

**FEASIBILITY ANALYSIS OF VEGETABLE SEED PROPAGATION
TECHNOLOGIES IN ARUMERU AND MVOMERO DISTRICTS, TANZANIA**

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE
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ABSTRACT

Improved seed propagation technologies have been proposed as solution to the poor quality of seedling experienced by vegetable farmers. The use of different technologies among farmers has shown to have economic implications. This study, therefore, was carried out to assess the economic advantages of seed propagation technologies and determine constraints facing farmers in vegetable nursery management in Arumeru and Mvomero districts. The study adopted a cross-sectional research design. A total of 240 vegetable farmers were randomly selected and interviewed with the aid of structured questionnaire. Data were analysed using descriptive statistics, partial budget and binary logit model. Results show that seedling trays and nursery beds were technologies used to raise vegetable seedlings in the study areas. However, the use of seedling trays was quite low whereby only about 13% of the vegetable farmers were using them. The partial budget results show that the use of seedling trays have a positive net income of TZS 32 800/tray and TZS 33 700/tray for tomato and sweet pepper respectively, indicating that it will be financially beneficial to switch from the use of nursery beds to seedling trays to raise seedlings. Furthermore, binary logit model results revealed that access to seedling trays ($p<0.05$), access to credit ($p<0.05$), marital status ($p<0.05$) and access to extension service ($p<0.05$) positively and significantly influenced the choice of vegetable seed propagation technology. Pest and diseases (99%), poor quality of seed (59%) and higher input prices (55%) were the prominent constraints to nursery management in the study area. Based on the findings it can be concluded that seedling trays could be used to raise vegetable seedlings with a view of increasing the efficiency of transplant production. Therefore, it is recommended that the government and

development stakeholders should extend training on technical knowhow aspect of the seedling trays to reach more vegetable farmers.

DECLARATION

I, Selina Patrick Nombo, do hereby declare to the Senate of neither the Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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Date

The above declaration is confirmed by,

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Date

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LIST OF ABBREVIATIONS AND SYMBOLS

AVRDC	Asian Vegetable Research Development Centre
C.I	Confidence Interval
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
Cm	Centimeter
DAICO	Districts Agriculture, Irrigation and Cooperative Officer
E	East
ESRF	Economic and Social Research Foundation
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistical Database
FYM	Farm Yard Manure
GAP	Good Agricultural Practices
GoT	Government of Tanzania
Ha	Hectare
HODECT	Horticultural Development Council of Tanzania
IITA	International Institute for Tropical Agriculture
Kg	Kilogram
LPM	Limited Dependent Model
M	Meter
MAFC	Ministry of Agriculture, Food Security and Cooperatives
MAFS	Ministry of Agriculture and Food Security
Mm	Millimeter
MMA	Match Maker Associates

MT	Metric Tons
NB	Nursery Beds
NI	Net income
OLS	Ordinary Least Square
PASS	Private Agriculture Sector Support
S	South
S.E	Standard Error
SEVIA	Seeds of Expertise for the Vegetable Industry in Africa
SIG	Significance
SNAL	Sokoine National Agricultural Library
SSA	Sub Sahara Africa
ST	Seedling Trays
TAHA	Tanzania Horticultural Association
TAPP	Tanzania Agricultural Productivity Program
TR	Total Revenue
TZS	Tanzania Shillings
VAEO	Village Agricultural Extension Officer
VC	Variable Cost
VICOBA	Village Community Banks
WUR	Wageningen University and Research Centre

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Vegetables are important components of daily diets and source of income, especially in urban and peri-urban areas. These crops provide a cheap source of proteins, vitamins and other nutrients which are essential for human health and well-being (James *et al.*, 2010). In addition, vegetables are effective in preventing micronutrient deficiencies and diseases. As a result, their demand is high for people who cannot grow them and hence create opportunities for smallholder farmers as a source of income (Xaba *et al.*, 2013). Vegetables also create a number of job opportunities in complementary businesses that arise such as marketing, processing, and transportation (Ajewole and Folayan, 2008). According to Economic and Social Research Foundation (ESRF), (2010) the demand for horticultural products is projected to grow significantly in the coming decades, due to an increase in awareness of their nutritional importance and the resultant increase in their consumption. This offers an opportunity to absorb an ever-increasing unemployed labour force in Tanzania. Therefore, any efforts to boost development of the vegetable sub- sector could have a positive impact on the living standard of people and contribute to food security.

Vegetable could be defined as an edible, usually a succulent plant or a portion of it eaten with staples as main course or as supplementary food in cooked or raw form (Asian Vegetable Research Development Centre (AVRDC), 1990). Furthermore, vegetables can be classified into three categories, depending on a planting practice: a) Vegetables that are usually transplanted,

e.g. chinese cabbage, broccoli, cauliflower, tomato, eggplant, pepper onion b) vegetables that are usually direct-seeded, e.g. watermelon, cantaloupe, squash, cucumber and c) vegetables that should be direct-seeded, e.g. radish, amaranth, carrots, beets (Guanzon and Holmer, 2003). According to Tewari (2009) most of vegetables are self-pollinated plants thus, are propagated by seed through natural or artificial means.

1.1.1 Major vegetable producing areas in Tanzania

Tanzania is endowed with favourable climatic conditions for growing different vegetable crops, whereby major producing zones are; Northern Highland zone (Arusha, Kilimanjaro and Tanga) which represent the highest potential for diverse horticultural investments, Eastern zone (Dar Es Salaam, Morogoro, Coast and Tanga), Southern Highland zone (Iringa and Mbeya) and Central and Lake zone (Dodoma, Singida and Mara) see Fig. 1 (MMA, 2017; ESRF, 2010; Putter *et al.*, 2007; Ministry of Agriculture and Food Security, 2002). It is estimated that vegetables account for over 50% of all non-staple food production in the country and the average annual consumption per person is about 30kg and 17 kg in urban and rural areas, respectively (Private Agriculture Sector Support (PASS), 2013). According to FAOSTAT (2014) at national level, area under vegetable is about 17.6% of all the crops.

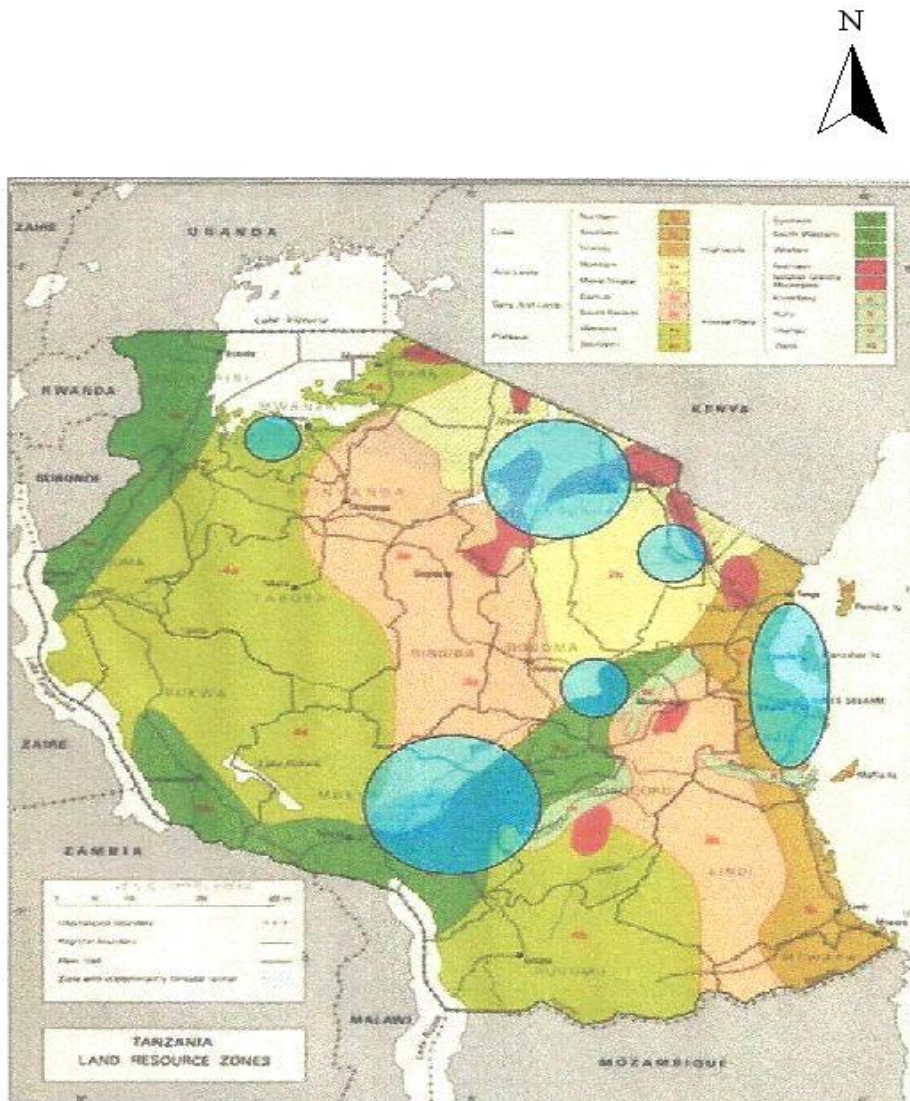


Figure 1: Major horticultural clusters in Tanzania

(Source: MMA, 2017).

NB: The cycle though not drawn to scale, provides a proxy of significance of the cluster in terms of potential land availability and current production volume in different markets.

1.1.2 Vegetable production trends in Tanzania

Vegetable production increased from 1.3 million metric tons in 2003 to 2.6 million metric tons in 2013, with an annual growth rate of 13.4% (FAOSTAT, 2014). However, these production levels are way below the projected 10.3 million metric for the year 2000 (AVRDC, 1990). This implies that despite the favourable climatic conditions for vegetable production in Tanzania the potential is not fully realised. Moreover, compared to other East African countries, Tanzania is not doing well in terms of productivity despite its comparative advantage of climatic conditions (reliable and well distributed rainfall), and abundant manpower/labor supply (ESRF, 2010). For instance, according to FAO statistics (2013) Kenya was ranked 90th vegetable producer in the world, producing about 142 000MT/ha whereas Tanzania was ranked 154th with a productivity level of about 72 000MT/ha (FAOSTAT, 2014).

Figure 2: Trend of vegetable production in Tanzania from 2009-13

(Source: FAOSTAT, 2014).

1.1.3 Characteristics of vegetable sub-sector in Tanzania

Vegetable sub-sector in Tanzania is dominated by small-scale farmers with less than 2 hectares, who account for 70% of vegetable producers (Tanzania Horticulture Association (TAHA), 2011). Nonetheless, the dominance of small-scale farmers in vegetable production presents an opportunity for poverty reduction through an increase in income and employment creation (James *et al.*, 2010; ESRF, 2010). Despite these facts vegetable crop productivity is low and this is attributed partly to use of poor technologies such as use of traditional seed and propagation methods which result in poor quality seedlings, among other factors (Temu, 2006; FAO, 2013; AVRDC, 2014). Seed propagation technologies are the facilities for growing transplants

(AVRDC, 1990). The first step in propagating seedling is to acquire the seed and the conditions may include, but are not limited, to placing of seeds close together in moist sand to help them germinate, scarification, alternating temperatures and chemical treatments (Ratha *et al.*, 2014). Poor seed propagation technologies could result to the fungal infection of seedlings, commonly known as damping-off which affects the quality of seedlings and is usually caused by excessive moisture and more air circulation (Bok *et al.*, 2006).

