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THE SURVIVAL PATTERN OF PLANTED TREES DURING HAMLE 22/2011E.C.IN GULLELE BOTANICAL GARDEN (GBG) ADDIS ABABA, ETHIOPIA

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The survival pattern of planted tree species during Hamle 22/2011E.C.in the Gullele botanical garden (GBG) Addis Ababa , Ethiopia

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ABSTRACT

Botanical gardens are playing a great role in our planet to protect and conserve the biodiversity of the world. Especially it protects plants and animals those exposed to be extinct. Botanical gardens also help to balance the ecosystem of the world. Gullele botanical garden is a newly established botanical garden in Ethiopia that is located at the North Western part of Addis Ababa. As other botanical gardens, the Gullele botanical garden is used to grow and display plants primarily for scientific and educational purpose. It also includes herbarium, lecture rooms, laboratories, libraries, museum and experimental plant research rooms. The comparative studies of the survival pattern of the planted tree species in Gullele Botanical Garden (GBG) on Hamle 22/ 2011 E.C. (July29/2019 G.C.), to identify the survived and not survived planted tree species in the botanical garden. During planting trees there were sixteen different types of tree seedlings with 4627 in total population. The thesis was identifying the total number of tree species by their scientific & local name and registered the survived planted tree species in the study period (October—April 2011E.C.). The paper also contains the survival percentage of each tree species and the growth rate of eight tree species in the study period of time. Overall survival percentage of each planted tree species and relative growth rate in height of eight indigenous tree species measured in the study periods. The aims of the botanical garden were replacing the eucalyptus trees by the indigenous plant species such as Acacia abyssinica (Bazragirar),Podocarpus falcanus (Zigba), Millettia ferrgunia (Birbira), etc.. The thesis paper contains five chapters, the introduction, review literature, methodology, results, discussion, conclusion and recommendations. The introduction part contains, the definition of botanical garden, the role or benefits of plants, the problem of destructing plant species, measures taking to protect plants, the significance of the problem and the objectives of the study.

Key words; GBG, Survival pattern, Survival percentage & Relative growth rate.

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ACRONYMS AND ABBREVATIONS

BGCI	Botanical Garden Conservation International.
EBI	Ethiopian Biodiversity Institute.
EMSA	Ethiopian Meteorological Service Agency.
EN	Endangered.
GBG	Gullele Botanical Garden.
GSPC	Global Strategy for Plant Conservation.
IABGC	International Agenda for Botanical Garden in Conservation.
KBG	Kunming Botanical Garden
LC	Last of concern.
UV	Vulnerable.

CHAPTER - ONE

1. INTRODUCTION

1.1. Background

The survival pattern of planted tree species in Gullele Botanical Garden (GBG) on Hamle 22/ 2011 or July29/2019 has been a great benefit for the country and at a global label. These planted trees have a great role in balancing the ecosystem, avoiding desertification, protecting the biodiversity, as well as used for industrial purpose such as for making timber, the shelter of wild animals and for medicinal purpose. The most important function of planting trees are minimizing the climate change, protecting the environment, bringing green development and etc. Plants are fundamental to solving many of humanity's most important challenges: food insecurity, water scarcity, energy, health, and climate change. The survived plant trees have also medicinal value. There were sixteen different planted trees species in the Botanical Garden during Hamle 22/2011 E.C... Most of them are indigenous tree species used for balancing the ecosystem and as a food by certain animals. Even *Psidium guajava* (Zeytona) and *Persea americana* (Avocado) are edible by human beings. Green development strategy must be a continuous program to bring changes in the environmental and global destruction. It helps to avoid desertification and to protect the biodiversity of the country. One of the main goals is planting trees in Gullele Botanical Garden is protecting and saving the indigenous plant trees and replacing the eucalyptus tree by indigenous tree species. Planting trees in the botanical garden have a better advantage than those planted trees in different part of the country, because the botanical gardens have well protected & controlled areas as well as avoiding soil erosion of the botanical garden. Therefore, the survival pattern of these planted trees in the Gullele Botanical Garden during Hamle 22/2011 E.C. were successful. The Gullele Botanical Garden in early times was totally covered by the eucalyptus trees species but now a days the government want to replace by indigenous plant trees. Even though eucalyptus tree have disadvantage in protecting and balancing the ecosystem than the indigenous trees. Those planted trees in the Gullele Botanical Garden during Hamle

22/2011E.C.were not found in the garden and then it helps to increase the biodiversity of the botanical garden.

The Gullele Botanic Garden has two topographic landscape units or physiographic features. The northern half is a plain land while the southern half is mountainous, with a maximum elevation of 3000m above sea level. Two perennial watercourses originate from this mountainous area and flow southwards to the city center. It is home to riverine vegetations and remnants of indigenous trees of the city of Addis Ababa. The greater part of the garden is covered by eucalyptus globules tree species, but the land closer to the river banks and inaccessible areas are covered by more than 250 trees, shrubs, herbs, climbers, ferns and other plant species. Also the planted trees during the campaign were in the southern half mountainous region of the botanical garden.

Reconnaissance survey on physical and socioeconomic situation of the garden including its vegetation cover type, dominate species, soil type, conservation requirements.

In Ethiopia there are about 6000 to 7000 species of higher plants with 10-12% endemism, from these plant species about 250 are collected in Gullele Botanic Barden, but these are now in the threat due to destruction of habitat, over-exploitation of forest, over grazing and soil erosion (Sebsebe Demissew 1988). Endemism is considered as species only found in certain part of the world and Ethiopia has different types of endemic species of flora and fauna.

Five miles northwest of Addis Ababa's thriving city center is the lush Gullele Botanic Garden (GBG), the first well-established site of its kind in Ethiopia that covers both forest and semi-forest vegetation. Of more than 2,500 botanical gardens that exist in the world, only an estimated 4 percent are in Africa, many of which can be traced back to colonial times in the 18^{th} and 19^{th} centuries

In the Gullele Botanical Garden 250 species of plants are collected. Out of these 66 are found to be medicinal plants. Twenty eight species are found to be endemic to Ethiopia based on the flora of Ethiopia. Sixteen of them belong to herb, 6 shrubs, 2 trees, 2 shrubs/trees, 1 herb/shrub and 1 climber. From total endemic species 35.71% of plant species are important for the preparation of traditional medicines found in the botanical garden.

Now a day's many plants diversity and species have been affected and forced to face extinction, these affected and extinction planted species must be replaced by indigenous plant species. According to the study of Abebe Demissew (2001), the diversity of plants in Ethiopia is on the process of being eroded mainly due to human induced pressure. Habitat destruction and deforestation for commercial timber, encroachments by agriculture and other land uses in addition to natural sources such as re-current of drought, disease and pest break have resulted in the loss of some thousand hectares of forest that are useful. The combination of these factors has resulted in decreasing of forest resources. Following this situation, there are some conservation measures that have been undertaken around the world aimed at protecting threatened plants from further destruction (Cunninghum, 1996). These include both on site (in-situ) and off site (ex-situ) conservation. Plants are the key part of biodiversity in our planet as they provide the aesthetic value, cultural and economic benefits to us. For example, plants can provide the source of food, medicine, shelter and clothing to most of the organism in the world. Besides to these, plants are also the key determinant factors to balance the environment and biodiversity and help our ecosystem to achieve the stability. Without plants, many wild animals are facing the danger of extinction due to the loss of habitat. Much more natural disasters are occur if human interventions such as cutting down the plants (deforestation) continue in the huge quantity from time to time. From this perspective, we can clearly know that plants are essential to support the biodiversity and help us to achieve the sustainable development. To protect our plant diversity, human beings should be involved in the conservation such as building up botanical garden and the campaign of green development must implement continuously throughout the country.

