CONTRIBUTION OF HORTICULTURE FARMING ON SMALLHOLDER FARMERS' INCOME AND FOOD SECURITY IN TANZANIA:

A CASE OF ARUMERU DISTRICT

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A CASE OF ARUMERU DISTRICT

By

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ADissertation submitted in partial fulfillment for the Requirements of the Award of Masters of Science in Economics of Mzumbe University

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CERTIFICATION

We, the undersigned, certify that we have read and hereby recommending for acceptance by the Mzumbe University, a research report entitled **"Contribution of Horticulture farming on Smallholder farmers'Income and Food security in Tanzania"**, in partial fulfillment of the requirements for the award of Masters of Science in Economics (MSc. Economics) at Mzumbe University.

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I, **Loishoo Likinjiye**, declare that this dissertation is my work and that it has not been submitted nor will be submitted to any other University for comparable or any other degree award.

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DEDICATION

I dedicate this dissertation to my mother, Ms. Natang'amwaki Likinjiye for the sacrifice she made to provide me with good education since primary level to university level.

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LIST OF ABBREVIATION

EAC	-	East Africa Community
FAO	-	Food and Agricultural Organization
FCS	-	Food consumption score
GDP	-	Gross Domestic Product
HODECT	-	Horticultural Development Council of Tanzania
MAFSC	-	Ministry of Agriculture, Food Security and Cooperatives
MDGs	-	Millenium Development Goals
NBS	-	National Bureau of Statistics
NHDS	-	National Horticultural Development Strategy
SADC	-	Southern African Development Community
SPSS	-	Statistical Package for Social Sciences
TAHA	-	Tanzania Horticultural Association
USA	-	United State of America
URT	-	United Republic of Tanzania

ABSTRACT

Horticultural farming is a most and potential agricultural sub-sector which contributes to the income of smallholder farmers and also acess to food security. Tanzania is among of the countries in the world where horticulture farming growing and contributes to the income generation and access to food security to small farmers. This study intended to assess the contribution of horticulture farming to smallholder farmer's income and food security in four selected wards atArumeru district in Tanzania. Purposely the study aimed at examine the role of horticulture farming to smallholder farmer's income and food security, determinants of small farmer's participation to horticulture farming and describe the challenges that hinders the performance of horticulture farming in Arumerudistrict.The study used cross sectional research design in data collection while purposive sampling was used in selection of wards and horticultural small farmerswith the sample size of 210. The primary data were collected by using interview and questionnaires and few data on secondary were obtained from horticulture stakeholders such as TAHA and HODECT. The analysis of data done by using multiple linear regression, probit and ordered probit model in relation to the specific objectives. The study found that; marital status, employed and self employed farmer, land size, farming experience, household size and access to credit are statistically significant influencing small farmer's income from horticulture farming. For probit model; land size, employed and self-employed and land size were statistically significant to determine farmer's participation and lastly ordered probit where marital status, self employed, land size and membership of a farmer to farming group were found to be statistically significant on influencing food security.

Lastly the study recommended on agricultural policy reforms and strategies as measures to be implemented by the government and other horticultural farming stakeholders towards improvement and sustainability of horticulture farming to smallholder farmers in the country. These includes provision of agricultural subsidies (fertilizers, seeds and pests), Market extension and access to credits.

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CHAPTER ONE
INTRODUCTION

1.1 Back ground of the study

Agricultural production is commonly recognized as the most important way to tackle poverty in the developing world. According to this understanding, the Sarris cited Department ofInternational Development (2003) reported that a 1% rise in agricultural productivity could theoretically decrease by 0.6 to 2 percent the number of poor people living on less than 1 dollar a day.

In the majority African countries, agriculture plays a significant role in society and the economy as a whole and enlarged productivity in the sector is well thought-out to be the very foundation for the continent's economic and social development. Agriculture contributes a significant segment to the national GDP and employing over 75% of the population in most developing countries (Salami et al., 2010).

In Tanzania, however, agricultureremains as the main sector and instrumental in reducing poverty. The sector contributes to almost 26.7% ofTanzania's GDP and enhances employment to the majority of the national's population. The sector has a significant inflation control position, where over 95% of the country's food needs are domestically produced. It also provides 65% of the country's industrial raw materials and contributes 30% of exportsincome (HODECT, 2010). Rural households in Sub-Saharan Africa as well as West African countries such as Ivory Coast and Ghana endowmainlyin agriculture where horticulture farming is imperativeoncrop produced in many areas (Temu and Temu, 2006). Horticultural crops correspond toa rationalquantity of agricultural crop produced in African countries with dissimilar spatial aggregation along with agricultural zones.

Horticulture is an industry dating from 17thcentury when the growth of large towns made the manufacture of compulsory garden plants impractical. Modern horticulture today represents a million-dollar company in high-profile countries like the Netherlands, China, Belgium, Germany , France, the USA, Japan , Australia and the Soviet Union countries and in Africa Zimbabwe (Baeyer, 2010).Commercially, the horticulture farming is subdivided into the nursery industryincluding (production of

fruit trees for fruit growers and ornamental plants for the ornamental horticulturist) andPlant industry (supply to the vegetable/flower and ornamental horticulturalist annual, biannual and perennial plants) and seed production industry produces and supplies seeds for the vegetables and flower growers (Virginia Cooperative Extension, 2007).

Horticulture farmers play a major contribution in socio-economic development as a means ofreducing poverty and generating sustainable employment and incomes (Mahadea, 2013). There are shreds of evidenceto believe that countries thathave a higher percentage of entrepreneurs on horticultural farming have developed much faster as compared to their counterparts (Vinesh, 2014). With plentiful natural resources which include land and large horticulture farming resources base in Tanzania, horticulture farming is becoming an imperative tool of agriculture that plays a noteworthy role in job formation which lead to income generation. Exposure of the majority of the local populations, whether rural or urban to food security and nutrition (Temu and Temu 2006). The horticulture sub-sector in Tanzania is rising rapidly annually by 6-10 percent, contributing to export income in the country and, as such, is being provided with production and market growth potential for domestic and foreign investment especially in flowers and export plants (HODECT, 2010).

1.2 Statement of the Problem

Horticultural crops represent a very reasonable amount of agricultural crop production in EAC and African countries with different spatial aggregation among agricultural zones. It is one of the growing industry in the world contributing almost $57 billion annually from trade (Government of Rwanda 2006).Sub-Saharan African countries accounts for just 5% of the whole trade. In East Africa, Kenya is a dominant country in horticulture where it exports more than $ 400 million USD dollars to abroad surpassing even coffee and tea. Uganda horticulture exports in 2005 amounted to only 60 million USD dollars. In numerous developing countries around the world, this industry provides a significant return where in the last decade, the horticultural sector has expanded significantly, but the volume still indicate a small part of the aggregate agricultural sector in general. Horticultural small farmers with a few large operators

are thus ultimately experiencing significant contributions to food sacurity, nutritional improvements and economic growth (HODECT, 2010).

Highly growing in demand and markets for horticulture produces in broad extend the latest avenues for enhancing household rural incomes in most of the East African countries (Temu and Temu, 2006). In Kenya horticultural farming consisting of vegetables which play an important and crucial function in increasing employment and is frequently produced in a small area of farms, thus it influences and increases income for poor smallholder farmers (Ndambiri et al., 2012). In addition contributes considerably to the accumulation of foreign exchange earnings and employsapproximately 2.5 million people as farmers in both formal and informal sectors (Ndambiri et al., 2012). Because of its presumed productivity, many growers prefer horticulture farming to other forms of agriculture (Mwangi et al., 2015). The subsector is, however, faced with major challenges in cases where farming is more expensive than other forms of agri-industry.

Despite the contributions and benefits that are experienced by smallholder farmers on horticulture farming, it has been found that the sector has been faced by various challenges, including inadequate export of good quality products and unprofitable production to the developing countries, especially in Africa. The challenges faced by horticultural small farmers are seen either in farming, post-harvest, selling or a combination of all of them (Ayandiji and Adeniyi, 2011).

Nevertheless, there are various studies done by researchers on horticulture production such as Chege (2014) who assessed the effect of export vegetable farming in Mbooni, Kirinyaga and Buuri on food security of small farmers in Kenya. The study found that, exporting vegetables was not statistically significant to food security in Buuri district. Furthermore, Shelukinga (2015) on his study on contribution of horticulture entrepreneurs to the development of local community, reported that entrepreneurship on horticulture farming enhances growth and development of the farmer's livelihoods where the welfare and other needs in the family were improved. Mhanga (2017) wrote on the contribution of horticulture in the livelihood of small scale farmers and found a significant contribution in the reduction of income poverty. Even though there are

other several studies on horticulture farming done by Mwangi (2016), Masunga (2014), still little is known regarding the contribution of horticulture farming to small farmer's income and food security in Tanzania.The study aimed to contribute and sharing the understanding and knowledge of farmers' participation in horticulture farming toward income generation and the extent of food security to farmers. It'stherefore, the intention of this study to add up more detailed knowledge and great understanding of horticulture farming on increasing farmers' income and food security in Arumeru district, Tanzania.

1.3 General Objective

To assess the contributions of horticulture farming on smallholder farmer's income and food security in Tanzania.

1.3.1 Specific objectives

The specific objectives of the study were to:

i. To examine the role of horticulture farming on small farmer's income and food security in Arumeru District.
ii. To analyze the determinants of Small farmers' participation in horticulture farming in Arumeru District.
iii. To describe the challenges that hinder the performance of small farmers on horticulture farming in Arumeru District.

1.3.2 Research Questions

i. What are the roles of horticulture farming on small farmer's income and food security in Arumeru District?
ii. What are the determinants of Small farmers' participation in horticulture farming in Arumeru District?
iii. What are the challenges that hinder the performance of small farmers on horticulture farming in Arumeru District?

1.4 Significance of the Study

The expectations of the findings of this research together with recommendations is a guide tool for policy formulation and decision making to the government and to other agricultural stakeholders in the economy. This enhancemore investment on horticulture farming as a growing sector where the government providesagricultural training and buildsconsciousness to small farmers including young people and women. This will increase more emphasis to farmers to engage on horticulture farming due to it's contribution onincome and also food security hence improve their welfare.

For sustainable and proper economic growth, the agricultural sector is a domain or an engine which contribute much in GDP of the country in which the horticultural sector plays a key responsibility in rising the small farmer's income, accesses to food security and additionally the inflow of foreign currency to the economy through exports. The study recommended on policy reforms and proper farming strategies that enables the smallholder farmers to improve horticulture production and adopt proper mechanisms and techniques of farming that would increase the productivity of crops and surplus on food security.

1.5 Scope of the study

The study conducted at Arumeru district in Nduruma, Sambasha, Kikwe and Ilkiding'a wards, where the horticulture farming is practiced and the data were collected to assess the contributions of horticulture farming on smallholder farmer's income and food security. The reason for this was because the participation and involvement of farmers to horticulture farming are not much high compared to the potentiality of the region on horticulture.

CHAPTERTWO
LITERATURE REVIEW

2.1 Introduction

This chapter consists a definition on main concepts, theoretical framework and empirical studies on the role of horticulture farmingto smallholder farmer's in income and food security. It is therefore, divided into subsections as presented hereunder.

2.2 Definition of Concepts

2.2.1 Horticulture

According to the Louisana State University in Germany (2011), horticulture is the scientific and artistic component of ornamental plants, flowers, turf, vegetables, fruit and nut products. It is unique with plant science because it requires not only science and technology, but also art and design concepts.

The term horticulture is also described as the science and art of growing ornamental fruits, vegetables or flora (Alam and Goyal, 2007). A science and art of growing fruit, plants, flowers, shrubs and trees (land gardening) can also be known as horticulture. Originally intended for planting, horticulture now means cultivation of plants previously grown in gardens. Commercial horticulture is divided into the nursery industry (the fruit trees are produced by fruit growers and ornamental plants are produced by the plant ornamentalist). Plastic processing industries (annual, biannual and permanent supply of vegetables and plants to the flowering industry and ornamental horticulturalists and seed production industries).

2.2.1.1 World Horticulture Outlook

For horticultural firms, conventional as well as new products, major growth opportunities exist across domestic, global and foreign markets. Global growth in horticulture between 2001 and 2008 was 13% on average (Fig.2.1). All four horticulture groups (fruits , vegetables, flowers and spices) have grown over 10% per year since 2001 with the fastest-growing spices and fruits. The USA and Europe are the main importers of vegetable crops. Nevertheless, Russia, India, the UAE and Turkey are among the fastest growing markets for horticultural exports (HODECT, 2010).

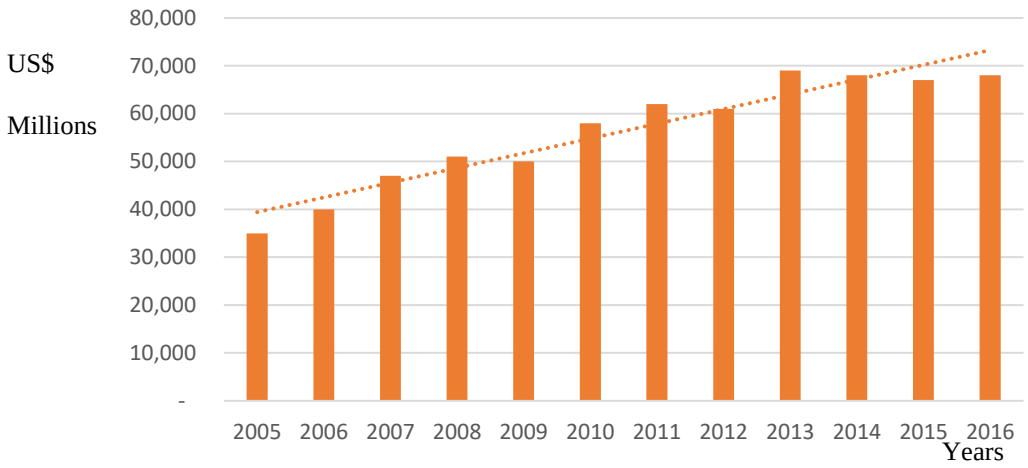


Figure 2.1 Horticulture- Global Overview

Source: TAHA (2019)

World vegetable imports have consistently increased by over 90% between 2005 and 2015 at local, regional and international markets. The growth has been due to the altered consumer preferences and growing health awareness, both Rapid urbanization and emergence of a middle-class of relative wealth rising incomes trade liberalization technological innovations (TAHA, 2019).