Moreover, vegetable production in Tanzania is also constrained by poor quality of seed and planting materials (MAFS, 2002). This reduces potential for smallholder farmers to meet the growing demand for vegetables in both developed countries and in their own urban centers (FAO, 2003). Therefore, use of improved nursery technologies to raise vegetable seedlings such as seedling trays could overcome the constraints in vegetable production.

However, it is argued that that many farmers use traditional farming methods of seed propagation, including sowing by broadcasting untreated seeds in nursery beds which reduces the possibility of obtaining good quality seedlings (Seeds of Expertise for the Vegetable Industry in Africa (SEVIA), 2014; Horticultural Development Council of Tanzania (HEDOCT), 2010). Seedling handling methods and management practices at nursery level contribute to their survival rate after transplanting and their subsequent growth performance and productivity (Munjunga *et al.*, 2013). Therefore, this study intends to analyse vegetable seed propagation technologies and factors driving smallholder vegetable growers to use new technologies in the study areas.

1.2 Problem Statement and Justification

Tanzania has a huge potential for vegetable crop production which is dominated by smallholder vegetable farmers, constituting about 70% (MMA, 2017). The country is among the world's major producers of fresh fruits and vegetables (Putter *et al.*, 2007). However, the vegetable sub sector is facing many challenges, one of which is use of traditional seedling production technology such as seed beds. The seedbed/nursery bed method has been used for a longtime as the most practical and cheapest method of producing seedlings (AVRDC, 1990). However, the method has following disadvantages; It that results in poor quality of seedlings; root damage due to uprooting during transplanting, difficulty in controlling spread of soil borne diseases within the seedbed and non-uniform final plant stands. According to Putter *et al.* (2007) seed quality and method of seedling production determine yield. Moreover, production of quality seedlings starts from securing quality seeds, nursery establishment and maintenance after emergence (Everaarts *et al.*, 2011).

According to SEVIA (2014) vegetable farmers lose about 60% of seed when raising seedlings on nursery beds. Moreover, the loss of seedlings is about 25% when raising them on nursery beds compared to loss of one or two seedlings when raising them in the seedling trays. Seedlings produced using seedbeds are transplanted with bare roots therefore re-growth is less successful than sowing in trays especially when weather conditions are unfavourable for establishment. These disadvantages prompted use of seed trays.

Consequently, the Government of Tanzania (GoT) and development partner such as AVRDC, SEVIA and TAHA have instituted intervention programmes to address the problem of poor

quality seedlings by introducing the seedling trays method in raising seedlings in the vegetable potential zones (AVRDC, 2014; SEVIA, 2014; TAPP, 2012). The technology has shown to be effective in improving quality of seedlings as they have been designed in a way that provide an independent area for each seed to germinate and grow with good air circulation and drainage (Bhimraj, 2011). Furthermore, Everaarts *et al.* (2011) argued that the efficiency of transplant production could be increased by raising seedlings in trays. Moreover, research done by SEVIA (2014) claim that the use of seedlings trays yielded about 25% to 48% more plants and seed use efficiency of 70% more than nursery beds. However, despite the stated advantages of seedling trays most farmers are still using the nursery beds and the reasons for that has not been fully established (TAPP, 2012).

Several studies have been conducted on vegetable nursery management and adoption of technologies such as (Emana *et al.*, 2015; AVRDC, 2014; Odiaka *et al.*, 2013; Asaduzzaman *et al.*, 2011; Nwalieji and Ajayi, 2009) but in Tanzania little has been done to assess benefits and cost of seedling production technologies. Thus, farmers could be interested in shifting from traditional to improved seedling production technology but are not well informed on the economic advantages of these technologies.

Therefore, this study was initiated to address the gap by identifying factors influencing farmers' choice of seed propagation technologies by focusing on seedling trays. Moreover, investing in a given seed propagation technology may also provide information on expected profit to farmers based on the technology used which is also lacking among farmers. Therefore, analysis of costs and benefits would provide evidence of expected gains from the proposed technology. Findings

from this study are intended to be used by policy makers, farmers and other development agencies with interest in increasing production and strengthening the vegetable sub- sector in the study areas and in Tanzania in general.

1.3 Research Objectives

1.3.1 Overall objective

The overall objective of the study was to assess the economic potential of vegetable seed propagation technologies and factors influencing their choice among farmers in Arumeru and Mvomero districts.

1.3.2 Specific objectives

The specific objectives were:

- To characterize vegetable nursery seed propagation technologies practiced in the study areas;
- To analyse costs and benefits associated with vegetable nursery seed propagation technologies used in the study areas;
- To determine factors influencing the choice of vegetable nursery seed propagation technologies in the study areas; and
- To determine constraints facing farmers in vegetable nursery management practices in the study areas.

1.4 Hypotheses

The second and third objectives were addressed by testing research hypotheses as follows;

- There is no significant difference in costs between seedling trays and nursery beds as seed propagation technologies.

- Years of experience, sex, age, access to trays, farm group membership, access to credit, family size, marital status and access to extension service do not influence farmers' choice of vegetable seed propagation technology.

1.5 Organisation of the Study

The study is organized into five chapters whereby chapter one provides an overview of the horticultural and the vegetable sub-sector in Tanzania. Other sections included are the problem statement, study objectives, hypotheses, and organization of the study. Chapter two presents, theoretical framework, analytical model, empirical review and conceptual framework. Chapter three outlines the methodologies including the sampling procedures, data collection and analytical procedures. It also presents a theoretical and empirical model for determining the relevance of the study. Chapter four presents the study findings and discussion. Finally, chapter five presents the conclusion and recommendations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Framework and Empirical Methods

2.1.1 The theory underpinning the study

This study is guided by the theory of the firm. The theory of the firm is the micro economic concept founded in neo-classical economic which states that firm/producer exists and makes decisions to maximize profits (Nicholson and Snyder, 2007). From the neo- classical theory, a firm/producer faces choice of what, how and how much to produce given the available scarce resources and technology (Oliver, 2008). This means a farmer will try to combine the input factors so as to maximize profit or minimizing cost of producing certain level of output.

In the theory of the firm, the behaviour of a particular farmer is said to be driven by profit maximization (Nicholson and Snyder, 2007). Therefore, a farmer makes his decision based on all his current information, his forward looking expectations and the relative costs and benefits of the two types of seed propagation technologies. Moreover, farmers may be motivated to choose a technology on the basis of their attitudes towards risk, the utility derived from production and for profit reasons (Samboko, 2011). Therefore, a farmer is assumed to take account of available information on potential costs and benefits in determining preference and to act consistently in choosing the self-determined best choice of action. This means, vegetable growers will opt whether or not to use the seedling trays to raise seedlings based on the information they have about the technology.

2.1.2 Analytical model

Choice models are normally used to assess the behaviour of a decision maker when faced with a set of alternative (Green, 2012). The model assumes that a decision maker, make a decision with the objective of maximizing profit (Green, 2012). The model relates the probability of choosing a

given alternative which is specific to each individual and characteristics of the decision maker. According to Green (2012) when the choice involves two alternatives the binary choice models are normally used. Various studies have specified logit or probit model to explain whether or not a farmer choose to use a given technology (Rasheli and Temu, 2014; Tesfu, 2014; Asaduzzaman *et al.*, 2011; Chaves and Riley 2001; Doss and Morris (2001); Adesina *et al.*, 2000).

Amemiya (1981) argues that both probit and logit model are statistically similar, although the parameter estimates may differ. He suggested that the difference between logit and probit model lies on the assumption about the distribution of errors; the probit model assumes a standard normal distribution while logit model assumes a standard logistic distribution of error. However, Sellar *et al.* (1986) argued that a logit model has a number of advantages for binary choices; first, its estimation is relatively simple; second, it usually provides a good approximation to the probit model. Moreover, Montgomery *et al.* (2001) argued that probit models lack flexibility in that they do not easily incorporate more than one prediction variable unlike logit models. However, the choice between the two models is normally based on researcher's convenience and the data generating process which is unknown.

This study therefore, employed a binary logit model in empirical analysis because the dependend variable (method of seed propagation) is categorical whereby a farmer choose the technology if there is a positive marginal net benefit compared to that of not choosing it. Therefore, the determination of the factors influencing the choice of agricultural technology using logit model is appropriate but not indicated with the ordinary least square regression as the estimates may be biased (Nchinda *et al.*, 2010). Equally, the use of linear probability model (LPM) may end in

predicting values that may fall outside the 0 – 1 interval, thereby violating the basic tenets of probability (Ajewole, 2010).

2.1.2.1 Assumptions underlying logistic regression analysis

- Logistic regression does not assume a linear relationship between the dependent and independent variables;
- The dependent variable must be a dichotomy (2 categories);
- The model is not sensitive to violation of the homoscedasticity and normality assumption of error term.
- The categories (groups) must be mutually exclusive and exhaustive; a case can only be in one group and every case must be a member of one of the groups; and
- Larger samples are needed than for linear regression because maximum likelihood coefficients are large sample estimates (Gujarat, 2003).

2.1.3 Analysis of cost and benefits associated with vegetable seed propagation technologies

The partial budget analysis is a simple but effective technique of analysing differences in costs and benefits between two or more technologies and estimate profitability (Upton, 1987). Castle *et al.* (1987) argue that a partial budget can be used on farms when changes are being made, such as converting from one enterprise to another, or analysing several enterprises and their interchangeability. According to CIMMYT (1988), the partial budget can go beyond just putting figures together, to help a farmer to define the reason or reasons for a change. It gives alternative

changes that can be made and eventually help the farmer to decide whether the proposed change will be worth it in the long run.

Kay *et al.* (2008) claim that a partial budget compares the benefits and costs of changes in practices for a given enterprise. It thus, takes into account only those changes in costs and returns that result directly from using a new technology. Hence, a partial budget can be used to establish benefits and losses of alternative production practices or technologies. Therefore, partial budget can help a vegetable farmers to estimate the net change in income from an investment decision.; This is because it considers all incremental revenue and incremental expenses that would change when the farm business operations are altered. In this case, based on argument from previous scholars (Barret *et al.*, 2012; Chase, 2010) this study adopted the partial budget analysis to determine the costs and benefits of vegetable seed propagation methods under smallholder vegetable farmers in the study areas. The partial budget approach was adopted based on the fact that cultivation of vegetables and seedlings production were the short term farm operations.

2.2 Empirical Literature Review

2.2.1 Seed propagation and nursery management

2.2.1.1 Seeds and seedlings

Seed is an embryonic plant enclosed in a protective out covering (Bhimraj, 2011). According to Munjuga *et al.* (2013) seeds determine yield potential, adaptation to environmental conditions, and resistance to insect pests and diseases. A seedling is a young plant that is grown from a seed, especially one grown in a nursery for transplanting and its development starts with the germination of the seed (Majunga *et al.*, 2013). Likewise, Ratha *et al.* (2014) argue that it is

important to raise insect pest and disease free seedlings from an early stage to ensure good plant growth performance and avoid yield losses.

2.2.1.2 Nursery and nursery management

A vegetable nursery is a place or an establishment for raising or handling of young vegetable seedlings until they are ready for more permanent planting (Munjuga *et al.*, 2013). Very small seeded vegetables require special care during their early growth stage. These are first sown in the nursery for better care and thereafter can be transplanted in the main field (Tewari, 2009). According to Bhimraj (2011) nursery is the best for future vegetable development and it depends on its physical and financial resources. Therefore, nursery can be a profitable venture when planned thoroughly. In this study farmers raised their own seedlings in the nursery before transplanting them in the main field thereafter.

Nursery management refers to activities and practices undertaken to better care for younger plants against pathogenic infections, insect pests, weeds, fertilization, watering, thinning and hardening off (Munjunga *et al.*, 2013). Good quality seedlings cannot be produced without care, therefore nursery plants need to be protected from extremes environmental conditions until they are strong enough (Munjuga *et al.*, 2013). In this study, farmers were responsible for taking care of the plants in the nursery. This involves insect pest and disease management through application of agrochemicals.