In addition to conservation, increasing the awareness and understanding of public towards plant species is also important, so the Ethiopian government creates diverse approach to conserve threatened and endangered species. Especially the Ethiopian Biodiversity Institute (EBI) which is mandated to co-ordinate work of botanical garden in the country as well as universities across the country, are committed in establishing and reviving botanical garden.

Currently the Ethiopian government plays a great role in planting trees throughout the country by the campaign which is lead by the Prime minister Dr. Abiy Ahmed.Within the campaign especially the study concerns those trees planted in the GBG on Hamle 22/ 2011 or July 29/2019.

In addition to the Shashemene, Jimma and Wendo Genet Forestry College, new institutions have been established, including Gulelle Botanical Garden (GBG) in Addis Ababa have responsible to protect and conserve the biodiversity of the country. The Gullele Botanical Garden (GBG)was established in reclamation number 14/2002 in 2002 E.C. by the Addis Ababa city administration on previous Eucalyptus plantation and occupies an area of 705 hectares of land along the Northwest outskirts of Addis Ababa. The botanical garden is becoming an important green space for the community as Addis Ababa expands. The botanical garden is used for research, education, eco-truisms and center for conservation of endemic and endangered species. According to Birhanu Belay (2009), the first aim behind establishing the garden has economic, aesthetic, medicinal and ornamental values" increasing population means expansion of agricultural land and shrinking forest coverage and establishing botanic gardens is one way to fight this challenge." Belay said also noted that preserving native plants has an additional benefit of better soil conservation and health. Unpublished GBG records show that efforts to established garden in Ethiopia date as far back as four decades. However, Gullele Botanical Garden was only officially inaugurated in January 2005, eight years after it was realized as a joint venture between Addis Ababa University and the City Administration, which provided full funding for the 705-hectare (1,740-acre) park. Berhanu Belay, the garden's director of botanical research and development, says awareness has improved significantly since then and that it's even been referred to as the "green lung" of Ethiopia's capital.As development proceeds, increasing in population leads to expansion of agricultural land, shrinking forest coverage and natural habitat become increasingly fragmented and extinction accelerates (Wilcox and Murphy, 1985). Consequently, the most endangered flora is lost within a short period of time. Therefore, establishing botanical garden with increasing the awareness of community is one way to fight this challenge in addition to involving in afforestation activity in order to rehabilitate the land and reduce environmental climate change. Besides this, botanical garden also plays a key role in conservation of biodiversity which is fundamental to achieving sustainable development. For example, as the study of (Fasil Adugna, 2010), shows that Gulelle Botanical Garden habitats are rich in mammals, amphibians, reptiles, birds and invertebrates like nematodes and other arthropods. Other activities that are practicing in the Gullele Botanical Garden are changing the

area by indigenous plant species. Therefore, the planted tree species in Gullele botanic garden during Hamle 22/2011E.C. has responsibility in protecting different genetic diversity, ecological diversity and species diversity of flora and fauna and adding input in developing herbarium, lecture room, laboratories, libraries, museum and experimental rooms for a research of indigenous plants.

Eucalyptus trees use in Ethiopia has been controversial because the trees exploit the soil and water, while stunting the surface growth of other trees. Such is the dominance of eucalyptus in Addis Ababa and generally in Ethiopia that the botanic garden had to remove about 100 hectares of its own land and replace with various indigenous trees. GBG is also involved in afforestation projects in Addis Ababa with plans for 2017 to select indigenous plants to plant along roads to serve as ornamental purpose as well as green cover for a city that's fast becoming a concrete jungle.

GBG is visible to the public, while GBG has been used by foreign diplomats for bike races and by athletes for jogging by couples celebrating their wedding ceremony and children to celebrate their birthdays, knowledge of its existence outside Addis Ababa is quite low. The garden reportedly has plans to advertise its activities by television and radio. "In the future we want to take the garden to the community instead of vice versa, helping botanic gardens beginning from the smallest locality," Belay said, that already in the capital it's trying to establish three other gardens with involvement from community schools.GBG also plans to publicize its work outside of Ethiopia, including collaboration with similar institutions in neighboring countries preserving plants that it shares with Ethiopia as well as endemic plant species of the neighboring nations.

1.2. The statement of the problem

Botanical gardens are important to maintain the existence of habitat loss, underground water, fresh air and protecting the diversity of flora and fauna, which encompass variety and variability of all forms of life on the earth that play a great role in human existence. Its conservation embraces maintenance, sustainable utilization and restoration of the lost and degraded biodiversity through two basic and complementary strategies such as in-situ and ex-situ. Ex-situ conservation is a technique of conserving of all levels of biological diversity outside their natural habitats through different approach like botanic garden. It plays a key role in communicating the

issues, raising awareness and gaining wide spread public and political support for conservation and for breeding endangered species in capacity for reintroduction. Ethiopia is considered as one of the richest centers of genetic resources currently. However, humans induced impacts are leading to mass extinction process affecting global biodiversity. The major reason for rapid distraction of biodiversity are attributed to conversion land for agriculture, wild fire, poor management of available land, over and improper exploitation habitat loss, fragmentation and urbanization pressure (Dejene et al, 2016). So the Ethiopian government has been established Gullele Botanical Garden five years ago in Addis Ababa for conserving endangered plant species, beside recreational, scientific research and educational purpose. But the Gullele Botanic Garden faces a problem of soil erosion, especially in the Western part. Therefore, the investigation of this study have been focusing on the management practice of conserving and protecting Gullele Botanic Garden in Addis Ababa and identifying the survival pattern of the planted trees in the garden specially during Hamle 22/2011E.C.

To protect this extinction of biodiversity throughout the country the Ethiopian government prepared a great campaign in planting trees in different parts of the country. So, one of campaigns was planting trees during 22/ 2011E.C.or July 29/2019G.C.in Gullele botanic garden. This work is an attempt to identify the survival pattern of trees planted during Hamle 22, 2012 in the Gullele Botanical Garden of A.A.. To balance the ecosystem and minimizing the loss of biodiversity, everybody have responsibility to planted tree species and protect the planted tree species in different part of the country including in the GBG. During visiting the botanical garden with my students we were looking those planted trees which start to dry in the garden and it was the reason to study the planted tree species in the botanical garden.

1.3. Significance of the study

The significance of the study mainly focused on identifying the survival pattern of trees planted during Hamle 22/2011E.C. or July 29/2019 G.C. in Gullele botanical garden. These trees seedlings were planted by different organizations within Addis Ababa city administration. It was also focused on identifying which trees species were more survived or not from the planted sixteen tree species.

1.4. Objectives

1.4.1. General objective

To assess the rate and the survival pattern of different planted species in Gullele Botanical Garden during Hamle 22/2011E.C.or July 29/2019G.C.

1.4.2. Specific objectives

- To identify which planted tree species are more survived and which species don't survive in the botanical garden.
- To determine the rate of growth and survival pattern of different seedling tree species.

1.5. Research questions

This research paper tries to address how to identify the following questions.

- What is the survival pattern of planted trees in the GBG planted during Hamle 22/2011E.C.?
- Which planted tree species were more successful to survive or not?

CHAPTER - TWO

2. LITERATURE REVIEW.

2. 1. Factors affecting the survival pattern of planted tree species seedlings.

Planting tree seedlings in the botanical garden are survived easily and have high potential for success, because most of the planted trees are protected regularly by botanical garden workers. But there are many factors affecting the survival pattern of planted trees in the Gullele Botanical Garden. These factors are the elevation of the garden, soil type, temperature land preparation, lack of water, protection and management properly.The planted tree species were easy to identify their survival pattern and observing their growth rate of the seedlings. According to the definition of Botanical Garden Conservation International (BGCI), and the International Agenda for Botanical Garden in Conservation (IABGC, 2000), botanical gardens are institutions holding documented collection of living plants for the purpose of scientific research, conservation, display and education. Botanical gardens are the institutions that maintain the living plant collection different varieties of plants, including the ornamental and cultivated ones, Wild medicinal plant species and economically important plant species.