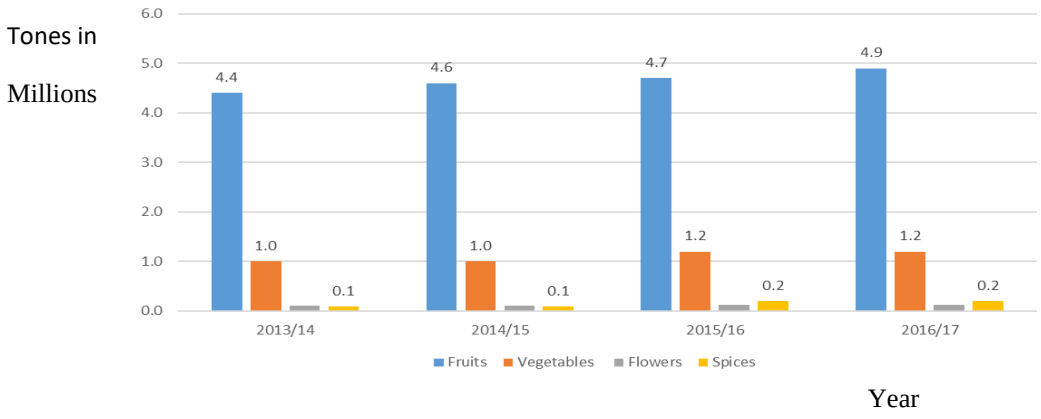
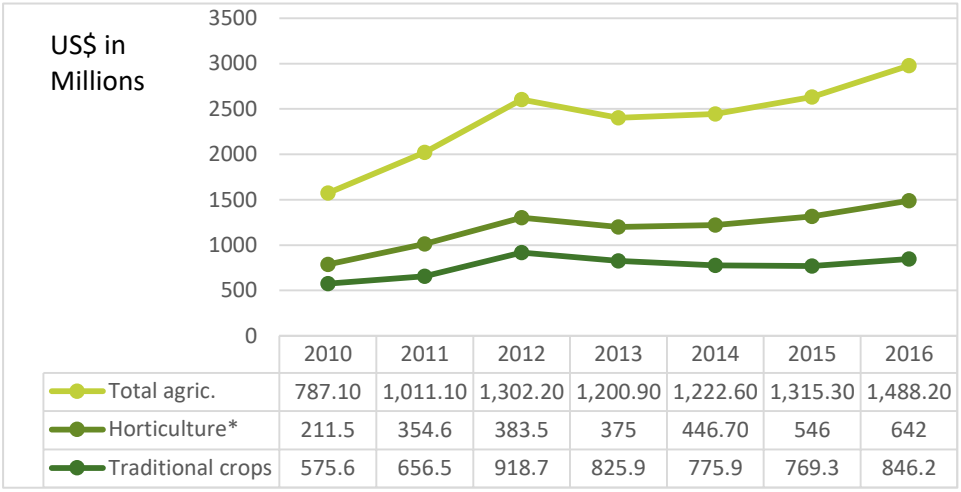


Figure 2.2 Horticulture Production in Million Tones

Source: TAHA (2019)

Figure 2.2, Shows that there is a Steady growth in production over the years whereas Fruits production is highly seasonal, bulky, uncoordinated, attributed by high levels of post-harvest losses while the flower production is dominated by big producers.



	2010	2011	2012	2013	2014	2015	2016
Total agric.	787.10	1,011.10	1,302.20	1,200.90	1,222.60	1,315.30	1,488.20
Horticulture*	211.5	354.6	383.5	375	446.70	546	642
Traditional crops	575.6	656.5	918.7	825.9	775.9	769.3	846.2

Figure 2.3 Horticulture Vs Traditional exports

Source: TAHA(2019)

Figure 2.3, Shows that there is a slight increase in traditional commodities**.** Cotton and tea show a declining trend from 2010 while horticulture becoming the main commodity overtaking other traditional commodities. Tobacco showing fluctuation trends, as themain contributor to foreign income earned from agriculture 43% in 2016. Strong export growth from the US $ 618.5millions in 2016 to US $ 718millions in 2017 of which horticulture farming has beenincrease in the two successive years at the 23.6% (TAHA, 2019).

2.2.1.2 Overview of Tanzania Horticulture Sub-sector

Horticultural outputs have been included in the Tanzania's diet and basis on food consumption components. The local fruits, vegetables, spices and flowers have been cultivated and traded inside and outside of the country.Tanzania commenced to export horticultural products mostly green beans to abrod in 1950s where export to Europe for perishable horticultural products started in the 1970s while following the achievement of Kenya's horticulture on exports. In the middle of 1980s, a cut flowe industry was established, followed by the development of a cutting industry of chrysanthemums. Currently companies have invested in the distribution of hybrid vegetable seeds, higher-value fruit, vegetables andcut-flowers other than roses(HODECT, 2010).

The development of the horticulture subsector in Tanzania has been noticed by the average growth rate of 11% per annum. Moreover, productivity has increased from 200% to 300% due to the adoption of technologies and good agricultural practices. There has been an increase in revenues collected from horticulture from the US $ 64 million in 2006 to US$ 718 million in 2017. The growth of this sector has led to the influx of new players especially youth and women in many parts of the Tanzania where Zanzibar is a typical example of agricultural transformation as it has reduced "importation" of vegetables and fruits from Tanzania Mainland from 80% in 2014 to 40% presently(TAHA, 2019).

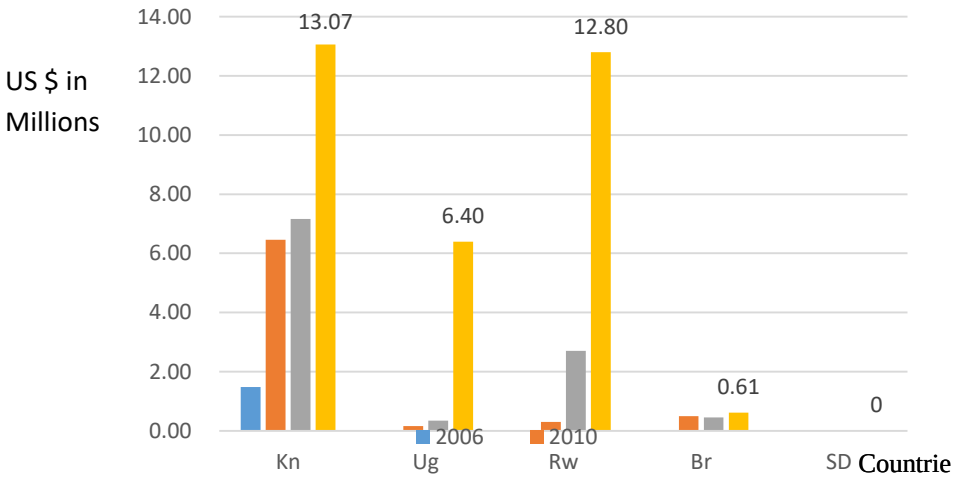


Figure 2.4 Tanzania performance in EAC: Tanzania Vegetable exports to EAC Countries (US $ million)

Source: UNCOMTRADE, (2019)

Figure 2.4, shows that nearly 30% of total EAC vegetable imports (equivalent to the US $ 43 million) are sourced from other countries. Tanzania's main exports to regional countries are onions, round potatoes, fresh and dried beans and peas. Tanzania holds a share of 14% of the total vegetable trade in the EAC, earning US $ 33 million in 2017. Kenya is Tanzania's most important vegetable regional export destination (US $ 13 million in 2017 up from 7.4 million in 2010. Burundi and South Sudan are insignificant Partners, with almost zero imports from Tanzania. There has been an abrupt increase in vegetable export to Rwanda from 2.7 million in 2014 to 12.8 million in 2017.

Tanzania has only11% share in the Kenyan vegetable market (UNCOMTRADE, 2019).

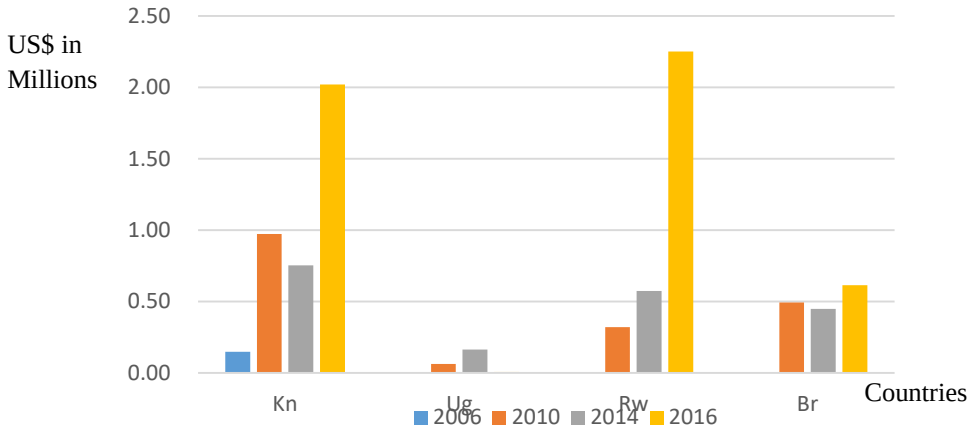


Figure 2.5: Tanzania's fruit trade with EAC (US $ million)

Source: UNCOMTRADE, (2019)

Figure 2.5, Shows that Kenya and Rwanda are the most important trading Partners, Fruits trade is lower compared to vegetables because of seasonality and higher demand forthe products in the domestic market as the intra trade is only 22% of the total EAC fruit trade.

Current Tanzania fruit trade with SADC countries

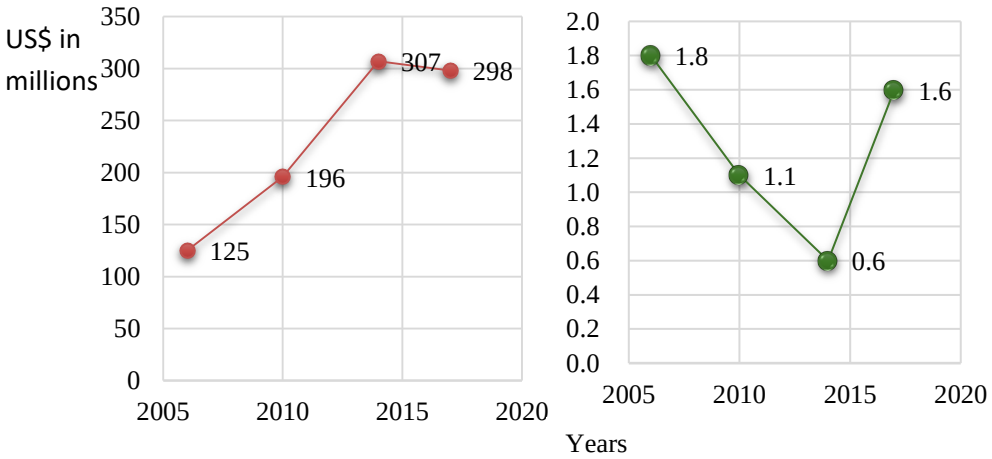


Figure 2.6 (a): SADC Imports US million (World)

Figure 2.6 (b): Tanzania Exports to SADC

Sources: TAHA, (2019)

From figure 6 (a) and (b): Market share in SADC is less than 1%. Tanzania has an insignificant trade with neighboring countries like Mozambique, Malawi, DRC and Comoro. The major Crop demands are on spices (ginger, garlic) potato, fruits.

Table 2.1 Major Horticultural Production zones in Tanzania

S/N	Zone	Fruit	Vegetable	Market
1.	**Coastal regions:** Dar es Salaam Coast Tanga	Mango, citrus, banana, papaya, pineapple, passion fruits, avocado	Tomato, chili, pepper, okra amaranth, sweet potato, watermelon, cucumber	Local market. Tanga region export fruits & vegetables to Kenya and the UA
2.	**The Southern Coast:** Mtwara and Lindi.	Orange, tangerine, papaya, mango, lime	Tomato, okra, eggplant, watermelon, pumpkins and cucumber	Local market only
3.	**Central Plateaux:** Dodoma, Singida&Tabora	Mango, grapes, papaya, guava, dates baobab, tamarind	Tomato, okra, eggplant, watermelon, pumpkins and cucumber	Local market
4.	**North & South Highlands:** Arusha Kilimanjaro Iringa, Mbeya, Rukwa, Ruvuma and Morogoro	Temperate fruits and tropical fruits, e.g .banana, citrus, papaya, pineapple avocado, passion fruits	Tomato, cabbage, onion, beans, potato, carrots, cucumber, leek	Local market Flowers, fruits and vegetables are exported to Kenya, UAE, EU, Uganda, From Arusha, Moshi, and Tanga
5.	**Lake areas:** These are regions around lake Tanganyika and Victoria: Kigoma, Mwanza, Kagera and Mara	Banana, Mango, pineapple, citrus, guava, papaya	Various vegetables	Local markets Exporting to Kenya, Uganda, Ruanda, DRC and Burundi

Source: MAFSC- Horticultural Unit

2.3 Food Security

Food security refers as a measure of food availability in the family or at community level and individuals' capability to access it. According to the 1996 World Food, Food security was described as "where all people have access to adequate, safe and nutritious foodat all times to maintain a healthy and active life." Commonly, the definition of food protection requires access to foods that meet the nutritional requirements of individuals and their food preferences, both physical and economic. Home food protection is established when all participants have access to adequate food

for an active healthy life at all times. Food security requires a measure of resilience to avoid or interrupt severe food supplies in future because of numerous risk factors such as droughts, instability in the shipping sector, fuel shortages, economic instabilities and wars.

Food security is availability and convenience at all times of sufficient food-staffs to acquire a steady development of food consumption and to overcome fluctuation in farming activities and price(Devereux and Maxwell, 2001). Family is food secure if it has adequate, protected and access food throughout the year so that, households can convene their nutrients need among the food they desire for an energetic and sustainable welfare (FAO, 2004). Also MAFSC,(2006) explained that food security consists of three different aspects but consistent such as food availability and accessibility.

Today, four main components are commonly understood to form a definition of food security which are availability , access, utilization and stability, while all these components must be sufficiently present for a state of food security to exist (Escamilla, 2017). Basing on the above components, the hub of this study is on food availability as described briefly in the following section.

2.3.1 Food availability

This is realized when sufficient quantities and qualities enough nutritious food needs are available to individuals and households for their consumption. The availability of food can be determined by the level of production, distribution and exchange.

2.4 Theoretical Review

2.4.1Theory of Production

The study based on production theory. It addresses efficiency from agricultural farming through the use and allocation of inputs to attain a maximum amount of output throughout farming. Keeping other production inputs constant, the theory defines development by farm or land size (Fallel, 1957). The productivity of agricultural production inputs are the main resources for coping with horticultural development in the district of Arumeru. The greatest satisfaction that individual small-scale farmers

are getting from the available choices contributes to productivity improvement, food security and income growth for small farmers.

2.4.2 Sen's theory of hunger

Sen's theory of hunger also guided this study. This theory tries at a household analysisunit to explain the causes of famine. In the opinion of Sen, famine is the consequence of the loss of resources and rights of access to goods by many people in a region (Devereux and Maxwell, 2001).

Sen defined entitlements as the set of option bundles of commodities that a person can control in a company using all of his or her rights and opportunities. It seeks to explain broadly all legal sources of food including cultivation of horticultural crops, which Sen reduces to four categories: food cultivation, food purchase, work for food and food distribution for others. (Devereux and Maxwell, 2001). Food security and the achievement of all Multi-Development Goals (MDGs) are prerequisites for achieving this goal.

The two key ways to achieve food security for rural households are farm production and purchase from market (Li and Yu, 2010). Although today's rural areas have altered and offer different opportunities for business, not just in agriculture (horticulture farming) but also in service sectors, the majority of farming households produce under the principles that gardening plays a major role in sustainability improvement for small farmer's livelihoods. Therefore it is mainly through food production by small farmers and generating enough income to enable rural populations to buy sufficient food that the solution to the immediate problem of hunger is solved (Matshe, 2009). Sen 's hunger theory was used in that case for the analysis of food protection from agriculture because smallholder farmers inArumeru district engage in gardening to buy horticultural crops and production in order to sustain foodsecurity (Baha et al.2013).