2.2.1.3 Seed propagation

Seed propagation is the process of creating new more plants from seeds and the condition of the seed is very important. The first step in successful vegetable production is to raise healthy and

vigorous seedlings (Kumar *et al.*, 2004). According to Verheij (2004) raising seedling is the most important means of developing cultivars in plant breeding. This is because young plants propagated from seeds require a lot of care, particularly during the early stages of growth (Ratha *et al.*, 2014). Therefore, they have to be protected from adverse climatic conditions such as temperatures, heavy rains, drought, wind as well as pests and diseases. Consequently, to overcome these problems, many vegetable crops are raised in nurseries before being transplanted in the field. According to AVRDC (2014), there are three main facilities that are used for raising seedlings in a nursery, which include; greenhouses where the environment is fully controlled, net house whose environment is partially modified and open field where climatic conditions are considered favourable for the crops grown. Thus, the choice for the facility are determined by available resources and prevailing environmental conditions.

2.2.1.4 Methods of seed propagation

Generally, in this study four methods of seed propagation are discussed. These are direct field planting, raising transplants in the nursery beds, raising seedlings in containers and raising seedlings in seedling trays.

(i) Direct field planting

Direct field planting according to Verheij (2004) involves gathering of seeds by farmers and sow them directly in the field. Before sowing the soil is loosened to improve water infiltration. This facilitates germination and fast growth of the crop. According to Erika (2013), direct field planting of small seeded vegetable crops often result in poor germination and stunted growth, resulting in delayed maturity and low yield. Moreover, Hatutale (2010), argue that direct field

planting is more laborious and a costly activity, which should be carried out to ensure a good plant, stand.

(ii) Raising transplants in the field nursery

According to Verheij (2004) field nurseries involves sowing seeds and raise the subsequent seedlings in a well-prepared bed until they are ready for field transplanting. This method is common in Tanzania (Verheij, 2004). The seedbed is prepared according to the nature of the land (Hatutale, 2010). However, there are two kinds of seedbeds namely, sunken beds which are widely used in areas with long dry, hot weather, and are kept slightly below the general ground level so that they could be easily irrigated, during the dry season. The other type is raised beds which are mostly used in moist areas, whereby nursery beds are raised 10-15cm above the grounds to facilitate drainage. The beds can also be supported either by bamboos or a line of bricks to prevent their edges from being washed away during the rainy season or by irrigation (Verheij, 2004). Raising seedlings on seed beds on small plots of land often results in poor and irregular emergence due to variation in size and quality which leads to poor establishment of the seedlings after transplanting in the field and may result in the crop not making a very good start (Wagenngen University Research(WUR), 2012).

(iii) Raising seedlings in containers

Sowing seed in containers is an alternative method to sowing seed in nursery beds. Containers used in this respect include clay pots, plastic pots, polyethene bags and multi-port seedling trays (Verheij, 2004). They provide the following advantages; minimize disturbance to the root systems, avoid the problem of uprooting for transplanting, ease in transportation and higher final seedling survival rate (Verheij, 2004). This implies that the expenses incurred in containers

would be offset by high profit margins emanating from good quality planting materials, and consequently high yield (Kumar *et al.*, 2004).

(iv) Raising seedlings in seedling trays

According to Bhimraj (2011), use of seedling trays and protective structures in raising seedlings has become a commercial venture in vegetable production. According to Bhimraj, (2011) the trays are of different kinds which include pro-trays (propagation tray) , plug trays or jiffy trays. The dimensions of the trays generally are 54 cm in length and 27 cm in breadth and a cavity depth of 4 cm.

These trays are made of polypropylene and are re-usable, whereby the life span depends on handling. Also, they have been designed in such a way that a seedling gets a pre-calculated growing media and the right amount of moisture as the trays have pre-punched holes to each cavity for proper drainage of excess water and also right spacing (Kumar *et al.*, 2004). Following sowing, seedling trays are commonly kept under nylon nets, wooden playhouses, shade houses, and low cost naturally ventilated greenhouses as protective structures against insect pests (TAPP, 2015). Moreover, planting materials in seedling trays with right growing media helps in proper germination as it provides an independent area for each seed to germinate and grow, which results in higher survival rate of the seedlings (Sefa and Beed, 2012).

As pointed out by Bosland and Votava (1999), plant stands established using seedling trays are more even and uniform and can achieve earlier maturity than direct-seeded plants. The use of seedlings trays also reduces thinning costs and can tolerate early un favourable plant growth

conditions. According to TAPP (2015), the advantages of trays include reduced damping-off disease, improved germination and saving many expensive seeds. Damping-off is a fungal seedling disease caused by *Rhizoctonia* and *Pythium* genera. The disease is favored by warm and wet conditions, water-soaked lesions on the stem of seedlings at the point of contact with the soil is one of the symptoms. The lesions soften the stem, causing the seedling to lodge and eventually dry up and die (AVRDC, 1990).

2.2.2 Review of studies on partial budget analysis

Horton (1982) adopted a partial budget to assess the net gain of using recommended seed technology in potato production and argued that the use of improved seed technology can be considered to have an economic advantages over use of the farmers own seed technology. Barrett *et al.* (2012) used partial budget analysis to estimate the cost benefits of using grafted transplants for root-knot nematode management in organic heirloom tomato production whereby their findings show that under severe root-knot nematode pressure, grafting may be an economically feasible measure to help maintain a profitable production.

Adeayo *et al.* (2011) used farm budget analysis to estimate the production cost, revenue and gross margin accruable to the farmers when examining the economic analysis of watermelon based production system in Oyo State Nigeria. They argue that gross margin per hectare generated by sole watermelon farms was lower than on farms that were intercropped between watermelon with cassava. Also, Chase (2010) employed partial budget to determine the profitability of changing carrots production practices and claimed that if the production change was implemented it would increase yield and profitability by \$38.50 per bed.

2.2.3 Review of factors influencing choice and tools for analysis employed

Doss (2006) suggested that a very important way of improving agricultural productivity in developing countries is through use of improved technologies, which will provide force in improving output and eventually improving lives of farmers. Bonabana-Wabi (2002) claims that factors such as government policies toward a technology, technological changes, markets forces, environmental factors, demographic factors and institutional factors do influence the choice of a given technology.

Banerjee and Martin (2009) conducted a study on factors influencing the choice of cotton modified seed using logit model whereby they claim that the decision as to whether or not to use modified seed is influenced by age, sex, total land size owned by the household, access to financial institutions, education level, and information flow. Moreover, Odiaka *et al.* (2013) conducted a study on the adoption of technologies in vegetable production using logit model and established that year of experiences, income and sex were significant and positively influenced the choice of technology. In addition, Idrisa *et al.* (2012) estimated the determinants of adoption of improved soybean seedling production technology and found that, farm size, access to credit, farming experiences and expenditure on labour do influence the choice of a certain technology.

In a study conducted by Nchinda *et al.* (2010), using a tobit model, was found that age, mixed cropping, hired labour and membership in farmers organizations positively and significantly influenced adoption of improved yam seed technology. Furthermore, Schultz (1995) cited by Tesfu (2014) claimed that the probability of adopting of a new technology will depend on the difference in profitability between the new and old technologies, and the ability of farmers to perceive the advantages and efficiently utilize a new technology.

Asaduzzaman *et al.* (2011) used a binary logit model to analyse factors that influence the choice of different homestead vegetables gardening technologies in rural Bangladesh and established that education, sex, and the garden size significantly influenced homestead gardening. In addition, Rasheli and Temu (2014) study on the market governance among smallholder vegetable farmers in Mgeta Tanzania, whereby they employed a binary logistic model to determine socio-economic factors influencing farmers' choice on market governance, and found that education level, sex, and farming experience positively influenced the choice of market governance.

Furthermore, Grove *et al.* (2006) argue that socio-economic characteristics have important implications on the use of available technology and resources. They argue further that an understanding of the general social and cultural behaviour and attitudes of the people in the areas it is important since these characteristics have some implications in farming decision making. Therefore, it is important to describe household characteristics of the respondents so that a general picture is understood. Therefore, based on the scholarly literature, data available and from a theory, a range of household, farm characteristics, and institutional factors were hypothesized to influence the choice of seed propagation technology by smallholder vegetable farmers in the study areas. These factors are credit access, age, farm group membership and contact with extension services, among other factors.

2.2.3.1 Farmer characteristics and socio-economic variables

(i) Age of the respondents

Age has been explained differently by different researchers on influencing choice of technology. Some researchers found that age positively influence adoption whereby old farmers are assumed to adopt a technology because they have accumulated capital or have greater access to credit, due to their age (Bekele and Drake, 2003; Etoundi and Dia, 2008). In addition CIMMYT (1993)

claim that older farmers may have more experience, resources or authority that would give them more possibilities for trying new innovations. However, as farmers advance in age, risk aversion increases and adopting a new technology seems less likely (Simtowe *et al.*, 2007).

(ii) Sex of respondents

Abunga *et al.* (2012) claims that the rate of technology adoption is higher among males compared to female because of discrimination, suggesting that women have less access to productive resources such as land, labour and capital, which are critical for adoption of technologies. Nonetheless, males and females perceive situations differently. Moreover, regarding sex, CIMMYT (1993) claimed that since women play a key role in most agricultural systems, it is important to consider the degree to which a new technology reaches female farmers.

(iii) Farming experience

Experienced farmers are assumed to have tried out a number of profitable technologies as experience helps an individual to think of a better way (Rahman, 2007). With experience comes knowledge, a universally accepted truth (Meijer *et al.*, 2015). So experience can influence the decision to use a new technology *ceteris paribus*.

(iv) Farm group membership

Affiliation to farmer groups increase social capital and allows exchange of new ideas between farmers (Asaduzzaman *et al.*, 2011). Farmer groups afford their members a wide opportunity for educating each other. Nkamleu (2007) argues that group affiliation enables farmers to learn about technology via other farmers and from development partners.

(v) Household size

Household size is used as proxy for labour availability in the family. According to Owombo *et al.* (2012) farming in most rural areas depend on manpower and largely family labour; therefore family size is associated with labour availability for timely operation of farm activities.

2.1.4.4 Institutional factors

(i) Access to credit services

Technology use is associated with the use of inputs like fertilizers, pesticides, and other associated input (Sheaban and Barrett, 2016). Therefore, access to credit facilities will further enable farmers to access such inputs. Adeoye *et al.* (2011) in their study on factors influencing adoption claim that access to credit relaxes income constraints of farmers hence enabling them to have access to key inputs such as labour hire. Hence, access to credit has been assumed to positively influence technology adoption.

(ii) Extension services

Access to extension service providers leads to more efficient transmission of information to farmers and adoption of innovations (Tesfu, 2014). Extension visits will help to reinforce the message and enhance the accuracy of implementation of the technology packages (Oladele, 2011). Agbebi (2012) claimed that there is a positive relationship between farmers' access to extension services and their profitability.

2.3 Conceptual Framework

The decision to accept any new technology and continue using might be affected by several factors which can be grouped into socio- economic characteristics, institutional factors and farm inputs. It is argued that institutional factors, farmer characteristics, and farm inputs affect choice

decision indirectly by influencing knowledge, and perception, which in turn influence farmers decisions of whether or not use an innovation Fig. 3. The role of knowledge, perception and attitudes are central to the choice of seed propagation technology. The first phase in a choice of improved seed propagation is the development of knowledge and acceptance of innovation. Farmers can have knowledge about the existing new technology/innovation, how to apply it and what the outcomes are in term of products, yield potential, environmental benefits, risks, and costs. The information an individual has about innovation forms the basis of the perceptions and attitudes this individual develops towards the technology (Meijer *et al.*, 2015). The perception farmers have about an innovation are very closely related to the knowledge they have about it. Knowledge and perceptions about an innovation together determine the attitude towards an innovation. In this case, positive attitudes towards an improved seed propagation technology will increase the likelihood of choosing it while a negative attitude will reduce the probability of using it. improved seed propagation technology.

