilizing 60% or more of their garden plot. Nevertheless, the majority (75.3%) of the households were using

30% or less of the garden plot. Table 14 below shows a summary of the intensity of gardening by the proportion of garden being used by the households.

Table 14: Intensity of gardening as measured by proportion of garden being used

	Proportion of garden being used	Proportion of households under the category (%)
LIG	Below 30%	75.3
MIG	Between 30 and 60%	11.2
HIG	More than 60%	13.5

From the analysis of the intensity of gardening, it was revealed that the number of crops, the size of garden being used and the proportion of the garden being used as a measure of gardening intensity showed more skewness in terms of distribution of households in a category. Hence, the following analysis used the income from gardening as a measure of gardening of gardening intensity.

4.3 Household Characteristics by intensity of gardening

The Table 15 below reveals that more male-headed households are in the low intensity group. However for the female headed divorced and male headed widowed they all belong in the medium intensity group.

Table 15: Type of household by intensity of gardening

Type of HH	LIG	MIG	HIG
2 parent type of household	72.0	88.0	73.3
Male headed	55.6	35	16.7
Female headed husband away most of the time	2.0	0	6.7
Female headed widowed	20	8	20
Female headed divorced	0	4	0
Male headed (widower)	3.3	0	0

From the results of the survey, the MEU of the high intensity group is higher than the mean of the whole sample while that of the low intensity group is lower than the mean of the group. The mean household size is 3.

Table 16: Household composition by intensity of gardening

	Mean (N)	***LIG mean***	***MIG mean***	***HIG mean***
Household head age (years)	57	59.5	52.37	59.13
Household size	3	3.2	1.7	4.1
MEU	2.74	2.5	2.42	3.3

From sampled households the mean age of the households is 57 years, showing that there are head that are more elderly. About 45% of the household heads are over 70 years (see Table 17). However, the minimum age of the household heads is 25 years and the maximum is 93 years.

Table 17: Distribution of age of household head by intensity of gardening

Age category	*Cumulative %*	*Proportion (%)*		
		LIG	**MIG**	**HIG**
25-50 years	40.4	40	32.4	27.6
Up to 60 years	54.5	10	62.4	27.6
Up to 70 years	72.7	16	64	20
Up to 80 years	89.9	16	64	20
Up to 90 years	99	16	77.3	6.7
Up to 100 years	100	2	98	0

4.3.2 Garden size by intensity of gardening

Categorizing households by intensity of gardening revealed that the high intensity group of households owned garden plots which had a relative bigger size that the average of the whole group (see table 18). On contrary, the lower intensity group had on average, garden plots that were less than the whole group's average. With the dry land plots both the high and lower intensity groups had lower average plot sizes as compared to the whole sample. Table 18 below summarizes the average plot sizes for the different intensity groups.

Table 18: Plot size by intensity of gardening

		Dry land plot	Garden plot
Whole sample	Mean area (ha)	1.6	0.21
	ST. Deviation	1.09926	0.17587
	Standard error	0.10993	0.01864
LIG	Mean area (ha)	1.59	0.17
MIG	Mean area (ha)	1.62	0.22
HIG	Mean area (ha)	1.59	0.24

The sampled group had 1,6 ha as the mean area for the dry land plot and 0, 2 ha for the garden plot. A cross tabulation between gardening intensity and plot size reveal that there is not much difference in terms of land size.

A cross tabulation of wealth class and gardening intensity (table 19) reveals that the majority of the households fall in the average wealth group and low intensity gardening. Very few household exist in both the worse off and high intensity.

Table 19: Wealth class by intensity of gardening

Wealth class / Level of intensity	Well off (%)	Average (%)	Worse off (%)
LIG	13	33	9
MIG	10	14	3
HIG	3	11	2

A correlation analysis between intensity in gardening and wealth status reveals that there is very little correlation between the two variables. The Pearson correlation coefficient between gardening intensity and wealth class is 0,103. This shows that there is very little correlation between the two variables.

4.4 Summary of major findings, conclusions, and recommendations

This chapter analyzed the major socio-economic differences between households under high intensity gardening and low intensity gardening using descriptive statistics. The chapter also highlighted the constraints that are faced by households in the field and in the garden. From the results presented in this chapter it can be concluded that there is not much differences in the two categories of intensity. However it was observed that the area has got elderly household heads. It was also shown that the household are endowed with a number of assets from which they earn a living. It was also shown that although, gardening was prominent in the area, some households were seasonal gardeners, some did very little gardening for subsistence. An analysis of the relationship between intensity of gardening and wealth status of a household revealed that there is no significant relationship, thus we can reject our hypothesis that said there was a strong relationship between wealth status and gardening intensity. This is in line with the study that was done by University of Pretoria, on the effects of treadle pumps on dambo horticulture which revealed that gardening can change the livelihoods of households positively.

CHAPTER 5: PRODUCTIVITY AND VIABILITY OF GARDENING ACTIVITIES

5.0 Introduction

This chapter analyses the viability and contribution of gardening activities among communal households in Seke district. However to concretize the results from the gross margin analysis, use is also made of the garden income share ratio which allows explicit testing of the contribution of gardening activities to the household income and welfare. Some of the hypothesized positive relationships between gardening activities, and welfare are supported by the analysis.