2.5 Empirical Review

2.5.1 Roles of horticulture farming to smallholder farmer's income

Agricultural growth in developing countries is widely considered as the most effective way to foster economic growth. Horticulture is a major agricultural activities which are potential for income generation and adding value to land resources in Tanzania

(Mashindano et al,. 2013). Rapidly growing markets for horticultural products in general are opening new avenues for enhancing rural incomes in East African countries (Mashindano et al,. 2013). In Rwanda, the horticulture sector attracts jobs and investment and promises the creation of jobs to a significant proportion of Rwandans and provides Rwandans with foreign currencies (Rwanda Government, 2006). Additional horticultural benefits, such as improved nutritional conditions in the human population, establishing a higher icon for Rwanda, encouraging private-public partnerships in horticultural industries and promoting public interest for industry, include economic receipts and jobs.

The horticultural sector has a large prospective for improving the living standards of the people and decrease poverty through improved nutrition arising from the consumption of fruits and vegetables, incomes raised from sales of horticultural products (Ndambiri et al., 2012). The increasing interest in horticultural farming in the majority parts of the world are being viewed more and more as a way to boost economies and a technique of tackling unemployment challenges characterizing mainly developing economies, particularly in developing economies (Mahadea, 2013).

Moreover, Ulrich, (2013) signifies that horticultural farming offers the continuing stipulation of safe, healthy and nutritious food in many countries. This gives many necessary vitamins and minerals hence forth supporting final consumers to attain a balanced diet. Further horticulture farming contributes to economies by export practices and the maturity of all supply chain components. In developed countries that contribute more frequently to the food supply of developed countries, especially in Europe and North America, this becomes progressively more important.

Studies on horticultural farming such as Obare et al (2003) signify that it promotes the practicability of rural communities through jobs and the maintenance of services such that retaining people validates the provision, through the activities of those associated with the development, manufacturing, markets, retail and related sectors, of services such as health and education and the general generation of income.

2.5.2 Roles of agricultural horticulture to smallholder farmers on food security

The food safety status for male and female households in Bongladesh was reviewed by Mallick and Rafi, (2010). These findings show the household leader's gender has no impact on security of households and that there is no accreditation that women participate in labor force culturally and socially. The food security determinants in rural South Africa were examined in a research by De Cock et al. (2013) and multivariate regression analysis revealed that the household dimension is an important determinant of household food security and that smaller households are less likely to be food insecure.

Kassie et al. (2014) evaluated the sex of household leaders in Kenya in connection with food security. They have documented that women's households are more vulnerable than women's households to food insecurity. In a similar way, the impacts of gender disparity on food security amongst smallholders in South Africa were assessed by Tibesigwa and Visser (2014). Their findings indicate that households with men's heads are healthier in food relative to their females. Moreover, it was noted that in rural areas, as opposed to urban households, a wider gap in food security was observed.

The household food security factors in Kolkata, India have been researched by Maitra and Rao (2015). The results of the probit model showed that a household manager with a higher education level raised his probability of food security in the household. Zhou et al. (2017) examined the factors which impact food security in Pakistan rural using the logistic regression model. The findings confirmed that the household's level of education and employment contributes to ensuring food for households.

Farm sizes in sub-saharan Africa have been shown as a determinant of food security (Frelat et al. 2016). The relationship shows that the probability that a household is food-safe also increases as farm sizes increase. The role of landownership in the productivity of farm rice farmers in the Philippines was studied by Koirala et al (2016) and the rice yield increased by 1 percent in agricultural size by 0.4 percent. The relations between agricultural size and productivity in Ethiopia were discussed by Paul

and WaGithinji (2018). The result shows that the farm size and per hectare yield are in inverse negative relationships.

Aidoo et al. (2013) examined household food security determinants in rural Ghana. The results of the study of a logistic regression model indicate that credit access has a positive impact on the protection of a household 's food. Awotide et al (2016) examined the impact on farm productivity of access to credit for small farmers and confirmed the increase in cassava productivity for households with accommodation. Tirivayi et al. (2016) argued in favor of agriculture interventions by establishing rural microcredit and micro-finance institutions to allevate credit access restrictions for smallholder farmers.

2.5.3 Determinants of smallholder farmer's participation in horticulture farming.

The determinants of the participation of youth in agriculture in Imo State, Nigeria, were investigated by Nnadi and Akwiwu (2008). Data were collected by means of interview schedules and questionnaires. The frequencies tables, simple percentage counts andthe regression pattern were used to analyze these. The findings revealed a participation of 84 per cent in land clearing, planting and fertilizer applications, whereas participation depends on age, education, marital status, parental income, the occupation of parents, household size and the status of dependent young people.

The nature and scope of rural female participation in agricultural and non-agricultural activities were identifies by Farid et al. (2009). The results showed that most of the respondents constitute mostly to illiterate economically active age group. However, the relationship between education and women's participation in farming activities was negative. Nnadi and Akwiwu, (2008) investigated on determinants of youths' participation in rural agriculture in Imo. The data were collected using questionnaires and interview schedules and analyzed by using logit regression model. The results revealed a positive link between household size and female participation.

Oladejo et al. (2011) analyzed women's participation in agricultural production in Egbedore's Local governmental area of Osun State in Nigeria. The results of the empirical results have shown that the size of the household, marital status and regional

taboos have a significant impact on women's participation in agricultural production. The analysis has been descriptive and inferential.

Factors identifying farmer's participation in agricultural projects using the Ghana Agricultural Value chain Mentorship Project have been identified by Etwire et al. (2013) recognized factors which delimitate farmer's participation in agricultural projects including horticulture a case of Agricultural value chain mentorship project in Ghana . The analysis were done by using binary probit model and the results of the analysis showed the importance of the farmers' involvement in agricultural projects by their land size, number of years in school, access to production loans and farm services.

2.5.4 Challenges that hinder the performance of smallholder farmers on horticulture farming

Horticulture around the world is facing some major challenges affecting horticultural production, processing and marketing (Muthoka and Ogutu, 2014). Also the research by Lenis, (2012) in Nigeria also pointed out that in many factors including inappropriate topography, climatic conditions and diseases caused by viruses, micro baked goods, fungi , insects, nematodes and pests have always hindered the domestications and significant cultivation of fruits in Nigeria. In raising credit finances from banks and borrowing over informal networking, horticultural farmers face complexities. Chadha et al.(2008) supported this case and found that, horticultural farmers are normally on small scale and therefore less relevant in financial and administrative matters.

In order to improve social and economical position of farmers, higher education level are considered a causal factor (Robinson and Kolavalli, 2010). In addition, experience, information and connections are required to tap into new markets. The majority of smallholders however still have little access to training and knowledge on how to take part in the market and therefore can not strategically sell products and services (Ndambari et al. 2012).

Horticulture farming, like the majority of small-scale farmers, faces obstacles in securing funds to establish and maintain their business (Kawa and Kaitira, 2007). For various reasons, the main constraints of horticulture farmers are access to the credit

mainly for the opening of a company. This includes a lack of collateral, a failure to accept household assets by loans to horticultural farmer as collateral and negative perceptions (Anang et al., 2013).

2.6 Conceptual Framework

The conceptual framework defined as a summary of ideas or theory used to build up new concepts an reinterpret the existing ones (Kothari, 2011). It describe the relationship between dependent and independent variables in the study. The study consists of horticulture farming as an Independent variable attributed by several factors while the dependent variables are smallholder's income, participation of farmers and food security. The conceptual framework used in this study provided the basis for the theories that were relevant to the study as they were used to guide the whole study.

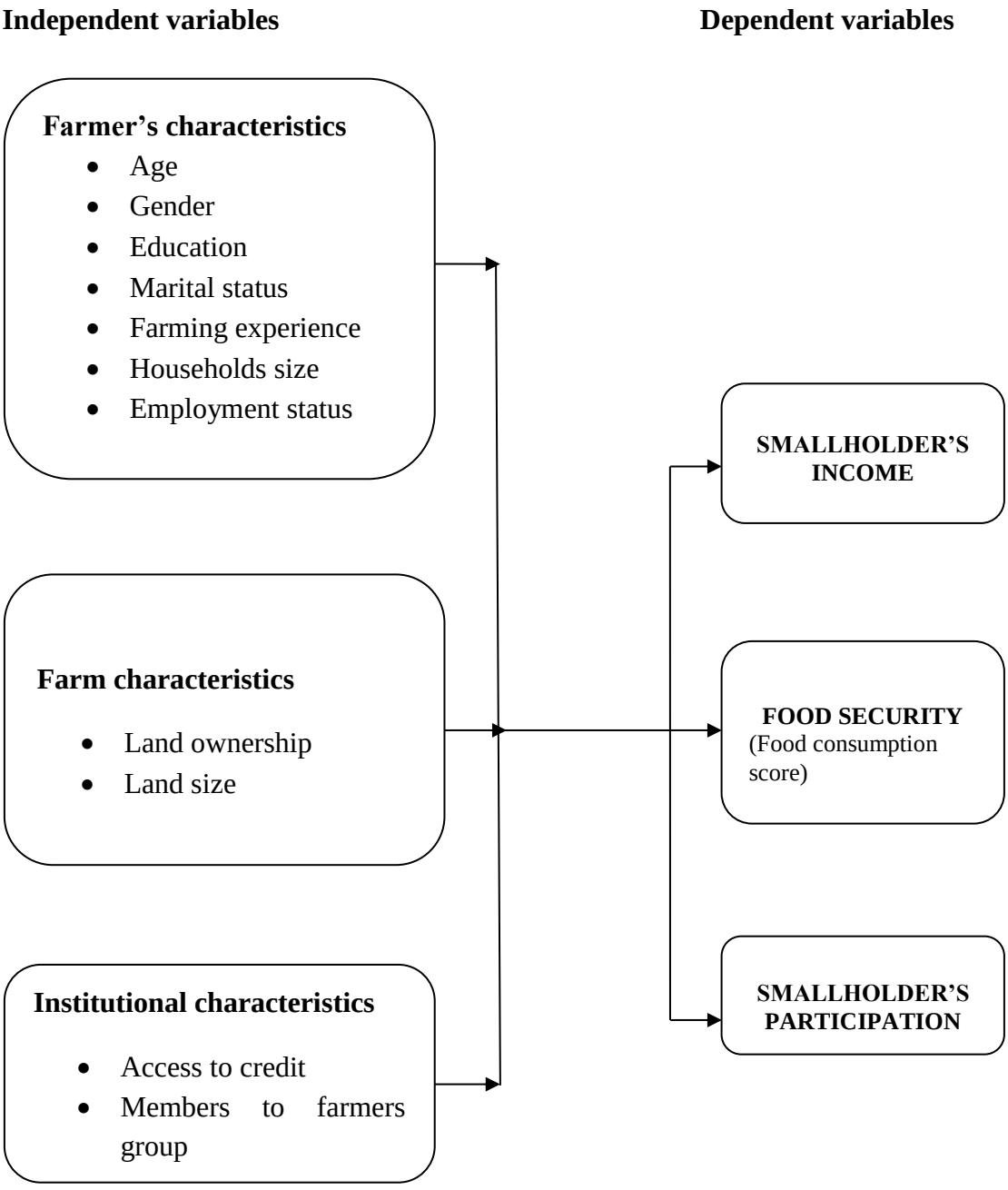


Figure: 2.6. The Conceptual Framework of the Study

Source: Researcher's construct 2020.

2.6.1 Explanation of variables

2.6.1.1 Dependent Variables

The dependent variables are the smallholder's income which is continuous and measured in Tanzania shillings, food security measured by using food consumption score as an indicator while is ordered into three categories namely highly food secured,

moderately food secured and lowly food secured.The last dependent variable is the participation of small farmers as influenced by horticulture farming variables used in the study hence measured by discrete choice whether if an individual participate in horticultural farming or not.

2.7.3 Explanatory Variables

The explanatory variables are selected based on previous literature and theories, Thus, the variables were divided into three groups; Farmer/household characteristics, farm characteristics and institutional characteristics. Therefore, **Farmer/household characteristics** include sex, age, education, marital status, farming experience, households size and employment status. **Farm characteristics** include land ownership and land size. Lastly **institutional characteristics** which include access to credit and membership to farmers' groups.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

This chapter explains various methodological techniques and procedures which were used in data collection. The chapter also describes the study area, research design, type of data, population of the study, sample size and sampling techniques, procedures and estimation method, data collection instruments, collection procedures and data management and finally data analysis.

3.2 The Study Area

The present study was conducted in Arumeru District which is among the six districts in Arusha region where horticulture farming is highly practiced compared with the rest of other agricultural activities and the majority of the people are engaging in horticultural activities. Arumeru District is located between longitude 35’37 and 35’47 East and latitudes 3’17 and 3’27 South. The total population is 323198 (NBS, 2012) whereby the main economic activities of the majority areagriculture and livestock keeping (Arumeru district profile, 2018).

3.3 Research Design

Both qualitative and quantitative design was used to test and assess the contribution of horticulture farming to smallholder farmers’ income and food security and hindering challenges on the performance of horticulture farming in Arumeru District. The cross-sectional research design was adopted because it facilitates the systematic collection of primary data and presentation of data that provides a clear picture of horticulture farming with a limited sample size. Furthermore, cross-sectional study design is quick and cheap as there is no follow up and hence fewer resources are required to conduct the study (Mann, 2003).

3.4 Targeted Population and sample selection

3.4.1. Target population

The targeted population of any research is the whole range of units for which the survey data should be used to draw conclusions, or is also defined as an eligible population that is included in research. Saunders et al (2007) states that, population is 'the complete set of cases from which a sample is taken.' Population is a group of persons, objects or items that take samples for measurement (Kombo and Tromp, 2006). For this study, smallholder farmers who were participating in horticulture farming in Arumeru district, based on four selected wards were used as the unit of analysis because were the beneficiaries on both income and food security. Further information also was investigated from key informants who were in a position to provide relevant information and ideas on constraints associated with horticulture farming.

3.4.2 Sampling Frame

The sampling frame refers to the list of all units from which the sample is to be drawn at any stage of sampling (DiGaetano,2013). To study a sample in stead of the entire population depends on several factors in cluding measurement of destructive nature, low cost of sampling error, size of the available population, limited time and budget and variation in the element of the population (Kothari, 2011). The process of determining the sampling frame for this study based on the total number of horticulture small farmers in Arumeru district from four selected wards which are approximately 1600 small farmers (TAHA, 2020). Therefore**,** 1600 smallholder farmers from the selected wards of Nduruma, Sambasha, Kikwe and Ilkiding'a formed a sampling frame from which sample size for the study was drawn.

3.5 Sample Size and Sampling Technique

3.5.1 Sample Size

Sample size for each researcher within a given time frame for a different purpose including policy decision and academics is a part of the population selected by the survey or research. The sample size is determined based on a number of quantitative as well as qualitative factors. Qualitative considerations include the design of the

study, method of data analysis, time and resource constraints, the sample size of comparable studies and a number of model variables. The desired degree of accuracy, default, the requested confidence interval and data analysis techniques are all quantitative factors (Malhotra, 2005).