Figure 3: A framework for choice of technology for vegetable seed propagation

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Areas

This study was conducted in six villages namely Mkuyuni, Manza, and Nyandira in Mvomero district and in Lake tatu, Olkang'adu and Karangai in Arumeru district. Selection of the study districts was based on their prominence in vegetable growing. According to PASS (2013) and Everaarts *et al.* (2011) the districts have high vegetable potential thus ideal for studying methods of seed propagation. Moreover, the districts are SEVIA, TAPP, AVRDC and TAHA priority research area where the projects on intensification of farming system are being implemented (SEVIA, 2014; Sefa and Beed, 2012; TAPP, 2012). The introduction of seedling tray technology is among the activity that has been implemented in the districts addressing the problem of poor quality of seedlings.

Arumeru district:

Arumeru district is located on North West of Arusha region between 3° 18' 18" South of the Equator and 36° 18' 3.6" East of Greenwich, (Kajembe *et al.*, 2005). The district is bordered to the North, West, and Southwest by Monduli district, Southeast by Arusha district and to the East by

Kilimanjaro region. Arumeru has two rainfall patterns, The short rains starting in September and ending in December and the long rains starting in March and ends in June. There are significant variations in rainfall distribution between the highlands and the lowlands. The highlands receive between 800 mm to 1 200 mm of rainfall while the lowlands receive between 500 mm to 700 mm of rainfall. The mean monthly temperature is 20°C to 17°C during the cooler season. Arumeru district is divided into three agro- ecological zones which are upper, middle, and lower zones (Kajembe *et al.*, 2005). Main economic activities are agriculture, livestock grazing, and forestry. Chinese cabbage, sweet pepper nightshade, tomato, and eggplant are some of the vegetables grown in the district (TAPP, 2015).

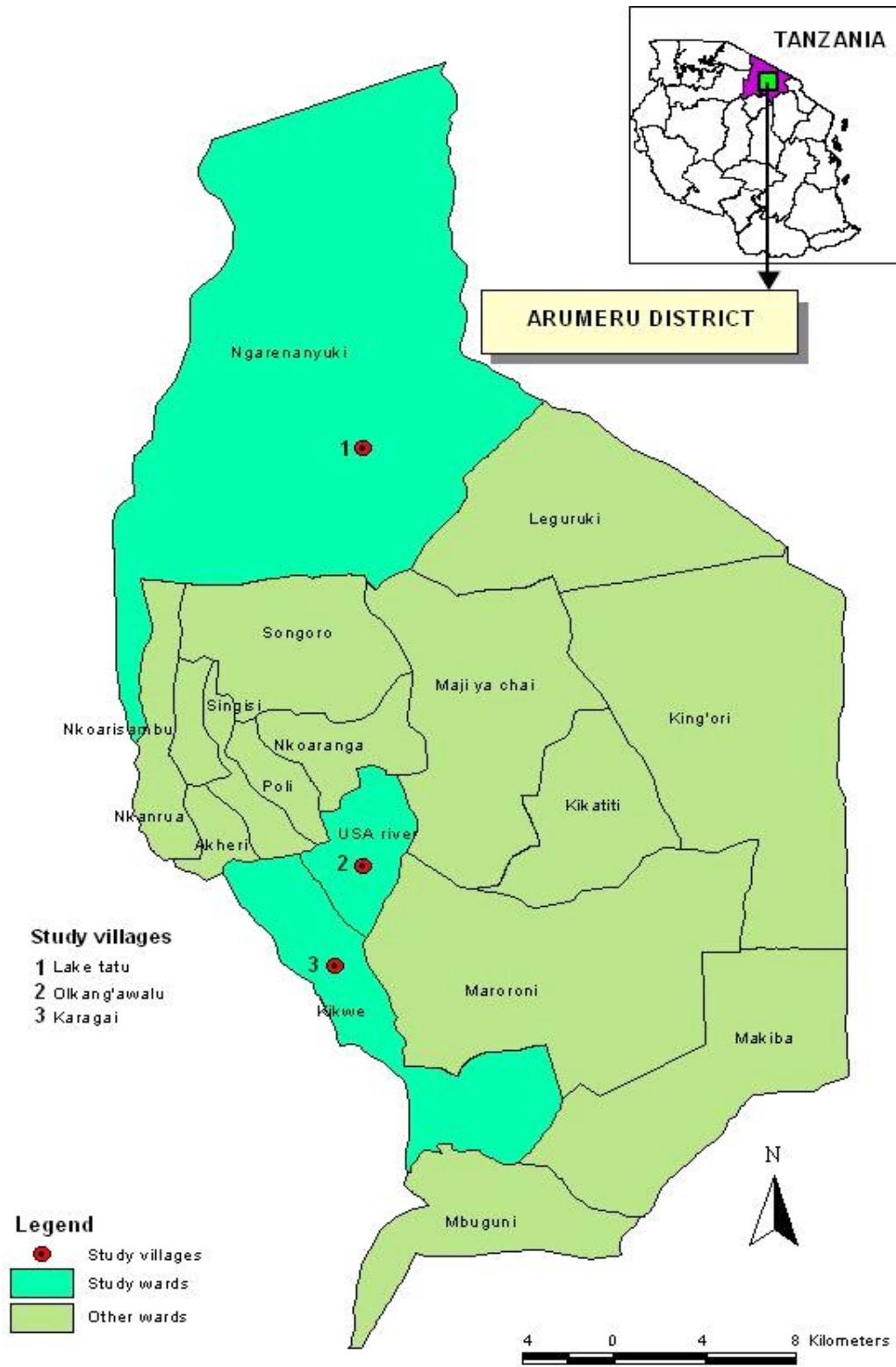


Figure 4: Map of Arumeru districts showing the study village

(Source: Ministry of Land, Housing and Human Settlement, 2012)

Mvomero district:

Mvomero district is located North-East of Morogoro region between 8° 00" and 10° 00" South of the Equator and between longitudes 37° 00" and 28° 22" East of Greenwich (Sefa and Beed, 2012). The district is bordered to the North by Tanga region, North-East by Coastal region, East and South-East by Morogoro Municipality and Morogoro District and the West by Kilosa district. The district has two rainfall patterns with short rains starting in October to December and the long rains starting in March to May. There are significant variations in rainfall distribution between the highlands and the lowlands. The highlands receive about 2 000 mm while the lowlands receives more than 600 mm. Temperature range from 30°C in lowlands and 18°C in the highlands. The district is divided into three agro-ecological zones which are highlands and mountain zone, Miombo woodland zone and Savannah River basin zone. These zones have potential for growing food and cash crops such as horticultural crops (URT, 2012). Among the horticultural crops, chinese cabbage, sweet pepper, nightshade, tomato, and eggplant are grown in these zones (Sefa and Beda, 2012).

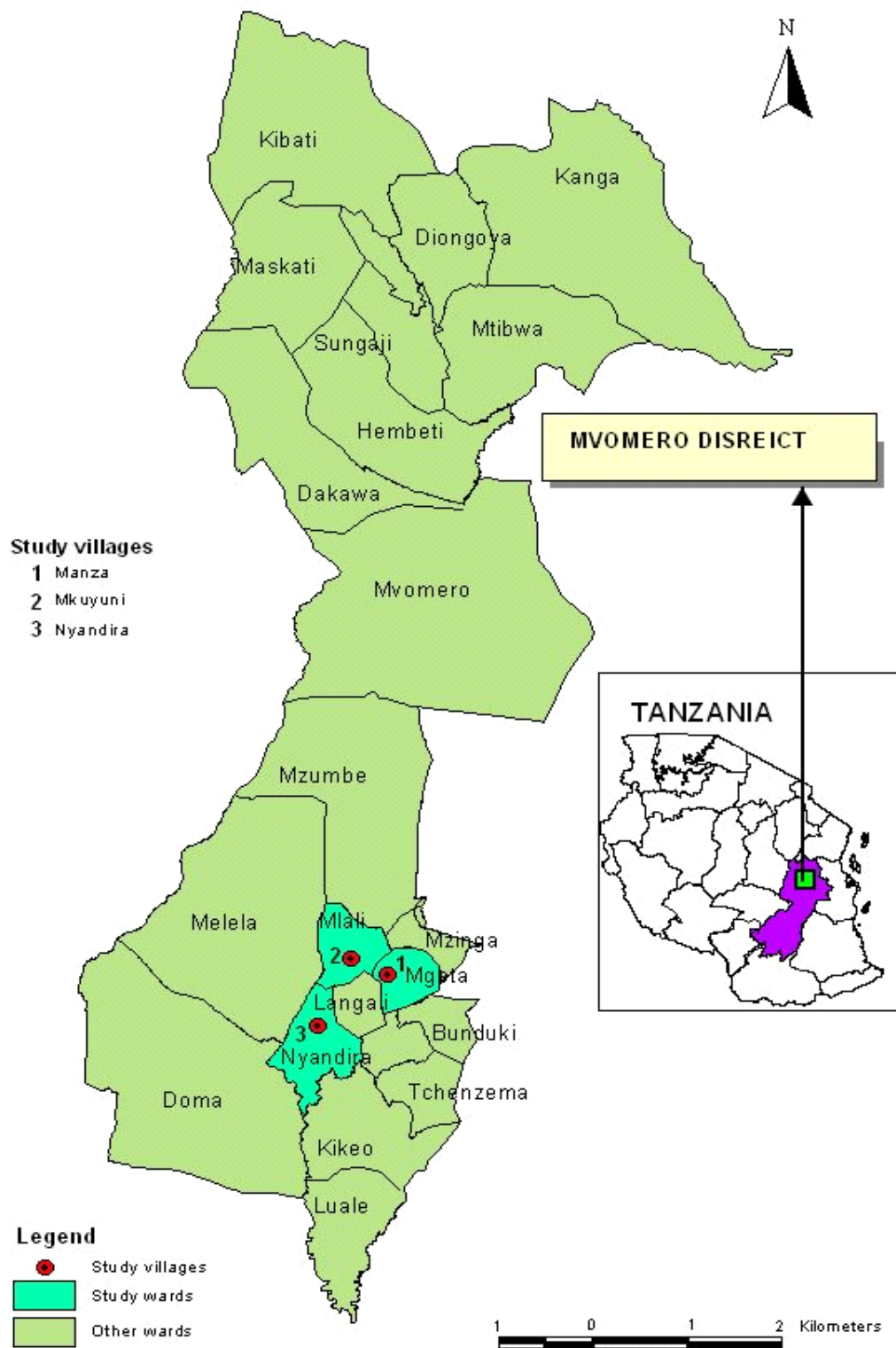


Figure 5: Map of Mvomero district showing the study villages

(Source: Mkonda, 2014)

3.2 Research Design

A cross - sectional design was employed whereby data were collected at a single point in time from a representative sample to describe the larger population at that time. This research design was used because of limited time in fieldwork and the fact that it was considered to be adequate for addressing the study objectives.

3.2.1 Sampling procedure and sample size determination

Sampling procedure is the process of selecting a sub-set of people or social phenomena to be studied, from the larger universe to which they belong in one of several ways so as to be a representative of that population (Kothari, 2004). The study population was vegetable farmers who engage in cultivation of transplanted vegetables in Arumeru and Mvomero districts. A multi- stage sampling involving a combination of purposive and random sampling procedures were used to select a representative sample of respondents. The first stage was purposive selection of districts and the second stage was a random selection of wards and villages. The final stage was random selection of respondents from the selected villages using a table of random numbers.