5.1 Variation in productivity in the garden and factors contributing

There is high variability in productivity among households. Figure 14 shows yield of leafy vegetables and tomatoes across households. Yield is a function of household characteristics, soil characteristics, inputs usage among other factors. From the study it can be deduced that a number of factors contributed to low productivity. Given the fact that the households are getting inputs from informal markets, the inputs could be of poor quality hence detrimental to the crops. The fact that also households mentioned weeds as a constraint, they have the potential of reducing the productivity of crops. Figure 14 shows yield distribution of leaf vegetables among households.

The yield level for the leafy vegetables ranged from 1 tonne to just below 40 tonnes per hectare. This is far below the expected average yield. Theoretically leaf vegetables yield in the ranges of 20 to 60 tonnes per hectare. From the analysis, it can be deduced that the

households are performing below the research average. The average yield levels of tomatoes also range between 1 and 6 tonnes per hectare which is also far below the expected yields. With onions the yield levels were ranging from 1 to 20 tonnes per hectare which is also far below the expected yield levels.

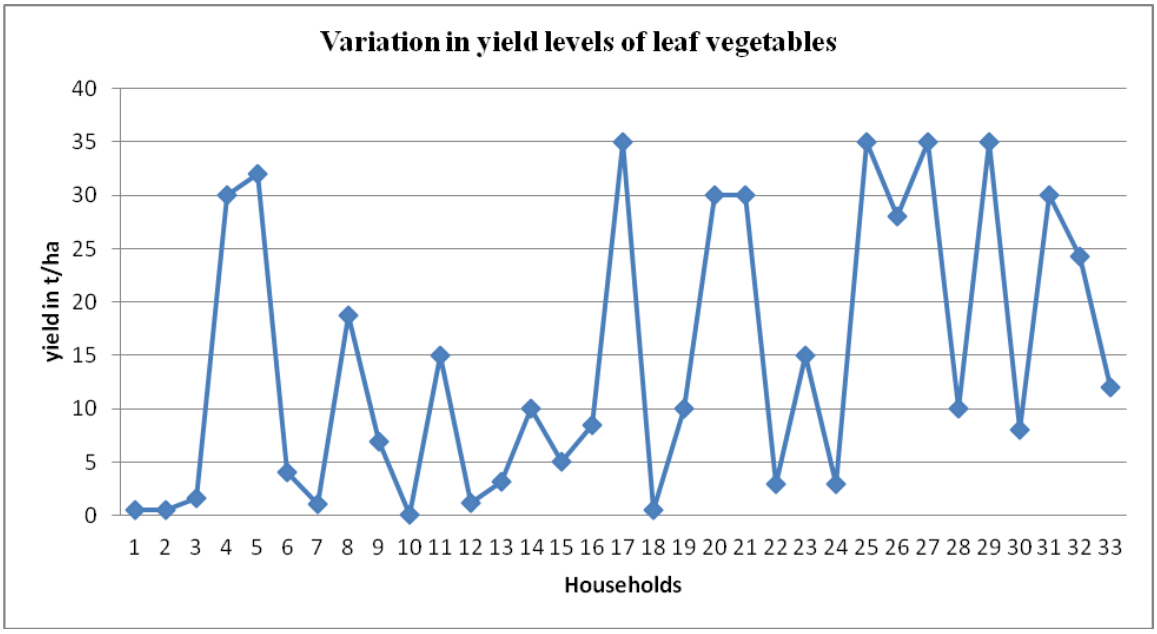


Figure 14: Yield variations in leaf vegetables

5.2 Variation in profitability and factors accounting for it

Besides outputs from the gardens, farmers would also be interested in producing crops that would minimize cost of production to save on the limited financial resources they have. The gross margin analysis is going to be used to analyze the returns the households are getting from the different garden crops.

5.2.1 Gross margin analysis

Table 20 summarizes the yield variable, costs of variable inputs and gross margins per hectare by crop in the field and gardening activities. In these calculations farm level profits per hectare were computed using farmed acreage instead of total hectarage. Gross margins are calculated by deducting costs (fertilizers, chemicals, seed, and labour) from the value of total production for each individual farmer and then averages are taken for each variable. Also given below is a comparison of the different garden crops and farm level profits on per hectare basis.

Table 20: Gross margin analysis of the garden crops

	Leaf vegetables	Tomatoes	Onion
Yield (t/ha)	**4.2**	**5.8**	**8.25**
Average area under the crop	**0.006**	**0.005**	**0.001**
Gross income per ha (US$/ha)	**3288.60**	**4730.16**	**3958.33**
Total variable costs (TVC) per ha (US$/ha)	**540.00**	**2433.97**	**1353.33**
Gross margin per ha (US$/Ha)	**2748.60**	**2266.19**	**2605.00**
Gross margin per TVC (GM/$TVC)	**5.09**	**0.93**	**1.92**

All the garden crops analyzed had positive gross margins. However, of the three main crops analyzed the leafy vegetables had the highest gross margin as well as the highest return on a dollar spent. The fact that leaf vegetables are in high demand both locally and

urban markets can be used to explain this. With tomatoes and onions, they are additives to the relish dish such that in case of financial crises one can forgo them.