Assumptions

Since there is no perfect information about the number of smallholder farmers who are participating in horticulture farming at Arumeru district, it won't be easy to estimate the proportion and hence the result based on personal judgement of the initial estimate of proportion 'p' for the study to be 90%, thus 5% degree of precision and 95% as trust interval has been taken into consideration, hence expressed as follow:

$$\boldsymbol{n} = \frac{\boldsymbol{z^2 \cdot p \cdot q \cdot N}}{\boldsymbol{e^2(N-1) + z^2 \cdot p \cdot q}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where;

n = Sample size

N = Total number of population …

Z = Confidence interval (1.96)

p = Estimate proportion (90% = 0.9)

q= degree of accuracy ($1 - p = 0.1$)

Therefore,

$$\boldsymbol{n} = \frac{\boldsymbol{z^2 \cdot p \cdot q \cdot N}}{\boldsymbol{e^2(N-1) + z^2 \cdot p \cdot q}} = \frac{\boldsymbol{1.96^2 \times (0.9 \times 0.1) \times (1,600)}}{\boldsymbol{0.05^2(1,600-1) + 1.96^2 \times 0.9 \times 0.1}}$$

$$\boldsymbol{n = \frac{553.1904}{4.343244} = 127.369 \approx 127}$$

The computed sample size is 127 smallholder farmers, however the study further assumed that for sound econometric analysis and considering the fact that each ward should have at least 50 respondents. Therefore, the sample size of 210 smallholder farmers was selected from four wards of Nduruma, Sambasha, Kikwe and Ilkiding'a in Arumeru district to participate in the study of which the adjusted number is 83.

3.5.2 Sampling technique

Sampling technique is one of the systematic techniques of choosing a group of respondents to represent the population from which it has been selected. Sampling also refers to a process of selecting a number of individuals or objects from a population which the selected group contains elements representative of characteristics found in the entire group (Kombo and Tromp, 2006). Sampling technique as defined by Kothari (2011) refers to a procedure which the researchers adopt in selecting items for the sample. This study was designed to capture a representative sample of smallholder farmers from four wards namely Nduruma, Sambasha, Kikwe and Ilkiding'a in Arumeru district. The purposively sampling technique was used in selecting respondents from selected wards and provided equal chances for smallholder farmers to be selected for the study.

3.6 Data Type

Both Primary data and Secondary data were used in this study. Primary data were collected from individual smallholder farmers through cross-sectional survey in four selected wards. The self- administered structured and unstructured questionnaires with both open-ended and closed questions were used. Primary data captured the variables of horticulture farming that contribute to smallholder farmer's income and food security in the study and try to answer the research questions. Secondary data from different sources such as journals, articles, reports and books were used to supliment the information from primary data.

3.7 Data Collection Methods

In this study, a descriptive type of research was adopted to facilitate data collection. According to Hoffman and Sandelands (2005), descriptive research is the method of collecting information by interviewing or administering questionnaires to a sample of individuals. Therefore, the main instruments for the collection of data for smallholder farmers were through questionnaire survey and interviews for primary data collection.

3.7.1Questionnaires

The questionnaires were made and distributed according to the sample chosen by the researcher which is 210 respondents. The questions that were contained in the

questionnaires included both open-ended as well as closed-ended questions for respondents where they provided their opinions and information of horticulture farming on income and food security in relation to the research target. The information obtained aimed to explain the specific objectives to assess the contribution of horticulture farming to smallholder farmer's income and food security and determinants of smallholder farmers' participation in this agricultural sub-sector in Arumeru district. Given the number of respondent farmers, a researcher used questionnaires which were equally distributed to all small farmers that were used for data collection.

3.7.2 Interview

The study also interviewed some key informants such as production managers, marketing managers, extension or agricultural officers from TAHA as a leading stakeholder on horticulture farming in Tanzania where they provided some other informations to support the information obtained on questionnaires.

3.8 Unit of analysis

The recently smallholder farmers who getting involved on horticulture farming in Arumeru district from four selected wards were selected to provide information on data collection for the study.

3.9 Variables measurements and descriptions

The study included variables associated with farmers' characteristics, farm characteristics and institutional characteristics such as age, gender, marital status, education level, farming experience, employment status, land size, household size, land ownership, access to credit and membership to farming group. Table 3.1 shows description of dependent variables associated with explanatory variables with their measurements.

Table 3.1 indicating variable measurements their description and expected signs

Dependent variables	**Measurements**	**Categories**	**Expected outcome**
Smallholder Income	Income obtained from selling crops in a year and its measured by using Tanzania shillings	Continuous	+ve
Participation	1 for participate or 0 otherwise	Binary	+ve/-ve
Food security	Amount of food that a small farmer consume or secure in a year measured by using food consumption score. 1 for highly food secured 2 for moderately secured 3 for lowly food secured	Ordinal	+ve/-ve
Independent variables			
Age	The age of a small farmer measured in number of years	Continuous	+ve/-ve
Educational level	Number of years of schooling and categorized as; 1 for primary level 0 otherwise 1 for secondary level 0 otherwise 1 for college/university level 0 otherwise	Ordinal	+ve/-ve
Marital status	The status that a small farmer is married or unmarried. 0 for unmarried 1 for married	Binary	+ve/-ve
Gender of a small farmer	If a small farmer is a male or female. 0 for female 1 for male	Binary	+ve/-ve
Employment status	This is categorized as; 0 if unemployed 1 if employed 2 if self employed	Ordinal	+ve/-ve
Household size	The number of households or small famers grouped in a family (1-3) households (4-6) households (7-10) households More than 10 households	Ordinal	+ve/-ve
Farming experience	The period that a small farmer has in farming measured in number of years Less than one year (1-3) years 4 years and above	Ordinal	+ve/-ve

Land ownership	This is if a small farmer own a land or not: 1 if own land 0 if not own land	Binary	+ve/-ve
Land size	The size of land that is used for horticulture farming measured in hectors. Less than a hector (1-3) hectors 4 hectors and above	Ordinal	+ve/-ve
Access to credit	This is if small farmer have access to credit or not: 1 for access credit 0 for no access to credit	Binary	+ve/-ve
Membership	If a small farmer is a member to farming group or not: 1 for membership 0 for non-membership	Binary	+ve/-ve

Source: **(Researcher's Own Design, 2020)**

3.10 Method of Data Analysis

The study used both descriptive and econometric method of data analysis due to their convenience in data analysis. Descriptive analysis through frequencies, mean, standard deviation and tables were used to produce an overview of the collected data. For Quantitative data, statistical analysis was conducted using numerical data collected in order to enlighten the contribution of horticulture farming to smallholder farmer's income and food security.

3.10.1 Descriptive method of data analysis

The descriptive statistic techniques likemeasuresofcentraltendency and measures of sample distribution were usedtoanalyze data collected from respondents in the study area. Moreover, the tabulationtechniques were used to represent data collected through tables. The Statistical Packages for Social Sciences (SPSS) version18and STATA 14were also used to support the analysis.

3.10.2 Econometric Method of Data Analysis

Data were analyzed by the use of Multiple Linear regression model, Binary choice (Probit) model and Ordered Probit Model depending on the nature of the dependent variables of income which is continuous, food security which is categorical and ordinal and farmers participation which is binary. In ordered probit, the dependent variable is ordinal but not continuous in the sense that the metric used to code the variables is substantively meaningful. While the multiple linear regression model was used to examine the contribution of the horticulture farming to the smallholders' income. Lastly the binary probit model used to analyze the determinants of Smallholder farmers' participation in horticulture farming. The hypothesis were tested through statistical data analysis programs such as SPSS and STATA where the outcomes were used to interpret the relation and explain the influence of independent variables to the dependent variables.

3.11 Model Specification

Different multivariate statistical methods were used to predict dependent variables from a number of independent variables of the model. The model of analysis expressed as linear equation with respect to specific objectives of the study.

3.11.1 To examine the roles of horticulture farming to smallholder farmer's income in Arumeru District

The multiple Linear Model

Watanabe and Ortega, (2011). Regression analysis shows the mathematical relation between exogenous and endogenous variables. A model of relationship is hypothesized and the estimate of the parameters values develop an estimated regression equation. Therefore, STATA opted the linear equation of regression to examine the relationship between the variables by using multiple regression analysis.

Therefore, the following model equation was applied:

$$\boldsymbol{Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \cdots + \beta_k X_k + \varepsilon_i}$$

Where:$\boldsymbol{Y}$ = Smallholder farmer's Income (Tshs.) in a year

$\boldsymbol{X_i}$ = independent variables, $\boldsymbol{\beta_1}$, $\boldsymbol{\beta_2}$ ... $\boldsymbol{\beta_k}$coefficient of respective independent variables and $\boldsymbol{\varepsilon_i}$ error term.

3.11.2 To examine the rolesof horticulture farming to smallholder farmers on food securityinArumeru District

Ordered Probit Model

The ordered probit regression model used on this objective to analyze food security against horticulture farming variables as described in the literature. This model is appropriate for the analysis than other regression model as the depended variable is categorical and ordinal (Greene, 2012).

Using food consumption score (FCS) as an indicator adopted by this study to measure food security where it's ranked into three categories such as highly food secured, moderately secured and lowly food secured. The model is calculated with the following equation;

$$y_i^* = x_i\beta + \varepsilon_i$$

where y_i^* is an unobserved random variable, x is a vector of socioeconomic variables assuming normal distribution, $\varepsilon_i = N(0,1)$, and $i = 1, 2, \ldots, N$.

y_i is the observable ordinal variable, $y_i = j$ if $\mu_{j-1} < y_i^* \leq \mu_j$

where $j = 0, 1, \ldots, n$, $\mu_{-1} = -\infty$, and $\mu_n = +\infty$.

The probability is calculated with the following interval decision rule;

$$Prob\,[y_i = j] = \varphi(\mu_j - x_i\beta) - \varphi(\mu_{j-1} - x_i\beta)$$

Whereφ denotes the cumulative distribution function and j represents the categories of dependent variables.

Therefore in this regard, ε_i is entry variable in the model. The entry variable is unobservable and determined in the maximum likelihood inference process for the ordered probit model. Thus, the linear regression equation expressed as follow:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \cdots + \beta_k X_k + \varepsilon_i$$

Where $\boldsymbol{Y}=$ Food Security in kilograms of quantity harvested and saved as its ordered into highly food secure, moderate food secure and lowly food secure.

$\boldsymbol{X_i} =$ independent variables, $\boldsymbol{\beta_i}$= Coefficient of variable and $i = 1, 2, 3 \ldots n$ and $\boldsymbol{\varepsilon_i} =$ error term.

3.11.3 To analyze the determinants of Smallholder farmers' participation in horticulture farming in Arumeru District

Binary probit model was used to analyze this objective whereas participation of small farmers valued 1 if participate and 0 if not participate. Following from Greene (2003), the model for the two choice models is expressed as follow:

$$Y_i^* = \begin{cases} 1 \ if Y_i^* > \Upsilon \\ 0 \ if Y_i^* \leq \Upsilon \end{cases} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

Where ϒ = a threshold which is assumed to be zero for this study. Assuming a normal distribution of errors and following from Greene (2003), the probability of a smallholder farmer participation in horticulture farming is given by;

$$P_r(Y = 1) = \int_{-\infty}^{\beta''} \phi(t)dt = \Phi(\beta' x) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (2)$$

Where φ (.) = standard normal distribution, (Y = 1) implies that a farmer is participating in Horticulture farming and x represent the exogenous variables likely to have an influence on farmers' participation. In addition to estimate the probabilities, the study also computed marginal effect which is used for the appropriate interpretation of the results as is simple and easy to describe. Following from Nyaupane and Gillespie (2011), the marginal effects for continuous variables are estimated using equation 3 below;

$$\frac{\partial E[Y/x]}{\partial x} = \phi(\beta' X)\beta \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3)$$

Marginal effects for dummy variables are however estimated using equation 4 below;

$$P_r[Y = 1/\bar{x}., d = 1] - P_r[Y = 1/\bar{x}., d = 0] \quad \text{..... (4)}$$

Where $\overline{x}$ refers to the mean values of all continuous variable. Empirically, the model for estimating the determinants of smallholder farmer's participation in Horticulture farming is specified as;

$$Y = \beta_0 + \sum_{i=1}^{n} \beta_i x_i \quad \text{..... (5)}$$

Where β_0 is the constant term or intercept and β_i represent the parameters to be estimated. The maximum likelihood estimates of the parameters are generated using the STATA software.

3.12 Data Reliability and Validity

3.12.1 Data Reliability

Data Reliability refers to measures which address the accuracy of research methods and techniques to produce data for analysis (Saunders et al, 2007). Moreover, Reliability of a research instrument concerns to which the instrument yields the same results on repeated trials (Bailey, 2008). To ensure that quality of data for this research was maintained, different procedures of data reliability were used from pre-testing stage to data analysis and therefore prior to data collection, the checklist questions were piloted to check for inconsistencies, ambiguity and to confirm whether the checklist questions provide the accurate information required in the study. In order to reduce bias and in a view of reliability the researcher used multiple methods in the study such as questionnaires and documentation. Considering the fact that most of the respondents understand well their local languages and Swahili, the researcher took the liberty to translate the questions for simplicity and clear understanding of the questionnaires to convenient data collection. Also provided assistance to the respondents in understanding the questionnaires for the issues that were not well understood.

3.12.2 Data Validity

Data validity is used to determine whether research has measured exactly what was intended in the study in order to provide truthful results. Data validity is concerned with whether the findings of the study are really about what they appear to be about

(Saunders et al. 2007). To ensure the validity of the data, the researcher collected information from targeted study area while ensuring that collected data are valid and consistency. The data were collected with care and accuracy to obtain the required results. Therefore, the main task of the researcher was to ensure the reliability of data by employing various methods such as interview, questionnaires as well as a documentary to make sure that the result from the respondents reflects the study objectives. Moreover, some econometric models were used to calculate and estimate the collected data in the study and illustrate the conclusions and implications of the study and the relationships between the variables used in the research.

CHAPTER FOUR

PRESENTATION OF FINDINGS

4.1 Introduction

This chapter presents the findings of the study on contribution of horticulture farming to smallholder farmer's income and food security in Tanzania a case of Arumeru District. The first part present findings using descriptive statistics where the last part used econometric analysis to show the influence of explanatory variables to the dependent variables of income, participation and food security.

4.2 Descriptive statistics

This section analyses the characteristics of the sample used in in the study. It describes the distribution of each variable such as mean, standard deviation,frequencyand the range of the values of the observations. The major variables are small farmer's current age, gender, education level of a farmer, marital status, farming experience, household size, employment status, land ownership, land size, access to credit and membership to farmers group.

Table 4.1: Summary statistics for categorical variables

Variables	Categories	Frequency	Percentage
Gender	Male	95	54.76
	Female	115	45.24
Education level	No Formal education	4	1.90
	Primary education	74	35.24
	Secondary education	78	37.14
	College/University	54	25.71
Marital status	Married	115	54.76
	Unmarried	95	45.24
Employment status	Unemployed	5	2.38
	Employed	95	45.24
	Self employed	110	52.38
Food security	Highly secured	63	30
	Moderately secured	121	57.62
	Lowly secured	26	12.38
Participation	Not participate	24	11.43
	Participate	186	88.57
Land ownership	Not own land	50	23.81
	Own land	160	76.19
Access to credit	Not access credit	102	48.57
	Access credit	108	51.43
Membership to farming group	Not member to farming group	87	41.43
	Member to farming group	123	58.57
Land size	<1 hector	152	72.38
	(2–3) hectors	17	8.10
	4 hectors and above	41	19.52
Household size	(1-3) households	34	16.19
	(4-6) households	44	20.95
	(7-10) households	92	43.81
	Above 10 households	40	19.05
Farming experience	Less than one year	115	54.76
	(1-3) years	20	9.52
	4 years and above	75	35.71

Source: Field Data, 2010

Table 4.1 shows that 54.76% of male farmers and 45.24% of female farmers who are getting involved in horticulture farming. In case of education level; 1.9% have no formal education, 35.24% have primary education, 37.14% secondary education and 25.71% have college/university education. Concerning marital status of farmers, 54.76% were married or marriage while 45.24% were neither married nor marriage. Also on land ownership; 76.19% owned land while 23.81% did not own land.