Proportional to size technique was used to obtain the proportion of farmers to be included in sample from each selected village (Table 1). The total population size of vegetable farmers from the selected villages was 2415; therefore, the optimal sample size was obtained using the method of determining sample size in Kothari (2004) as shown below in equation 1. The formula, which is depicted in equation 1 assumes a degree of variability (proportion) of 5% and a confidence level of 95%, which is appropriate to use in social science studies.

..... (1)

Whereby;

n = sample size, z = Z score, p = proportion of the population, $q = 1 - p$, e = allowable error, N = population size.

However, a sample size of 240 respondents was used and considered sufficient for the statistical analysis and model employed. This sample size was also predetermined depending on the homogeneity of the population and the available time and financial resources. Moreover, Bailey (1998) argues that a minimum sample size of 30 is normally sufficient for studies in which statistical data analysis is to be done in social sciences (based on population size). Furthermore, Matata *et al.* (2001) claimed that a sample size of 80-120 is adequate for soci-economic studies in sub- Saharan Africa(SSA) household.

Table 1: Sample size of surveyed villages

Village	Population	Proportions(%)	Sample size
Nyandira	480	19.87	48
Mkuyuni	290	12.00	29
Manza	399	16.52	41
Olkang'andu	492	20.37	49
Lake tatu	384	15.90	36
Karangai	370	15.32	37
Total	2415	100	240

3.2.2 Types of data

Both primary and secondary data were used in the study. Primary data were collected using a household survey questionnaire and interviews. Primary data included farmer characteristics (for example age, sex, education level attained, marital status, experience, family size and

occupation.) and institutional factors (credit access, extension services and farmgroup membership, inputs used and their prices, nursery tools, methods of raising vegetable seedlings, operational cost, type of seed sown, the actual area under crops and constraints encountered, among others (Appendix 1).

Secondary data on seedling market prices, potential yield, and currently available methods used for seed propagation were also used in this study to complement survey data. These data were largely obtained from the District and village agricultural offices reports, Sokoine National Agricultural Library (SNAL) and websites.

3.3 Data Collection Methods

Structured questionnaires containing both closed and open ended questions were used to collect primary data from the respondents in selected villages via face to face interviews. Besides, additional information was gathered from agricultural extension staff.

3.4 Data Processing and Analytical Methods

Prior to analysis, the survey data were first tabulated, coded and summarized in; Microsoft Excel and STATA computer soft packages version 13. Descriptive statistics such as mean, frequencies, percentage and cross tabulation were computed to characterize seed propagation technologies, and determine the constraints facing farmers in vegetable nursery management. Partial budget analysis was used to estimate the costs and net income due to change of seed propagation technology. Furthermore, binary logit model was used to determine factors influencing farmer's choice of seed propagation technology. Below is the description of the analysis used in the study

3.4.1 Specific objective one

Specific objective one intended to characterize seedling propagation technologies. The technologies were mentioned by respondents and responses were summarized using descriptive statistics (frequencies and percentages). Results were presented in graphical forms.

3.4.2 Specific objective two

The partial budget was used to analyse the costs and benefits associated with vegetable seed propagation methods. Partial budget analysis focused only on those income and expenses that change with the proposed new alternatives. Data on costs and benefits based on implemented technologies were collected. It was important as farmers would prefer to evaluate all the changes that are involved in adopting a new practice.

3.4.2.1 Estimation of components of partial budget

According to Lessley *et al.* (1999) there are several methods to organize a partial budget and in each of the methods costs and incomes are calculated. However, a partial budget has seven common components which include: increased revenue and reduced cost (total of positive effects), reduced revenue and increased costs (total of negative effects) and net change (positive minus negative effects). The components of partial budget were estimated as follows:

(i) Increased costs

These include seedling trays cost, prices paid for other inputs, depreciation cost for seedling trays and wages for labourers employed in activities such as sowing, watering, seedbed preparation, fertilizer application, media preparation and tray filling. However, following the standard practice in nursery industry, expenses for purchasing planting materials (seeds) for seedling were

not included in the variable costs because seed price varies with cultivars (Myles *et al.*, 2014). Therefore, input costs were estimated as a product of unit price and quantities purchased. Family labour was valued at hired labour wages per man- days on each activity in the study areas. Depreciation cost was obtained using the straight line method where the salvage value was assumed to be zero implying that the trays cannot be used for another purpose after its service life. A seedling tray was considered to be used for three years, but this depends on the handling. The conclusion of the service life of the seedling trays was made based on the survey data as well as from previous studies such as (Bhimraj, 2011). Depreciation cost was included in the partial budget because seedlings trays investment capital are variable to nursery beds. Therefore, including depreciation cost allow to evaluate the cost of production with this tangible asset expensed over it useful life in a rational and systematic manner (Garrison and Noreen, 2000 cited by Myles *et al.*, 2014)

$$\text{Depreciation} = \dots\dots\dots (2)$$

(ii) Reduced costs

This includes costs that will no longer be occurred as a result of using the new technology. These include fertilizer and pesticide cost since the use of trays involved less use of fertilizer and pesticides.

(iii) Increased revenue

Increase in revenue was estimated as the monetary value obtained from the sell of seedlings produced when using seedling trays. There is distinction in the output market between seedlings

produced using seed trays and nursery beds. This is because other studies (TAPP, 2015; SEVIA, 2014; TAHA, 2012; AVRDC, 1990) have argued that seedlings raised in trays are vigorous, healthy and free from diseases as compared to those raised in nursery beds, thus making them to have higher market value.

3.4.2.2 Procedure for preparing a partial budget

Using the Castle *et al.* (1987) approach, the partial budget was calculated as the change in net income as a result of use of given seed propagation technology. The net profit was computed as the difference between total losses and total gains (Malaiyandi *et al.*, 2010, Kraybill *et al.*, 2009). A partial budget was prepared by following the format in Table 2.

Table 2: Partial budget format

Negative effects	Positive effects
Additional costs (costs incurred as a result of using a new technology)	Additional revenue (<i>returns received as a result of using a new technology</i>)
Reduced revenue (<i>returns that are given up as a result of no longer using the technology being used</i>)	Reduced costs (<i>costs that will no longer be incurred as a result of using the +new technology</i>)
A. Total additional costs and reduced revenue TZS _____	B.Total additional revenue and reduced cost TZS_TZS Net change in profit (B-A).....TZS—

Decision: If the net benefit is positive, then the alternative may have some economic advantages while if the net benefit is negative a farmer would be better off staying with the current situation or look for a different alternative.

Rate of Return in the partial budget was useful for evaluating the economics of using new technology. It measures the increase in net income which is generated by each additional unit of expenditure. Therefore, since the use of seedling trays is more costly, and then rate of return was looked at.

$$\text{Rate of Return} = \Delta \text{Net Profit} / \Delta \text{Variable Costs} \dots\dots\dots (3)$$

Whereby;

$$\Delta\text{Net Profit} = \Delta\text{TR} - \Delta\text{VC} \dots\dots\dots (4)$$

Thus, the new technology should be accepted only if its Rate of Return is higher than 1.0 (Chase, 2010).

The independent T-test sample was then used to ascertain whether there was a statistical difference in unit production costs between seedling trays and nursery beds users at 5 percent level of significance. The prior expectation was that use of seedling trays to raise seedlings has higher cost compared to nursery bed given the hypothesis below;

Ho: =

Ha:>

Where: = Means of seedling trays, = Means of nursery beds

3.4.2.3 Assumption of the partial budget

One important assumption was made in partial budget analysis. The study assumes that farmers are rational seeking at maximizing profit, thus sell seedlings at the reasonable market prices to cover their production costs. Therefore, although the original plan was to raise seedling for transplanting them into their main plot, this study assume that farmers were selling the seedlings. This assumption was made to capture the effect of the technology at nursery level since post nursery activites were not the same and this study did not go further to undertake the field experiments to control the variations.

3.4.2.4 Limitation of partial budget

The partial budget is not appropriate to longer term changes or purchases if so it suggested to use capital budgeting. Moreover, the partial budget does not take into account the time value of money (Kraybill *et al.*, 2009). Despite of the limitations this study adopt the partial budget because seedlings production is a short term operations.

3.4.3 Specific objective three

The determinants of farmers choice of seed propagation technology was analysed using binary logit model. The choice between seedling trays and nursery bed technology was hypothesized to be influenced by socio-economic and institutional factors. Therefore, the dependent variable was the choice of seed technology given by latent variable Y^* which is an index of the unobserved propensity for an event to occur. In the binary logit model, seedling trays were taken as 1, while nursery bed as 0 as a method for seed propagation.

The latent model was specified as follows:

$$\dots\dots\dots (5)$$

Whereby follows standard logistic distribution and unobservable.

$$=1 \text{ if } 0 \text{ and unobservable}$$

The probability of choosing an alternative over not choosing is expressed by logit equation as in (6) where represents the cumulative distribution function of a standard logistic of random variables

$$\dots\dots\dots (6)$$

Whereby;

= The probability of the i^{th} farmer choosing seedling trays and is influenced by explanatory variables presented in equation (6) and β represent the vector of parameters associated with explanatory variables.

The relationship between a specific variable and the outcome of the probability was interpreted by means of the marginal effect, which accounts for the partial change in the probability. The marginal effect associated with continuous explanatory variables X_k on the probability, holding the other variables constant, was derived as follows;

$$\text{Marginal Effect of } X_k = \lim [\Pr(Y = 1|X, X_k+\Delta) - \Pr(y=1|X, X_k)] / \Delta \dots\dots\dots (7)$$

As Δ gets closer and closer to 0

The marginal effect on dummy variables was estimated differently from continuous variables. Since discrete changes in the predicted probabilities constitute an alternative to the marginal effect when evaluating the influence of a dummy variable. Such an effect was derived from the following;

$$\text{Marginal Effect } X_k = \Pr(Y = 1|X, X_k = 1) - \Pr(y=1|X, X_k = 0)\dots\dots\dots (8)$$

The marginal effects provide insights into how the explanatory variables shift the probability of technology use. Using the econometric software STATA marginal effect was calculated for each variable while holding other variables constant.

3.4.3.1 Definition of variables included in the model

Dependent variable: Choice of technology, categorical variable which takes the value of one if the farmer chooses seedling trays and the value of zero if a farmer chooses nursery beds.

Independent variables: Variables that were hypothesized to influence the farmer's choice of technology were selected based on the empirical literature and data available. Below is the summary of explanatory variables included in the model as shown below in (Table 3) with detailed explanation of the expected relationship with the dependent variables.

Table 3: Definition of independent variables and their expected results

Variable	Variable label	Expected sign	Theory/logic behind
X1= Sex	Sex of respondent (1=male, 0=female)		Males and female perceived situations differently also based on culture female lack access to resources.
X2=EXPERI	Number of years engage in vegetable cultivation	+	With experience comes knowledge, a universally accepted truth. Therefore, experience can influence the decision to use seedling trays ceteris peribus.
X3=ACCE_TRAY	Easy access to trays (1=easy, 0= otherwise)	+	A farmer can use technology, which is accessible so accessibility can influence the use of trays.
X4=AGE	Age of respondent measured in years	±	Age is the primary underlying characteristic adoption decision. Age and use of agricultural technologies depend on the type of technology being introduced.
X5= EX_CO	Extension contact (1=Yes, 0= No)	+	Contact with the extension service leads to more efficient transmission of information to farmers, and the adoption of innovations.
X6=FARM_G	If farmer belong in any farming group	+	Groups create social capital and allow exchange of ideas.