5.2.2 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 gross margins across households. Yield is affected by household characteristics, input usage, and soil characteristics among other factors. In order to assess the effects of different variables on yield, productivity analysis was done using a log–linear model specified as followed:

$$\text{Ln } Y = ß_o + ß_1 \text{Ln HHage} + ß_2 \text{Ln topdress} + ß_3 \text{Lnarea} + ß_4 WI + ß_5 MEU + ß_6 GDW + ß_7 PIG + ß_8 GS + \mu \quad \text{(i)}$$

Where

Y	yield
$ß_o$	the intercept term
$ß_{1-7}$	unknown parameters to be estimated
Topdress	amount of top dressing fertilizer used
Area	area under the leaf vegetable
WI	wealth index of the household
MEU	Man equivalent unit
GDW	distance of water source to garden
PIG	people involved in gardening (1=all, 0= not all)
HHage	household head age

GS Garden size

μ error term

Initial a very large number of variables were used. A correlation matrix was done and for those that were highly correlated one of the variables was dropped out. The regression was then carried and the results produced are presented below.

The results are presented in table 21 below.

Table 21: Results of the log-linear regression

Variable	***Coefficient***	**t-value**
constant	316.15	-1.627*
Topdress	-0.016	-0.296*
Area	-1.159	1.075**
WI	1.071	-0.036*
MEU	-0.008	1.656
GDW	0.381	1.951
PIG	-0.280	0.901
GS	0.980	-0.023**
HHage	0.946	-1.627***
r-	0.757	
r squared	0.573	
F statistic	1.342	
Durbin Watson	2.38	

*****significant at 10%; ****** significant at 5%; ******* significant at 1%

Discussion of these results

Out of the 8 factors that were hypothesized to have an effect on the household gross margin, only 1 was found to have a significant effect on gross margin at 1%. Area under the leafy vegetables was significant at 5%. Wealth index, distance of the garden from the household, household age and the garden size had a positive effect on the gross margin. This can be explained that well off households have higher gross margins because they have the resources to access inputs to use in the farming activities. For distance of the garden to the homestead, it can be explained by the fact that near garden people tend to be disturbed when they are working rather than the further away gardens. The bigger the garden the higher the gross margin can be explained by the fact that there will be more horticulture production, which will increase the net household gross margin. People involved in the garden had a negative but insignificant relationship to the gross margin of the household. R squared of the model is 0.573 meaning that the effects of variables highlighted above are contributing 57.3%.

5.3 Results and discussion

From the analysis, gardening is viable as shown from the results of the gross margin analysis. The average gross margin per hectare for the leafy vegetables stood at US$2748.60, for tomatoes it stood at US$2266.19 and US$2605 for the onions. On average, the area under leaf vegetables is 0.006 whilst 0.005 under tomatoes, and 0.001 on tomatoes. Bigger areas could significantly increase the contribution of income from the garden to the total household income.

5.5 Summary and conclusion

This chapter has looked at the contribution of the garden income to the total household income. Gross margin analysis of the three main garden crops revealed that, all the three are relatively profitable. Regression analysis showed those higher gross margins are because of a number of factors such as the size of the garden, distance of the garden and amounts of fertilizer applied. However, the household size, distance to garden and the people involved in gardening were not significant in influencing the gross margin. This is somehow contrasting as labour has a large bearing on the costs of production hence the gross margin.

CHAPTER 6: ECONOMETRIC MODELLING OF THE HOUSEHOLD FARMING SYSTEM AND IMPLICATIONS ON THE SIZE OF THE GARDEN

6.0 Introduction

The challenges of unpredictable weather patterns, resulting in unreliable rain fed agriculture have been cited as one of the main constrain in agriculture production. Garden activities can lessen the effects of unpredictable rainfall. Some households have ventured into gardening as a way of generating food and income. However the challenge is on the optimal sizes of gardens for maximum returns. Information is therefore required on the optimal garden size.

The purpose of this chapter is to assess the household decision criteria, to be taken by households with different levels of labour. The main question to be answered in this analysis is what size of garden households should cultivate, given the available labour the household has. The analysis will also assess the implications of venturing into gardening on household food security and income. Linear programming was used to analyze the production combinations that would improve the household incomes and food security, given the food security objective and the different production constraints.

6.1 Specification of the linear programming model

Maize is the main field crop grown for food security by households. In the gardens household mainly grow leaf vegetables and tomatoes for sale. The decision is made under land, labour, and capital constraints. There is prevailing incomplete local market restrictions on labour. This means that a household can hire in or out limited amounts of

labour in a season. Distorted prices also exist such that buying and selling prices are different. Household have to make decisions on the size of the field crop and garden crop to grow so as to improve their welfare.

6.1.1 Objective Function

The objective function is to maximize the household farm income. This objective will be maximized by the maize gross margin and the gross margin from the garden crops. The household can hire in or out limited amounts of labour. The household is also able to buy or sell maize. Imperfect market conditions always exist where the buying price is higher than the selling price.