A big botanical garden posses plant species from several corner houses, library and research laboratories. Luca Ghine was the first person to establish a botanical garden on scientific lines in 1543 at Pisa in Italy. Although the birth of the "Garden "dates back to the Zhou dynasty in China, the modern concept of a botanical garden originated in Europe (Italy's Padova Botanic Garden was built in 1545).

Today, there are about 2500 botanical gardens in the world (Golding et al., 2010). Together, these botanical gardens cultivate more than 6 million accessions of living plants, representing around 80,000 taxa, or about one-quarter of the estimated number of vascular plant species in the world (Jackson, 2001, O'Donnell and Sharrock, 2017). These gardens thus play a central role in the *ex situ* conservation and exploration of global plant biodiversity (Mounce et al., 2017). Indeed, one of the targets of the Global Strategy for Plant Conservation (GSPC) is to have 70% of the world's threatened plant species conserved *ex situ* (Callmander et al., 2005, Sharrock and Jones, 2009, Huang, 2018). Botanical gardens also have an important role in the preservation of species necessary for human use and well-being (Waylen, 2006, Dunn, 2017), and this role is

likely to become increasingly important as climate change becomes more severe (Donaldson, 2009; Primack and Miller-Rushing, 2009, Ren and Duan, 2017).

The range of scientific activities conducted by the botanical gardens often includes conservation, propagation, horticulture, seed science, taxonomy, genetics, biotechnology, restoration ecology, public education and much more (http://www.bgci.org/garden search.php; Maunder et al..2001, Donaldson, 2009).

Plant diversity is currently being lost at an unprecedented rate, resulting in an associated decrease in ecosystem services. Currently about a third of the world's 300,000–450,000 vascular plant species face extinction due to a variety of devastating anthropogenic activities, including over-harvesting, over-exploitation through destructive agricultural and forestry practices, urbanization, environmental pollution, land-use changes, exotic invasive species, and global climate change (Pitman and Jørgensen, 2002, Ren and Duan, 2017). There is, therefore, an increased need to develop integrative conservation approaches for plants, particularly those threatened plant species in the wild (Li and Pritchard, 2009).

In this minireview, we introduce the scientific research, *in/ex situ* conservation and utilization, citizen science, education, and public communication taking place at Kunming Botanical Garden (KBG). Furthermore, to clarify the integrated functions of botanical gardens across the world, we introduce the future challenges and responsibilities these gardens face. Education, promoting awareness, and capacity building, involving both the public and staff at botanical gardens, are vital functions of modern botanical gardens (Blackmore et al., 2011). These functions provide unique opportunities for plant biodiversity research, horticulture, and conservation biology in popular public places. Raising public awareness of the problems facing our planet may be sufficient to bring about fundamental behavioral changes. Finally, we also want to emphasize specific work done at KBG to commemorate its 80^{th} anniversary.

Botanical garden is garden dedicated to the collection, cultivation and display of a wide of plants labeled with their botanical name. A botanical garden is a controlled and staffed institution for the management purpose of educational research together with such as libraries and museum as are essentially to its particular under taking. Each botanical garden naturally develop its own special field of interest depend on its personnel, location, extent, available funds and terms of its character. In other way botanic garden can be defined as 'public garden which maintains

collection of live plants mainly for study, scientific research, conservation and education. Botanic garden usually label their plants, different data tell us information about plants on local names, scientific names, family, special features, uses and parts etc. Sometimes the label may give us more information about when and where the plants were collected, its habitat, and range of distribution. In the available literature, the botanic garden is described as an outdoor living museum. As stated by Almond (1993), the botanical garden ever changing museum of living plants. According to Chakra Varthy and Mukhopodhyay(1990), a botanic garden can be broadly be a living repository of plants arranged and maintained on some scientific basis and where the collection are usually labeled or marked for identification. Furthermore, as explained by Mohammed Kasso and Mundathra Balakrishnan(2013), botanical garden consist of living plants, grown out of doors or under glass green houses and conservatories. They are used to grow and display plants primarily for scientific and educational purpose. They also include herbarium, lecture room, laboratories, libraries, museum and experimental or research plants.

The history of botanical gardens is closely linked to the history of botany itself. The botanical gardens of the 16th and 17th centuries were medicinal gardens, but the idea of a botanical garden changed to encompass displays of the beautiful, strange, new and sometimes economically important plant trophies being returned from the European colonies and other distant lands. Later, in the 18th century, they became more educational in function, demonstrating the latest plant classification systems devised by botanists working in the associated herbaria as they tried to order these new treasures. Then, in the 19th and 20th centuries, the trend was towards a combination of specialist and eclectic collections demonstrating many aspects of both horticulture and botany.The establishments of a botanic garden as a living museum of plants which otherwise might become last or extinct is long overdue in Ethiopia.

The GBG is situated on 705 hectares of land along the northwest outskirts of Addis Ababa, a joint venture of Addis Ababa University (AAU) and the city of Addis Ababa. The garden is used for research, education, eco-tourism and conservation currently hosts 780 of the country's estimated 6,500 plant species.

For one, the country has plants whose survival is threatened and which are part of its cultural heritage. These and those introduced from elsewhere have to be preserved live or in a herbarium with adequate documentation for future generations to act as referral for these plants. Such a

botanic garden that is laid out tidily and aesthetically offers opportunities for research, restful relaxation and enjoyment by tourists, members of the general public as well as by scientists, students etc.

It is with the above in consideration that the Addis Ababa city administration and the Addis Ababa University signed memorandum of understanding to jointly develop and manage the Gullele Botanic Garden on 705 hectares at the outskirt of Addis Ababa. Here, the vegetation can be broadly classified into Afro-montane forest type or the evergreen montane forests.

The flora of Ethiopia is estimated to be about 6000 to 6500 species of higher plants with 10-12 percent endemism but these are now in the verge of warning forever due to deforestation, overgrazing, soil erosion, desertification and others. The attempt carried for about three decades by different concerned scientists and institutions to establish a botanic garden that severs the purpose of conservation and research only materialized by the joint action of the Addis Ababa University which led to the signing of memorandum of understanding on April 22nd 2005 which ensured the allocation of 705 hectares of land for this purpose. Plants are fundamental to solving many of humanity's most important challenges: food insecurity, water scarcity, energy, health, and climate change. With more than 20% of the world's plant species currently threatened with extinction, the loss of plant diversity is resulting in reduced options for human innovation, adaptation, and resilience. The world's botanic gardens already conserve and manage around a third of all known plant species in the collections as well as seed banks as an insurance policy against extinction and as a resource to support scientific research. This work needs to be expanded rapidly if we are to avoid further plant species extinctions. Regarding to this, the garden is generally defined as a place for growing flowers, fruits or vegetables. But botanical garden is an educational institution for scientific works and general public or layman to awake and enlightened interest in plant life.

Endemic plants in GBG were categorized in 11 different families. Asteraceae stands 1st with 11 (39.28%) species, Lamiaceae 2nd and Fabaceae 3rd with 5 (17.86%) & 3 (10.71%) species respectively, while others are having one species each. On the other hand, when the conservation status of each species was checked it must protect regarding to their vulnerable, endangered plant species. (2005), five were vulnerable (VU) and two endangered (EN), 12 of them least of concern (LC), and nine were near threatened. Botanical garden is a garden dedicated to the

collection, cultivation and display of a wide of plants labeled with their botanical name.one of the main target of green development strategy is replacing the vulnerable and endangered plant species in Gullele Botanical Garden.