X7=CRED_ACCESS	Access (1=Yes, 0= Otherwise)	+	Credit helps farmers to purchase technology and associated farm inputs.
X8= F_S	Number of family members in the household		The use of tray requires labour. Household member influence labours availability.
X9=MARI_STA	Marital status (1=married, 0= not married)	+	Married household expected to be stable and settled career-wise.

3.4.4 Specific objective four

In order to address the fourth objective, which was intended to determine constraints which farmers are facing in nursery management activities, descriptive statistics were used. These included percentages and frequencies for constraints mentioned by respondents during the survey such as pest and diseases attacks, poor quality of seed, high input prices and lack of technical knowhow.

3.5 Limitation of the Study

Studies focusing on vegetable seed propagation in Tanzania are inadequate to date, however the study has reviewed relevant studies on nursery management and vegetable production in general. Post nursery operations and input used are not the same therefore yield differences are not limited to methods of seed propagation. The study therefore assume farmers sell the seedling and partial budget was done at nursery level.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents findings of the study. It is divided into four sections. Section one characterizes nursery technologies and household characteristics of vegetable farmers in the study areas. Section two present the results for partial budget. The third section presents factors influencing the choice of technology and finally the constraints encountered by vegetables farmers in nursery management is presented in section four.

4.1 Characterization of Seed Propagation Technology

The survey showed that the most of vegetable seeds were transplanted and some were directly planted such as carrots and amaranth. The results show that nursery beds and seedling trays were the mostly methods used for vegetable seed propagation in the study areas. Moreover, the findings show that majority of vegetable farmer's were using nursery beds (87%) for seed propagation as shown in Fig. 6. These results suggests that the use of seedling trays was relatively low, only about (13%) as compared to nursery beds, despite advantages associated with seedling trays namely; good germination, disease free seedlings, intact root systems and seed use efficiency. These results were similar to those of Everaarts *et al.* (2011) who found that field nurseries were common used method for vegetable transplants production in Tanzania. Cost of trays, lack of technical knowhow and lack of information on the economic advantages of seedling trays were mentioned by farmers during the survey to be among the reasons for not using it. The results therefore, suggest that agricultural technologies should be designed in such a

way that they would be affordable to farmers. Moreover, extension workers and farmers need trainings for capacity building and technical assistance on the use of seedling trays.

Figure 6: Seed propagation technologies practiced in the study areas

The Plates below show how the seed were planted in the trays and how were kept after germination



Plate 1: (a) Growers sowing tomato in the trays at Lake Tatu village (b) Seed emerging in seed trays after 3-5 days (c.) Seedling in trays 20 days after emergence

4.2.1 Vegetables grown in the study areas

This study focuses on high value transplanted vegetables. The findings show that tomato, sweet pepper, and eggplant were commonly commercial transplanted in the study areas. With respect to methods of propagation, the results show that seedling trays were mostly used for raising

tomato seedlings (8.8%) as shown in Table 4. This suggests that tomato was the most important vegetable commodity in terms of acreage, production and economic value. These results conform with those of Mtui *et al.* (2010) who found that tomato is Tanzania’s main economic vegetable. Moreover, the study found that some farmers were growing more than one type of vegetable in the same season such as tomato and eggplant or sweet pepper and tomato. However for the case of partial budget analysis This study, based on these three vegetables but for partial budget only two crops i.e. tomato and sweet pepper were used since none of the farmers use seedling trays for eggplant seed propagation.

Table 4: Vegetables grown and seed propagation technologies used

Variable	Methods of propagation				Total	
	Nursery beds		Seedling trays		N	%
Vegetable grown	N	%	N	%	N	%
Tomato	132	55	21	8.8	153	63.8
Sweet pepper	30	12.5	2	0.8	32	13.3
Eggplant	15	6.3	0	0	15	6.3
Tomato and sweet pepper	24	10	8	3.3	32	13.3
Tomato and eggplant	8	3.3	0	0	8	3.3
Total	209	87.1	31	12.9	240	100

4.2.2 Areas under vegetable cultivation in acres

The findings show that the mean area under production for vegetables in the study areas was at most one acre constituting 0.8 acre, 0.5 acre and 0.2 acre for tomato, sweet pepper and eggplant respectively as shown in Fig. 7. This implies that the mean area under tomato was above half an acre compared to other vegetables as shown in Fig. 7. These results were relatively similar to

Putter *et al.* (2007) who found that the area under vegetable production was on average, 0.5 acres in Tanzania.

Figure 7: Average area under vegetable production

4.2.3 Type of seeds sown and propagation technologies

The findings show that majority of vegetable growers, were using improved seeds while others were using recycled seeds as illustrated in Fig. 8. The survey found out that the amount of seeds sown depended on the area of the main field, spacing, seed viability and seed emergence rate. Moreover, during the survey it was observed that nursery size or number of trays for raising seedlings depend on seed weight.

Figure 8: Type of seed used based on the technologies



Plate 2: A farmer display a packet of an improved tomato seed at Lake Tatu village in Arumeru district

4.2.5 Fertilizer and pesticide application

The findings show that the majority of farmers (96%) who raise seedlings in the field nurseries use fertilizers as compared to those who raise them in seedling trays as shown in Table 5. The reason was that farmers who used seedling trays prepared growing media which is rich in nutrients and organic matters. These results were similar to those of Yosef *et al.* (2013) who found that farmers were using fertilizer in seedling production during establishment of community nurseries in the Central Highlands of Ethiopia. Moreover, the study found that most commonly used fertilizers for the seedlings in the nursery were industrial chemical fertilizers (Nitrogen, Phosphorous and Potassium). The study observed that the use of farmyard manure in the nursery was quite low since farmers complained that it caused damage to roots and burning of seedlings when not prepared well. The findings also show that pesticides were mostly applied by those farmers who raise seedlings in the nursery beds (Table 5). This results are similar to those of Ratha *et al.* (2014); Manjunga *et al.* (2013) and Bhimraj, (2011) claimed that use of trays leads to soilborne disease free seedlings (especially damping off disease). However, during the survey it was observed that some of the farmers who raise seedlings in trays were using pesticides for managing insect pest and airbornes diseases.

Table 5: Fertilizer and pesticide application in the nursery

Description	Methods of propagation					
	Nursery beds		Seedling trays		Total	
	N	%	N	%	N	%
Fertilizer use						
Yes	172	96.6	6	3.4	178	100
No	37	59.7	25	40.3	62	100
Total	209	87.1	31	12.9	240	100
Pesticide use						
Yes	124	94.7	7	5.3	131	100

No	85	78	24	22	109	100
Total	209	87.1	31	12.9	240	100

4.2.6 Socio-economic characteristics of surveyed vegetable farmers

Results show that majority of vegetable farmers (16%) who use seedling trays were found to fall within age group of 41-50 years while for the nursery beds (87%) were within age group of 18-40 years (Table 6). This means that the use of seedling trays in the study areas was dominated by middle aged vegetable farmers. Therefore, the implication is that the use of trays requires extra cost and most of middle aged farmers could have enough capital to cover those costs at *ceteris paribus*. The results are consistent to those of Nwalieji and Ajayi (2008) who claimed that middle-aged farmers are highly involved in use of improved vegetable production practices. However, the age difference in relation to the use of technology was not correlated ($P > 0.07$). The findings are supported by CIMMYT, (1993) which contends that choice of a given innovation may not be strictly correlated with age.

The findings also show that most of farmers had six to 10 members per household (Table 6). These results are relatively similar to those of URT (2014) that average people per household is 5 in Tanzania. This indicates that the family size of vegetable farmers was similar to the national average. The average family size has got an impact on the availability of labour, especially considering that most smallholder farmers depend on family labour (Asaduzzaman *et al.*, 2011; Edriss and Simtowe, 2003). However, the Chi-square test showed that there is no relationship between family size and the choice of the technology.

Table 6: Distribution of household characteristics by method of propagation

Description	Method of propagation						P-value
	SeedlingTray		Nursery beds		Total		
	N	%	N	%	N	%	
Gender							
Male	24	13.3	157	86.7	181	100	0.077
Female	7	11.9	52	88.1	59	100	
Total	31	12.9	209	87.1	240	100	
Marital status							
Married	30	14.9	172	85.1	202	100	0.025
Not married	1	2.6	37	97.4	38	100	
Total	31	12.9	209	87.1	240	100	
Education level							
Formal education	31	13.6	197	86.4	228	100	0.318
Informal education	0	0	12	100	12	100	
Total	31	12.9	209	87.1	240	100	
Family size							
1-5	3	6	47	94	50	100	0.143
6-10	25	14	153	86	178	100	
Above 10	3	25	9	75	12	100	
Total	31	12.9	209	87.1	240	100	
Age (years)							
18-40	14	12.2	101	87.8	115	100	0.430
41-50	14	16.1	73	83.9	87	100	
Above 50	3	7.9	35	92.1	38	100	
Total	31	12.9	209	87.1	240	100	

With respect to sex and marital status the findings show that for both technologies, married male farmers dominated vegetable cultivation in the study areas (Table 6). This is because most

women did not own land and married women need consent of their husbands. Moreover, according to World Bank (2009) studies in Africa, it is claimed that when a crop is perceived as commercial, men are more likely to take over from women, leaving women with another vegetable type for home consumption and other household activities. These results are similar to those of Lavison (2013); Xaba *et al.* (2013); Adeayo (2011) who claimed the domination of married males in vegetable production in West Africa. The status of being married in relation to the use of technology was statistically significant ($p < 0.05$). This means married farmers can easily make a unified decision with the minimum risk aversion to invest in new technology so as to improve socio economic status of the households.

Education wise the majority of respondents for both technologies have formal education (Table 6). This suggests that a formal education is sufficient to understand the functioning of modern technologies of seed propagation. These results are in agreement with that of TAHA (2011) who claim that in Tanzania, most farmers have formal education particularly primary education and rely on traditional farming methods. The Chi -square test results indicates that there is no relationship between level of education and the use of seedling trays. This implies that having formal or informal education do not differ in their level of seedling trays use.

4.2.6.1 Source of labour

The findings show that main source of labour for field nurseries was family labour (99%) while for seedling trays were both family and hired labour (34%) as shown in Table 6. Hired labour with the use of seedlings trays was associated with filling of trays and media preparation activities. This findings is consistent with those in West Africa by Lavison, (2013); Owombo *et*

al. (2012); Asaduzzaman *et al.* (2011) and Edriss and Mshote (2003) who claim that the main source of labour for vegetable farmers was family labour.

Table 7: Source of labour

Description	Methods of propagation					
	Nursery beds		Seedling trays		Total	
	N	%	N	%	N	%
Source of labour						
Family labour	194	99	2	1	196	100
Family and hired labour	15	65.9	29	34.1	44	100
Total	209	87	31	13	240	100

4.2.6.2 Extension service contact and access to credit

With respect to extension services, the results show that more than half of farmers who used seedling trays had access to extension services as compared to those who used field nurseries as shown in Table 8. That was because farmers were eager to use the new technology, thus, sought guidance from extension agents. Generally, extension services to vegetable farmers were quite low due lack of enough extension officers at the village level. The findings also suggest that farmers who use seedling trays have access to credit facilities as compared to farmers who raise seedling on nursery beds (Table 8). This further suggests that they take credits to assist the purchase of inputs. Generally, the availability of formal agricultural credit facility was limited in the study areas. However, it was established that the main source of credit was from savings scheme commonly known as (VICOBA). Moreover, it was reported that lack of collateral, higher interest rates and fear to investment risks were among the constraints to credit access in the study area.