The farming household has to allocate the available resources in a manner that the household's needs are met, and if not then enough money should be generated to be able to buy. The household decision making is highlighted as an optimization problem, where the main objective is to maximize household income.

$$\text{Max } Y = \sum (P_i Q_i - P_{xi} X_i)$$

Where : P_i is the price per kg for a given crop ($crop_i$)

Q_i is the crop output per hectare in kg for $crop_i$

P_{xi} is the price of input used in the production of $crop_i$

X_i is the amount of inputs used to produce $crop_i$

The income is to be maximized subject to the following constraints:

a. Land constraint

This is the amount of land resource used to produce the $crop_i$. This land should not exceed the total land available to the household. In the garden the land should not exceed the size of the garden, whilst for the field crop it should not exceed the total size of the arable land. The land constraints are given by equation 1 and 2 below.

$$\sum L_{fd} <= L_f \quad (1)$$

$$\sum L_{gc} <= L_g \quad (2)$$

Where: L_f is total land used in field crop production

L_{fd} is total arable field land

Where: L_g is total land used in garden crop production

L_{gd} is total size of garden

b. Labour constraint

The household is also constrained by labour such that the total labour used in the farming activities for both the garden and field together with the hired labour should not exceed the total farm labour available plus the labour hired at any given time. The labour constraint is given by the equation.

$$L_f + L_{in} - \sum L_{ai} - \sum L_{fc} - \sum L_g - L_{out} = 0$$

Where: L_f is the total family labour

L_{in} is hired in labour

L_{out} is hired out labour

L_{ai} is labour used for other activities

L_{fc} is labour required for the field crops

$L_{g\ is}$ labour required for the garden crops.

c. Capital constraint

The household is limited by a capital constraint such that the total cost of production plus the total cost of purchasing maize, plus the total cost of hiring in labour should not exceed initial savings together with money generated from hiring out labour. The capital constraint is presented below.

$$So + Lout*Wi- \sum Cfi*Af - \sum Cgi*Agi – Mzbt- Lin*Wi= 0$$

Where; S_o is the initial amount available to a household

L_{out} is the total labour hired out

W_i is the wage rate for hiring the labour out

C_{fi} is the cost of producing one hectare of a field $crop_i$

C_{gi} is the cost of producing one hectare of a garden $crop_i$

A_f is the area under field $crop_i$

A_{gi} is the area under garden $crop_i$

M_{zbt} is the price of purchasing maize

d. Food security constraint

The household produces maize to meet the basic food requirements for self-sufficiency. The household relies on maize as a source of grain, thus the minimum grain requirement will be met through the production of maize. The balance of the minimum grain requirement can be met through market purchases. The food security constraint is presented below.

$$\sum Gm * A_f + QM_{zbt} >= FLE * 120\ (1+\alpha)$$

Where Gm is the total amount of grain harvested for maize per unit area

A_f is the area put under maize

QM_{zbuy} is the total amount of maize purchased

FLE is the family adult labour equivalent.

6.2 Calibration of the model for Seke communal households

Households will make decisions on the area to put under maize or the garden size based on the available information such as gross margins per hectare, the cost of production and the labour available. The information presented in Table 22 below will guide in decision-making process.

Table 22: Calibration of model for Seke communal farmers

Parameter	*Maize*	*Leaf vegetables*
Mean area (ha)	0.8	0.006
Yield (t/ha)	1.3	5.78
Seed (kg/ha)	26	suckers
Basal fertilizer (kg/ha)	180	500
Top dressing (kg/ha)	163	580
Labour days (LD/ha)	49	960
Price of seed (US$/kg)	2.20	Not bought
Price of basal (US$/kg)	0.60	0.60
Price of top dressing (US$/kg)	0.56	0.56
Price of labour (US$/kg)	5.00	5.00
Price of produce (US$/kg)	0.24	1.00
Cost of production (US$/ha)	254	420

Assumptions made:

i. The household is involved in gardening and dry land farming

ii. Household's main livelihood activity is agriculture production

iii. Households can hire out limited amounts of labour to supplement the cash income of the household

iv. Household can hire in limited amount of labour at any given time.

6.3 Results and discussion of the optimization models

Presented below is a table showing a summary of results for the optimization model under three scenarios.

Table 23: Results of the optimization model

Variable	*Various sizes of the garden per household (ha)*		
	0.2	0.4	1
Objective function - the farm gross margin (US$)	1655.20	2811.20	6279.20
Initial savings	490.40	574.40	826.40
Shadow values			
Land			
Garden	0	0	0
field	0	0	0
Labour	-12.23	-12.23	-12.23
Capital	0	0	0

(Please refer to appendix III for more details on Lingo model and solutions)

Scenario 1

In the first scenario the household will realize a profit of US$ 1655.20 from the garden and field. This profit will be realized after farming on 0.2 hectares of the garden area and 1.6ha open field area. The capital constraint is zero meaning that the budget is non-responsive of increases in input prices. This means there is no value attached to an extra dollar to the capital constraint.

