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ENHANCING SOIL FERTILITY FOR IMPROVING GROWTH OF TOMATOES PRODUCTIVITY AT HOME: A CONTRIBUTION FOR HOUSE HOLD FOOD SECURITY

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By

Firehiwot Taye

Thesis submitted to the school of graduate studies in Partial fulfillment of the requirements for the degree of Master of Science in Biology

September 14, 2015

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Advisor: Melaku Wale (Ph.D.)

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Approval Sheet

As thesis research advisor, I hereby certify that I have read and evaluated this thesis prepared, under my guidance, by **Firehiwot Taye**, entitled "**ENHANCING SOIL FERTILITY FOR IMPROVING GROWTH OF TOMATOES PRODUCTIVITY AT HOME: A CONTRIBUTION FOR HOUSE HOLD FOOD SECURITY**

." I recommend that it can be sub mitted as fulfilling all the thesis requirements.

Name of major advisor	Signature	Date
Melaku Wale (PHD)	_____	_____

As member of the Board of the Examiners of the M.Sc. thesis open defense examination, we certify that we have read and evaluated this thesis properly which was prepared by Firehiwot Taye. We recommended that the thesis could be accepted as fulfilling the Thesis requirement for the degree of Master of Science (in biology).

_____	_____	_____
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Name of Internal Examiner	Signature	Date
_____	_____	_____
Name of External Examiner	Signature	Date

Declaration

I, the undersigned, declare that this thesis is my own work. It does not presented in other university, colleges or institutions, seeking for similar degree or other purposes. All source of materials used for the thesis have been duly acknowledged.

Name**: Firehiwot Taye**,

Signature _____

This thesis has been sub mitted for examination with my approval as advisor.

Name: **Melaku Wale (PhD)**

Signature _____

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List of Abbreviations

ANOVA: Analysis of Variance

NMABDBO: National Metrological Agency Bahir Dar Branch office

HSD: Honestly Significantly Difference

SAS: Statistical Application System

BPA: Biphenol A

US: United State

DAP: Diammonium Phosphate

Ppm: Part Per Million

Ppb: Part Per Billion

Jmp: Soft Ware

CSA: Central Statistical Agency

HDC: Horticulture Development Corporation

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Acknowledgements

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Abstract

Different environmentally friendly soil fertility enhancing sources were employed to assess their contribution for food security at household level. This was tested on tomatoes which play a pivotal role in family balanced diet. The treatments tested include commercial fertilizer as standard check (10g /pot), untreated soil as control, manure + soil, azolla + soil, manure alone and sand +soil. Mixed treatments were kept at 1: 1 ratio by volume. Two tomato seedlings were grown per pot in which treatments were applied. The six treatments were replicated three times. Watering and other activities were carried out as required. Data collection included plant height, number of leaves per plant, number of branches during the vegetative stage and number of fruit per plant, plant base diameter and total biomass yield per pot at harvest. Data collection was carried out one week interval. Data were analyzed by using two way analysis of variance followed by mean comparison by using Tukey Honestly Significant (HSD) difference test. According to the result of analysis of variance among fertility enhancing treatments ($F_{29, 150}$ = 77.4, P< 0.0001), ($F_{29, 150}$=49.7, P< 0.0001) growth stages and their interaction. ($F_{29, 150}$ = 24.04, p < 0.0001). Plant height, number of leaves and branches did not significantly vary between treatments during the time from the vegetative stage through flowering and fruiting. Differences appeared at maturity and harvest. At harvest, fruit yield per pots was significantly higher on pots treated with manure only, manure + soil, chemical fertilizer, azolla +soil and soil alone. That meant manure performed relatively better in terms of fruit yield. The same trend was observed on biomass yield. Despite lack of significant difference, plants grown on pots treated with manure had the highest stem diameter and number of segments per plant. In conclusion, manure appeared to be a good candidate for vegetable production to apply at the household level on pots where land for growing them is limited. This study showed that tomatoes could be grown on pots at home at any available free space and supplement or even replaces dependence on the market for food supply.

Key words; Tomato, Soil enhancing fertility, Azolla, Manure.

1. Introduction

1.1. Back ground of the study

Food security is a global challenge especially in the developing countries like Ethiopia. Governmental and non-governmental organizations are working hard to ensure food security at the household level. Many different schemes are launched that envisage food self sufficiency. However, the challenge still persists and food prices are rising steadily worldwide On the other hand, households themselves can do more to ensure their own food self sufficiency. Growing vegetables at the household level is one intervention which is easy to handle by family members while contributing significantly for food self sufficiency (Pittenger, 2005). While such a tradition is not strongly rooted in our community, there are many other countries which grow these food products in the most unlikely places such as in the verandah, or even in containers suspended from the window (Pittenger, 2005).

Home gardens have been vital to human societies for thousands of years: from clusters of beneficial trees and shrubs planted on forest edges during pre-historic times, to the lush edible gardens grown traditionally in many tropical regions, to the tiny, densely planted backyards that cities worldwide (Lemma *et al,* 2003).

Home gardens play an important role in food security and nutrition, especially when food supplies are inadequate or unreliable. In urban areas, fresh produce may be expensive and hard to find, and in rural areas, much of the agricultural land is devoted to staple-crop monocultures: maize, rice, soy, etc. Which is crucial, but not enough for a complete diet. Home gardens help fill the nutritional gaps: even a small plot can supply a variety of fruits and vegetables at a relatively low cost, for example, urban home gardens produce an estimated 50-60% of the leafy vegetables and 20% of all the vegetables consumed by the households (Mukwiti, 2009). Generally, home gardening refers to the cultivation of a small portion of land which may be around the householder within walking distance from the family home.

Home gardens can be described as a mixed cropping system that encompasses vegetables, fruits, plantation crops, spices, herbs, ornamental and medicinal plants as well as livestock that can serve

as a supplementary source of food and income. Home garden cultivation is fully or partially committed for vegetables, fruits, and herbs primarily for domestic consumption (Nicolas, 2006).

Vegetables may be eaten raw or cooked; fresh, frozen, canned, or dried/dehydrated; and may be whole, cut up, or mashed (Kortright and Sarah, 2010). The confusion about 'fruit' and 'vegetable' arises because of the inferences in usage between scientists and cooks. Scientifically speaking, a tomato is definitely a fruit. True fruits are developed from the ovary in the base of the flower, and contain the seeds of the plant (though cultivated forms may be seedless). Blueberries, raspberries, and oranges are true fruits, and so are many kinds of nut (Jankauskiene *et al.,* 2013). Tomatoes are often closely associated with Italian cuisine; they are actually originally native to the western side of South America around by Columbia, Ecuador, Peru, Chile, and the western half of Bolivia. The Galapagos Islands off the coast of Ecuador are also believed to be part of tomatoes' native area. The first type of tomato grown is thought to have more resembled the smaller-sized cherry tomato than the larger varieties (Landon-Lane, 2011).

In the tropics, tomato is mostly produced by transplanting. Good quality of seedling usually leads to better growth, higher yields and earlier maturity. Tomato is among the most important vegetables crops in Ethiopia. Both fresh and processed tomato varieties are popular and economically important vegetable crops produced in the country (Kortright and Sarah, 2010; Lemma *et al,* 2003).

T**o**mato is one of the most popular home garden crops in the tropics or in greenhouses in temperate areas. It is low in calories and a good source of Vitamin C and it is the most widely consumed fresh fruits and vegetables. It be grown in a small area, bear through most of the season, it is easy to grow, and has many culinary uses in the home (Ted, C.et al, 2009). This growing habit of tomatoes can help households to grow them in small plots or even in containers in the smallest place available in residential compounds. It may be grown at monthly intervals so that they supply a portion of their needs for tomatoes. Growing them is easy and it can be done causally at all times and during one's leisure time just in the compound (Boondia *et al*, 2011). The wide spread adoption of this habit in the community reduces the burden on the community brought about by price oscillations across the season and contributes for food security in the household. In Ethiopia there is a general lack of awareness about the potential of growing one's

own vegetable needs right at home. This research paper was therefore conducted to investigate the possibility of growing tomatoes in a small compound and determine the yield that can be obtained by using different soil fertility enhancing techniques. This experiment had the objective of testing the possibility of growing tomatoes at home for home consumption and saving money.

1.2. Statement of the problem

Due to increasing word population and growth of interest for food in our community, the demand for vegetables is increasing dramatically. Tomatoes play universal role in today's food habit of the population especially in the urban areas (WHO 2002.). The challenge, however, is the shortage of tomatoes in the market, which sometimes gets too expensive and other times it disappears altogether or farmers produce surplus and they do not fetch enough returns from their investment. Therefore, producing one's own tomato needs just in one's own compound relieves the burden on the household and saves the hard earned income from being wasted by trying to buy expensive stuff. The target population is urban areas where plots of land are not as easily available as in rural areas. A 250 m^2 plot of residential house cannot claim that there is no space to grow a portion of one's own vegetable supply. In other countries, even the verandah or belong of condominiums and roofs are used for the same purpose.

1.3. Objective of the study

1.3.1. General objective

The general objective of this study was to evaluate different tomato growing soil medium at household level for household consumption.

1.3.2. Specific objectives

a. To determine the yield of tomato produced using different soil media growing in the residential compound.
b. To determine if household efforts can help produce a productivity of the food family members need in a sustainable manner.