The Gullele Botanic Garden is planned to be realized on a large tract of land, North West of the city of Addis Ababa, straddling the escarpment west of the pass on the Gojam road. The project program consists of several building ensembles, outdoor facilities and gardens. The project aims to turn the tide of environmental degradation, rehabilitate damaged eco-systems and ensure sustainable use of natural resources, by serving as an example of proper environmental management for the Horn of Africa region. It envisages enabling the study of nature, promotion of sustainable use of biodiversity resources and demonstration of appropriate environmental technologies. Participating firms are expected to form an international consortium combining knowledge and expertise from Ethiopia with foreign ideas and skills from the Horn of Africa region or elsewhere.

Historically, botanic garden science has been dominated by the disciplines of economic botany and taxonomy (Blackmore, 2017).Many post-enlightenment European gardens were established as physic gardens for growing medicinal plants; similarly, economic botany was the main driver for the founding of the great colonial gardens such as Kew, Singapore, Peradeniya, Calcutta, Bogor, and Sydney. Coffee, tea, rubber, and other plant-based industries were exported and established through these botanic gardens and the science of collecting and describing plant diversity was the means to the end that would lead to the next big commodity or economic opportunity. Gradually, collecting, naming, and describing plant diversity became the major scientific output itself—always with the potential for discovery of useful plants or derivatives, but rarely at a scale that would transform an economy. At least 20% of plant species are currently threatened with extinction (RBG Kew, 2016), and this has consequences for human innovation, adaptation, and resilience.

2. 2. The role of botanical garden

Visitors mainly come to visit different botanic gardens such as Pretoria National Botanic Garden in South Africa, Singapore Botanic Garden, Calcutta Botanic Garden in India etc. used to enjoy the plants and their pleasant surroundings. But how many of them have any idea that plants have also key to the environment and often amazing practical uses. The traditional role of botanic

garden has been to collect, identify, classified and grow plant species from all over the world. The general practice is to display the various plant species under the best and visually most attractive conditions, Balick (1986). Today botanical gardens play a fundamental role in the field of conservation by motivating people and creating interest in nature and its protection. Botanical garden has also vital role in rising awareness about environmental garden. Environmental gardens have double mission of conservation and education. The botanical garden with their living collections, seed banks, trained specialists and scientists are like insurance, Policy mechanism, which provides guarantee against the loss of species. Botanic garden can play role in the preservation of plant species for investigation of how best to propagate, grow and maintain ecosystem. Institutions such as museums, colleges and universities have played major role in exploring, description and study of our world's flora. Botanical garden in particular was initially instrument in the assessment of plant resources from an economic point of view and was actively engaged in the first introduction into cultivation of this species. As noted in recent publication (International Union for the Conservation of Nature and Natural Resources, 1987), botanic gardens "were the forerunners of today's agricultural experiment station". As Heywood (1983), suggests that the early tropical botanic garden had a major role in the introduction, cultivation and distribution of both native and exotic crops of potential valuable and seedling of valuable timber trees as well as providing guidance and advice to the local settlers on how to grow and maintain the crops and keep them free from disease. The botanic gardens are best represent the last resort for the preservation and maintenance of rare and endangered species. According to Neyar (1990), botanic garden forms an effective network conservation of plants of utility and aesthetic value. Beside this it play, role in protecting ecological balance, preventing environmental degradation and maintaining a pollution free natural atmosphere. Furthermore, as explained in his suggestion botanic gardens are taken as the main center of conservation of plant resources from their extinction and also concerned

- To serve as a" safe place" for the rare and endemic plants.
- To promote educational programs and research in experimental botany and ornamental horticulture.

- To undertake research in propagation of rare and threatened species for afforestation, energy and alternative or substitute food plants. Species of different climate condition are to be grown in specialized conservation like green house.
- To generate awareness about value of trees with their beautiful and interesting plants with display.
- To introduce economically important species and study the physiology of species for field trails and cultivation.
- To act as data bank for information and documentation on holding in botanic garden of the country or regions.
- Bramwell (1993), suggests that botanic garden are the place where we need to inform and educate people about the rationale use of earth's resources, about biodiversity they need to protect major ecosystem as cushion against climatic change and so on, where we really need to produce new generation of administration and legislators who understand what environmental issue are about. According to him botanic garden is like an insurance policy against the loss of species, the depletion of biodiversity and it is provider of resources to build for the future, introduction of species, and rehabilitation of ecosystem and so on.
- In addition to this, botanic garden are wonderful places for people to learn more about plants such as where they from, what they are for and when they are important. They give people a chance to see plants, not only from the country they live in but also from other countries. For many people living in urban environments, botanic garden offer window to nature. And also botanic gardens are special places for plants and collections are managed in scientific way. It gives people information about various types of plants, specifically a place where rare and endangered plants as well cared and studied. In short botanic gardens are special target and focus place for plants. A botanical garden is much more significant than beautifully land escaped garden. It is a documented collection of plants which provides a resource base for research, education and recreation. Beside growing and exhibiting plants, botanic gardens are ideal place to teach people about
  - the richness of the plant kingdom.
  - how human beings use plants economically, culturally and aesthetically.
  - the major threat to plants and the consequence of extinction.
  - the relationship that plants have with the environment.

- the importance of plants in our lives.
- the morphology of plants with their adaptation

CHAPTER – THREE

3. Materials and Methods

3.1. Study Area

3.1.1. Location

The study was conducted within the Gullele Botanical Garden (GBG) located at the North Western part of Addis Ababa city Administration, in Gullele and Kolfe-Keraniyo sub-cities. The GBG is situated on 705 hectares of land along the northwest outskirts of Addis Ababa, a joint venture of Addis Ababa University (AAU) and the city of Addis Ababa. The garden is used for research, education, eco-tourism and conservation currently hosts 780 of the country's estimated 6,500 plant species. The flora of Ethiopia is estimated to be about 6000 to 6500 species of higher plants with 10-12 percent endemism but these are now in the verge of warning forever due to deforestation, overgrazing, soil erosion, desertification and others.

Five miles northwest of Addis Ababa's thriving city center is the lush Gullele Botanic Garden (GBG), the first well-established site of its kind in Ethiopia that covers both forest and semi-forest vegetation. Geographically, the area belongs to the central plateau of Ethiopia with co-ordinates extending between altitudes of 80 55'N and 90 05'Nand longitudes of 380 05'E and 390.05'E with. The botanical garden covers a total of 705 hectares**.** Picture 1. The map of Gullele botanical garden