The reduced cost for labour for other activities and for the garden is 12.23 meaning that the profit would decrease by 12.23 an extra unit of labour is diverted to the garden or other activities.

The slack or surplus values for all the constraints are zero meaning that no constraints are violated. This means that all the constraints are binding. The results also show that household can hire out and in 0.25 of labour and the wage rate would be $12.23. The labour constraint is -12.23 meaning that the profit will decrease by US $12.23 with any increase in use of labour. The results also show that there is a shortage of labour and hence expensive. The scarcity value of both the field land and the garden land is zero. This means that there is excess land lying around and there is plenty of land. The quantity of maize to be bought is 533.6 kg.

Scenario 2

In the second scenario, the household will realize a profit of US$ 2811.20 from both the garden and field. This profit will be realized after farming on 0.4 hectares of the garden area. As like scenario 1 the capital constraint is zero meaning that the budget is non-responsive of increases in input prices. This means there is no value attached to an extra dollar to the capital constraint. Again, all the constraints are binding and the only difference will be the initial savings that the household should have.

Scenario 3

In the third scenario, the household will realize US$6279.20 from both the field and the garden. This will be realized after farming on 1ha of the garden. Again, all the constraints are binding and a higher amount of initial household savings will be required.

6.4 Summary and conclusions

Linear programming results shows that households should increase the size of their gardens if they are to realize more income hence the improved welfare. The small areas that households are cultivating are affecting the contribution of their income from the garden to the total household income. However, increasing the size of the garden also has a bearing on the water table. With time, the water table will be compromised, thus destabilizing the ecosystem. The results also suggest that gardening may not be the option for households without other sources of income since they will need higher amounts of initial investments into the garden. This would mean that these households would need other intervention strategies other than gardening activities. This supported by the fact that gardening is a high capital investment project.

CHAPTER 7: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

7.0 Introduction

Unreliable rainfall and often-insufficient water for crop production is a major impediment for improving the welfare of households. Rainfall is variable, unpredictable, and unreliable and this has resulted in low productivity. The uncertainty of rain fed agriculture results in low yields, thus most households might fail to meet their minimum food requirements.

In order to counter the effects of unreliable rainfall and improve household food security at household level, a number of NGOS has been promoting the development of gardens across the whole country. Seke communal area is rich in wetlands and most households have been tapping into this resource. Many households in this community are operating gardens and the selling their produce locally and in the neighbouring towns Chitungwiza, Marondera and Harare. However, the contribution of the gardening activities to the total incomes of the households is not yet clear to most farmers, researchers, and policy makers.

This study aimed at looking at prospects of increasing household incomes through gardening. The study specifically sought to assess whether there was any significant differences between the households in the high intensity gardening and those in the low intensity gardening. The study also evaluated the performance of the garden crops. Finally, the study aimed at assessing the optimal garden sizes for the households.

7.1 Summary of findings

This section presents a summary of the major findings from the study.

7.1.1 Household characterization and intensity of gardening

This chapter analyzed the major socio-economic differences between households under high intensity gardening, medium intensity and low intensity gardening using descriptive statistics. There were major differences in demographic characteristics between the three groups. However, it was observed that the area has elderly household heads and labour was a major constraint in the community. It was also shown that the household are endowed with a number of assets from which they earn a living. These ranged from fixed assets like houses to movable assets like livestock

The results revealed that although, gardening was prominent in the area, some households were seasonal gardeners; some did very little gardening for subsistence as was revealed through analysis of intensity of gardening. However, the income from the garden was not contributing much to the total household income; it was on average contributing 18% to the total household income. This is in contrast on what is seen on the ground, as it seems, as gardening is the main livelihood for the households in the community. This may be because the sizes of gardens are very small thus; the level of intensity is fairly low and hence the area under the horticultural crops. On the analysis of the relationship between gardening intensity and wealth class, it was revealed that there was very small relationship. This implies that there is no relationship between the wealth status of a household and the level of gardening intensity.

7.1.2 Productivity and profitability analysis in the gardening community

It was hypothesized that gardening is viable and contributes 50% or more to the household incomes of households. Gross margin analysis of the different garden crops revealed that the gardening activity is viable. On analyzing the factors that affect households' gross margins shows that there was no significant relationship between household gross margin and the household size (MEU), the people involved in gardening and the distance of the garden from the homestead. This is in contrast with literature which says that labour has a large bearing on total variable costs hence the gross margin. Also looking at the distance of the garden from the household it did not have any significance influence on the gross margin. This could be due to the fact that whether the household is near or far decisions to work on the garden were not influenced by the distance.

7.1.3 Farming system and optimal garden sizes

Low productivity resulting from unreliable and unpredictable rainfall is a major concern for all. This can lead to household's food insecurity. Thus, households should maximize the use of the scarce resources available. Allocation of the limited available resources should in such a way that the household goals are met.

Linear programming results shows that households should increase the size of their gardens if they are to realize more income hence the improved welfare. The small areas that households are cultivating are affecting the contribution of their income from the

garden to the total household income. Optimal garden sizes will make households realize more income. The results also suggest that gardening may not be the option for households without other sources of income since they will need money for investment into the gardening activities.