2 .Literature Review

2.1. Tomato Production

Horticultural crop production in Ethiopia is scattered throughout the country on patches of land in peasant smallholder farm. Whereas large scale production and processing of fruits and vegetables is carried out only by state organizations, predominantly by the Horticulture Development Corporation (HDC), which has been carrying out production and marketing development activities since 1980 (Girma A. J.(2013)

Tomatoes are the second most important vegetable commodity after pota-toes, planted to about 6 000 hectares. Tomatoes contribute about 24 % of the total vegetable production in South Africa. Major production areas in South Africa Tomatoes are grown all over the country in summer and in winter in frost-free areas, and their production is concentrated in Limpopo, the Mpumalanga Lowveld and Midlevel, the Pongola area of, the southern parts of the Eastern Cape, and the Western Cape. Growing of tomatoes in tunnels is becoming a popular and important crop production method in South Africa (KwaZulu.N (2001).

2.2. History

Although tomatoes are often closely associated with Italian cuisine, they are actually originally native to the western side of South America, in the region occupied by Columbia, Ecuador, Peru, Chile, and the western half of Bolivia. The Galapagos Islands off the coast of Ecuador are also believed to be part of tomatoes' native area. The first type of tomato grown is thought to have more resembled the smaller-sized cherry tomato than the larger varieties.

The tomato does not appear to have been first cultivated in South America, however, but rather in Mexico, most likely in Aztec civilizations and probably in the form of small yellow fruits. The word "tomato" may actually originate from the Nahautl (Aztecan) word "*tomatl*"meaning "the swelling fruit." It wasn't until the 1500's that Spanish explorers and colonizers brought tomato seeds from Mexico back to Spain and introduced this food to European populations (Landon-Lane, 2011).

Although the use of tomatoes spread throughout Europe (including Italy) over the course of the 1500's, tomatoes did not enjoy full popularity then and were seen by many people as unfit to eat. Part of this "food inappropriateness" was associated with the status of the tomato plant as a nightshade plant and its potential poisonousness in this regard. (It's true, of course, that tomatoes belong to the *Solanaceae* or nightshade family of plants, along with potatoes, sweet and hot peppers, eggplant, tomatillos, tamarios, pepinos, pimentos, paprika, and cayenne. It's also true that tomatoes contain alkaloids substances that even in small doses can be associated with adverse reactions in sensitive individuals. But it's also true that the levels of alkaloids found in nightshade foods are well-tolerated by many individuals in diets worldwide. For more on nightshades, please see our article "What are nightshades and in which foods are they found?")

Today tomatoes are enjoyed worldwide to the tune of about 130 million tons per year. The largest tomato-producing country is China (with approximately 34 million tons of production), followed by the United States, Turkey, India, and Italy (Rea, 2006).

In the U.S., cultivation of tomato varieties is usually determined by their final destination: (1) consumption in fresh form by consumers or (2) use in processing by manufacturers of tomato products. Tomato processors need varieties that have a greater proportion of soluble solids in order to make products like tomato paste more efficiently. Between 80-90% of all commercial tomato cultivation in the U.S. is cultivation for eventual use in processing. (Processing tomatoes are needed for the manufacturing of pasta sauces, pizza sauces, and tomato pastes. Both processing and fresh market tomatoes may be used in the production of salsa—although fresh market tomato salsas or homemade salsas—like our Fresh Tomato Salsa—are the salsas that we like best on account of their minimal processing.) California and Florida produce about two-thirds of all commercially grown fresh market tomatoes in the U.S. During the winter months, because Florida tomatoes are generally shipped to other states along the east coast of the U.S., imported Mexican tomatoes make up a high percentage of commercially grown fresh tomatoes along the west coast (Sanjiv and Akkinappally, 2000).

Choose tomatoes that have rich colors. Deep reds are a great choice, but so are vibrant oranges/tangerines, brilliant yellows, and rich purples. Tomatoes of all colors provide outstanding nutrient benefits. Tomatoes should be well shaped and smooth skinned with no wrinkles, cracks,

bruises, or soft spots. They should not have a puffy appearance since that characteristic is often associated with inferior flavor and may also result in excess waste during preparation. Ripe tomatoes will yield to slight pressure and will have a noticeably sweet fragrance (Rea, 2006).

When buying canned tomatoes, it is often better to buy those that are produced in the United States as many foreign countries do not have as strict standards for lead content in containers. This is especially important with a fruit such as tomatoes, whose high acid content can cause corrosion to, and subsequent migration into the foods of, the metals with which it is in contact (Ganesan *et al.,* 2012).

While on the topic of canning, you may also be interested in some of the most recent information about canned tomato products and BPA (bisphenol A). BPA is an added component in the vinyl lining of numerous canned foods, and it's also known to be problematic from a health standpoint because of its impact on estrogen metabolism. (For more extensive information about BPA, click here.) A recent study of canned foods in Canada has shown an average of about 1 ppb of BPA in canned tomato paste products (with a maximum amount of about 2 ppb), and an average of 9 ppb in pure tomato products liked diced, sliced, or whole peeled tomatoes (with a maximum amount of about 23 ppm). While the U.S. Food and Drug Administration has not set a limit on the amount of BPA allowed in canned tomatoes, the European Commission Directive for BPA has set a limit of 600 ppb. While any amount of BPA in canned tomatoes seems undesirable, we are glad to see that the BPA levels were fairly low in this recent study, especially in canned tomato paste products. You'll need to look for a claim of "BPA-Free" on the label of your canned tomato products (or call the manufacturer) if you want to be sure that your canned tomatoes contain no BPA, since even some certified organic canned tomato products may contain and are allowed to contain BPA (through migration from the can) (Sanjiv and Akkinappally, 2000).

Since tomatoes are sensitive to cold, and it will impede their ripening process, store them at room temperature and out of direct exposure to sunlight. They will keep for up to a week, depending upon how ripe they are when purchased. To hasten the ripening process, place them in a paper bag with a banana or apple since the ethylene gas that these fruits emit will help speed up the tomato's maturation. If the tomatoes begin to become overripe, but you are not yet ready to eat them, place them in the refrigerator (if possible, in the butter compartment which is a warmer area), where they will keep for one or two more days. Removing them from the refrigerator about 30 minutes before

using will help them to regain their maximum flavor and juiciness. Whole tomatoes, chopped tomatoes and tomato sauce freeze well for future use in cooked dishes. Sun-dried tomatoes should be stored in an airtight container, with or without olive oil, in a cool dry place (Ganesan *et al.,* 2012).
Ketchup can be a surprisingly good source of tomato nutrients, including lycopene. But if you are going to purchase tomatoes in the form of ketchup, we recommend that you choose organic ketchup. We make this recommendation not only because you're likely to avoid unwanted pesticide residues and other contaminants if you purchase organic, but also because we've seen a recent study showing higher lycopene content in organic versus non-organic ketchup (Sanjiv and Akkinappally, 2000).
Before serving, wash tomatoes under cool running water and pat dry. If your recipe requires seeded tomatoes, cut the fruit in half horizontally and gently squeeze out the seeds and the juice. However, we encourage you to think about the recipe and consider whether the tomato could be incorporated with seeds intact. There are simply too many valuable nutrients in the seeds that you would not want to lose unnecessarily.

When cooking tomatoes, we recommend avoidance of aluminum cookware since the high acid content of the tomatoes may interact with the metal in the cookware. As a result, there may be migration of aluminum into the food, which may not only impart an unpleasant taste, but more importantly, may have a potentially unwanted impact on your health (Rea, 2006).

Whenever possible, try to develop recipes that make use of the whole tomato. We've seen research showing higher lycopene content in whole tomato products. For example, when the skins of tomatoes are included in the making of the tomato paste, the lycopene and beta-carotene content of the paste is significant higher according to research studies (Rea, 2006).

2.3. Home gardens

Home gardens are found in both rural and urban areas in predominantly small-scale subsistence agricultural systems .The very beginning of modern agriculture can be dated back to subsistence production systems that began in small garden plots around the household. These gardens have persistently endured the test of time and continue to play an important role in providing food and income for the family. Home gardens are defined in multiple ways highlighting various aspects

based on the context or emphasis and objectives of the research. The background and gender of the researcher or scientist may also bias their perception on home gardens and may not entirely reflect the opinion of the family involved in home gardening activities (Nicolas, 2006).

Home gardening is an important method that can be used for food production but yet neglected a lot as an aspect of food production system over time. The majority of people in the developing world gardening remains the most important method of food production. Daily food Requirement by household members is needed for better nutrition and health. Home gardens play a significant role to household food security (Bean, 2014).

In everyday usage, a vegetable is any part of a plant that is consumed by humans as food as part of a savory course or meal. The term "vegetable" is somewhat arbitrary, and largely defined through culinary and cultural tradition. It normally excludes other main types of plant food, fruits, nuts and cereal grains but includes seeds such as pulses. The original meaning of the word vegetable, still used in biology, was to describe all types of plant, as in the terms "vegetable kingdom" and "vegetable matter" (Bean, 2014).

Originally, vegetables were collected from the wild by hunter-gatherers and entered cultivation in several parts of the world, probably during the period 10,000 BC to 7,000 BC, when a new agricultural way of life developed. At first plants which grew locally would have been cultivated, but as time went on, trade brought exotic crops from elsewhere to add to domestic types. Nowadays, most vegetables are grown all over the world as climate permits, and crops may be cultivated in protected environments in less suitable locations (Basil, 2009).