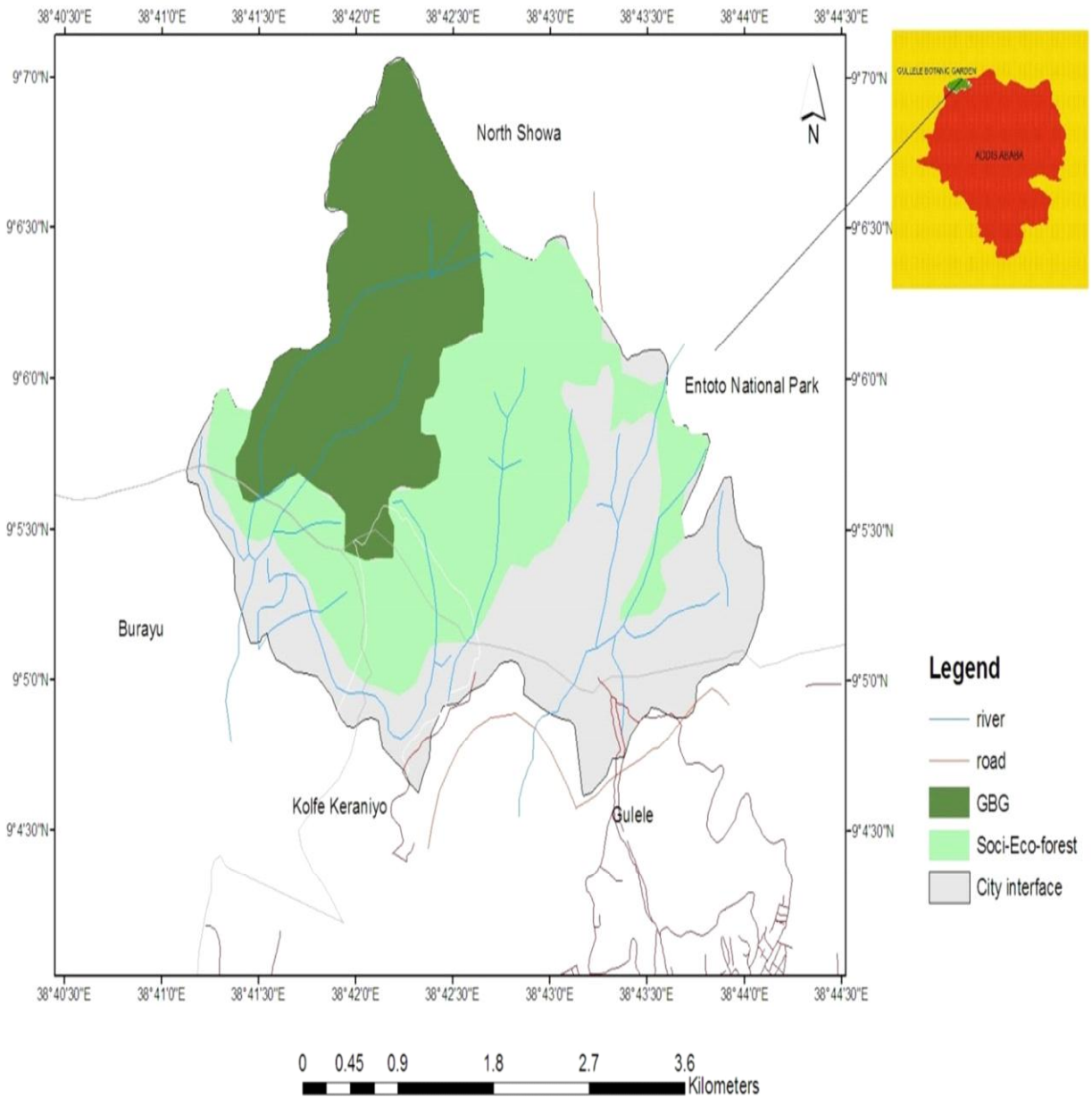

Figure 1. The map and location of Gullele Botanical Garden.

Source Gullele botanical Garden

3.1.2. Climate

The rain fall and temperature condition of the area were described based on the data collected from 1994-2006 by Ethiopia Meteorological Service Agency (EMSA). According to the data from EMSA, the result of the analysis showed that the mean annual temperature of the study area is 7.5°C and 20.7°c in December and February respectively. The mean annual minimum and maximum temperature is 8.4°c and 18.4°c, respectively. The hottest month is February with maximum temperature of 20.7°c, followed by March 20. 2°c and May 20°c and coldest month is December with minimum temperature of 7. 5°c. The mean annual rain fall of the area is 121.4mm per year.

3.1.3. Vegetation

The vegetation can be broadly classified in to Afro-montane forest type or the dry evergreen montane forest. The greater part of the botanic garden is covered by Eucalyptus globules, but the land closer to the river banks, inaccessible areas, new plantation in the thematic garden, cultivated garden and the road side enriched the plant resources to more than 500 plant species with growth habitats of trees, shrubs, herbs, climber and ferns. Some of the dominant indigenous woody species found in the area are *Juniperus procera* Hochst, *Hypericum revolutum Vahl*, *Olinia rochetiana* A. Juss, *Myrsine melanophloeos* (L.) R. Br., *Myrsine Africana* L. and *Erica arborea* L.**.**

3. 2. Methodology

3.2.1. Method of the study

The best method to identify the survived plant seedlings was field surveying (looking , counting, recording and naming of the planted trees on Hamle 22-2011 E.C) and interviews by asking open end questions were conducted to three of administrators in the offices field workers in the field and gardeners of the botanical garden. The primary data collection and analysis was a quantitative approach which involves identifying, counting, recording and naming the planted trees with their types of species. The secondary data collection was referring documents, articles and journals about the botanical garden.

The study design of this research was observational including descriptive and analytical. The quantitative approach was applied to collect data from the community and administrators in the garden. For primary data, non -participant observation, interview three of core process owners were used. For secondary data report documents and literatures were reviewed from hardware and software copied.

3.3. Data collection

Primary data collection; The source of data collection in this study was monthly surveying and observing of each planted tree species in the planted area of the Gullele Botanical Garden. The planted trees were 4627 trees with 16 different species.

Secondary data collection was collecting from written documents such as brushers, magazines and Internet.

3.3.1. Total population of planted trees

The total populations were taken from the whole 4627 planted trees. The 16 species which were planted by different institutions such as Addis Media Network Journalist groups, United Nation in Ethiopia, the Royal Norwegian Embassy, the Eritrean ambassador workers and botanical garden workers, etc. The plant populations were grouped by their planting location areas and their planted groups. The total population groups are given on the annex 1. On page 36

3.3.2 The planted tree seedling height

The seedlings height were measured from the root to the highest point of the plant monthly every 30 days for 210 days (October 2012 up to April 2012) and the average mean height for each species was recorded and given in table 3..

3.3.3. Survival percentage

From the field survey, the number of wilted or dead seedlings from different area of each species was counted and discarded from the study. Then at the end of the study period by removing the dried tree seedlings from the study and calculating the survival percentage of each the survived planted trees.

3.3. 4. Data Analysis

The data was analyzed by descriptive way. Quantitative data was collected by counting and recording within their species type. The population size and the location of the planted tree species were taking information from the botanical garden administrators and community of the garden using structured questionnaire by data the collector. Quantitative data were collected using monthly surveying and counting each planted tree seedlings from the study area. The data used for this study was obtained from both primary and secondary sources. Data from primary source were collected through personal direct observation from the study area. The interviews were based on semi-structured and open ended question. The interviews were conducted for gardeners and two field workers in the garden as well as for administrators in the offices.

The required secondary data were collected from documents such as reports and publications that were reviewed. The 16 species which were planted by different institutions such as Addis Media Network Journalist groups, United Nation in Ethiopia, The Royal Norwegian Embassy, the Botanical Garden workers, etc. The plant populations are grouped by their scientific and local name as follow (Table 1).

Figure 2. Measuring the length of the planted tree seedling.

The required secondary data were collected from documents such as reports and publications that were reviewed. The 16 species which were planted by different institutions such as Addis Media Network Journalist groups, United Nation in Ethiopia, The Royal Norwegian

Embassy, the Botanical Garden workers, etc. The plant populations are grouped by their scientific and local name as follow (Table 1).

Figure 3. Field surveying with field assistants during counting and measuring the tree seedlings

CHAPTER - FOUR

4.1. RESULTS

The results of the survival pattern of the planted tree species during Hamle 22/ 2011E.C. are given on table 1. The total planted trees were registered at the beginning of the study day up to the end of observed and counting in each month (October – April 2011). These planted trees are labeled according to their scientific name, local name and their total number of planted trees in different areas of the garden which given in annex 1. The result indicates the survival percentage of each of planted tree species in each of the surveying months. The survival percentage is given on table 2 and clearly indicated by bar graph (chart 1).

Including the survival percentage of the result part also contains the comparative growth rate of the eight indigenous planted tree species within the study periods.

The comparative results of the growth rate of different planted trees have a significant difference between planted trees in the study period Table 3..

Table 1. Total planted trees population observed in each month.