Furthermore, the results show that 51.43% of small farmers have access to credits while 48.57% of small farmers have no access to credits. Apart from that, the findings also found 58.57% of small farmers are performing horticulture farming in group wise while only 41.43% are performing individual wise. In case of land size; 72.38% of small farmers were cultivating a land of less than one hector, 8.10% land size of (2-3) hectors and 19.52% were cultivating a land 4 hectors and above. The household size also ranked into four groups as follow; 16.19% was one to three households, 20.95% for four to six households, 43.81% for seven to ten households and 19.05% for more than ten households. On farming experience; 54.76% of small farmers were having experience of less than one year on horticulture farming, 9.52% for farmers with experience of one to three years and 35.71% for small farmers with the experience of four and above years.

Moreover, the researcher also wanted to know whether a small farmer was interested more to participate in horticulture farming rather than other economic activities where 88.57% were more interested to participate in horticulture farming while only 11.43% were not much interested as they were doing other activities such as business, livestock keeping and others were civil servant. For food security; 30% were highly food secured, 57.62% moderately food secured and only 12.38% were lowly food secured.

Table 4.2: Summary statistics for continuous variables

Variable	Observation	Mean	Std. Dev.	Min	Max
Age	210	35.40476	8.120679	19	55
Income	210	8133333	5194931	2000000	20000000

Source: Field Data, 2020

From Table 4.2, show the statistics summary for continuous variables used in the study. The average age of small farmers was 35 years with minimum age of 19 years and maximum age 55 years. The study found 8133333Tshs. as the average income earned by a small farmer on horticulture farming with the minimum of 2000000Tshs. and maximum of 20000000Tshs. Per year.

4.3 Econometric analysis

This section presents the findings of the econometric analysis to achieve the objectives of examining the role of horticulture farming on smallholder farmer's income and food security and analyzing the determinants of Smallholder farmers' participation in horticulture farming in Arumeru District. Both multiple linear regression model, probit model and ordered probit model were used to analyze the two objectives.

4.3.1 Roles of horticulture farming to smallholder farmer's income in Arumeru District

The first objective of this study was to examine the roles of horticulture farming to smallholder farmer's income in Arumeru District. This objective used multiple linear regression model in STATA 14, where the small farmers were asked to mention the amount of income experienced seasonal wise or per annum from horticulture farming. The dependent variable in this analysis was small farmer's income measured in Tanzania shillings, while the explanatory variables were age of a small farmer, gender, education level, marital status, employment status, farming experience, household size, land ownership, land size, access to credits and membership to farmer's group.

Table 4.3: Roles of horticulture farming to smallholder farmer's income in Arumeru District using multiple linear regression model results.

LnINC	Coef.	Std. Err.	T	P>t	[95% Conf.	Interval]
LnAGE2	0.0430433	0.0460627	0.93	0.351	-0.0478136	0.1339002
GENDER01	0.0349539	0.0432591	0.81	0.420	-0.0503731	0.1202809
M_STAT01	0.0991437**	0.0442685	2.24	0.026	0.0118258	0.1864615
EDUC01	-0.0821438	0.1625643	-0.51	0.614	-0.4027957	0.2385081
EDUC02	-0.0904356	0.165399	-0.55	0.585	-0.4166788	0.2358077
EDUC03	-0.1371918	0.1647644	-0.83	0.406	-0.4621834	0.1877998
F_EXPD1	0.1843038**	0.0777053	2.37	0.019	0.0310331	0.3375746
F_EXPD2	0.1828876***	0.0533257	3.43	0.001	0.0777047	0.2880705
HH_SIZD1	0.0664395	0.0765016	0.87	0.386	-0.0844569	0.2173359
HH_SIZD2	0.0504032	0.0646783	0.78	0.437	-0.0771723	0.1779787
HH_SIZD3	0.1405525*	0.0779738	1.80	0.073	-0.0132478	0.2943527
EMPLY01	0.1504509	0.1441727	1.04	0.298	-0.1339243	0.4348261
EMPLY02	0.6248507***	0.1471025	4.25	0.000	0.3346966	0.9150048
LAND_OW01	0.0205352	0.0540943	0.38	0.705	-0.0861637	0.1272341
LAND_SIZD1	0.2961545***	0.0856182	3.46	0.001	0.1272759	0.4650331
LAND_SIZD2	0.7003267***	0.0740448	9.46	0.000	0.5542761	0.8463773
AC_CRDT01	0.1000395**	0.0469705	2.13	0.034	0.007392	0.1926869
M_SHIP01	0.0159157	0.0445231	0.36	0.721	-0.0719043	0.1037358
_cons	14.67268	0.4194687	34.98	0.000	13.8453	15.50007

Number of observation	=	210
F(18, 191)	=	33.95
Prob > F	=	0.000
R-squared	=	0.7619
Adj R-squared	=	0.7394
Root MSE	=	0.30212

* ** *** represents significance level at 10%, 5% and 1% respectively.

Source: Field data (STATA output, 2020)

The results from regression shown that R-squared (R^2) of the model was 0.7619 equivalent to 76%, where the variable of natural logarithm of age of a small farmer omitted due to the problem of collinearity. The R^2 in the model explained the total variations by76% where only 24% of the variations did not explained as a minimum percent hence justify that the model was good and fit the study.

The results from Table 4.3 shows that marital status, farming experience, household size, employment status (self employed), land size and access to credit are statistically

significant while the rest of the variablesare not statistically insignificant. These are described briefly as follow:

4.3.1.1 Marital status

According to Table 4.3, marital status as a dummy variable in this study, have been found to be statistically significant at 5% hence the P-value was 0.026 with a positive relation to income of a small farmer.

4.3.1.2 Land size

The size of land that is used by a small farmer for horticultural farmingas categorized in to less than one hectors, 1.5 to 3 hectors and 4 hectors and above. Both the land size of 1.5 to 3 hectors and 4 hectors and above were found statistically significant at 1% level, since their P-values are0.001 and 0.000 respectively, with a positive relation to a small farmer's income.

4.3.1.3 Farming experience

According to the finding results from Table 4.3, farming experience as ordered into three categories of experience, the experience of one up to three years found to be statistically significant at 5%, since the P-value was 0.019 and has a direct or positive relation with income of a small farmer, while four and above years of experience found to be statistically significant at 1% where its P-value was 0.001 with a positive relation to small farmer's income. The repercussion behind is that, a farmer with more years of experience will definitely earn more income from horticultural farming when sells the crops harvested from the farmrs compared toa farmer with less years of farming experience.

4.3.1.4 Employment status

The study also found self employed of a farmer on horticulture farming to be statistically significant at 1% level since the P-value was 0.000 where it has positive or a direct relationship to income of a small farmer on horticulture farming compared to unemployed farmer.

4.3.1.5 Household size

According to the finding results,the household size was categorized into four categories such as one to three households, four to six households, seven to ten households and more than ten households, hence the base category was one to three households. The household of more than ten years is statistically significant at 10%, since the P-value was 0.073 and has a direct or positive relation with income of a small farmer. This justify that, family size of a farmer obviously determine income that would a farmer earn on horticulture farming compared to a family with small household size.

4.3.1.6 Access to credit

Table 4.3 found that, the access to credit to a small farmer on horticulture farming to be statistically significant at 5% level with the P-value of 0.034. This shows the direct relation to income from horticulture farming earned by smallholder farmers implying that the small farmers with access to credit would earn more income from farming compared to a small farmer with no access to credit.

4.3.2 Determinants of Smallholder farmers' participation in horticulture farming in Arumeru District

This objective was to analyze the determinants of smallholder farmer's participation in horticulture farming in Arumeru District, where it was analyzed through the use of Probit model in STATA 14. The smallholder farmers were asked through questionnaire questions to answer yes or no response to participation in horticulture farming due to possibility of predicting the probability statements on binary responses on 'yes' or 'no'whereas the maginal effect computed given the nature of the dependent variable with binary values of 1 if participate and 0 for not.

Table 4.4 Determinants of Smallholder farmers' participation in horticulture farming in Arumeru District using Probit regression model results

Variables	Coef.	Std. Err.	Z	P-value	Marginal effect
LnAGE	0.7767745	0.6359092	1.22	0.222	0.0704364
GENDER01	0.4684646	0.2912558	1.61	0.108	0.0416254
M_STAT01	0.2719445	0.2987451	0.91	0.363	0.0253618
EDUC01	-3.453701	197.6776	-0.02	0.986	-0.6951943
EDUC02	-3.310382	197.6777	-0.02	0.987	-0.6387956
EDUC03	-4.177081	197.6776	-0.02	0.983	-0.913867
F_EXPD1	0.8433441	0.7020354	1.2	0.230	0.0439076
F_EXPD2	0.490186	0.370021	1.32	0.185	0.0401673
HH_SIZD1	-0.0480696	0.4363495	-0.11	0.912	-0.0044653
HH_SIZD2	0.7127282*	0.4179032	1.71	0.088	0.0624773
HH_SIZD3	-0.6873051	0.4693924	-1.46	0.143	-0.0900253
EMPLY01	1.995427***	0.7016045	2.84	0.004	0.2040488
EMPLY02	1.844653**	0.7400652	2.49	0.013	0.2204327
LAND_OW01	-0.4591546	0.3876641	-1.18	0.236	-0.0343079
LAND_SIZD1	0.9302694	0.6267454	1.48	0.138	0.0448856
LAND_SIZD2	1.24455*	0.7369843	1.69	0.091	0.066421
AC_CRDT01	0.2857486	0.2955282	0.97	0.334	0.0262661
M_SHIP01	-0.2595478	0.2886109	-0.9	0.368	-0.0227748
_cons	-0.1264091	197.6948	0	0.999	

Number of observation = 210
LR chi2 (18) = 38.81
Prob >chi2 = 0.0030
Pseudo R2 = 0.2600
Log likelihood = -55.225101
* ** *** represents significance level at 10%, 5% and 1% respectively.

Source: Field data(STATA output, 2020)

The results of the Probit regression model in Table 4.4 above indicating regression by coefficients and odds ratio to analyze the determinant factors of Smallholder farmers' participation in horticulture farming while the natural logarithm of age squared of a small farmer was omitted by the software due to the problem of collinearity. The fitness of the data was statistically significant given that, the P-value 0.003 implying that, the joint significant test of all variables in the model is significant at 1%. And the Pseudo R^2 was 0.2600 (26%) which indeed tells how the maximum likelihoods estimates were obtained through iteration fitting the model, while the LR chi2(18) = 38.81 which is the log of the likelihood chi-square test with 18 degrees of freedom.

The repercussion of the log-likelihood -55.225101 is that, the null hypothesis of insignificant variables is rejected hence do not influence small farmers participation to horticulture farming. From the results, households size of seven to ten households, employed farmer, self employed farmer and land size of four and above hectors were found to be significant and these are the factors that determine smallholder farmers' participation to horticulture farming.

4.3.2.1 Household size

The probit regression above indicates that, the marginal effect of household size of seven to ten households is positive and statistically significant at 10% (0.088). This implies that, keeping other factors constant, household size of seven to ten households increased the probability of a smallholder farmer to participate in horticulture farming by a margin of 6.2 percent as contrastedto the household size of one to three households.

4.3.2.2 Employment status

The marginal effect of employed farmer found to be positive and statistically significant at 1%, while the marginal effect of self employed farmer was also positive and statistically at significant at 5% level. This imply that, a small farmer being employed or self employed increased the probability to participate in horticulture farming by a margin of 20% and 22% respectively compared to unemployed farmer.

4.3.2.3 Land size

Furthermore, the marginal effect of land size of 4 hectors and above was also found to be positive and statistically significant at 10% level. This justify that, the land size of 4 hectors and above increased the probability of a small farmer to participate in horticulture farming in Arumeru district by a margin of 6.6% as compared to the land size less than one hector.

4.3.3 Roles of horticulture farming to smallholder farmers on food security in Arumeru District

4.3.3.1 Ordered probit results

This objective was to examine the roles of horticulture farming to smallholder farmers on food security where it was analyzed by using the ordered probit model. To obtain

the results, the ordered probit regression was run by using STATA and the marginal effects were computed. An ordered Probit regression model was used given the nature of the dependent variable ranked as 1 for highly food secured, 2 for moderately food secured and 3 for lowly food secured. Therefore, the marginal effects were calculated in order to obtain the precisely effects of the independent variables to the dependent variables.

The results of the ordered probit regression model were presented in table 4.5. The fit of the data was statistically significant with P-value of 0.000 at (P < 1%). The LR chi2(18) = 116.52 while the accuracy of the prediction (Pseudo R^2) was 0.2959 equivalents to 30 %.

Table 4.5 General Fitness of the model

Number of obs	=	210
LR chi2(18)	=	116.52
Prob > chi2	=	0.000
Pseudo R2	=	0.2959
Log likelihood	=	-138.61155

Source: Field data (STATA output, 2020)

The study used the ordered probit model to estimate horticulture farming variables that influence food security where its categorized in to three ranks of orders such as highly, moderately and lowly food secured hence the output results were presented in Table 4.6 below;

Table 4.6 Ordered Probit Regression Results

F_SEC	Coef.	Std. Err.	Z	P>z	[95% Conf.	Interval]
LnAGE	-0.2006477	0.4094194	-0.49	0.624	-1.003095	0.6017996
GENDER01	-0.2134211	0.1828651	-1.17	0.243	-0.5718301	0.1449878
M_STAT01	-0.4601264	0.1932256	-2.38	0.017	-0.8388416	-0.0814112
EDUC01	0.3811071	0.7080496	0.54	0.59	-1.006645	1.768859
EDUC02	0.3864115	0.7198343	0.54	0.591	-1.024438	1.797261
EDUC03	0.2955115	0.7170588	0.41	0.680	-1.109898	1.700921
F_EXPD1	-0.1827677	0.3276435	-0.56	0.577	-0.8249372	0.4594018
F_EXPD2	-0.3432091	0.223558	-1.54	0.125	-0.7813747	0.0949565
HH_SIZD1	-0.46479	0.3117836	-1.49	0.136	-1.075875	0.1462945
HH_SIZD2	-0.2854659	0.2631286	-1.08	0.278	-0.8011885	0.2302568
HH_SIZD3	-0.2544329	0.329654	-0.77	0.440	-0.9005429	0.3916771
EMPLY01	-0.8062982	0.577849	-1.40	0.163	-1.938861	0.326265
EMPLY02	-1.321741	0.5978843	-2.21	0.027	-2.493573	-0.1499091
LAND_OWN01	0.3170404	0.2374753	1.34	0.182	-0.1484025	0.7824834
LAND_SIZD1	-1.077693	0.360973	-2.99	0.003	-1.785187	-0.3701991
LAND_SIZD2	-1.962322	0.358038	-5.48	0.000	-2.664064	-1.26058
AC_CRDT01	0.1488656	0.1980821	0.75	0.452	-0.2393681	0.5370993
M_SHIP01	0.4394581	0.1918896	2.29	0.022	0.0633614	0.8155548

Source: Field data(STATA output, 2020)

4.3.3.2 Marginal effects results of the ordered Probit

The marginal effects results are used to measure the expected change in the dependent variable as a result of a change of explanatory variable, other covariates remaining constant.Therefore,the marginal effect is computed to interpret the coefficients given both magnitude and direction.