China is the largest producer of vegetables, and global trade in agricultural products allows consumers to purchase vegetables grown in faraway countries. The scale of production varies from subsistence farmers supplying the needs of their family for food, to single product crops. Depending on the type of vegetable concerned, harvesting the crop is followed by grading, storing, processing and marketing (Adekunle, 2013).

Vegetables can be eaten either raw or cooked and play an important role in human nutrition, being mostly low in fat and carbohydrates, but high in vitamins, minerals and fiber. Many governments

encourage their citizens to consume plenty of fruit and vegetables; five or more portions a day often being recommended (Kortright and Sarah, 2010).

2.4. Characteristics of a home garden

Five intrinsic characteristics of home gardens: 1) are located near the residence; 2) contain a high diversity of plants; 3) production is supplemental rather than a main source of family consumption and income; 4) occupy a small area and 5) are a production system that the poor can easily enter at some level (Galhena, 2013). There is a vast body of literature presenting research and case studies focusing on the role of home gardens as agro forestry or food production systems, or a combination of both.

Home gardens are ecologically divided into two categories: tropical and temperate. Home gardens in the tropical areas in Central and South America. There is also a substantial interest for home gardens in South and South-East Asia and Africa. Conversely, only a few documented studies exist on home gardens from temperate regions and from developed countries General tendencies with respect to home garden food production systems based on 15type-specific characteristics adopted and present an ethnographical synthesis of home gardens across the globe (Galhena, 2013).

Home gardens are commonly established on lands that are marginal or not suitable for field crops or forage cultivation because of their size, topography, or location. The specific size of a home garden varies from household to household and, normally, their average size is less than that of the land owned by the household. However, this may not hold true for those families that do not own agricultural land and for the landless. New innovations and techniques have made home gardening possible even for the families that have very little land or no land at all. The home gardens may be delimited by physical demarcations such as live fences or hedges, fences, ditches or boundaries established through mutual understanding (Debjitbhowmik, *et al.,* 2012)..

Application of kitchen waste, animal manure, and other organic residues has been a practice amongst home gardeners and this exercise has helped to considerably increase the productivity and fertility of these gardens. While some similarities exist across the board, each home garden is unique in structure, functionality, (Nicolas, 2006) composition, and appearance as they depend on the natural

ecology of the location, available family resources such as labor, and the skills, preferences, and enthusiasm of family members. Home garden cultivation tends to be quite dynamic.

The decisions related to the selection of crops, procuring inputs, harvesting, management, and so forth are mostly driven by the consumption and income generation needs of the household. A study from Indonesia observed that the structure, composition, intensity of cultivation, and diversity of home gardens can be subjected to the socioeconomic status of the household. For instance, as the families became economically stable their cultivation shifted from staples to horticultural crops and some families began to raise livestock (Debjitbhowmik, *et al.,* 2012).

Differentiated two types of home gardens: 1) subsistence gardens and 2) budget gardens. Access to planting material and social capital are noted as important attributes to species diversity in gardens. Collectively, the ecological potential, economic status, and social elements influence the presence of food and non-food crops and animals in the garden (David and Eric, 1974). The home garden frequently uses family labor women, children, and elders are of particular importance in their management but, depending on the economic capacity and affordability, households may hire wage laborers to cultivate and maintain the home garden that in turn affect the composition and intensity of home garden activities. Like any other food production system, home gardens may be vulnerable to harsh environmental conditions such as drought and floods. Despite the fact that home gardening activities demand a lesser amount of horticultural and agronomic know-how, crop losses and other negative implications can be reduced when the household members are empowered with better skills (Mukwiti, 2009; Nicolas, 2006).

Today the world faces a fundamental challenge of ensuring that millions of households living in poverty have access to enough food to maintain a healthy life. Over the years Africa has been looking for ways to solve the food in security problem and most African leaders have taken cognizance of this challenge. Most of the developing countries, agriculture is an essential sector of the proportion of the agricultural activities that take place in rural areas since agriculture has been said to be the backbone in rural areas and many countries rely upon it for survival . Numerous attempts in South Africa to implement garden programs often fail to improve food security of the

poor. Home gardens a reconsidered a community's most adaptable and accessible land resource and are an important component in reducing vulnerability and ensuring food security (Bean, 2014).

Home gardens form an integral part of urban and rural livelihoods. For many generations, small plots of land near the homestead have been used as home gardens. They are sites that people grow not only staple foods but where they also cultivate plants for income and for medicine. Thus home gardens are important to families because they provide income and sustenance throughout the year from the diversity of crops contained within them which are harvested at different times. The cultural value attached to home gardens has been reinforced by their important contribution to household food security over the past 50 years. In contemporary South Africa, income is the principal determinant of household food security. For monetary income South African black rural households mainly depend on sources other than farming (Debjitbhowmik, *et al.,* 2012).

Smallholder is the potential drivers of Agricultural development in less develop regions. "Smallholder Agriculture is important to employment, human welfare and political stability in sub Saharan Africa to be either ignored or treated as just another small adjusting sector of a market economy. Home gardening is an important method that can be used for food production but yet neglected a lot as an aspect of food production system over time. For the majority of

People in the developing world gardening remains the most important method of food production. Daily food requirement by household members are needed for better nutrition and health. Home gardens play a significant role to household food security (Debjitbhowmik, *et al.,* 2012; Lemma, *et al, 2003*].

2.5. Community food security

Community gardens were initiated back from the eighteenth and nineteenth centuries where tropical vegetable culture survived in remote areas and mixed gardens in south East Asia. Community gardens in Africa involved irrigation in home gardens since prehistoric time with the provision of vegetables for household consumption. (Basil, 2009).

The goal of community gardens was to increase household and intra household food security throughout the year. Community gardens provide marketing opportunities to rural people and built a base for food production for the vulnerable. Recently mass establishment of community gardens was done by non-governmental organizations namely Action Faim Zimbabwe in a bid to maintain sustainable rural livelihoods (Bernard, C, *et,al* 2013) .

By providing urban residents with the means to produce for themselves diverse varieties of high quality produce, urban gardens can contribute to the food security of individuals, households, and communities. Food security at the household level focuses on access to safe, nutritious food sufficient to maintain health. Over time the meaning of the term has become increasingly complex, recognizing that access to food and an individual's food needs can be constrained in a number of different ways, and not just by economic access.(Nnabude, P.*et,al* 2002)

''Community food security'' is generally used to indicate a more systematic understanding of food security which recognizes that food security is a community-level concern and that food needs must be achieved in an environmentally and socially sustainable way to ensure food security over the long term. Community food security, then, can be defined as a situation in which all community members are able to access a safe, nutritious, and culturally acceptable diet, achieved sustainably and in a way which maximizes community self-reliance and social justice (Mckelvey, 2009).

The sustainability of food production and the degree of control communities have over the food system are also important elements of long-term community food security. Sourced worldwide by trans-national Corporation's through complex networks of distribution, food often travels through long, energy-intensive commodity chains before it arrives, anonymous, on our local supermarket shelves (Vincent, L. (2008).

As White puts it, ''as our society becomes technologically more sophisticated it also becomes biologically more ignorant. We no longer know what we eat or drink or where our wastes are taken. In this context, food security is threatened by food supply systems that are not environmentally sustainable and by a lack of local understanding and control (at both the individual and community level) of the food we eat. As can be seen from this brief review, there is considerable scope for further investigation of urban backyard food growing and its contribution to food security within a community context. The potential of house-lot food production to play a part in supporting the physical, social, and environmental health of urban communities is promising (Kortright and Sarah, 2010)

Greater understanding of urban food production practices and reciprocity (community) networks is needed in order to effectively support house-lot food gardening practices and the food security of gardeners at the individual, household, and community scale (Kortright and Sarah, 2010; Akekunle, 2013).

2.6. Benefits of Tomatoes

Did you know that tomatoes do not have to be a deep red color to be an outstanding source of lycopene? Lycopene is a carotenoid pigment that has long been associated with the deep red color of many tomatoes. A small preliminary study on healthy men and women has shown that the lycopene from orange- and tangerine-colored tomatoes may actually be better absorbed than the lycopene from red tomatoes. That's because the lycopene in deep red tomatoes is mostly trans-lycopene, and the lycopene in orange/tangerine tomatoes is mostly tetra-cis-lycopene. In a recent study, this tetra-cis form of lycopene turned out to be more efficiently absorbed by the study participants. While more research is needed in this area, we're encouraged to find that tomatoes may not have to be deep red in order for us to get great lycopene-related benefits (Debjitbhowmik, *et al.,* 2012).
Tomatoes are widely known for their outstanding antioxidant content, including, of course, their often times-rich concentration of lycopene. Researchers have recently found an important connection between lycopene, its antioxidant properties, and bone health (Mitchell and Hanstad, 2004).

There are literally hundreds of different tomato varieties. We usually choose our favorite varieties by some combination of flavor, texture, and appearance. But a recent study has shown that we may also want to include antioxidant capacity as a factor when we are choosing among tomato varieties. Surprisingly, researchers who compared conventionally grown versus organically grown tomatoes found that growing method (conventional versus organic) made less of an overall difference than variety of tomato.