				Observations months of the planted trees.						
No	Scientific name	Local name	Beginning	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	*Acacia abyssinica* (Hochst)	Bazragirar	1313	1310	1302	1282	1274	1256	1254	1254
2	*Grewia ferruginea (*Hochst)	Alengoza	1085	1082	1079	1077	1074	1068	1062	1062
3	*Rhus glutinosa* A. Rich.	Embus	610	608	606	604	596	584	579	576
4	*Olea europaea* L.subsp Cuspidata	Weira	162	160	158	149	143	137	133	132
5	*Podocarpus falcatus* (Thunb)	Zigba	77	75	75	74	69	57	53	49
6	*Cordia Africana* Lam..	Wanza	125	118	113	109	105	97	93	89
7	*Phoenix canariensis* Chabaud	Zenbaba	168	165	165	164	142	137	129	126
8	*Syzygium guineense* (Willd) DC.	Dokema	200	198	195	192	182	174	168	165
9	*Millettia ferrunia* (Hochs	Birbira	122	120	120	118	109	104	103	102
10	*Dodonea viscose* auct.mult...	Kitkita	350	349	348	346	341	336	335	332
11	*Hagenia abyssinica* (Brace)	*Kosso*	*20*	20	20	20	19	18	18	17
12	*Crotalaria exaltata* Polhill	Abacenan	100	99	99	98	94	89	87	85
13	*Persea amaricana* Mill.	Avocado	25	24	24	23	22	19	16	15
14	*Albizia gummifer* (J.F. Gmel)	Sesa	50	50	49	48	48	45	43	42
15	*Mayteus addat*(Loes0 *Sebsebe*	Atati	200	198	196	194	189	182	180	178
16	*Psidium guajava* L.	Zeyetona	20	20	18	18	15	12	09	08
Grand Total			**4627**	**4576**	**4567**	**4516**	**4422**	**4315**	**4262**	**4233**

This table, contains the total planted trees at the beginning of the planted day up to the end of observed months (October-April). These planted trees are labeled according to their scientific names, local names and their total number planted in the garden.

Table 2 shows that the survival percentage of each planted tree species.

No	Scientific name	Local name	Oct.	Nov.	Dec.	Jun.	Feb.	Mar.	Apr.	AVERAGE (%)
1	*Acacia abyssinica* (Hochst)	Bazragirar	1313	1302	1282	1274	1256	1254	1254	95.5
2	*Grewia ferruginea (*Hoch	Alengoza	1085	1085	1082	1074	1068	1062	1062	97.8
3	*Rhus glutinosa* A.Rich	Embus	610	610	604	596	584	579	576	94.4
4	*Olea europaea* L.Subsp Cuspidata	Weira	162	158	149	143	137	133	132	81.5
5	*Podocarpus falcatus* Thunb	Zigba	77	77	74	69	57	53	49	63.6
6	*Cordia africanum* Lamb.	Wanza	125	113	109	105	97	93	89	71.2
7	*phoenix canariensis* Chab.	Zenbaba	168	168	164	142	137	129	126	75
8	*Syzgium guineense* (Willd) DC.	Dokema	200	200	192	182	174	168	165	82.5
9	*Millettia ferrunia*	Birbira	122	122	118	109	104	103	103	84.4
10	*Dodonea viscose*	Kitkita	350	348	346	341	336	335	332	94.86
11	*Hagenia abyssinica* Brace	Kosso	20	20	20	19	18	18	17	85
12	*Crotalaria exaltata* Polhill	Abacenane	100	100	98	94	89	87	85	85
13	*Persiea amarican*	Avocado	25	25	23	22	19	16	15	60
14	*Albizia baractata*	Sesa	50	50	48	48	45	43	42	84
15	*Mayteu saddat*	Atati	200	200	194	189	182	180	178	89
16	*Psidium guajava*	Zeytona	20	20	18	15	12	9	8	40
	Grand total		4627	4598	4521	4422	4315	4262	4233	91.48

This table Indicates the total planted trees observed monthly starting from October up to April. Most of the planted trees are well survived and given in the percentage of the survived trees at the end of study period. The percentage of the planted tree species in the Gullele Botanical Garden (GBG) planted on Hamle 22/ 2011 is 91.48%.

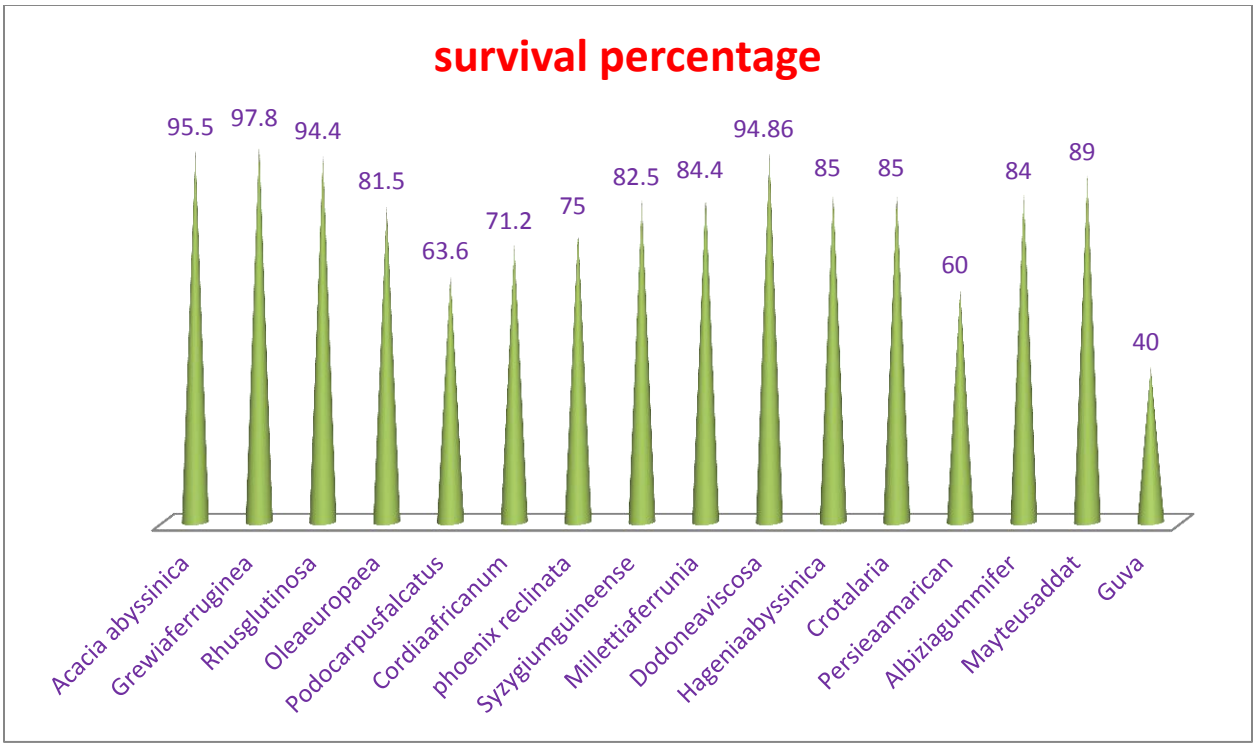

figure 3.The survival percentage of each planted species

4.1. Survival percentage

The overall survival percentage during the study period was high for each planted trees ranging from 40% of *Psidium guajava* (Zeytona) to 97.8% of *Grewia ferruginea* (Alengoza). At the end of the study period the average of survival percentage of planted tree species were 91.48% and which did not survived tree species were 8.52% which indicated in table 3. As the Prime Minster Abiy Ahmed stated that those planted tree seedlings planted in 2011E.C./ throughout the country 81% were survived. But those planted tree seedlings in the Gullele Botanical Garden were 91.48% more survived

Table 3. The survival percentage of the each planted tree species within the study periods.