Table 4.7 Marginal effects results of the ordered Probit

Food security in ranks (orders)	Highly Secured dy/dx	Std. Err.	Moderately secured dy/dx	Std. Err.
LnAGE	0.0628069	0.12809	-0.0419105	0.08574
GENDER01	0.0672088	0.05793	-0.0452792	0.04008
M_STAT01	0.1412089**	0.05814	-0.0908486**	0.03973
EDUC01	-0.1142285	0.20218	0.0703806	0.11314
EDUC02	-0.116375	0.2076	0.0723615	0.11869
EDUC03	-0.0876339	0.20035	0.0529236	0.10651
F_EXPD1	0.0600193	0.11222	-0.0431592	0.08589
F_EXPD2	0.110714	0.07387	-0.0774726	0.05504
HH_SIZD1	0.1574118	0.11205	-0.1182297	0.09248
HH_SIZD2	0.0902837	0.08393	-0.0612368	0.05859
HH_SIZD3	0.083733	0.11339	-0.060394	0.0874
EMPLY01	0.2550933	0.18149	-0.1725332	0.12421
EMPLY02	0.3908135**	0.16066	-0.230543***	0.08554
LAND_OWN01	-0.1045136	0.08173	0.0755603	0.06392
LAND_SIZD1	0.3990077***	0.1347	-0.3429158***	0.13013
LAND_SIZD2	0.6711462***	0.09371	-0.5671981***	0.0902
AC_CRDT01	-0.0466447	0.06213	0.031171	0.04194
M_SHIP01	-0.1404749**	0.06245	0.0968567**	0.04706

*,** &*** represent 10%, 5% & 1% significant level respectively

Source: Field data (STATA output, 2020)

Table 4.7 shows the independent variables of marital status, self employed, land size of two to three hectors and four hectors and above and membership of a small farmer to farming groups were found to statistically significant to food security in Arumeru district, while the rest of other independent variables were not statistically insignificant to manipulate food security in the study area. Though, the magnitude and sign of variables varies across the options or outcome of food security, hence the awareness

in interpreting the ordered probit model results is mostly required to guarantee the appropriateness and accurately of the results.

In order to avoid duplication in discussions, the marginal effects results were discussed as they indicated both the sign and magnitude of each variable in the model which computed as the partial derivatives of the non-linear probability function. Furthermore, the researcher wanted to justify if food security in Arumerudistrict is subjective to horticulture farming. Therefore, the explanatory variables of horticulture were regressed with highly food security as the alternative of food security that a small farmer may experience and lastly is the regression of the same independent variables of horticulture farming against moderately food security.

4.3.3.1 Marital status

Based on the results, marital status was statistically significant as shown in the table above. The study found that marital status was statistically significant at 5% level at rank one and two consecutively. Additionally married farmer had a probability of 0.1412089 for highly food secured and -0.0908486 for moderately food secured. Thus a farmer being marriage had more probability to secure food highly while less probability had reported to small farmer to secure food moderately.

4.3.3.2 Self employed

Self employed was significantly effect to food security as indicated in the above Table 4.7. This was statistically significant at 5% and 1% levels for highly food secured and moderately food secured respectively. The self employed farmer had a probability of 0.3908135 for highly food security and -0.230543 for moderately food security, hence the self employed farmer had more probability to secure food highly while less probability reported on moderately food security.

4.3.3.3 Land size

The land sizeof two to three hectors was found to be statistically significant at 1%level in influencing food security and positively related to the probability of a smallholder farmer to secure food highly as was 0.3990077 while it is negatively related to the probability of a small farmer to secure food moderately which was -0.3429158. Also the land size of 4 hectors and above had a probability of 0.6711462 for highly food

secured and -0.5671981 for moderately food secured. Thus, the land size of two hectors and above had more probability to secure food highly while less probability on moderately food security.

4.3.3.4 Membership of a small farmer to farming group

The membership of a small farmer to farming group was statistically significant at 5% level as presented in Table 4.7, this is negatively related to the probability of a small farmer with highly food security which was -0.1404749 while it's positively related to the probability of the same small farmer with moderately food security as it was 0.968567. This indicated that a smallholder farmer in horticulture farming who have membership to farming group had more probability to secure food moderately while low probability reported on highly food security.

4.3.4 Model Specification test use of Ordered Probit

Gujarati (2014) argued that model specification is an essential aspect in econometric analysis where the model has to becorrectly specified. He further affirmed that if the model is not appropriately specified, then the analysis may experience the problem of model specification error or model specification bias. The study conducted this test for the specification using Link test command in Stata Version 14. The Link test looks for specific errors known as link-error where the dependent variable is linked to precisely relate with the independent variables.

Table 4.8 Link Test Results.

Ordered probit	Regression		Number of obs	=	210	
			LR chi2(2)	=		117.46
			Prob > chi2	=	0.000	
Log likelihood	-138.14384		Pseudo R2	=		0.2983
Food Security	Coefficients	Std. Err.	Z	P>z	[95% Conf.	Interval]
_hat	0.5801346	0.4482801	1.29	0.196	-0.2984783	1.458747
_hatsq	-0.0866168	0.0903721	-0.96	0.338	-0.263743	0.0905093
/cut1	-2.344158	0.5078414			-3.339508	-1.348807
/cut2	-0.0326848	0.4562644			-0.9269466	0.861577

Source: Field data (STATA Output, 2020)

It should be noted that, H_0: Model is well specified and H_a: is not well specified. Since the probability (P> |t|) of hatsq was 0.338 which was greater than 5% level of significance, therefore the t test of the hatsq is insignificant. Hence, this gives precisely information to fail to reject H_0 and therefore the model is well specified, hence the results are good and do not suffer model specification error.

4.4 Challenges that hinders the performance of smallholder farmers on horticulture farming

Table 4.9 Challenges hinders the performance of smallholder farmers on horticulture

Challenges hinders performance of small farmers in horticulture farming	Mean	Std. Deviation
Inadequate of market	3.95	0.730
Climatic condition and soil fertility	3.82	0.682
Price fluctuation	4.09	0.411
High cost on agricultural inputs	4.12	0.699
Proper farming education	3.79	0.701
Access to agricultural credits	4.06	0.715

Source: Field Data(SPSS Output, 2010)

From the table 4.9 above, showed some challenges presented as the responses from respondents in Arumeru district from the respective wards whereby the small farmers asked questions on challenges and required to provide answers by rating them in a scale where 5 present the strongly agreed, 4 agreed, 3 undecided, 2 for disagreed and 1 for strongly disagreed. From the sample of 210 who participated in the study, their responds were as follows;

4.4.1 Inadequate of market

This seems as the most challenge that used to hinder smallholder farmers on the performance of horticulture farming in Arumeru district, whereas farmers from different wards were provided the same concern. This challenge was averaged at 3.95 with a standard deviation of 0.730.

4.4.2 High cost in agricultural inputs

This is the cost where the smallholder farmer incurs on buying the agricultural inputs such as fertilizers, pests. The farmers reported that in some cases, the cost of these

inputs fluctuates by increasing which makes them to demand and save more money so that they can afford the higher cost on this inputs in the market. This experienced with the average of 4.12 and a standard deviation of 0.699.

4.4.3 High price fluctuation

Though the small farmers devote much by investing a lot in horticulture farming, but still the problem of price fluctuation on crops produced in the market experienced. This is insisted by the respondents from Kikwe wards on the year where they harvested tomatos but they found a very low price in the market which made them to incur loss compared with the total expenses used on farming. This is justified as the problem by an average 4.09 and the standard deviation of 0.411, hence there is a need of measures to be taken by the government on price control so that the farmers may not feel discouraged rather being more motivated to participate in horticulture farming.

4.4.4 Proper farming education and training

This involve various training, workshops and education in general that aim to provide skills and technology to small farmers on proper method of farming towards mass production and efficiency on outputs. Many farmers reported that still they are lagging behind on education access compared to their demand where in few cases they are sponsored by TAHA and rarely extension officer. They urgued that, provision of training or even workshops on horticulture farming to them would increase/improve their productivity where food security increases and accumulation of more income than previous. This problem was commonly experienced at the average of 3.79 and a standard deviation of 0.701 resulted from the responses of smallholder farmers in the study area.

4.4.5 Access to agricultural credits

The provision of credits to farmers enhances more participation to horticulture farming which also leads to mass production due increase in land size cultivated and easily manage the cost of agricultural inputs, hence a small farmer subjected to hire the efficiency inputs and afford their cost prices in the market. The access to credits to small farmers in Arumeru district perceived as challenge to farmers as they reported where just few of them have access to agricultural loan while the majority do not have

at all. This is due to lack of collateral securities to small famers which required by the commercial banks on credits provision and other farmers reported that, they worry bank's returns because of high interest rate. This challenge mentioned several time by the farmers from the four wards at the mean of 4.06 while the standard deviation of 0.715.

4.4.6 Climatic condition and soil fertility

The challenge on climate and soil nutrients have also reported in Arumeru district, whereas more rainfall and shortage of rain (summer) affect the prosperity of horticultural crops such as patotoes, onions. Example small farmers from Sambasha ward reported that, their onions were taken and destructed more in farms last year (2019) through erosion due to high rainfall occurred in all part of the country. The soil fertility also constraints them hence, they don't have specific measurement of nutrients that favour plantation of a certain crops and the type or amount of fertilizer to be used rather they just planting. Example in Nduruma where the land experience a dark soil, a farmer harvest 50bags of onions for one hector while specifically one hector expected to give more than 150 bags for a fertile soil or where appropriate fertilizer used. This is commonly a challenge in Arumeru district at the average of 3.82 and a standard deviation of 0.682, hence justify the extent of it to all wards.

CHAPTER FIVE

DISCUSSIONS OF THE FINDINGS

5.1 Introduction

This chapter discusses in details the findings obtained from the former chapter on data analysis. The detailed discussion is more emphasized on descriptive and empirical findings. The discussion is prepared with regard to the specific objectives where the results from multiple linear regression, probit regression and ordered probit model were discussed.

5.2 Role of horticulture farming on smallholder farmer's income in Arumeru district

Based on the findings on role of horticulture farming on smallholder farmers' income by using multiple linear model,the study confirmed that; marital status, land size, farming experience, employment status, household size and access to credit were statistically significant with the income of a small farmer obtained from horticulture farming.

5.2.1 Marital status

The marital status was statistically significant to smallholder farmer's incomeat 5% level, with coefficient of 0.0991437 having a positive relation to income. This implies that a small farmer being married or unmarried increases the income from horticulture farming compared to unmarriage farmer. This revealed with the study done by Masunga, (2014) on the assessment of socio-economic and institutional factors influencing tomato productivity as a horticultural crop amongst smallholder farmers and found that marriage or married farmers have a great influence on tomato productivity compared to unmarriage farmer.

5.2.2 Land size

The land size of 1.5 to 3 hectors and 4 hectors and above were found statistically significant at 1% level, with the coefficients of 0.2961545 and 0.7003267 respectivelyportraying a positive relation to a small farmer's income. This interpreted that a small farmer cultivating larger than one hector for horticulture farming would

obtain more crops that resulted to more income as sells to the market compared to a farmer cultivating less than a hector. This is consistent with the study by Mhanga, (2017) which found that the size of land that used by small farmers on tomato production determine or increases the level of income due to the amount of tomato sold in the market.

5.2.3 Farming experience

The farming experience of one up to three years found to be statistically significant at 5% level with positive relation to income of a small farmer since the coefficient value is 0.1843038, While four and above years of experience found to be statistically significant at 1% with a positive relation to small farmer's income while the coefficient is 0.1828876. The repercussion behind is that, a farmer with more than one years of farming experience will produce more horticultural crops which leads to high income earning by selling the crops to the market compared to a farmer with less than one year of experience. The same results have been obtained by Shelukinga, (2015) on his study he found that farming experience as its positive related to horticulture entrepreneurs influences the income that would be earned on production.

5.2.4 Self employed

The self employed farmer on horticulture farming found to be statistically significant at 1% level with the coefficient of 0.6248507 hence it has a positive or a direct relation to income. This implies that a small farmer being self employed increases the income from horticulture farming compared to unemployed farmer.This is due to fact that when a farmer is subjected to self employment by engaging on horticulture farming is obvious that would earn more income from the sold crops in the market and alleviate poverty results to welfare improvement as compared to a jobless or unemployed household.

5.2.5 Household size

The results shown that household size of more than ten households was statistically significant at 10%, with direct or positive relation to income of a small farmer. This may be interpreted as the household size with large number of households increases the income earned by a farmer compared to the household size with small number of

households. This isjustified hence more households in the family increases the labour force or supply leading to efficiency in production while keeping other factors constants. Therefore, the family with large household size will have access of labour force and able to cultivate the large size of land on production resulting to maximum yield of output crops, while the family with less household size is limited to labour force hence the less portion of land will be cultivated in production and leads to low productivity of crops with poor and less income to the community and family level.

5.2.6 Access to agricultural credit

The access to credit to a small farmer on horticulture farming was also found to be statistically significant at 5% level with a positive relation to income earned by a farmer from horticulture farming. This implies that, a small farmer with access to credit would earn more income on horticulture farming compared to a small farmer with no access to credit. The credits obviously encourage and attract more investment to entrepreneurs in the economy as the farmers or entrepreneurs ask credits from money institutions in order to enlarge and improve their investment on agriculture. The farmers with access to loans arehighly subjected to the maximum production and earn a huge income in the economy due to the large investment.

5.3 Determinants of Smallholder farmer's participation in horticulture farming

Table 4.6 summarizes the factors determining participation of a farmer in horticulture farming by using probit model. The results showed that, employed farmer, self employed, household size and land size were statistically significant hence has influences small farmers participation on horticulture farming in Arumeru district.

5.3.1 Household size

The household size of seven households and above was statistically significant and positively related to farmers' participation in horticulture farming in Arumeru district. The implication behind this result is that a family size with seven household and above have a high probability to participate in horticulture farming compared to the family with less than seven households. The marginal effect of seven households and above was 0.0624773 which indicate that, seven households and above in the family increases the participation in horticulture farming by 6.2% in the study area. The result

was similar with the results obtained by Oladejo et al., (2011), who did a study on analysis women participation in agricultural production in Egbedore Local Government Area of Osun State, Nigeria using probit model. The empirical results from his study revealed that household size, marital status and local taboos had significant impact on the women participation in agricultural production.