While all tomatoes showed good antioxidant capacity, and while the differences were not huge, the following four varieties of tomatoes turned out to have a higher average antioxidant capacity regardless of whether they were grown conventionally or organically: New Girl, Jet Star, Fantastic, and First Lady. It's only one study, of course, and we're definitely not ready to recommend these four varieties at the exclusion of all others. But these findings are fascinating to us, and they suggest that specific types of nutrient benefits may be provided by specific varieties of tomatoes. Also, if you're seeking good antioxidant protection and you're in the grocery standing in front of a New Girl, Jet Star, Fantastic, or First Lady Tomato, you would probably be well-served to place it in your shopping cart (David and Eric, 1974).

Intake of tomatoes has long been linked to heart health. Fresh tomatoes and tomato extracts have been shown to help lower total cholesterol and triglycerides. In addition, tomato extracts have been shown to help prevent unwanted clumping together (aggregation) of platelet cells in the blood - a factor that is especially important in lowering risk of heart problems like atherosclerosis. (In a recent South American study of 26 vegetables, tomatoes and green beans came out best in their anti-aggregation properties.) But only recently are researchers beginning to identify some of the more unusual phyto nutrients in tomatoes that help provide us with these heart-protective benefits. One of these phyto nutrients is a glycoside called esculeoside A; another is flavonoid called chalconaringenin; and yet another is a fatty-acid type molecule called 9-oxo-octadecadienoic acid. As our knowledge of unique tomato phytonutrients expands, we are likely to learn more about the unique role played by tomatoes in support of heart health. Tomatoes are also likely to rise further and further toward the top of the list as heart healthy foods (Snajiv and Akkinappally, 2000).
The table 1 below graphically details the % that a serving of Tomatoes provides for each of the nutrients of which it is a good, very good, or excellent source according to our Food Rating System. A link that takes you to the In-Depth Nutritional Profile for Tomatoes, featuring information over 80 nutrients, can be found under the Food Rating System Chart (Harold *et al*. 2007)

Tomatoes are a treasure of riches when it comes to their antioxidant benefits. In terms of conventional antioxidants, tomatoes provide an excellent amount of vitamin C and beta-carotene; a very good amount of the mineral manganese; and a good amount of vitamin E.
Specific antioxidant nutrients found in tomatoes, whole tomato extracts, and overall dietary intake of tomatoes have all been associated with antioxidant protection. Sometimes this protection comes in the form of reduced lipid peroxidation (oxygen damage to fats in cell membranes or in the bloodstream). Sometimes this protection comes in the form of better antioxidant enzyme function (for example, better function of the enzymes catalase or superoxide dismustase). Better antioxidant protection has also been shown using broad measurements of oxidative stress in different body systems. We've seen studies involving tomato and specific antioxidant protection of the bones, liver, kidneys, and bloodstream (Britt and Kristin, 2010).

Table 1. Nutritional value of tomato (source Harold *et al*., 2007)

Tomatoes,sliced,raw1.00 cup(180.00 grams)	**Calories**
Nutrient	**%**
Vitamin C	33
Biotin	24
Molybdenum	20
Vitamin K	16
Potassium	12
Copper	12
Manganese	11
Fiber	9
Vitamin A	8
Vitamin B6	8
Vitamin B3	7
Folate	7
Phosphorus	6
Vitamin B1	6
Vitamin E	6
Magnesium	5
Chromium	4
Iron	3
Zinc	3
Choline	3
Pantothenic acid	3
Protein	3

Reduced risk of heart disease is an area of health benefits in which tomatoes truly excel. There are two basic lines of research that have repeatedly linked tomatoes to heart health. The first line of research involves antioxidant support, and the second line of research involves regulation of fats in the bloodstream (Britt and Kristin, 2010).

No body system has a greater need for antioxidant protection than the cardiovascular system. The heart and bloodstream are responsible for taking oxygen breathed in through the lungs and circulating it around throughout the body. In order to keep this oxygen in check, antioxidant nutrients are needed in an ample supply. Earlier in this Health Benefits section, we gave you a close-up look at some of the best-researched antioxidants in tomatoes. It's worth noting here that conventional vitamin antioxidants like vitamin E and vitamin C are sometimes overlooked in tomatoes because of their unique phytonutrient composition. Yet vitamin E and vitamin C provide critical antioxidant support in the cardiovascular system, and they are an important part of the contribution made by tomatoes to our heart health.

It's the carotenoid lycopene, however, that has gotten the most attention as tomatoes' premier antioxidant and heart-supportive nutrient. Lycopene (and a related group of nutrients) has the ability to help lower the risk of lipid per oxidation in the bloodstream. Lipid per oxidation is a process in which fats that are located in the membranes of cells lining the bloodstream, or fats that are being carried around in the blood, get damaged by oxygen. This damage can be repaired if it is kept at manageable levels. However, chronic and/or excessive lipid peroxidation in the bloodstream leads to trouble. Overly damaged fat components sound an alarm to the body's immune and inflammatory systems, and the result is a series of processes that can lead to a gradual blocking of blood vessels (atherosclerosis) or other problems (Mitchell and Hanstad, 2004).

The second line of research linking tomatoes with heart health involves regulation of fats in the blood. Dietary intake of tomatoes, consumption of tomato extracts, and supplementation with tomato phyto nutrients (like lycopene) have all been shown to improve the profile of fats in our bloodstream. Specifically, tomato intake has been shown to result in decreased total cholesterol and decreased triglyceride levels. It's also been shown to decrease accumulation of cholesterol molecules inside of macrophage cells. (Macrophage cells are a type of white blood cell that gets called into action when oxidative stress in the bloodstream gets too high and the activity of macrophages, including their accumulation of cholesterol—is a prerequisite for development of atherosclerosis.) Many phyto nutrients in tomatoes are likely to be involved with the improvement of our blood fat levels. Two little-known phyto nutrients one called esculeoside A and the other

called 9-oxo-octadecadienoic acid are currently under active investigation by researchers as tomato phyto nutrients especially important in blood fat regulation (Ganesan *et al*., 2012).

Yet another area of increasing interest in tomatoes and heart health involves blood cells called platelets. The excessive clumping together of platelet cells can cause problems for our bloodstream in terms of blockage and unwanted clotting, and prevention of this excessive clumping is important for maintaining heart health. Numerous phytonutrients in tomatoes have been shown to help prevent excessive clumping of our platelet cells. (This ability is usually referred to as an "antiaggregatory effect.") In combination with the other heart benefits described above, this platelet-regulating impact of tomatoes puts them in a unique position to help us optimize our cardiovascular health (Van Duyn and Pivonka, 2000; Adebayo and Aromolaran, 2004).

Bone health is another area of growing interest in tomato research. Interestingly, the connection of tomato intake to bone health involves the rich supply of antioxidant in tomatoes. We don't always think about antioxidant protection as being important for bone health, but it is; and tomato lycopene (and other tomato antioxidants) may have a special role to play in this area. In a recent study, tomato and other dietary sources of lycopene were removed from the diets of postmenopausal women for a period of 4 weeks to see what effect lycopene restriction would have on bone health. At the end of 4 weeks, women in the study started to show increased signs of oxidative stress in their bones and unwanted changes in their bone tissue. We expect to see follow-up studies in this area that will hopefully determine exactly what levels of tomato intake are most helpful in protecting bone tissue (Snajiv and Akkinappally, 2000).

While not well researched for all cancer types, tomatoes have repeatedly been show to provide us with anti-cancer benefits. The track record for tomatoes as a cancer-protective food should not be surprising, since there is a very large amount of research on tomato antioxidants and a more limited but still important amount of research on tomato anti-inflammatory nutrients. Risk for many cancer types starts out with chronic oxidative stress and chronic unwanted inflammation. For this reason, foods that provide us with strong antioxidant and anti-inflammatory support are often foods that show cancer prevention properties (Mitchell and Hanstad, 2004).

Prostate cancer is by far the best-researched type of cancer in relationship to tomato intake. The jury verdict here is clear: tomatoes can definitely help lower risk of prostate cancer in men. One key tomato nutrient that has received special focus in prostate cancer prevention is alpha-

tomatine. Alpha-tomatine is a saponin phyto nutrient and it's shown the ability to alter metabolic activity in developing prostate cancer cells. It's also been shown to trigger programmed cell death (apoptosis) in prostate cancer cells that have already been fully formed. Research on alpha-tomatine has also been conducted for non-small cell lung cancer, with similar findings (Van Duyn and Pivonka, 2000).

Along with prostate cancer and non-small cell lung cancer, pancreatic cancer and breast cancer are the two best-studied areas involving tomatoes and cancer risk. Research on tomatoes and breast cancer risk has largely focused on the carotenoid lycopene, and there is fairly well documented risk reduction for breast cancer in association with lycopene intake (Mitchell and Hanstad, 2004).

While not as thoroughly researched as these other areas of antioxidant support, cardiovascular support, and anti-cancer benefits, several other health benefit areas are important to mention with respect to tomatoes. Diets that include tomatoes have been linked with reduced risk of some neurological diseases (including Alzheimer's disease) in multiple studies. Tomato-containing diets have also been linked in a few studies with reduced risk of obesity (Ganesan *et al*., 2012; Hashini *et al.,* 2013).