7.2 Implications of research findings and recommendations

Declining productivity caused by unreliable rainfall call for more sustainable ways of farming. Linear programming shows that if households increase their garden, they will realize more income. More income will translate to improved welfare of household and improved food security. Gardening can afford farmers means to be gainfully employed, as they will generate more income. Irrigating crops can lead also to availability of food at household level through increased productivity, stable production and increased incomes.

Irrigation can also play a role in agricultural and economic development of the country, especially communal gardening because of its low investment costs. The high yields obtained, couples with other benefits such as increased incomes, food security, employment creation through the forward and backward linkages, drought relief savings to name a few are an indication that gardening also can be a vehicle for the long term agricultural and macro-economic development. Because of the low investment in communal gardens, investing in gardening can go a long way in improving the livelihoods of communal farmers. However, this increase in area will be constrained by labour, as it is scarce and expensive in the area.

7.3 Areas for further research

This study only looked at the relationship between wealth status and gardening intensity and the performance of the garden crops (gross margin analysis). There is need to carry out an economic analysis of smallholder irrigation. In addition, there is need to carry out a market analysis for the community so that the community can be able to plan their cropping programmers effectively thus the issues of flooding of the markets is avoided. There is also need to carry out the value chain analysis for the different horticultural crops in the areas. 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 market.

It would also provide much needed information by looking at the impact of increasing garden size on the water table and therefore garden production as well. This will definitely inform policy makers when dealing with issues on gardening.

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Appendix 1: Household survey questionnaire

An analysis of the contribution of gardening to the incomes of households

Household level survey: Questionnaire for Farmers

1. Enumerator: _____ 2. Date of interview:_____

3. Province _____ 4. District _____

5. Ward _____ 6. Village _____

A. GENERAL INFORMATION

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

7. Name of respondent: _____

8. Gender of respondent: [1] Male [2] Female

9. Age of respondent (in years): _____

10. Relation to head of the household? 1. head 2 spouse 3 son 4 daughter 5 other

12. Gender of HH head: [1] Male [2] Female

13. Type of Household [1] two parent headed [2]-female headed husband away most of time [3]-female headed widowed, [4]-female headed divorced [5]-female headed never married [6]-male headed wife died [7]-male headed wife away most of the time [8]-male headed divorced [9]-male headed never married [10]-child headed orphaned [11]-child headed parent away most of the time [12] other_____

14. Educational level of male head : [1]none [2] Primary sch. [3] Sec. sch. [4] Post sec. [5] Adult education

15. Education level of female head: [1] none [2] Primary sch. [3] Sec. sch. [4] Post sec. [5] Adult education

B. HOUSEHOLD COMPOSITION

16 We are interested in knowing more about the composition of your **household** (all the people living in the same compound, eating from the same "pot" and working on the family farm)

Name	Gender 1=F 2=M	Age in Years	Relation to head: (See Code below)	Marital status (See Code below)	Literacy status (See Code below)	Current occupation (Code below)
			0=Head 1=Spouse 2=Parent 3=Child/grand child 4=Nephew/Niece 5=Son/daughter-in-law	1=Single 2=Married 3=Widowed 4=Separated 5=Divorced	0=Minor 1=Illiterate 2=Primary 3=Secondary 4=Post sec 5=Adult education	1- field (crop) sales 2- vegetable sales 3- petty trading 4- fruit sales 5- formal employment 6- casual farm work

			6=Brother/Sister 7=other relative			7-other (specify) 8-N/A

C. HOUSEHOLD RESOURCES

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

17. What type of dwelling do you live in?

1) Mud hut & grass thatch roof 2) Mud hut & asbestos/iron roof 3) Brick house & grass thatch roof 4) Brick house & asbestos/iron roof 5) Block house & grass thatch roof 6) Block house & asbestos/iron roof

7) Pole and dagga & grass thatch 8) Other (specify) _____

18. What is your endowment of land resources

Sector	Plot type	Size (ha)

Sectors [1]-Communal area [2] -A1 [3]- A2 [4]- OR [5]- SSCFA [6]- LSCFA

Plot type [1]- dryland [2]- irrigation scheme land, [3]- wetland [4] garden

19Family household assets

Assets	No. owned currently	Unit value	Total value

Chickens			
goats			
Draft animals			
Total livestock			
Pigs			
Animal scotch cart			
Animal plough			
Wheel barrow			
Bicycle			
Urban house			
stand			
Commercial stand			
Borehole			
Deep well (protected)			
Deep well (unprotected)			
Perimeter fence			
Fruit trees			

d. AGRICULTURAL GARDEN PRODUCTION AND MARKETING ACTIVITIES

(Please indicate the unit ha/ acres/ m^2)

20. What is the total size of the dry farm land you have/own?.....

21. Do you have a garden [1]=Yes [2] = No

If yes continue and if no go to question 23

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

23. What is the source of water for your garden? [1]- wetland [2]- borehole [3]- river [4]- shallow well [5] other (specify)……..