Table 8: Access to extension services and credit

Description	Methods of propagation					
	Nursery beds		Seedling trays		Total	
	N	%	N	%	N	%
Extension service						
Yes	96	82.1	21	17.9	117	100
No	13	91.9	10	8.1	23	100
Total	209	87	31	13	240	100
Access to credit						
Yes	48	72.7	18	27.3	66	100
No	161	92.5	13	7.5	174	100

Total	209	87	31	13	240	100
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4.3 Analysis of Costs and Benefits of Vegetable Seed Propagation Technologies

The second specific objective of this study was to analyse the Cost and Benefits of vegetable seedling propagation technologies. The partial budget was used to analyse what would happen to costs and benefits/incomes when seedling trays are used for tomato and sweet pepper seed propagation rather than the use of nursery beds.

4.3.1 Partial budget for tomato seed propagation in 2014-15 season

The option was either to use nursery beds or seedling trays in tomato seedling production. Results for the analysed option are presented in Table 9.

Table 9: Partial budget results for choosing seedling trays over nursery beds (Tomato)

Negative effects TZS		Positive effects TZS	
Additional costs		Additional revenue	
Labour cost	964	Yield (seedling per tray)	301
Costs of other tools	3 692	Price per seedling	150
Seedling tray cost	6 000	Expected revenue (Q*P)	45 150
Depreciation cost of trays	2 000	Reduced costs	
Reduced revenue		Fertilizer cost	62
None		Pesticides cost	313
A. Total additional costs and reduced revenue	TZS 12 656	B. Total additional revenue and reduced cost	TZS 45 525
			TZS <u>12 656</u>
		Net change in profit(B-A)	TZS 32 869

The result show that the expected yield (seedlings per tray) were 301 plants and the average market price per plants was TZS 150. Then the additional revenue was TZS 45 525. Moreover, the shift from nursery beds to seedling trays reduces non labour input costs by TZS 375 per tray. Labour requirement and inputs however, would be increased by TZS 12 656 per tray.

Considering the components of partial budget in this study there was no reduced income due to change. Therefore, total positive effect outweigh total negative effects by TZS 32 800 per tray indicating that it would be financially beneficial to switch from nursery beds to seedling trays for raising seedlings.

Results also show that total mean nursery costs were TZS 12 600 and TZS 8 100 for the use of seedling trays and nursery beds respectively. The results for testing significance differences in nursery cost indicates that the mean difference for the alternative (nursery beds to seedling trays) was statistically significant ($p < 0.05$). This means that, unit production costs per tray was TZS 7 600 higher as compared to nursery beds. Furthermore, the estimated rate of return value was 3.02 which is greater than one. This indicates that the rate of return is 302% above the costs of additional investments. Thus it seems likely that this technology would be chosen in spite of its relatively initial investment cost.

4.3.2 Partial budget for sweet pepper seed propagation in 2014-15. season

The partial budget results show that when a farmer chooses to use seedling trays rather than nursery beds to raise sweet pepper seedlings, he/she would make a net gain of TZS 33 800 per tray (Table 10) and costs for labour and other inputs would be increase by TZS 11 600. The results also show total mean nursery cost for farmers who use seedling trays were TZS 4 300 and TZS 11 600 for raising plants in nursery beds and trays respectively. Therefore, the use of trays has higher cost which was attributed to the purchase of trays and labour cost whereby more labour was required to fill the trays and media preparation.

The results for testing significance differences in nursery cost indicates that the mean difference for the alternative nursery beds to seedling trays was statistically significant ($p < 0.05$). This means that, unit production costs for seedling tray was 7 200 higher as compared to nursery beds. The rate of return is 3.64 which means that net income will increase by 364% for each additional unit of expenditure.

Table 10: Partial budget by choosing seedling trays over nursery beds (sweet pepper)

Negative effects		Positive effects	
Additional costs		Additional revenue	
Labour cost	1 080	Yield (seedling per tray)	300
Costs of other tools	2 261	Price per seedling	150
Seedling tray cost	6 200	Income	45 000
Depreciation cost of trays	2 066		
Reduced revenue		Reduced costs	
None		Fertilizer cost	50
		Pesticides cost	401
A. Total additional costs and reduced revenue	TZS 11 607	B. Total additional revenue and reduced cost	TZS 45 451
			TZS <u>11 607</u>
		Net change in profit(B-A)	TZS 33 844

4.4 Factors Influencing the Choice of Vegetable Seed Propagation Technologies

A binary logit model was used to determine factors influencing the choice of vegetable seed propagation technologies whereby in this study, were the seedling trays and nursery beds. Table 11 provides results of the model estimated. The model was statistically significant ($p = 0.000$). Based on the results of estimated model, four variables significantly influenced farmer's choice of seed propagation technologies. These variables were access to trays ($p < 0.05$), access to credit ($p < 0.05$), extension service contact ($p < 0.05$) and marital status ($p < 0.05$) as shown in Table 11.

Thus, based on the results there was enough evidence to reject the null hypothesis in favour of the alternative hypothesis. Therefore, there is evidence that at least one of the independent variables jointly has an influence on the probability of using seedling trays.

Table 11: A binary logit model results showing factors influencing choice of seed propagation technology in the study area

Variables	Coefficient	P> z	Std error	Marginal effect	P> z	Std error
SEX	-0.6000	0.345	0.6355	-0.0246	0.416	0.0302
EXPERI	-0.0338	0.286	0.0317	-0.0012	0.322	0.0012
AGE	0.0186	0.512	0.0283	0.0007	0.508	0.0010
ACCE_TRAYS	2.2744	0.000	0.5573	0.1233	0.011**	0.0487
FARM_G	0.6657	0.231	0.5559	0.0242	0.272	0.0221
CRED_ACCESS	1.6345	0.001	0.5116	0.0845	0.036**	0.0403
HH_S	0.0458	0.848	0.2385	0.0016	0.850	0.0086
MARI_STA	2.7436	0.003	1.4144	0.0518	0.004**	0.0180
EX_CON	1.8978	0.000	0.6462	0.0735	0.012**	0.0311
Constant	-8.2822		1.6434			

* means significant at **=5% level of significance, Number of observation =240 Prob> chi2=0.0000

4.4.1 Marital status

As expected, the results show that marital status of the respondents has a positive influence on the probability of using seedling trays to raise vegetable seedlings ($p < 0.05$) as shown in (Table 11). The implication is that married smallholder farmers were 5% more likely to use seedling trays in comparison to those who are not married holding other factors constant. This is because a married couple usually has joint decision which intends to ensure they choose a propagation method that could improve yield. Moreover, married farmers have more responsibilities of ensuring the family has enough food. Therefore, any innovation that increases the yield of the crop could be well chosen. These results conform to the findings by (Tesfu, 2014; Tesfay, 2010)

who reported that marital status has a positive influence on adoption of modern agricultural technologies.

4.4.2 Access to credit

As expected, access to credit facilities was positive and significantly influenced the probability of using seedling trays to raise seedlings at $p < 0.05$ as shown in Table 11. This reveals that farmers who had access to credit were more likely to use seedling trays by 8% in comparison to those who have no access to credit facilities *ceteris paribus*. This implies that credit allows farmers to have additional capital that could be used to invest in a new technology or to acquire labour, seed, fertilizer and other inputs. Similar findings were reported by (Owombo *et al.*, 2012 and Banerjee and Martin, 2009) showing that credit access significantly influenced the use of improved seed in vegetable production among smallholder farmers. The results implies that making agricultural credit available, coupled with technical support from extension officers, had a high potential for increasing the number of farmers using seedling trays.

4.4.3 Access to seedling trays

The result shows that availability of seedling trays positively and significantly influences the use of seedling trays as shown in Table 11. This implies that farmers with easy access to trays were 12% more likely to use trays compared to farmers who have no easy access to trays. Results were similar to those of Badmus and Yekinni (2011); Tadesse (2009) who argued that availability of exotic vegetable seeds and improved seed influence vegetable production and profitability.

4.4.4 Access to extension services

The result as presented in Table 11 shows that access to extension services positively and significantly influenced the use of seedling trays in seed propagation ($p < 0.05$). At *ceteris paribus*, a smallholder vegetable farmer who accessed extension services was more likely to use seedling trays by 7% as compared with a smallholder farmer who did not contact an extension agent. This implies that access to extension services impact knowledge of agronomic practices to smallholder farmers (Rahman, 2007). Thus, a smallholder vegetable farmer with knowledge of agronomic practice could have practiced the farming technique in a better way than the one without knowledge. Therefore, current findings concur with those of Maponya *et al.* (2014) and Alene and Manyong (2007) who argue that regular contact with extension agents enables to acquire knowledge of improved vegetable production technologies. The results therefore, suggest that there should be regular visits by extension agents to vegetable farmers for technical support and information dissemination.

4.5 Constraints Facing Vegetable Farmers in Seedlings Production

Survey results revealed that vegetable farmers of selected villages encountered a number of constraints during seedling production as shown in Table 12. This included insect pest and disease incidences (96.3%), ineffective pesticides (68.8%), lack of assurance of good quality seeds (59%), higher input prices (55%) and lack of extension officers (51%). Similar results were also reported by (Emana *et al.*, 2015; Maponya *et al.*, 2014; AVRDC, 2012 and MAFC, 2008). Nonetheless, it was reported that pests and disease destroy most seedlings before attaining maturity. The pests were identified as Root-knot nematodes (*Meloidogyne spp*) and red spider mites (*Tetranychus spp*). These were mostly reported in Nyandira and Mkuyuni villages in

Mvomero district and Karangai village in Arumeru district. Root-knot nematodes and damping off disease were the most commonly reported diseases among farmers that raised seedlings on nursery beds due to poor drainage and air circulation. Others reported that lack of information on weather conditions and theft of seedlings hinders nursery management as shown in Table 12.

Table 12: Constraints facing vegetable farmers in nursery management

Variable		
Constraints in vegetable nursery management	Frequency	Percent
Pest and diseases attack		
Yes	231	96.3
No	9	3.8
Total	240	100
Ineffective pesticides		
Yes	165	68.8
No	75	31.3
Total	240	100
Poor quality of seeds		
Yes	142	59.2
No	98	40.8
Total	240	100
Higher input prices		
Yes	131	54.6
No	109	45.4
Total	240	100
Inadequate extension support on horticultural crops		
Yes	122	50.8
No	118	49.2
Total	240	100
Lack of information on weather conditions		
Yes	121	50.4
No	119	49.6
Total	240	100
Theft of seedling in the nursery		
Yes	92	38.3
No	148	61.7
Total	240	100

4.6 Summary of the Findings

Nursery beds and seedling trays were techniques employed by farmers to raise their seedlings. However, the use of seedling trays is quite low compared to nursery beds. Among the reasons for low use of seedling trays were the cost of trays and other associated activities such as media preparation and tray filling. Moreover, some farmers were even not aware of the existence of the technology.

With regard to the second specific objective, the partial budget for proposed change indicated a positive net gain for both tomato and sweet pepper seedling when using trays. This implies that the use of seedling trays has an economic advantage over current seedling production methods. Nursery costs were higher for vegetable farmers who use seedling trays as compared to farmers who use field nurseries.

To cater for the third objective results estimates showed that access to credit, ease access to seedling trays, extension services as well as marital status was positively significantly influenced the use of seedling trays to raise vegetable seedlings in the study areas holding other factor constant. Moreover, other variables those were conceptualized, the analysis show that they were positively but insignificant, this implies that farmers decision to use a new agricultural technology in preference to other alternative technology were statistical not associated to them. The most pressing constraint associated with vegetable nursery management is pest and disease incidences, counterfeit seed and pesticides followed by higher input prices, lack of extension officers based on horticultural crops, lack of information on weather and technical know-how.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Continuous effort has been made for the development of vegetable crops, but still, the sector is faced with many constraints related to seedling quality and nursery management. Taking these issues into account the study sought to; (i) characterize vegetable seed propagation technologies, (ii) analyse costs and benefits associated with the use of seed propagation technology, (iii) determine factors that influence the choice of vegetable seed propagation technology (iv) identify constraints facing vegetable farmers in nursery management. The following are the major conclusions drawn from the findings of this study.