The tomato is the fruit of the plant *Lycopersiconesculentum*. (Botanically speaking, tomato is not only a fruit, but also a berry since it is formed from a single ovary.) Originally, tomato was named after the food family to which it belongs - the *Solanaceae* (sometimes called "solanoid" or "nightshade") family. The botanical name *Solanumlycopersicum* for tomatoes has now largely been replaced by the name *Lycopersiconesculentum*. (The genus/ species name Lycopersiconesculentum is also sometimes used to refer to tomatoes) (Hashini *et al.,* 2013).

The French sometimes refer to the tomato as pomme damour, meaning "love apple," and in Italy, tomato is sometimes referred to as "pomodoro" or "golden apple," probably referring to tomato varieties that were yellow/orange/tangerine in color.

Regardless of its name, the tomato is a wonderfully popular and versatile food that comes in over a thousand different varieties that vary in shape, size, and color. There are small cherry tomatoes, bright yellow tomatoes, Italian pear-shaped tomatoes, and the green tomato, famous for its fried preparation in Southern American cuisine (Britt and Kristin, 2010).

Only the fruits of this plant are eaten since the leaves often contain potentially problematic concentrations of certain alkaloids (see Individual Concerns section below). Tomatoes have fleshy internal segments filled with slippery seeds surrounded by a watery matrix. They can be red, pink, yellow, orange/tangerine, green, purple, brown, or black in color (Britt and Kristin, 2010).

Beefsteak and beef master tomatoes are among the largest-sized varieties. Roma tomatoes are more of an intermediate size, while cherry and grape tomatoes are small and rounded. The term "heirloom tomatoes" has become somewhat confusing as it can have a variety of different meanings. In the most traditional sense, "heirloom" refers to seeds from tomato cultivars that get handed down over time from family to family. Obviously, seeds handed down in this way do not make it possible for tomato production on a very large commercial scale. Yet there are definitely "commercial heirloom" tomatoes in the marketplace (sometimes produced from cross-breeding and sometimes produced through open pollination (Sanjiv and Akkinappally, 2000).

Although tomatoes are fruits in a botanical sense, they don't have the dessert quality sweetness of other fruits. Instead they have a subtle sweetness that is complemented by a slightly bitter and acidic taste. They are prepared and served like other vegetables, which is why they are often categorized as such, including in our A-Z List of the World's Healthiest Foods. Cooking tempers the acid and bitter qualities in tomatoes and brings out their warm, rich sweetness (Mitchell and Hanstad, 2004).

There are few food sensations that better mark the summer and early fall months than the sweet juiciness of a vine-ripened tomato. Although tomatoes are available year-round across the U.S., some of the most delicious tomato flavors come from fresh tomatoes that have been planted in late spring or early summer and ripen from July through September (Mitchell and Hanstad, 2004).

3.Materials and Methods

3.1. Description of the study area

3.1.1. Location

The study was conducted in Bahir Dar city at home. Bahir Dar is the capital of the Amhara Regional state in the Federal Democratic Republic of Ethiopia. It is located at 11 ^{o} 36' 0'' N, 37 ^{o} and 22' 60'' E on the southern shore of Lake Tana (where the blue Nile starts).The altitude of the city is about 1801 m above sea level (NMABDBO, 2013) The mean annual temperature of Bahir Dar city ranges from 12.6-27 ^{0}C and the mean annual rain fall is about 1406.98 mm. (NMABDBO, 2013).

3.1.2. Demography

Demographic conditions of the residents of a country are useful for designing and preparation of development plans as well as for monitoring and evaluation of the impact of its implementation. Its characteristics convey important messages of multidimensional related with social and economic situations. Although fast population growth is a burden particularly for developing countries as long as their economic progress lags behind, it is not a cause by itself since it is also a fundamental resource for development. The active labor of the population is the determinant factor to run whatever technology is introduced while high population creates demand for the growth of productions and services.

The first national population and housing census conducted in 1984 puts the population of Bahir Dar City as 54, 766. The 2nd national population housing census conducted 10 year latter in 1994 shows that the total population as 94,235 in the city. Based on figures from the Central Statistical Agency in 2005, this city has an estimated total population of 167,261, of whom 86,355 were males and 80,906 were females. With an estimated area of 28 square kilometers, Bahir Dar has an estimated population density of 5,973.60 people per square kilometer.

Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), this city has a total population of 221,991, an increase of 130.90% over the population recorded in the 1994 census, of whom 108,456 are men and 113,535 women. The annual population growth rate is also estimated to be 5.5%. Among reasons for the rapid population growth, its being capital of the region and hence residence for various government and non-government organization staffs and immigration of people from surrounding zones, woreda's and kebeles are mentioned as the main ones.

Table 2: Population of 2007 by Sex and Economic Activity Status

Sex	Population No	Economic participation above 10 years of age					
		Economic activity status			Of Economically active		
		Economically active	Economically Inactive	Rate	Employed	Unemployed	Rate
Both Sexes	221,991	105,479	75,516	58.3	95,481	9,998	9.5
Male	108,456	56,983	30,939	64.8	53,017	3,966	7.0
Female	113,535	48,496	44,577	52.1	42,464	6,032	12.4

Source: CSA Census 2007

The CSA 2007 Census report, as can be seen from the above table, showed that the sex composition of the city to be 48.9% Male and 51.1% Female. In addition to that, 52.1% of the population is calculated to be economically inactive and the rate of unemployment in the city is 9.5% of the total population.

The Regional Bureau of finance and economic development has come up with population projections up to 2012 based on the census results of 2007.

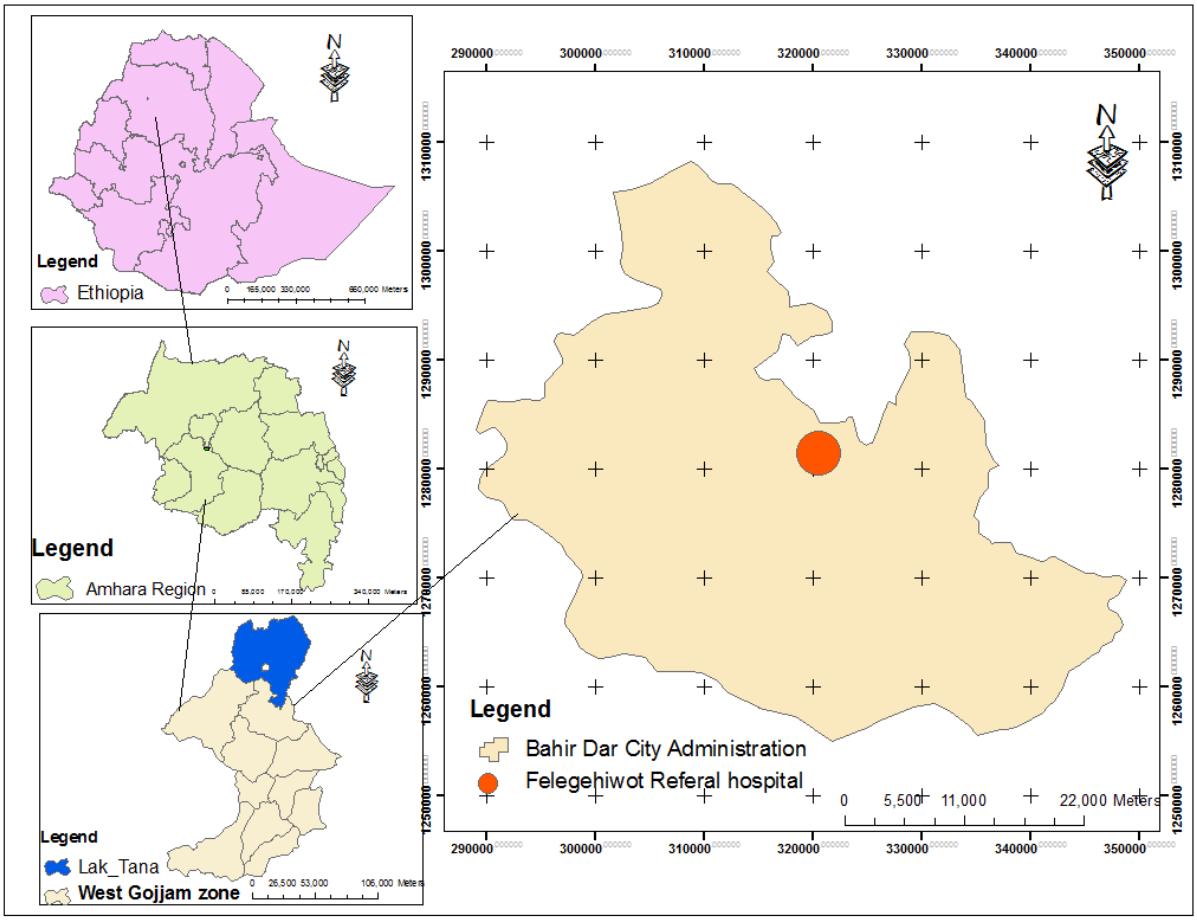

Figure 1. Map showing the location of the study

3.2. Experimental design

The experiment was laid out in completely randomized design with six treatments replicated three times. The test crop was tomatoes grown on plastic pots with 26 cm area by 26 cm height .The spacing between two consecutive pots was 30 cm. Treatments were tested on 3 pots each. The spacing between tomatos plants was 10 cm. The total area of experimental pots was 10.08 m^2 and two plants per pot were planted.