24. What is the distance of your garden from the homestead? _____ (specify unit of measure)

25. What type of fence is around your garden? [1]- wire [2]- branches [3]- live fencing [4]- grass fencing [5]- other (specify) …….

26. 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……

27. What were the types, quantities, source and the cost of inputs and outputs used in the field crop during the past season

		Field crops					
	Crop/ area (ha)	/	/	/	/	/	/
Inputs seed	Qnty (kg)						
	source						
	Unit price ($)						
fertilizer	Qnty (D)						
	source(D)						
	Unit price(D)						
	Qnty (AN)						
	Source (AN)						

	Unit price(AN)						
labour	Qnty (labour days)						
	source						
	Unit price ($)						
	Type of labour						
Chemicals …… ……..	qnty						
	source						
	Unit price						
output	qnty						
	mkt						
	Reason for mkt						
	Unit price ($)						

[1]-Maize [2]-p. millet [3]-f. millet [4]-sorghum [5]tobacco [6]-cotton [7]-soyabean [8]-sugar bean [9]- gnuts [10]-sunflower [11]- cowpeas [12]-bambara nuts [13]-cowpeas [14]-sweet potato [15]paprika

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

Market type code [1]- local [2]- Mbare [3]- Chikwanha [4]-roadside [5]-middlemen [6]-horticultural companies [6] 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

28. What were the types, quantities, source and the cost of inputs and outputs used in the garden during the past season

		garden crops					
	Crop/ area (ha)	/	/	/	/	/	/
Inputs seed	Qnty (kg)						
	source						
	Unit price ($)						
fertilizer	Qnty (D)						
	source(D)						
	Unit price(D)						
	Qnty (AN)						
	Source (AN)						
	Unit price(AN)						
labour	Qnty (labour days)						
	source						

	Unit price ($)						
	Type of labour						
Chemicals …… …… …..	qnty						
	source						
	Unit price						
output	qnty						
	mkt						
	Reason for mkt						
	Unit price ($)						

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]- Mbare [3]- Chikwanha [4]-roadside [5]-middlemen [6]-horticultural companies [6] 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

29. What are the 3 main production constraints limiting productivity in the field

1._____

2. _____

3._____

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

i.…….

ii……

iii ……

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

i……

ii …….

iii. …….

33. 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)……..

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

34. How important are the following sources of income to your household on a scale of 0 (not relevant and 1(not important) to 5(very)?

1- Field (crop) sales 2- garden sales3- petty trading 4- fruit sales 5- formal employment

6- Casual farm work 7- self-employment 8- livestock/fish sales 9-other (specify)

35. Sources of income 2009/2010 season

Category	Amount (local currency)	Category	Amount (local currency
Crops (grains/seeds) sales		formal employment	
garden sales		Self employed	
Fruit sales		Remittances	
Livestock/fish sales		Other (specify)	
Petty trading			

36. What are the three most serious threats for livelihoods of your household? (e.g., droughts, food insecurity, etc.)

[1] ----------

[2] ----------

[3] ----------

37. 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] ----------

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

39. Last season how much months of cereal did you produce ……

40. 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- livestock/fish sales 9-other (specify)

41. What is your main market for purchasing the balance cereal …….

42. Are there any chronically ill people in the household? 1- yes 2- No

43. In the past 3 months has there been a death in the family? 1- yes 2- no

44. If yes what was the cause of the death? …….

End of interview: Thank you for your cooperation

Appendix II: Lingo results

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Modeling of household farming system and implication of the garden size on the household incomes

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! optimisation household model with maize and leaf vegetables(0.2ha);

[objective_function]max=pmz*Dfd*Mzyld+pg*Dgc*Gyld+Lout*Wi-Lin*Wi;

!constraints;

[landf_constraint]∑Dfd<=Dfd;

[landg_constraint]∑Dgc<=Dgc;

[labour_constraint]Lf + Lin- ∑Lai - ∑Lf -  ∑Lg - Lout =0;

[budget_constraint]So + Lout*Wi- ∑Cfi*Af - ∑ Cgi*Agi - Mzbt- Lin*Wi=0;

[consumption_constraint]∑Gm*Af+ Qmzbt >= 120(1+α)*FLE;

data:pmz,Mzyld,pg,Gyld,Wi=240,1.3,1,5.78,5;enddata

data:Dfd,Dgc,Lf,Cfd,Cgc,FLE=1.6,0.2,2.78,254,420,2.78;enddata

end

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! optimisation household model with maize and leaf vegetables(0.4ha);

[objective_function]max=pmz*Dfd*Mzyld+pg*Dgc*Gyld+Lout*Wi-Lin*Wi;