No	Species	Local name	No. of planted trees at the beginning	Survived planted trees.	Wilted or dried trees	Survival percentage
1	*Acacia abyssinica (*Hochst)	Bazragirar	1313	1254	59	95.5
2	*Grewia ferruginea* (Hochst)	Alengoza	1085	1062	23	97.88
3	*Rhus glutinosa* A. Rich	Embus	610	576	34	94.4
4	*Olea europaea* L.Sub sp cuspidata	Weira	162	132	30	81.5
5	*Podocarpus falcatus* (Thunb)	Zigba	77	49	28	63.6
6	*Cordia abyssinica* Lam.	Wanza	125	89	36	71.2
7	*phoenix canariensis* Chabaud	Zenbaba	168	126	42	75.0
8	*Syzgium guineense* (Willd) DC.	Dokema	200	165	35	82.5
9	*Millettia ferrunia* (Hochs)	Birbira	122	103	19	84.4
10	*Dodonea viscose* auct.mult...	Kitkita	350	332	18	94.86
11	*Hageni a abyssinica* (Brace)	Kosso	20	17	3	85.0
12	*Crotalaria exaltata* Polhill	Abacenane	100	85	15	85.0
13	*Persea americana* Mill.	Avocado	25	15	10	60.0
14	*Albizia gummifer* (J.F. Gmel)	Sesa	50	42	8	84.0
15	*Mayteus addat* (Loes *Sebsebe*	Atati	200	178	22	89.0
16	*Psidium guajava* L.	Zeytona	20	08	12	40.0
	Grand total		4627	4233	394	
	Average (%)		100%	91.48%	8.52%	

this table indicates that the total number of planted trees at the beginning and the number of survived trees at the end of the study period, the number of dried (wilted) trees and the survival percentage of each planted trees species.

4.2. The Comparative growth of the planted tree species studied.

4.2.1. Growth in height

Differences in the mean height between the initial and the last measurements of seven months or 210 days were significant for all study of planted trees. The changes in height among the sixteen species only eight in each area (ordered from high to low) were 42 cm. for *Acacia abyssinica* (Bazragirar), 31 cm. for *Olea europaea* (weira), 61.4 cm. for *Podocarpus falcatus* (Zigba), 38 cm.for *Cordia africana* (Wanza), 32.2 cm. for *phoenix reclinata* (Zenbaba), 42.4 cm, for *Syzgium guineense* (Dokma), 54.3 cm. for *Grewia ferruginea* (Alengoza), and 46 cm. for *Hagenia abyssinica* (Kosso).

At the end of the study period *Acacia abyssinica* (Bazragirar), with the height of 52.6 cm. and the difference between the beginning and the end of the study was 10.6 cm. The second tree was *Olea europaea* (weira) with a height of 40.8 cm. with the height of 11.8 cm. differences at the end of the study period. The third was *Podocarpus falcatus* (Zigba) with a mean height of 69.2 cm. with the height of 8.2 cm. difference. The fourth was *Cordia africana* (Wanza) with a mean height of 44.2 cm. with the difference of 6.2 cm. The fifth was *phoenix reclinata* (Zenbaba) with a mean height of 41.7 cm. with the difference of 10.5.cm. The sixth species was *Syzygium guineense* (Dokma) with a mean height of 51.3 cm. with the height of 11.1 cm. differences. The seventh tree species *Millettia ferrunia* (Birbira) with a mean height of 62.2 cm. with the difference of 8.1cm. and the last species *Hagenia abyssinica* (Kosso) with a mean height of 53.3 cm. with height of 7.3 cm. differences.

T able 4. The relative growth rate of eight indigenous planted tree species with their height in the study periods.

No.	The measured young tree species		The monthly measured of the height by cm.						
	Scientific name	Local name	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1	*Acacia abyssinica*	Bazragirar	42.0	43.2	45. 4	46.9	48.5	50.8	52.6
2	*Olea europaea*	Weira	31.0	33.2	35.6	37.4	38.2	39.9	40.8
3	*Podocarpus falcatus*	Zigba	61.4	63.2	64.2	65.1	66.0	68.2	69.2
4	*Cordial africana*	Wanza	38.0	38.7	39.6	40.5	41.3	42.9	44.2
5	*Phoenixcanariensis*	Zenbaba	32.2	33.7	35.5	37. 3	38.6	39.8	41.7
6	*Syzygiumguineense*	Dokma	42.4	43.9	45.6	47.2	48.6	49.8	51.3
7	*Millettia ferrunia*	Birbra	54.3	55.8	56.6	57.5	59.6	60.7	62.2
8	*Hagenia abyssinica*	Kosso	46.0	47.5	48.3	49. 2	50.8	52.2	53.3

4.2.2. Relative growth rate of the planted tree seedlings in terms of height(RGRH).

The relative growth rates in height of the eight young tree species were different among one another during the entire study period. The RGRH of each young tree species was also different during the dry (December-March for 120 days) and small rainy season (October, November and April for 90 days). The values of RGRH for these eight different young tree species were different in dry and rainy season. According to table 4, the value of RGRH for *Acacia abyssinica* (Bazragirar) growth rate was in average 1.5 cm. and increases by 10.6 cm. in height. The value of RGRH for *Olea europaea* (Weira) growth rate was in average 1.4 cm and increases by 9.8 cm. in height. The value of RGRH for *Podocarpus falcatus* (Zigna) growth rate was at an average 1.11 cm. and increase its height by 7.8 cm.. The values of RGRH for *Cordial africanum* (Wanza) were at an average 0.9 cm. and increase its height by 6.2 cm. The value of RGRH for *Phoenix reclinata* (Zenbaba) at an average was 1.4 cm. and increases its height by 9.5 cm. The values of RGRH for *Syzgium guineense* (Dokma) growth rate at an average was 1.3 cm. and increase its height by 8.9cm. The RGRH for *Millettia ferrugnea* (Birbira) at an average was 1.12 cm. and increase its height by 7.9 cm. The RGRH for *Hagenia abyssinica* (Kosso) growth rate at an average was 1.04 cm. and increase its height by 7.3 cm...

The mean relative growth rate of all planted young tree species height was at an average 1.4 cm. The relative growth rate of the planted tree species were reduced their growth rate in the three dry months especially in December, January and February.

CHAPTER - FIVE

5. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1. Discussion

The survival pattern of planted trees during Hamle 22/2011 in Gullele Botanical Garden shown in a good successful growth. All of the planted young trees are showing well adaptation in the garden. Especially *Acacia abyssinica* (Bazragirar) performed best with respect to changes in mean height (Table 1&2).

- At the beginning of the study, there were 1313 of *Acacia abyssinica* (Bazragirar), later on 59 seedlings dried and discarded from the study. At the end of the study 1254 seedling were survived and in percent 95.5%. Earliest studies have also shows that those planted trees in Gullele Botanical Garden have better survival percentage and have better growth rate than those planed trees in different parts of the country Legesse Negash (1992). For example, *Acacia abyssinica* (Bazragirar) as one of the fastest growing indigenous tree species of Ethiopia in the garden.
- At the beginning of the study there were 162 of *Olea europaea* (Weira), from these tree seedling 132 planted young tree species were survived with 81.5% and 30 seedlings were not survived with 18.5%. *Oleae uropaea* (Weira) shows more growth in rainy season than dry season.
- *Podocarpus falcatus* (Zigba) was found with the highest survival percentage and this agrees with its high stomata resistance, minimizing water loss during drought which is important for survival. *Podocarpus falcatus* was the only species that was not eaten by animals and this condition also contributed for its survival. Therefore, at the beginning of the study, there were planted 77 seedlings and at the end of the study the survived trees were 49 with 63.6%.
- *Syzgium guineense* (Dokma) 200 seedlings were planted at the beginning of the study and most of them were survived. At the end of the study 165 (82.5%) survived and 35 (17.5%) of them discarded from the study.

Comparing to other planted trees, the above four planted young tree species achieved a good performance in their height growth and in their root collar diameter.

- 125 young seedlings of *Cordial africana* (Wanza) were planted and most of them 89 or

71.2% were survived. *C. africana* was planted on most eroded area and covered by soil.