3.3. Nursery management

Tomato seeds (Roma V.F.N), plastic jars, soil, manure, sand, chemical fertilizer and azolla were used in this study.

Tomato plants require abundant moisture for best growth, watering was carried out as required. Well drained area was selected to prevent poor drainage and root loss. Early maturing tomato (Roma V.F.N) was used. Tomato seed were planted directly in the garden when the soil was warm and from six to eight days before transplanting. The soil was thoroughly made wet as required.

3.4. Soil media

Treatments in this study were the different growing media used in growing tomato (Roma V.F.N). The components are lightweight and hold water and oxygen much better than garden soil. Soilless mixes will also be free of weeds or diseases, and many contain a slow-release fertilizer.

However, in the present study, six different media were prepared: soil, manure alone which decompose for three month before used us a fertilizer. Mixtures of natural soil and manure, natural soil and sand, chemical fertilizer (Dap and Urea) and soil, natural soil and azolla. Each media was prepared three times representing three replications. In all cases mixtures were equal in proportion volume by volume. In the case of the chemical fertilizer treatment 10 g was applied per pot.

3.6. Transplanting

Plants that have leaves with a medium green were selected for transplanting with the age of two weeks after seedling appered. During transplanting six leaves per plant were observed. Plants that show signs of stress, such as yellowish foliage were avoided. They were planted as soon as possible taking them off the soil. A hole deep enough (two to three inches deeper than it grew in the nursery) was dug to plant the seedlings. The advantage was that roots will develop along the buried stem. They transplants (seedlings) were watered immediately after transplanting. To conserve garden space, tomatoes were supported with wooden stakes. This kept fruits off the ground and reduced decay and insect damage. As the vines grew, cover them with insect net.

3.7. Data collection

Data collection started 45 hours after transplanting and continued at one week intervals until harvest. The parameters that were considered during data collection were: plant height, number of branches and number of leaf were measured from vegetative to harvest time, number of fruit per plant and its weight, plant base diameter, number of unmarketable fruits, biomass yield were measured at harvest time.

Plant height was measured in centimeter (cm) with the help of ruler from soil surface to the top of the plant. The total numbers of leaves were estimated by counting the leaves from top to bottom of the plant. In addition Total numbers of branches were counted directly per plant and After 90 days of growth, all fruits per plant were counted for each replication directly and weighted using bean balance. Also the base diameter of each plant was measured using a caliper. Biomass was also weighed per pot at harvest. The criteria that taken to choose marketable and unmarketable fruit were fruits that show sign of stress such as a bit smaller sized and stunted growth and attack by pest were grouped under unmarketable fruits. Biomass was measured without root and fruit .which includes leaves and stem of the plant .plant base diameter of the plant were measured at harvest time.

3.8. Data analysis

The data collected were subjected to descriptive Statistical as well as ANOVA for computation of differences between treatments. Individual means were separated by using Tukey honestly significant difference (HSD) test. All statistical analysis was carried out using (SAS, 2008) statistical soft ware version JMP 5.0.1.

4. Results and Discussion

4.1. Results

A. Plant growth and development

According to the results of the analysis of variance, plant height, number of leaves and branches significantly varied among growth stages, fertility enhancing treatments and the interaction (Global $F_{29, 150}$=77.41, p<0.0001, $F_{29, 150}$=49.67, P<.0001, $F_{29, 15O}$ =24.04, P<.0001, respectively) .Table 2 show the detail of specific ANOVA tables for individual variables such as plant height, number of leaves and branches in relation to treatments growth stages and interactions. Here too treatments growth stage and interaction significantly varied in variable measured.

Details of the plant growth and development are summarized in Table 1. Plant height, number of leaves and branches significantly increased with age of the plants. All treatments had statistically similar plant height from vegetative to the flowering stage. Plant height at maturity and harvest was significantly higher than earlier growth stages in all treatments. At maturity and harvest, plant height did not significantly vary between pots treated with manure, manure with soil and azzola. From fruiting onwards, plants on pots that had manure with soil and manure only had the highest mean number of leaves and branches. Soil used us a control. Even if Roma tomatoes were determinate the growth were not stopped as it mature and as the fruit mature and cope for consuming soon after one week data for harvest were taken this is the case for no difference between means at harvest and maturity in pots that treated with soil and chemical fertilizer.

Table 2. Effects of fertilization inputs on the growth and development of tomatoes.

Treatments	Stages				
	Vegetative	Flowering	Fruiting	Maturity	Harvest
	Plant height (cm)				
Chemical fertilizer + soil	5.58e	7.90e	9.58e	32.33d	35.67cd
Manure + soil	5.53e	12.5e	14.00e	51.83a	46.03a-c
Azolla + soil	5.08e	10.17 e	12.50 e	47.17ab	46.83ab
Manure only	5.50e	13.5e	14.83e	55.00 a	50.75a
Soil only	5.38 e	10.67e	12.67e	39.33b-d	36.83bd
Sand + soil	4.67e	11.75e	13.33e	35.67cd	34.17d
	Number of leaves				
Chemical fertilizer + soil	10.00j	16.16ij	19.33h-j	36.50d-f	36.50 d-f
Manure + soil	10.00j	40.66 c-e	54.50bc	85.16a	78.16 a
Azolla + soil	10.00j	26.16e-i	35.66d-g	45.66cd	40.66 cd
Manure only	10.00j	30.00d-i	45.66cd	66.00b	60.00 b
Soil only	10.00j	20.16g-j	30.16d-i	43.83cd	40.83 cd
Sand + soil	10.00j	25.66e-j	21.50f-j	33.16d-h	32.16 d-h
	Number of branches				
Chemical fertilizer + soil	1.00e	3.83de	6.00b-d	9.66ab	9.66 ab
Manure + soil	1.00e	6.50b-d	8.00b-d	9.66ab	8.66 ab
Azolla + soil	1.00e	5.66cd	7.33b-d	9.00bc	9.00 bc
Manure only	1.00e	5.88b-d	8.66bc	13.00a	12.00 a
Soil only	1.00e	5.50cd	7.16b-d	8.66bc	8.21 bc
Sand + soil	1.00e	4.00e	6.83b-d	8.50bc	8.16 bc

A. (Means followed by the same letter(s) are not significantly different from each other according to Tukey Honestly Significant Difference test at α=0.05).

B. Yield and yield components

According to the result of analysis of variance, fruit yield, the number of fruits and biomass yield significantly varied among different soil fertility enhancing treatments (Global $F_{5,30}$=4.62, p<0.003, $F_{5.30}$=3.37, p<0.01, $F_{5.30}$=4.03, p<0.006, respectively). However, average fruit weight and number of unmarketable fruits did not significantly vary among different treatments. ($F_{5.30}$=0.33, p<0.88, $F_{5.30}$=1.03 p<0.41,) respectively.

The details of yield and yield components are summarized in figures below. Fruits yield, number of fruits and biomass of the plants were significantly varied. All treatments had statistically similar number of unmarketable fruits and average fruit weights per pot. Plants on pots that had manure only, manure with soil and chemical fertilizer with soil had the highest mean fruit yield, number of fruits and biomass yield. However, plants on pots with sand and soil had the lowest mean fruit yield, number of fruit and biomass yield.