5.3.2 Employment status

The employment status were also found to be statistically significant in the study as employed farmer was significant at 1% level while the self employed farmer was significant at 5% level, hence they are positively related to participation in horticulture farming. Their marginal effects are 0.2040488 and 0.2204327 as implying that, small farmer being employed or self employed increases the probability of participating on horticulture farming by 20% and 22% respectively than being unemployed. This finding is consistent with the study done by Nnadi and Akwiwu (2008) investigated on the determinants of Youths' participation in Rural Agriculture in Imo State, Nigeria where used logit regression model on data analysis. Their results found a positive relationship whereas Youths' participation determined by parents' occupation or employment status together with other variables such as education, age, marital status. The situation where by a small farmer subjected to engage in horticulture production either by being employed or self employing definitely encourage him/her to participate in agricultural activities rather than if he could remain jobless.

5.3.3 Land size

The land size also was found to be statistically significant at 10% level and positive related to farmers' participation in horticulture farming while the marginal effect is 0.066421. This implies that, as land size increases from 4 hectors and above, then increases the probability of a small farmer to participate on horticulture farming by 6.6 percent in Arumeru district. This revealed to the hypothesis and justify the truth that, when farmers have access to large land size which is potential to fertility or soil nutrients increases them to participate more on agriculture production by expanding the farm size to more hectors hence will experience mass production. The findings are in line with the results of a study conducted by Etwire et al. (2013) identified factors which delimitate farmer's participation in agricultural projects using the case of the

Agricultural Value Chain Mentorship Project in Ghana. The study found that; land sizes, number of years in school, access to credits are the factors that significantly determine farmer's participation in agricultural projects.

5.4 Roles of horticulture farming to smallholder farmers on food security

The analysis reveals that; marital status, land size, access to credit and membership to farmer's group statistically significant to food security while other factors in this part were statistically insignificant to food security. Therefore, only the significant factors are discussed as follow;

5.4.1 Marital status

The marital status was statistically significant at 5% level for both outcome one and two. The married farmer had a probability of 0.1412089 for highly food security and -0.0908486 for moderately food security. This implies that probability of married farmer to secure food highly was increasing by 14% while the probability of food security moderately decreased by 9%. Thus, indicate that, a farmer being married had more probability to secure food highly while less probability had reported to a small farmer to secure food moderately. The result is similar with the results obtained by Matshe, (2009) who investigated the extent of smallholder Production for Food Security. The study found a statistically significant of marriage farmers to access more food security than a farmer who is single or unmarriage.

5.4.2 Self employed

Self employed of a small farmer found statistically significant at 5% level for highly food security and 1% level for moderately food security as was shown in Table 4.7. The self employed farmer had probability of 0.3908135 to highly food security and -0.230543 for moderately food security. This interpreted that, a self employed farmer increased the probability of food security to highly secured by 39% while lower the probability of moderately food secured by 23%. This revealed with the study done by Zhou et al. (2017) on his results demonstrated that education level and employment status of the household contribute to households being food secured. This is quite obvious hence the small farmer once performing horticulture farming as part of

entrepreneurship will have more chance to secure food from the grown and harvested crops rather than selling all the output crops to the market.

5.4.3 Land size

The land size of two to three hectors and 4 hectors and above were found to be statistically significant at 1%level in influencing food security. The land size of 1.5 to 3 hectors had probability of 0.3990077 for highly food security and probability of -0.3429158 for moderately food security. The land size of 4 hectors and above had probability of 0.6711462 for highly food security and probability of -0.5671981 for moderately food security. This implies that, the land size of two hectors and above increased the probability of food security to highly secure by 67% whereas, decreased the probability of moderately food security by 57%. This result is supported by Frelat et al. (2016) commented on farm size as a determinant of food security in sub-Saharan Africa.The same results obtained by Koirala et al. (2016) who found that, increase in farm size increased the rice yield.

5.4.4 Membership of a small farmer to farming group

The membership of a small farmer to farming group as was statistically significant with the probability of -0.1404749 to highly food security and 0.968567 for moderately food security as presented in Table 4.7; This implies that, membership of a small farmer to farming group decreased probability of highly food security by 14% while increased the probability of moderately food security by 96%. Thus, small farmers in Arumeru district secure more food moderately rather than other orders as used to rank food security in the study. This might be due to large family size or inefficiency on horticulture farming in the area which results to less harvest. The study revealed the same with the study done by Li and Yu, (2010) who analyzed households food security in poverty stricken region in western rural China and found a positive relation of membership of a farmer to food security.The small farmers working in group are more likely to secure food and access the food surplus due to sharing of new knowledge and experience of on farming from other fellow farmers than a farmer who is working alone.

5.5 Challenges that hinders the performance of smallholder farmers on horticulture farming

5.5.1 Inadequate market

The access to adequate market is still a challenge to most of the farmers in the economy. The agricultural outputs are traded domestically and some time enough and competing markets are limited. This have been reported by the small farmers in Arumeru district that access to foreign market for their crops is severely experienced and even some time domestic market not much consistence in relation to amount of crops harvested in their farms. This is connected with what reported by (Muthoka and Ogutu, 2014) on marketing factor as a challenge faced by small farmers on horticulture farming. The situation is worsened by limited entrepreneurship capacity which affects majority of farmers questing for information for marketing of their products.

5.5.2 High cost in agricultural inputs

The research revealed that high cost of agricultural inputs is among the challenges facing small scale farmers on horticulture farming. Small farmers wish to engage more in horticulture farming but the problem is costs of agricultural inputs such as seeds, pesticides and fertilizers takes a big portion of their financial capital. This is connected to Banson (2014), who found that many African countries, cultivation and production of crops is produced by smallholder farms with limited mechanization and capacity, leading to high transaction costs and poor yields. This implies that sometimes the actual contribution of horticulture farming in improving livelihoods of small farmers is not seen clearly as the income obtained is used more for acquiring of horticulture farming needs than other family needs.

5.5.3 Price fluctuation

The respondents who are the small farmers mentioned price fluctuation as a big challenge facing horticultural crops in the market. The price in the market not stable rather it fluctuate to various period, thus, during harvest season the price fall while after when the harvest is over then increases caused to the shortage in the market. This affected small farmers because they had to sell their products at a loss even if they had used a lot of money to invest in farming. This is similar to what reported by Lenis (2012), Horticulture production is an important source of income for smallholder

farmers because the demand for its products is rising in both domestic and the international Markets, which tends to increase smallholder farmers' participation in the national market.

5.5.4 Proper farming education

Farming education on proper farming method which ensure maximum output of horticultural crops and efficiency on horticultural production still a challenge as stated by small farmers in the study.Proper farming education are thought to be a contributory factor in improving farmers' social and economic positions through income obtaining from horticulture farming. This problem justified the same by Ndambari et al., (2012). However, most of the farmers often lack access to training and experience in on how to participate in the market place and are therefore unable to market goods and services strategically.

5.5.5 Access to credit

The small farmers experienced the problem of agricultural credits from financial institution and small financial institution such as SACCOS. The provision of loans to them would increase farming capacity on land cultivated and hiring of production resources like capital machines, labours, increasing the land size and buying of pests, seeds and fertilizers. As they gave out their views, most of them they fail to access credits from financial institutions due to lack securities such as assets, education on the proper use of loans and higher interest rate. Chadha et al. (2008) reported the same problem on his study that access to credit hinder small farmers on horticulture farming. Also Anang et al., (2013) confirmed the same on his study insisted on lack of collateral, an unwillingness to accept household assets.

5.5.6 Climatic condition and soil fertility

This have been also a challenge experienced by small farmers in Arumeru district, where most of them said in some season their crops get destroyed and fail to grow or prosper due to high rainfall or shortage of rain. The small farmers gave out some examples of onions and potatoes which were destructed in farm this due to heavy rainfall, while the soil fertility contribute as a challenge when its unfertile or lack soil nutrients. This is reported the same by Olufolaji (2009). That means unsuitable soil,

climatic conditions and diseases caused by viruses, micro bacteria, fungi, insect, nematodes and pests discourage the performance of small farmers in horticulture farming.

CHAPTER SIX

SUMMARY, CONCLUSION AND POLICY IMPLICATION

6.1 Chapter description

This chapter presents a summary of the findings obtained from the discussion in the previous chapter. The conclusion and policy implication also is presented whenever necessary for improving the situation by policy makers and planners. Moreover, this chapter presented areas of further research and the limitations of the study.

6.2 Summary and conclusion

The main objective of this study was to examine the contribution of horticulture farming to smallholder farmer's income and food security. Specifically, the study aimed to analyze the role of horticulture farming to smallholder farmers' income and food security, determinants of small farmers' participation on horticulture farming and challenges that hinders performance of small farmers on horticulture farming in Arumeru district. To achieve this, study used cross sectional data which was obtained from 210 small farmers in Arumeru district.

In the first objective, the study assessed the role horticulture farming to smallholder farmer's income and food security using multiple linear regression and ordered probit model. Based on the study findings on contribution to small farmer's income; marital status, farming experience, household size, self employed, land size and access to credit were statistically significant and positively related to small farmer's income in production. Also in food security whereas the ordered probit model was used to analyze the data collected, the findings found marital status, self employed, land size and membership of a small farmer to farming groupto be significant to the study hence influence food security to farmers in Arumeru district.

The second objective of this study was to determine small farmer's participation to horticulture farming where the probit model was used for data analysis. The findings found employment status both employed and self employed, household size and land size as statistically significant and positively related small farmer's participation in horticulture farming in Arumeru district.

The third objective was to describe the challenges that hinder the performance of smallholder farmers in horticulture farming. The descriptive analysis was used for data collected from the study area, where the inadequatemarketing system, high cost in agricultural inputs, price fluctuation, proper farming education, access to credit, climatic condition and soil fertility found as the main challenges encountered by small farmers in Arumeru district on horticulture farming.

6.3 Policy implications

The study recommends on agricultural policy reforms and strategies as measures to be implemented by the government and other horticultural farming stakeholders like TAHA towards improvements and sustainability of horticulture farming to smallholder farmers in the country.

The government should have to empower the small farmers on market extension domestically and abroad by regulating price domestically and link the farmers to foreign markets where they will export horticultural crops to other countries in the world market hence accumulation of foreign currency to the economy.Also more emphasis on provision of agricultural subsidies, credit to farmers and control the price fluctuation in the market to encourage more participation of farmers and growth of horticultural subsector in the economy.

Furthermore, the government should review and make follow up on credits that authorized to farmers and agricultural policy on reducing the interest rate so that encourage more borrowing to farmers with the aim of improving agricultural investment in the economy.Moreover, irrigation schemes and green house should be given priority to small farmers of horticulture farming as other countries like Kenya, this is would be more sustainable and less on being threatened by pests compared to open farming. Promotion programs and campaigns like exhibitions of products, workshops, open days, regional horticultural fairs, to increase consumption of locally produced fruits and vegetables are critical for horticulture industry development in the economy.

6.4 Limitation of the study

The study was limited to contribution of horticulture farming to smallholder farmer's income and food security with the sample size of 210 farmers. The study based only on Arumeru district in Arusha region where the data were analysed by using multiple linear, probit and ordered probit model. The study also encounter the problem of language on data collection hence respondents were mostly familiar with their vernacular language and little in Swahili while the questionnaires were prepared in English language. Therefore, the researcher decided to employ three people from the same tribes who helped to translate the english language to their language depending on the question asked in the questionnaire. There was also a problem of cost that a research incurred in the field more than the expected budget due to some inconvenience such as increased transport costs, cost on motivation to respondents and cost on paying the three employed people who helped me to collect data from the study area.

6.5 Areas of Further Study

The researcher proposed the further studies on contribution of horticulture farming to smallholder farmer's income and food security to be done in other regions of the country where the significant variables found in Arumeru district may be justified if they have the same influence or significant to those small farmer in the study area as found in Arumeru. Finally, the researcher suggested the study to be done on the assessment of market sustainability to smallholder farmers on horticultural crops in the economy where the problem of price fluctuation and market accessibility on horticultural produce will be controlled and regulated.

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APPENDICES

APPENDIX I: QUESTIONNAIRE

Dear respondent,

My name is **LOISHOO LIKINJIYE**, a student from Mzumbe University pursuing Master of Science in Economics (MSc. Econ). I'm respectfully requesting your assistance in filling this questionnaire by giving your views concerning **Contribution of Horticulture Farming to Smallholder farmers' income and Food security**. The information collected is strictly confidential, will only be used for academic purposes, hence no likely risks associated with the research. This questionnaire takes not more than 5 minutes to answer. Kindly respond to the following questions to the best of your knowledge. For more, contact the researcher through

Phone: +255 763 200 044/+255 710 920 044
Email: lloishoo2@gmail.com

Particulars:

Date of interview ……..

Ward……

Questioner No……

Name of respondents (optional)……

Section A: General Information/ demographic information

1. Age in years (Tick √)……

2. Sex (Tick √)

a. Male [ ] b. Female [ ]

3. What is your marital status (Tick √)

a. Marriage[ ] b. Unmarried [ ]

4. Education level (Tick √)

a. No Formal education [ ] b. Primary education [ ] c. Secondary education [ ]

d. College/University education [ ]

5. Are you interested to participate in horticulture farming rather than other farming activities?

a) Yes [ ] b) No [ ]

6. What is your farming experience on horticulture farming?

A. <1. [ ] B). 1-3. [ ]

C). 4 and above.[ ]

7. What is the number of your household size?

a) 1-3 [ ] b) 4-6 [ ] c) 7-10[ ]

d) More than 10[ ]

8. Head of household employment status

a. Not employed [ ] b. Employed [ ]

c. Self employed

9. Do you own the land that your using for horticultural activities?

a) Yes [ ] b) No [ ]

10. What is the size of the land that your own? (In hectors).

a. <1. [ ] b) 1-3 [ ]

c) 4 and above[ ]

Section B: Contribution of horticulture farming to income and food security.

11. What is the major reason that brought you to engage in horticulture farming?

a. Is a source of household income [ ]

b. Is a source of food [ ] c. Both a and b [ ]

12. Do you performing any other income generating activity apart from farming?

a) Yes [ ] b) No [ ]

13. If the respond is yes, then what are those other income generating activities? (Tick √)

a. Livestock keeping [ ] b. Business [ ] c. Civil servant [ ]

14. How much do you earn as income through horticulture farming per annum or season? ……

15. What are the impacts of horticulture farming to food security that farmers might experience?

a. Highly food secured [ ] b. moderately food secured [ ]

c. Lowly food secured [ ]

16. How much amount of food from horticulture farming do you access seasonal wise or yearly? ..... (kgs or tons)

17. Some horticulture farmers will explain benefits obtaining from horticulture farming. In the following list tick (√) all that you are benefited.

Statement	Responses	
	Yes	No
Taking my children to school		
Afford medical services		
Diversification of agriculture		
Business channel		
Food security in the family		
I get social network		
Source of capital		
Income generated for agriculture input		
Building my own house		

18. Do you have access to credit from any financial institution?

a) Yes [ ] b) No [ ]

19. Do you think that credit provision to small farmers would lead to improve and increase efficiency on production in the economy?

a) Yes [ ] b) No [ ]

20. Do you performing horticulture farming in group wise (farmers' group)?

a) Yes [ ] b) No [ ]

21. If the answer above is yes, then what is the actual number of members in your group? ……

22. Did you have access to any farming information?

a) Yes [ ] b) No [ ]

23. If ''Yes'' What is the sources of information on farming? (Tick √)

a) Fellow farmers [ ] b) Extension workers [ ]

c) Government initiatives [ ] d) Horticulture agents e.g TAHA [ ]

e) others (specify)……

24. What do you need Government to support you to raise the production?

a) Provision of start-up capital

b) Training of horticultural activities

c) Provide/strengthen extension service

d) Ensure price control of horticultural products.