Based on the findings, it can be concluded that raising seedlings in seedling trays is the profitable venture but the proportion of farmers using the technology is very low. This means that most of the vegetable farmers in the study area are using field nurseries. Therefore, in order to increase the level of technology use there is a need for government and other development partners to promote the use of seedling trays technology to vegetable farmers by disseminating information about the economic advantages and other benefits of the technology through trainings, workshops, and farm field schools with support of extension workers. Although the initial investments cost for the use of seedling trays are higher, however the cash outflow from the investment is expected to be recovered from the cash inflows generated by investment.

The findings also show that the use of seedlings trays in the study areas is strongly influenced by variables namely access to credit, extension services, access to trays and marital status at constant. Therefore, it can be concluded that access to credit and extension services are very important factors to promote adoption of the technology under consideration. Moreover, financial institutions like banks should provide affordable credit facilities to the farmers. This will encourage them to practice commercial farming and to adopt innovative technologies. Furthermore, the study conclude that pest and disease incidences, higher input prices, counterfeit seed and pesticides are the most pressing constraints in vegetable nursery management in the study areas. Therefore, respective authorities should quickly solve these problems.

Generally, this study observed a great potential for vegetable production in Mlali and Mkuyuni village in Mvomero and Lake Tatu and Karangai in Arumeru through improved technologies. Therefore, government and relevant private stakeholders should support farmers in these villages with low cost appropriate technologies and market linkages. It is therefore vital that agriculture technologies introduced should meet the needs of small, medium and large scale farmers.

5.2 Recommendations

In view of the major findings and the above conclusion, the following recommendations are drawn which may be useful to policy makers and other agencies who are directly or indirectly involved in the development of the horticultural sub sector in Tanzania.

5.2.1 Recommendation to farmers

It is recommended that, farmers in the study area should use seedling trays seedling for seed propagation in order to improve seedling quality since the technology is financially beneficial. Although the technology has a challenge of higher initial investment costs, it is recommended to farmers to find a best way to access affordable credits, such as village savings and loan groups. This will support nursery business financially.

5.2.2 Recommendations to policy makers

Access to agricultural credit facilities is the most important factor influencing the choice of seedling trays and which initial investment costs are higher in comparison to existing technology that is nursery beds. Therefore, it is recommended that government should establish good financial policies on agricultural credit facilities in order for vegetable farmers to access those credits on time and at affordable rates. Moreover, it is recommended that extension services should be strengthened in villages, the focus should be on training to extension agents to build capacity to them since some practices are new to them. Focus should also be on dissemination of information about new innovations, increasing number of extension workers because during the survey some villages were not having extension agents and technical assistance on how to control pests and diseases.

Furthermore, it is recommended that regulatory authorities for registering and certifying agricultural inputs should explicitly enforce their policies on quality controls on seed and pesticides market and hold accountable inputs dealers who are responsible for counterfeit seeds and pesticides. These counterfeit seed and pesticides pose loss of money and crops to farmers.

5.2.3 Area of further research

This study analysed the costs and benefits of raising seedlings in seedlings trays at nursery level.

This study did not discuss the effect of produced transplants on main field yield. This was due to lack of experimental data as post nursery operations and field conditions are not the same. Thus, further studies are warranted to evaluate the impact of transplants raised in trays on main field yield.

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APPENDENCES

Appendix 1: Interview Schedule

Questionnaire for household's survey

Purpose: This questionnaire is prepared with the aim of collecting data about vegetable nursery technologies in Arumeru and Mvomero district. This questionnaire will serve as an input for the Master thesis research but also to farmers in vegetable cultivation. Hence, the respondent is kindly required to provide his/her genuine responses to the sets of questions being designed. Importantly, the respondent is rest assured with the confidentiality of his/her responses. Thank you in advance for your cooperation.

Title: Feasibility Analysis of Vegetable Seed Propagation Technologies in Arumeru and Mvomero Districts.

General information

Date of interview.....

District..... Ward..... Village.....

Questionnaire Number.....

Name of enumerator.....

Section 1: Household Socio-economic Characteristics

1.Name of respondent.....

2. Respondent phone no.....

3. Is he/she the head of the family? 1. Yes.....2.No.....

4. Age of respondent.....

5. Sex..... 1=Male, 2= Female

6. Marital status (Tick appropriate answer)

Marital status	Tick	Code
Single		1
Married		2
Divorced		3
Widowed		4

7. Education level (Tick appropriate)

Education level	Tick	Code
No education		1
Adult education		2
Primary education		3
Secondary education		4
Tertiary		5

8. Household size.....

9. Age of household members;

No	Name	Age	Sex 1.male...2.female...	Education level	Relation to HH 1.spouse 2.child 3.Others(specify)
1					
2					

Section 2: Nursery Activities for objective no I

10. Do you engage in vegetable production? 1. Yes.....2. No.....

11. If yes how many years have you been growing vegetables?

12. Are you a full time farmer in vegetable cultivation? 1. Yes...2. No.....

13. If no, what other activities do you undertake besides vegetable cultivation?

1. Petty cash business...2. Employed...3. Cultivation of grains.....4. Livestock keeping5. Others (specify).....

14. What types of vegetable did you grow in your plot for the last season 2014-15?

Type	Plot area	Location(slope of the plot) 1.flat 2.Medium 3.High 4.Both
1.Tomatoes		
2.Sweetpepper		
3.Eggplant		
4.Varieties		
5.Others (specify)		

15. Farmer perception about soil fertility 1.Poor... 2.Medium...3.Fertile...4. Manured...

16. What is the source of seedlings for transplanting in your main field?

1. Own source..... 2. Buying from others.....3. Both 1&2.....

17. What is the purpose for vegetable cultivation?.....

1. Subsistence farming 2. Selling of vegetable 3. selling of seed and seedlings

18. What is the size of your nursery for the particular vegetable grown?

Crop type	Nursery size (seed bed, trays)

19. How many seasons per year did you raise the seedlings?.....

Which of the technologies did use for seed propagation for the planting season 2014-15

20. What type of seed did you sow?.....1. Adulterated seed 2. Improved seed 3. Hybrid seed.

21. Did you propagate seed direct in the nursery bed or by using containers?.....

22. If containers which kind of container did you use?.....

1= trays, 2=plastic bags 3= buckets, 4= pots, 5= clay pots, 6= seed boxes, 7= poly bags

23. What kind of plant media are you using?.....

24. What methods are you using in controlling pests and diseases in the nursery?..... 1.Local methods 2.Industrial chemicals 3.IPM 4.Others (specify)

25. What methods are you using in controlling weeds in the nursery?.....1.Manual weeding
2. Chemical weeding 3.Others specify

26. What methods are you using in irrigating the seedlings plants in the nursery?.....
1= watering cans 2= drip irrigation 3.Plastic bucket 4.Others (specify)

27. Did you apply fertilizer to the plants in the nursery?..... 1.Yes 2. No

28. If yes, what kind of fertilizer are you applying?.....
1= Farm yard manure, 2= Industrial fertilizer 3. Both 1&2

29. What is the nursery life span? (time between sowing and maturity for transplanting)...

30. Did you know any of vegetable seedling propagation technologies?.....1.Yes 2.No

31. If yes, what are those technologies?.....

32. Did you use any of those technologies mentioned above?.....1.Yes 2.No If no skip to qn
36)

33. If yes what are the reasons for adoption?.....

1. It is profitable
2. It is easy to practice
3. Influenced by other farmers
- 4.Assisted by the project
5. Others (specify)

33. Can you describe survival percentage of seedling when using improved method compared to
traditional methods?.....

34. Can you describe changes in seedling vigour and health compared to when using local
methods.....

35. Can you describe changes in crop yield after transplanting since you started using improved technologies? 1. Increased.....2. Decreased.....3. No change

36. Why did you decide not to use improved seed propagation technologies?

.....

1. They are so expensive
2. I have no knowledge on them
3. I am used to old practices and I have no interest on them
4. They are not profitable
5. I have no information
6. Others Specify.....

Section 3: Components of expenditure and revenue for objective no II

37. How did you acquire the land?.....1. Inherited 2.Purchased 3. Leased 4. Inherited and leased

38. If leased, what is the rate per area (Tsh).....

39. If purchased, what is the price per area.....

40. What is your source of labor for nursery activities?.....1.family labour 2. Hired and family labour 4.Hired and communal labour

41. What are your expenses in the following fixed capital for the nursery

S/N	Particulars	Quantity	Tsh/Unit	Total
1	Fencing			
2	Workshed			
3	Irrigation with pipeline			
4	Land preparation, nursery bed, roads			
5	Water storage (water tank, drums)			

42. Nursery labour use for seedling propagation technologies in 2014-15 planting season

Operations	Family labour	Hired labour	Wage rate/day	Total man days	Total cost
	Seed bed preparation				
Media preparation					
Tray filling					
Sowing seed					
Weeding					
Watering					
Fertilizer application					
Pesticides application					

43. How much do you pay your labour force on nursery activityTshs perday/ week/ month?

44. Non labour cost for the nursery activities

Crop	Manure		Seeds		Chemicals		Fertilizer for seedlings		Total cost
	Amount	cost	Amount	cost	Amount	cost	Amount	cost	

44. Cost of Tools and Equipment's

S/N	Items	Entity	Price /unit	Total cost
1	Spray pumps			
2	Sprinklers			
3	Axes/ hammer			
4	Wheelbarrows			
5	Boxes			
6	Watering cans			
7	Digging forks			
8	Spade			
9	Plastic buckets			
10	Hoes			
11	Trays/polybags			
12	Other tools specify.....			

45. What level of output realized and benefits obtained from the sales of seedling (for the case of commercial selling of seedlings)

Type of crop	Yield(seedling)	Price per unit	Quantity sold	Revenue

Section 4: for objective no III

47. Do you get extension services support?..... 1.Yes 2. No

48. If yes, how many times do extension officers visit in your area?.....

49. Please indicate the type of extension services you get

50. If no why.....

51. Do you receive training about practicing nursery management in vegetable production?..... 1.Yes 2. No

52. If yes from who?..... 1. Researcher 2.extension workers 3.Fellow trained farmers 4. Project/NGOs.....

53. Do you take credit for nursery management activities?..... 1.Yes 2.No

54. If yes, indicate the amount of credit obtained.....

55. What was the source of credit?.....1.Friends 2.Cooperative group 3.Financial institutional

56. What is the repayment period?.....

57. If no for question no 55 why?.....

58. Do you think credit is helpful?.....1. Yes 2.No

59. What is the distance from nursery to water source? (time walked).....

- 1. below 5min 2. 5 to 10min 3.10 to 20min 4. 20 to 30 min 5.above 30min

60. What is your farm category?..... 1. Subsistence production of vegetables
2. Small-scale production of vegetables 3. Large scale production of vegetable

61. What is the condition in term of trays accessibility?

1= ease access 0= other wise

Section 5: Challenges and opinions in Nursery management practices for objective no IV

62. Do you face challenges in vegetable nursery management practices?.....

1. Yes 2.No

63. If yes what are the major challenges in nursery management practices?

.....
.....
.....

64. What are your opinions concerning improved nursery technologies?

Opinion 1.....

Opinion 2.....

Opinion 3.....

65. In your own views, what do you think is the easiest (i.e. cheapest) practices for nursery management

.....
.....

66. In your own views, what do you think is the best practices as far as nursery management is concerned

.....