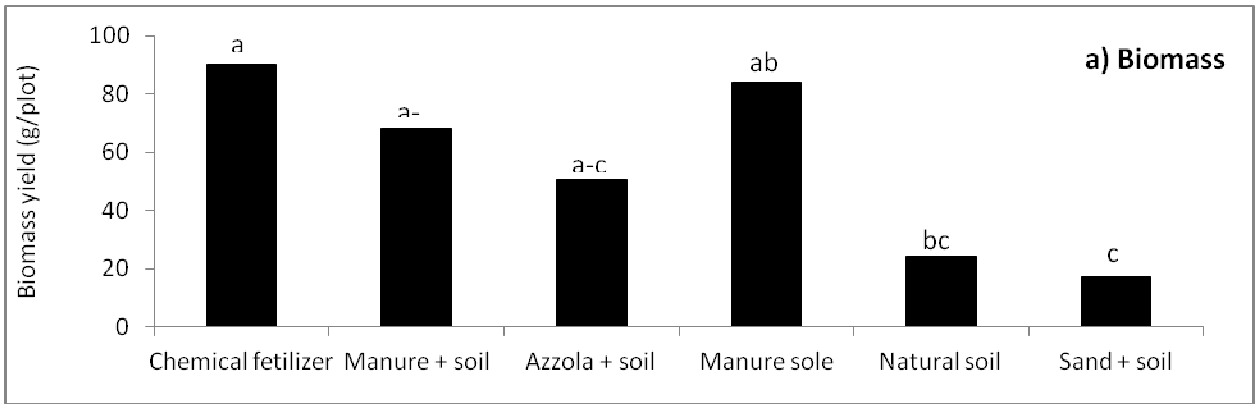

Figure 2: effect of soil fertility enhancing sources on biomass yield

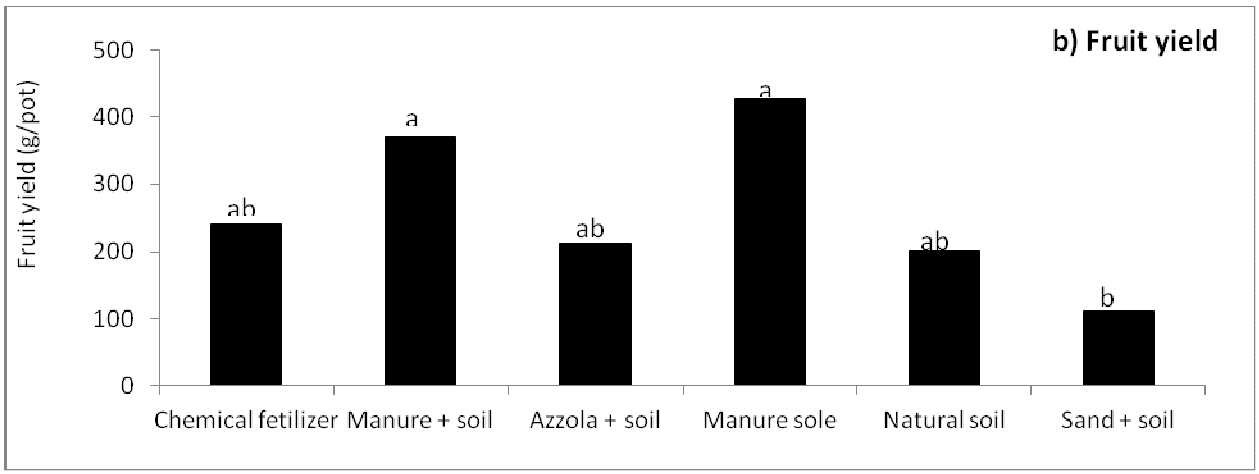

Figure 3: effect of soil fertility enhancing sources on fruit yield

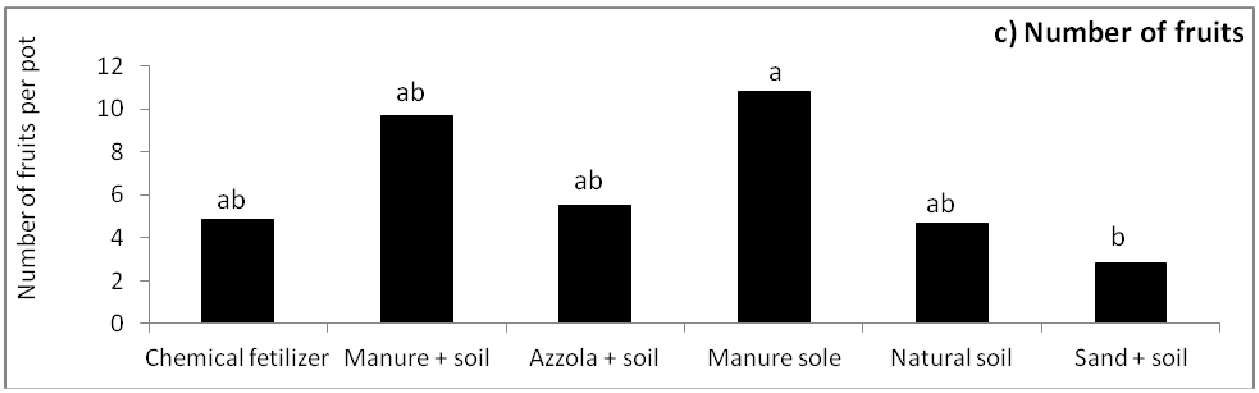

Figure 4: effect of soil fertility enhancing sources on number of fruits

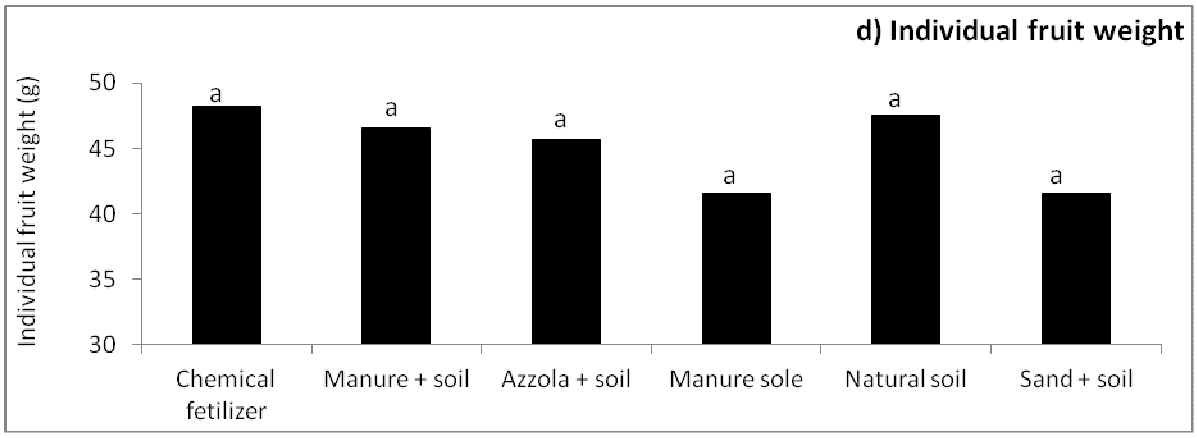

Figure 5: effect of soil fertility enhancing sources on individual fruit**.**

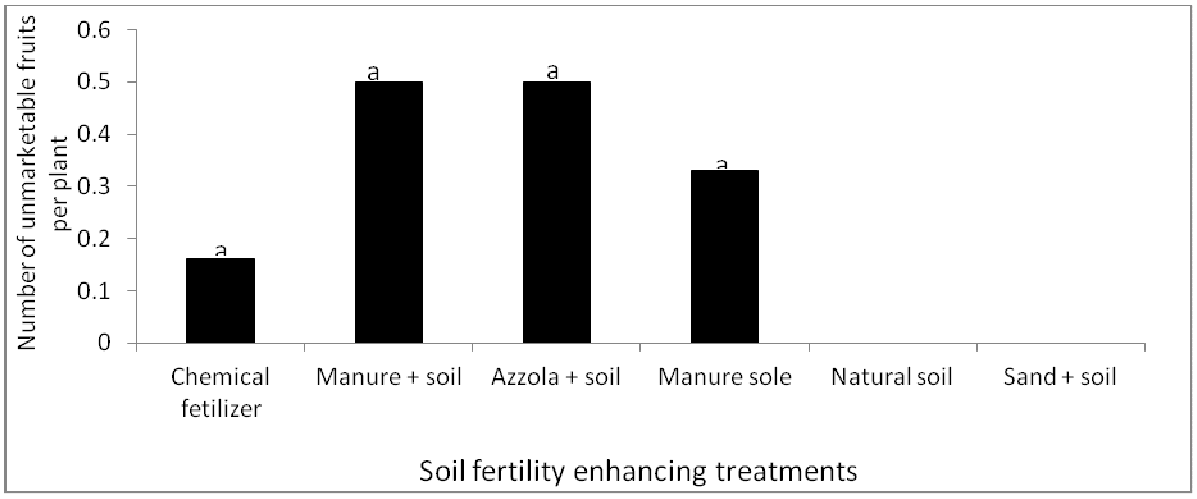

Figure 6. Effect of soil fertility enhancing sources on number of unmarketable fruit.

(Means followed by the same letter(s) are not significantly different from each other according to Tukey Honestly Significant Difference test at α=0.05).

C. Plant base diameter and number of segments per plant

Plant base diameter and number of segments per plant were not significantly varied among different treatments (Global $F_{5, 30}$= 1.57, p = 0.19, $F_{5, 30}$= 2.34, p = 0.06, respectively). However, despite the lack of significant difference, plants grown on pots with manure had the highest plant base diameter and number of segments per plant. (Table 4).

Table 4. Plant base diameter and number of segments per plant.

Treatments	Plant Base diameter	Number of Segment
Chemical F + Soil	1.33a	7.50a
Manure +Soil	1.43a	8.66a
Azolla + Soil	0.90a	9.00a
Manure	1.94a	9.50a
Soil	1.19a	7.16a
Sand+ Soil	0.65a	7.33a

4.2. Discussion

Plant height, number of leaves and branches per pot were significantly higher on pots with manure because it contains a high level of nutrients such as N and P and more organic matter. Organic fertilizer (cattle manure) used for crop production for centuries and is considered suitable local organic fertilizer. Application of organic and inorganic fertilizers significantly increased the total number of harvested tomatoes and the organic fertilizers are more environmentally friendly since they are organic source. In contrast, observation shows that use of mineral fertilizers were giving a good yield. Organic fertilizers are naturally available and cheap and require in enough amount.

There is growing interest in the use of organic manures due to soil fertility depletion in most African land as the problem is coupled with the scarcity and cost of mineral fertilizers. Similarly, (Charles, O., *et, al, (2012).* Grew tomatoes by using cow manure and nitrogen fertilizer and obtained better yields. Organic fertilizers such as cattle manure directly to the soil showed promising results for gating a better yield similarly (De.C and Hoitink, 1999; Viana *et al*., 2000).found that organic fertilizer such as cattle manures gives a best yield.