Section C: Challenges faced by the smallholder farmers on Horticulture farming:

25. Are there challenges that you always facing on your horticulture farming?

a. Yes [ ] b. No [ ],

26. Challenges hinder performance of smallholder farmers in horticulture farming,

Likert Scale assumes that;

1- Strong Disagree 2- Disagree 3 -Undecided 4 - Agree 5- Strong Agree

Factors or Reasons	Responses				
	Strong Disagree	Disagree	Undecided	Agree	Strong Agree
Markets					
Climatic Condition					
Price fluctuations					
High cost on agricultural inputs					
Government support and policies					
Proper farming education					
Access to Credit					
Membership to farming groups					
Soil fertility deterioration					
Availability of seeds					

Section D: Mechanisms that can be used to increase smallholderfarmers' income and food security on horticulture farming.

27. What do you think could be the measures to be taken by the government and the other development stakeholders to ensure the farmer's income and food security are well improved from horticulture farming?

……..

******Thank you very much*********

APPENDIX II: INTERVIEW GUIDELINE FOR KEY INFORMANTS

1. For how long have you been working here at Arumeru District engaging in horticultural farming? .....

2. How many farmers is your association (TAHA) working with? .....

3. How do you see horticultural farming practices in this area?

……

4. Does horticulture farming has any contribution in reducing income poverty in this area? ……

5. If Yes, explain how..... ……...

6. To what extent horticulture farming improved and increased food supply to small farmers and also in the area in general?

……

7. Do you have any contribution on improving horticulture farming in the area and also to farmers? .....

8.if

Yes,explain……

……

9. Is there any access of market for horticultural crops produced in the area? ……

10. Do you have any partnership with group of farmers or other institutions that support and promote horticulture farming in Arumeru district? ……...

11.IfYeswhichone?Andhow……

12. Do you provide extension services for horticulture farming to farmers? .....

13.IfYes,mention them……

14. Following the government efforts to support agricultural activities, have you seen anychangesinthissubsectoroffarming?Explainthechanges……

……

15. How do you overcome the problem of agricultural inputs to horticultural farmers?

…….

16. What are challenges facing small scale farmers engaging in horticulture farming? Just mention…….....

17. What further steps should be done to improve horticulture farming in Arumeru district?

……

******Thank you very much**

APPENDEX III: STATA OUTPUT

Multiple linear regression output on role of horticulture farming to smallholder farmer's income

Source	SS	df	MS	Number of obs	=	210
				F(18, 191)	=	33.95
Model	55.7725134	18	3.09847297	Prob > F	=	0.0000
Residual	17.434002	191	.091277497	R-squared	=	0.7619
				Adj R-squared	=	0.7394
Total	73.2065154	209	.350270409	Root MSE	=	.30212

LnINC	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LnAGE	0	(omitted)				
LnAGE2	.0430433	.0460627	0.93	0.351	-.0478136	.1339002
GENDER01	.0349539	.0432591	0.81	0.420	-.0503731	.1202809
M_STAT01	.0991437	.0442685	2.24	0.026	.0118258	.1864615
EDUC01	-.0821438	.1625643	-0.51	0.614	-.4027957	.2385081
EDUC02	-.0904356	.165399	-0.55	0.585	-.4166788	.2358077
EDUC03	-.1371918	.1647644	-0.83	0.406	-.4621834	.1877998
F_EXPD1	.1843038	.0777053	2.37	0.019	.0310331	.3375746
F_EXPD2	.1828876	.0533257	3.43	0.001	.0777047	.2880705
HH_SIZD1	.0664395	.0765016	0.87	0.386	-.0844569	.2173359
HH_SIZD2	.0504032	.0646783	0.78	0.437	-.0771723	.1779787
HH_SIZD3	.1405525	.0779738	1.80	0.073	-.0132478	.2943527
EMPLY01	.1504509	.1441727	1.04	0.298	-.1339243	.4348261
EMPLY02	.6248507	.1471025	4.25	0.000	.3346966	.9150048
LAND_OW0	.0205352	.0540943	0.38	0.705	-.0861637	.1272341
LAND_SI0	.2961545	.0856182	3.46	0.001	.1272759	.4650331
LAND_SI1	.7003267	.0740448	9.46	0.000	.5542761	.8463773
AC_CRDT0	.1000395	.0469705	2.13	0.034	.007392	.1926869
M_SHIP01	.0159157	.0445231	0.36	0.721	-.0719043	.1037358
_cons	14.67268	.4194687	34.98	0.000	13.8453	15.50007

.

Probit model regression outputs: Determinants of small farmer's participation on horticulture farming.

Probit regression — Number of obs = 210
LR chi2(18) = 38.81
Prob > chi2 = 0.0030
Log likelihood = -55.225101 — Pseudo R2 = 0.2600

PARTN	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LnAGE	.7767745	.6359092	1.22	0.222	-.4695847	2.023134
LnAGE2	0	(omitted)				
GENDER01	.4684646	.2912558	1.61	0.108	-.1023862	1.039315
M_STAT01	.2719445	.2987451	0.91	0.363	-.3135851	.857474
EDUC01	-3.453701	197.6776	-0.02	0.986	-390.8946	383.9872
EDUC02	-3.310382	197.6777	-0.02	0.987	-390.7516	384.1309
EDUC03	-4.177081	197.6776	-0.02	0.983	-391.6181	383.2639
F_EXPD1	.8433441	.7020354	1.20	0.230	-.5326199	2.219308
F_EXPD2	.490186	.370021	1.32	0.185	-.2350419	1.215414
HH_SIZD1	-.0480696	.4363495	-0.11	0.912	-.903299	.8071598
HH_SIZD2	.7127282	.4179032	1.71	0.088	-.1063471	1.531804
HH_SIZD3	-.6873051	.4693924	-1.46	0.143	-1.607297	.2326872
EMPLY01	1.995427	.7016045	2.84	0.004	.6203077	3.370547
EMPLY02	1.844653	.7400652	2.49	0.013	.3941523	3.295155
LAND_OW0	-.4591546	.3876641	-1.18	0.236	-1.218962	.3006531
LAND_SI0	.9302694	.6267454	1.48	0.138	-.2981289	2.158668
LAND_SI1	1.24455	.7369843	1.69	0.091	-.1999126	2.689013
AC_CRDT0	.2857486	.2955282	0.97	0.334	-.293476	.8649731
M_SHIP01	-.2595478	.2886109	-0.90	0.368	-.8252148	.3061191
_cons	-.1264091	197.6948	-0.00	0.999	-387.601	387.3482

.

Marginal effect output of probit regresion model

```
Marginal effects after probit
      y  = Pr(PARTN) (predict)
         =  .95740519
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
LnAGE	.0704364	.46021	0.15	0.878	-.831559	.972432	3.5385
GENDER01*	.0416254	.26972	0.15	0.877	-.487011	.570262	.452381
M_STAT01*	.0253618	.16464	0.15	0.878	-.297322	.348046	.547619
EDUC01*	-.6951943	43.797	-0.02	0.987	-86.5359	85.1455	.352381
EDUC02*	-.6387956	45.457	-0.01	0.989	-89.7324	88.4548	.371429
EDUC03*	-.913867	22.415	-0.04	0.967	-44.8466	43.0189	.257143
F_EXPD1*	.0439076	.32299	0.14	0.892	-.589141	.676956	.095238
F_EXPD2*	.0401673	.26716	0.15	0.880	-.483462	.563797	.357143
HH_SIZD1*	-.0044653	.05047	-0.09	0.929	-.103375	.094444	.209524
HH_SIZD2*	.0624773	.40031	0.16	0.876	-.722112	.847067	.438095
HH_SIZD3*	-.0900253	.49847	-0.18	0.857	-1.06701	.886964	.190476
EMPLY01*	.2040488	1.04997	0.19	0.846	-1.85385	2.26194	.452381
EMPLY02*	.2204327	1.08463	0.20	0.839	-1.90541	2.34627	.52381
LAND_OW0*	-.0343079	.23523	-0.15	0.884	-.495353	.426737	.761905
LAND_SI0*	.0448856	.33384	0.13	0.893	-.609426	.699197	.080952
LAND_SI1*	.066421	.46751	0.14	0.887	-.849884	.982726	.195238
AC_CRDT0*	.0262661	.17105	0.15	0.878	-.308983	.361515	.514286
M_SHIP01*	-.0227748	.15074	-0.15	0.880	-.318214	.272664	.585714

(*) dy/dx is for discrete change of dummy variable from 0 to 1

.

Ordered probit regression model: Role of horticulture farming to small farmers on food security

```
Ordered probit regression                       Number of obs     =        210
                                                LR chi2(18)       =     116.52
                                                Prob > chi2       =     0.0000
Log likelihood = -138.61155                     Pseudo R2         =     0.2959
```

F_SEC	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LnAGE	-.2006477	.4094194	-0.49	0.624	-1.003095	.6017996
LnAGE2	0	(omitted)				
GENDER01	-.2134211	.1828651	-1.17	0.243	-.5718301	.1449878
M_STAT01	-.4601264	.1932256	-2.38	0.017	-.8388416	-.0814112
EDUC01	.3811071	.7080496	0.54	0.590	-1.006645	1.768859
EDUC02	.3864115	.7198343	0.54	0.591	-1.024438	1.797261
EDUC03	.2955115	.7170588	0.41	0.680	-1.109898	1.700921
F_EXPD1	-.1827677	.3276435	-0.56	0.577	-.8249372	.4594018
F_EXPD2	-.3432091	.223558	-1.54	0.125	-.7813747	.0949565
HH_SIZD1	-.46479	.3117836	-1.49	0.136	-1.075875	.1462945
HH_SIZD2	-.2854659	.2631286	-1.08	0.278	-.8011885	.2302568
HH_SIZD3	-.2544329	.329654	-0.77	0.440	-.9005429	.3916771
EMPLY01	-.8062982	.577849	-1.40	0.163	-1.938861	.326265
EMPLY02	-1.321741	.5978843	-2.21	0.027	-2.493573	-.1499091
LAND_OW0	.3170404	.2374753	1.34	0.182	-.1484025	.7824834
LAND_SI0	-1.077693	.360973	-2.99	0.003	-1.785187	-.3701991
LAND_SI1	-1.962322	.358038	-5.48	0.000	-2.664064	-1.26058
AC_CRDT0	.1488656	.1980821	0.75	0.452	-.2393681	.5370993
M_SHIP01	.4394581	.1918896	2.29	0.022	.0633614	.8155548
/cut1	-2.76403	1.831649			-6.353997	.8259365
/cut2	-.4286169	1.820073			-3.995895	3.138661

.

Marginal effect output of probit regresion model (outcome 1)

```
. mfx, predict (outcome (1))

Marginal effects after oprobit
      y  = Pr(F_SEC==1) (predict, outcome (1))
         =  .24306161
```

variable	dy/dx	Std. Err.	z	P>|z|	[	95% C.I.	]	X
LnAGE	.0628069	.12809	0.49	0.624	-.188251	.313864		3.5385
GENDER01*	.0672088	.05793	1.16	0.246	-.046335	.180753		.452381
M_STAT01*	.1412089	.05814	2.43	0.015	.027257	.25516		.547619
EDUC01*	-.1142285	.20218	-0.56	0.572	-.510489	.282032		.352381
EDUC02*	-.116375	.2076	-0.56	0.575	-.52327	.29052		.371429
EDUC03*	-.0876339	.20035	-0.44	0.662	-.480307	.30504		.257143
F_EXPD1*	.0600193	.11222	0.53	0.593	-.159924	.279962		.095238
F_EXPD2*	.110714	.07387	1.50	0.134	-.034065	.255493		.357143
HH_SIZD1*	.1574118	.11205	1.40	0.160	-.062208	.377032		.209524
HH_SIZD2*	.0902837	.08393	1.08	0.282	-.074219	.254786		.438095
HH_SIZD3*	.083733	.11339	0.74	0.460	-.138516	.305982		.190476
EMPLY01*	.2550933	.18149	1.41	0.160	-.100623	.61081		.452381
EMPLY02*	.3908135	.16066	2.43	0.015	.075929	.705698		.52381
LAND_OW0*	-.1045136	.08173	-1.28	0.201	-.264702	.055675		.761905
LAND_SI0*	.3990077	.1347	2.96	0.003	.135	.663015		.080952
LAND_SI1*	.6711462	.09371	7.16	0.000	.487475	.854818		.195238
AC_CRDT0*	-.0466447	.06213	-0.75	0.453	-.168418	.075128		.514286
M_SHIP01*	-.1404749	.06245	-2.25	0.024	-.262872	-.018078		.585714

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effect output of probit regresion motdel (outcome 2)

```
. mfx, predict (outcome (2))

Marginal effects after oprobit
      y  = Pr(F_SEC==2) (predict, outcome (2))
         =  .70632399
```

variable	dy/dx	Std. Err.	z	P>|z|	[	95% C.I.	]	X
LnAGE	-.0419105	.08574	-0.49	0.625	-.209967	.126146		3.5385
GENDER01*	-.0452792	.04008	-1.13	0.259	-.123839	.033281		.452381
M_STAT01*	-.0908486	.03973	-2.29	0.022	-.168726	-.012971		.547619
EDUC01*	.0703806	.11314	0.62	0.534	-.151369	.29213		.352381
EDUC02*	.0723615	.11869	0.61	0.542	-.160266	.304989		.371429
EDUC03*	.0529236	.10651	0.50	0.619	-.155841	.261688		.257143
F_EXPD1*	-.0431592	.08589	-0.50	0.615	-.211509	.125191		.095238
F_EXPD2*	-.0774726	.05504	-1.41	0.159	-.185355	.03041		.357143
HH_SIZD1*	-.1182297	.09248	-1.28	0.201	-.299478	.063018		.209524
HH_SIZD2*	-.0612368	.05859	-1.05	0.296	-.176067	.053593		.438095
HH_SIZD3*	-.060394	.0874	-0.69	0.490	-.231696	.110908		.190476
EMPLY01*	-.1725332	.12421	-1.39	0.165	-.415972	.070905		.452381
EMPLY02*	-.230543	.08554	-2.70	0.007	-.398202	-.062884		.52381
LAND_OW0*	.0755603	.06392	1.18	0.237	-.049721	.200842		.761905
LAND_SI0*	-.3429158	.13013	-2.64	0.008	-.597964	-.087867		.080952
LAND_SI1*	-.5671981	.0902	-6.29	0.000	-.743996	-.3904		.195238
AC_CRDT0*	.031171	.04194	0.74	0.457	-.051032	.113374		.514286
M_SHIP01*	.0968567	.04706	2.06	0.040	.004621	.189092		.585714

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Ordered probit: Link Test Results for model specification

Ordered probit regression — Number of obs = 210
LR chi2(2) = 117.46
Prob > chi2 = 0.0000
Log likelihood = -138.14384 — Pseudo R2 = 0.2983

F_SEC	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_hat	.5801346	.4482801	1.29	0.196	-.2984783	1.458747
_hatsq	-.0866168	.0903721	-0.96	0.338	-.263743	.0905093
/cut1	-2.344158	.5078414			-3.339508	-1.348807
/cut2	-.0326848	.4562644			-.9269466	.861577