!constraints;
```

[landf_constraint]∑Dfd<=Dfd;

[landg_constraint]∑Dgc<=Dgc;

[labour_constraint]Lf + Lin- ∑Lai - ∑Lf - ∑Lg - Lout =0;

[budget_constraint]So + Lout*Wi- ∑Cfi*Af - ∑ Cgi*Agi - Mzbt- Lin*Wi=0;

[consumption_constraint]∑Gm*Af+ Qmzbt >= 120(1+α)*FLE;

data:pmz,Mzyld,pg,Gyld,Wi=240,1.3,1,5.78,5;enddata

data:Dfd,Dgc,Lf,Cfd,Cgc,FLE=1.6,0.2,2.78,254,420,2.78;enddata

end

! optimisation household model with maize and leaf vegetables(1ha);

[objective_function]max=pmz*Dfd*Mzyld+pg*Dgc*Gyld+Lout*Wi-Lin*Wi;

!constraints;

[landf_constraint]∑Dfd<=Dfd;

[landg_constraint]∑Dgc<=Dgc;

[labour_constraint]Lf + Lin- ∑Lai - ∑Lf - ∑Lg - Lout =0;

[budget_constraint]So + Lout*Wi- ∑Cfi*Af - ∑ Cgi*Agi - Mzbt- Lin*Wi=0;

[consumption_constraint]∑Gm*Af+ Qmzbt >= 120(1+α)*FLE;

data:pmz,Mzyld,pg,Gyld,Wi=240,1.3,1,5.78,5;enddata

data:Dfd,Dgc,Lf,Cfd,Cgc,FLE=1.6,0.2,2.78,254,420,2.78;enddata

end

LINGO RESULTS

a) Solution of household on 0.2ha garden area

Garden 0.2ha

Local optimal solution found.

Objective value:	1655.200
Infeasibilities:	0.000000
Total solver iterations:	8

Variable	Value	Reduced Cost
PMZ	240.0000	0.000000
DFD	1.600000	0.000000
MZYLD	1.300000	0.000000
PG	1.000000	0.000000
DGC	0.2000000	0.000000
GYLD	5780.000	0.000000
LOUT	0.2500000	0.000000
WI	12.23000	0.000000
LIN	0.2500000	0.000000
LF	2.780000	0.000000
LAI	0.000000	12.23000
LG	0.000000	12.23000
SO	490.4000	0.000000

CFD	254.0000	0.000000
CGC	420.0000	0.000000
MZBT	0.000000	0.000000
GM	0.000000	0.000000
QMZBT	533.6000	0.000000
FLE	2.780000	0.000000

Row	Slack or Surplus	Dual Price
OBJECTIVE_FUNCTION	1655.200	1.000000
LANDF_CONSTRAINT	0.000000	0.000000
LANDG_CONSTRAINT	0.000000	0.000000
LABOUR_CONSTRAINT	0.000000	-12.23000
BUDGET_CONSTRAINT	0.000000	0.000000
CONSUMPTION_CONSTRAINT	0.000000	0.000000

b) Solution of household on 0.2ha garden area

Garden 0.4 ha

Local optimal solution found.

Objective value:	2811.200
Infeasibilities:	0.000000
Total solver iterations:	8

Variable	Value	Reduced Cost
PMZ	240.0000	0.000000
DFD	1.600000	0.000000
MZYLD	1.300000	0.000000
PG	1.000000	0.000000
DGC	0.4000000	0.000000
GYLD	5780.000	0.000000
LOUT	0.2500000	0.000000
WI	12.23000	0.000000
LIN	0.2500000	0.000000
LF	2.780000	0.000000
LAI	0.000000	12.23000
LG	0.000000	12.23000
SO	574.4000	0.000000
CFD	254.0000	0.000000
CGC	420.0000	0.000000
MZBT	0.000000	0.000000
GM	0.000000	0.000000
QMZBT	533.6000	0.000000
FLE	2.780000	0.000000

Row	Slack or Surplus	Dual Price

OBJECTIVE_FUNCTION	2811.200	1.000000
LANDF_CONSTRAINT	0.000000	0.000000
LANDG_CONSTRAINT	0.000000	0.000000
LABOUR_CONSTRAINT	0.000000	-12.23000
BUDGET_CONSTRAINT	0.000000	0.000000
CONSUMPTION_CONSTRAINT	0.000000	0.000000

c) Solution of household on 0.2ha garden area

Garden 1 ha

Local optimal solution found.

Objective value:	6279.200
Infeasibilities:	0.000000
Total solver iterations:	8

Variable	Value	Reduced Cost
PMZ	240.0000	0.000000
DFD	1.600000	0.000000
MZYLD	1.300000	0.000000
PG	1.000000	0.000000
DGC	1.000000	0.000000
GYLD	5780.000	0.000000

LOUT	0.2500000	0.000000
WI	12.23000	0.000000
LIN	0.2500000	0.000000
LF	2.780000	0.000000
LAI	0.000000	12.23000
LG	0.000000	12.23000
SO	826.4000	0.000000
CFD	254.0000	0.000000
CGC	420.0000	0.000000
MZBT	0.000000	0.000000
GM	0.000000	0.000000
QMZBT	533.6000	0.000000
FLE	2.780000	0.000000

Row	Slack or Surplus	Dual Price
OBJECTIVE_FUNCTION	6279.200	1.000000
LANDF_CONSTRAINT	0.000000	0.000000
LANDG_CONSTRAINT	0.000000	0.000000
LABOUR_CONSTRAINT	0.000000	-12.23000
BUDGET_CONSTRAINT	0.000000	0.000000
CONSUMPTION_CONSTRAINT	0.000000	0.000000