Untreated soil not only lacked good plant stand but also had low yield indicating how depleted soil have become in the area. Low soil fertility is one of the main factors responsible for low productivity of vegetable crops in Ethiopia. Soil fertility can be presumably enhanced by organic and inorganic fertilizers application. However, the use of any type of fertilizer depends on several factors such as soil type, nature of crop and socio-economic conditions of the area. Use of organic fertilizers is highly encouraged in the area because it is available due to the presence of high livestock population while in-organic fertilizers are less available and costly, and cannot be afforded by the small holder and traditional vegetable producers in the area (Ibrahim and Fadni 2013).

Tomato plants grow slowly initially, a situation corroborate (Dennis, R. (1999) who found that the plant height and number of leaves grow rather slowly in beginning increasing to a maximum, then slowing down again. The aquatic fern azolla does not need nitrogen source because it N-fixing sym-biotic cyanobacteria Anabaena azolla. Azolla is a genus of small aquatic ferns with a world-wide distribution in temperate and tropical regions. Studies on Azolla have generated tremendous interest in the scientific community because of the nitrogen-fixing ability of this fern. Azolla is a

genus of small aquatic ferns that are native to Asia, Africa, and the Americas. As a green manure, azolla's influence on soil fertility is due to its organic matter and nitrogen. A humus compound is formed as a result of the incorporation and decomposition of azolla (Bindhu, K.B**.** (2013). Humus increases the water holding capacity of soil and promotes aeration, drainage, and the aggregation essential for highly productive soils; Organic matter can bind together soil particles.

In this study azolla was thoroughly mixed with the soil 50% by 50% azolla. This method used to reduce the application of fertilizers in the form of synthetic nitrogen to the soil (Al-Baldawi, I. A et, al ,(2012). Azolla could prevent rigorous weed growth in tomato fields and maintain pest like leaf rolled. The result agreed with the finding of other research (Thomas and Donald (2014). who found that the rice plant showed that a good yield by using azolla as a green manure. Azolla treated plant had high plant height; number of leaves, branches and yield next to manure because it had low biomass when we compared with that of manure.

The highest fruit weight was obtained in manure and the lowest value in sand with soil. Azolla appeared to have performed lower than manure because the azolla used did not have time to decompose and release the N it contained.

4.2. Conclusion

From the present research, it has been made clear that organic sources of soil fertility enhancing sources improved the growth and yield of tomatoes. Although fertilizers can be made with manufactured chemicals that will give great results, the safest and healthiest options are made with organic or naturally occurring ingredients. Good, high quality finished manure was the base of our tomato fertilizer. Manure and also azolla, both organic sources significantly improved plant growth and development and also the final yield. These sources are easily available, are renewable and cheap for even poor families to afford natural soil media preformed the least of all indicating that the soils around as are depleted beyond any doubt and therefore need to be treated by natural fertility enhancing sources rather than mineral fertilizers. Caring for soil by recording nutrients and composting, and Moderation of nutrient application with reliance on the buffer action of humus derived from compost. Tomatoes may need fertilization at certain times of their growth depending on what available nutrients are in the soil. Some pest observed on this study damage the fruit which results unmarketable

4.3. Recommendations

Based on the experiment and other associated factors with this study, the following are recommended.

Concerned stake holders need to educate and create awareness among different households to grow tomatoes in their home garden.

Agro extension workers, district and zonal agriculture office and regional bureau offices also need to signal the implementation of this cheap and easy technology to benefit the household.

This technology should, further, be recognized and encompassed as one of the components of food poverty alleviation strategies.

The current study was just a start. More concerted research effort is needed to further establish the possibility of growing vegetables at home and satisfy family needs. A random sample of families may be chosen, reach an agreement to grow their own vegetable needs and find out they can meet three needs. The nutrient status of vegetable grown on this condition may be agenda for research.

Different combinations of soil and manure or azolla in different ratio should further be investigated. Timing of application of this organic product is also an area for investigation. Different planting techniques such as hanging pots, with field beds and spatial and temporal exploitation of space for vegetable growing are some of priorities for further research interventions

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6. Appendices

Appendix 1: ANOVA Tables

Table 1. Analysis of Variance of average fruit weight

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	262.5302	52.506	0.3326
Error	30	4736.6564	157.889	Prob > F
C. Total	35	4999.1866		0.8892

Effect Tests on average weight of fruits.

Source	DF	Sum of Squares	F Ratio	Prob > F
Treatment	5	262.53024	0.3326	0.8892

Table 2. Analysis of Variance of biomass in g

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	27927.245	5585.45	4.0356
Error	30	41521.588	1384.05	Prob > F
C. Total	35	69448.833		0.0064

Effect Tests on biomass yield.

Source	DF	Sum of Squares	F Ratio	Prob > F
Treatment	5	27927.245	4.0356	0.0064

Table 3. Analysis of Variance of number of branches

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	29	2150.5333	74.1563	24.0420
Error	150	462.6667	3.0844	Prob > F
C. Total	179	2613.2000		<.0001

Effect Tests on number of branches

Source	DF	Sum of Squares	F Ratio	Prob > F
Growth_stage	4	1918.5889	155.5052	<.0001
Treatment	5	130.6667	8.4726	<.0001
Growth_stage*treatment	20	101.2778	1.6418	0.0498

Table 4. Analysis of Variance of weight of fruit in g

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	412726.20	82545.2	4.6288
Error	30	534992.69	17833.1	Prob > F
C. Total	35	947718.89		0.0030

Effect Tests on fruit weight

Source	DF	Sum of Squares	F Ratio	Prob > F
Treatment	5	412726.20	4.6288	0.0030

Table 5. Analysis of Variance of number of leaf

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	29	76969.911	2654.13	49.6760
Error	150	8014.333	53.43	Prob > F
C. Total	179	84984.244		<.0001

Effect Tests on number of leaves.

Source	DF	Sum of Squares	F Ratio	Prob > F
Growth stage	4	45262.522	211.7886	<.0001
Treatment	5	22289.578	83.4364	<.0001
Growth stage*treatment	20	9417.811	8.8134	<.0001

Table 6. Analysis of Variance of number of flowers

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	721.5000	120.250	14.3740
Error	65	543.7778	8.366	Prob > F
C. Total	71	1265.2778		<.0001

Effect Tests on number of flowers.

Source	DF	Sum of Squares	F Ratio	Prob > F
Treatment	5	668.11111	15.9724	<.0001
Flower count	1	53.38889	6.3818	0.0140

Table 7. Analysis of Variance of number of fruit

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	295.88889	59.1778	3.3709
Error	30	526.66667	17.5556	Prob > F
C. Total	35	822.55556		0.0156

Effect Tests on number of fruit.

Source	DF	Sum of Squares	F Ratio	Prob > F
Treatment	5	295.88889	3.3709	0.0156

Table 8. Analysis of Variance of plant base diameter in cm

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	5.977881	1.19558	1.5759
Error	30	22.760083	0.75867	Prob > F
C. Total	35	28.737964		0.1970

Effect Tests plant base diameter**.**

Source	DF	Sum of Squares	F Ratio	Prob > F
Treatment	5	5.9778806	1.5759	0.1970

Table 9. Analysis of Variance of plant height in cm

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	29	52158.038	1798.55	77.4054
Error	150	3485.325	23.24	Prob > F
C. Total	179	55643.363		<.0001

Effect Tests on plant height.

Source	DF	Sum of Squares	F Ratio	Prob > F
Growth stage	4	47962.732	516.0501	<.0001
Treatment	5	2141.450	18.4326	<.0001
Growth stage*treatment	20	2053.857	4.4197	<.0001

Table 10. Analysis of Variance of number of segment

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	29.13889	5.82778	2.3468
Error	30	74.50000	2.48333	Prob > F
C. Total	35	103.63889		0.0653

Effect Tests on number of segments**.**

Source	DF	Sum of Squares	F Ratio	Prob > F
Treatment	5	29.138889	2.3468	0.0653

Table 11. Analysis of Variance of number of unmarketable fruit

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	1.583333	0.316667	1.0364
Error	30	9.166667	0.305556	Prob > F
C. Total	35	10.750000		0.4145

Effect Tests on number of unmarketable fruit

Source	DF	Sum of Squares	F Ratio	Prob > F
Treatment	5	1.5833333	1.0364	0.4145

Table 12. Effect tests of growth stages treatments and interactions on plant height, number of leaves and branches per plant

Parameter	Source of variation	DF	Sum of squares	F ratio	P value
Plant height	Growth stage	4	47962.7	516.05	<0.0001
	Fertilizer treatments	5	2141.5	18.43	<0.0001
	Growth stage * Treatments	20	2053.9	4.42	<0.0001
Number of leaves	Growth stage	4	45262.522	211.7886	<.0001
	Fertilizer treatments	5	22289.578	83.4364	<.0001
	Growth stage*treatment	20	9417.811	8.8134	<.0001
Number of braches	Growth –stage	4	1918.5889	155.5052	<.0001
	Fertilizer treatments	5	130.6667	8.4726	<.0001
	Growth - stage*treatment	20	101.2778	1.6418	0.0498

Appendix 2. Different activities during pot experimentation

Figure 1. A) Preparing azolla and B) Prepared pots for tomato growth.

Figure 2.A) Tomato during transplant and B) at vegetative stage.

Figure 3. A) Watering and B) tomato flowering

Figure 4. A) Tomato at fruiting with stakes and B) fruit yield.