- *Phoenix reclinata* (Zenbaba) were planted around the ring road and road side of the botanical garden. It was affected by animals especially around the ring road site. At the beginning of the study there were 168 and at the end of the study period 126 young species with 75% were survived.
- *Millettia ferruginea* (Birbira) young seedlings were planted around stony area and they were not growing properly. Even the *M. ferrunia* were shading their leaves in the dry months. They were planted 122 seedlings and at the end of the study period 103 with 84.4% young seedlings were survived.
- *Hagenia abyssinica* (Kosso) very few young seedlings were planted most of them were survived. At the beginning of the study 20 young trees species were observed at the last 17 (85%) planted seedlings were survived.
- *Grewia ferruginea* (Alengoza) was a shrub planted tree species and shows a great growth rate and has great survival condition. There were 1085 planted and at the end of the study 1062 (97.88%) tree plated were survived. Only 30 or 2.12% planted tree species were not survived.
- *Rhus glutinosa* (Embus) planted young tree seedlings were 610 from these 576 (94.4%) planted young seedlings were survived.
- There were 350 planted *Dodonea viscosa* (Kitkita) young tree species. From these 332 (94.86%) were survived at the end of the study period.
- *Crotalaria abyssinica* (Abacenane) planted 100 tree seedlings and 85 (85%) of the young tree seedlings were survived.

On Hamle 22/2011, also planted edible fruit tree plant species like, *Persiea amaricana* (Avocado) and *Psidium juajava* (Zeytona) in the botanical garden.

When These edible fruit tree plants well protected properly in near future the people of Addis Ababa will enjoying in the botanical garden by eating these edible fruit tree plants.

- At the beginning of the study , *Persiea amaricana (*Avocado) only 25 young seedlings were planted and 15 (60%) of them were survived properly.
- From 20 *Psidium guajava* (Zeytona) planted tree seedlings less than half of 8 (40%) the planted young seedling were survived.

- *Albizia gummifera* (Sesa) planted 50 young seedlings and more of these tree seedlings 42 (84%) were survived.
- 200 *Maytenus addat* (Atati) young tree seedlings were planted during Hamle 22/2011 most of them 178 (89%) young tree seedlings were survived (Tab. 2).

However it must be noted that the concept of survival percentage was relative high since some of the young trees that have survived during the entire study period may die in the following years, if they do not watered and protected regularly by the botanical garden workers.

As the results show that, *Acacia abyssinica* (Bazragirar), *Grewia ferruginea* (Alengoza), *Rhus glutinosa* (Embus) and *Dodonea viscosa* (Kitkita) planted tree species were survived well and the elevation was suitable for these seedlings. Especially these planted trees are planted in dark clay soil.

5.2. CONCLUSION AND RECOMMENDATION.

5.2.1. Conclusion

Gullele Botanical Garden has an ultimate goal in preserving Ethiopia's botanic heritage and promote in building other domestic botanical garden throughout the country.

The overall survival percentage of *Acacia abyssinica* (Bazragirar), *Grewia ferruginea* (Alengoza), *Rhus glutinosa* (Embus) and *Dodonea viscosa* (Kitkita) planted tree species were survived more than 90% when comparing with other twelve planted tree species. Even though these four tree species were planted many in numbers when comparing to other planted tree species at the beginning of planting day and these tree seedlings well adapted the elevation of the botanical garden.

Oleae uropaea (Weira), *Syzgium guineense* (Dokma), *Millettia ferrunia* (Birbira), *Hagenia abyssinica*(Kosso), *Crotalaria abyssinica* (Abecenane), *Albizia gummifera* (Sesa) and *Maytenus addat* (Atati) planted tree species their survival percentage was in between 81.5% and 89%. These the above seven tree seedlings also well adapted the area and have good survival percentage than other tree seedlings.

The remaining planted tree species, their survival percentage was less than 80%. Some planted tree species like the stem and leaves of *Psidium guajava* (Zeytona) and, *Persea amaricana* (Avocado) are eaten by browsing animals. In general the survival pattern of the planted trees in Gullele Botanical garden was successful and the survival percentage also initiate to planting in the future.

The overall survival percentage of all planted tree species at an average was 91.48%. This survival percentage came without any watering, following up and protecting the planted trees.

The result of this study indicated that *Acacia abyssinica* (Bazragirar), *Grewia ferruginea* (Alengoza*), Rhus glutinosa* (Embus) and *Dodonea viscosa* (Kitkita) shows more than 90% of their survival percentage were protected properly may replace the eucalyptus tree species in the Gullele Botanical Garden. Also other planted tree species are planting in a good way and protecting properly may cover and replace the eucalyptus tree species in the botanical garden. The planted trees have shown different relative growth rate in terms of height.

5.2.2.Recommendations

Currently, indigenous trees of Ethiopia are declining at an alarming rate. For example, nowadays less than 1% of the original *Podocarpus falacatus* (Zigba), *Oleae uropaea* (Weira), *Cordia africanum* (Wanza) and *Syzgium guineense* (Dokma), have remained. Thus such high survival percentage as seen in the study could be a promising condition for the reestablishment of these indigenous tree species. During planting tree species, another problem was the land and hole preparation was not prepared properly and did not protect the planted trees regularly. Therefore, the following recommendations are taking in to consideration while planting tree seedlings in different parts of the country.

- Before planting trees, land preparation and digging the hole properly is very important.
- Before planting tree seedlings it is better to identify suitable elevation (altitude) for different tree species.
- This thesis paper also indicate that those planted tree seedlings in Gullele botanical garden and even in different parts of the country planted by the campaign of the people must be protected and watered regularly until they exist and survive properly.
- Billions of tree seedlings are reported to have been planted every year by the

Ethiopian people. However, many of these seedlings fail to grow. As a result resource, labor and time are wasted for nothing.

Thus special attention should be given for the successful establishment of indigenous tree species. A good management that includes watering regularly, protecting from different animals (herbivore) or other damaging agents, coupled with effective operational inputs like mulching and adding manure would help the establishment of young indigenous trees and replacing the eucalyptus tree in the Gullele Botanical Garden.

Therefore, the Ethiopian Biodiversity Institution, the Gullele Botanical Garden administration , all Universities throughout the country, other stakeholders, the community, regional governments and federal government have responsible in land preparation, especially digging a hole before planting the seedlings and even after planting the seedlings must be watering, protecting from different animals and managing regularly is very important in restoration of the indigenous tree plants of Ethiopia.

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ANNEXES

Annex 1. List of planted trees with their plantation site & institutions involved in planting trees.

No	Scientific name	Local name	Habit	No of seedling planted	Plantation site	Institution or groups to be planted	Plantation date	Remark
1	Acacia abyssinica	Bazragirar	Tree	1100	Near EEP substation(acacia wood land)	• Consolidated engineering service and research plc	22/11/2011	
	TOTAL			1100				
1	Grewiaferruginea	Alengoza	Shrub	200	Woinadega simulation	• Ethiopia charters • AAU • Ethiopia academy of science • Women's groups • Amanuel church children organization	22/11/2011	
2	Oleaeuropaea	Weira	Tree	100				
3	Rhusglutinosa	Embus		100				
4	Cordiaafricana	Wanza	Tree	100				
5	Acacia abyssinica	Bazragirar	Tree	100				
	TOTAL			600				
1	Oleaeuropaea	Weira	Tree	2	Woinadega simulation	• Baheran and his friends	21/11/2011	
2	Podocarpusfalcanus	Zigba	Tree	2				
3	Acacia abyssinica	Bazragirar	Tree	10				
4	Grewiaferruginea	Alengoza	Shrub	70				
5	Millettiaferrgunia	Birbira	Tree	2				
	TOTAL			86				
1	Syzygiumguineense	Dokema	Tree	100	Woinadega simulation	• Addis	10/12/2	

2	Phoenix reclinata	Zemba ba	Tree	40		media net work	011	
3	Millettiaferruginea	Birbira	Tree	100				
4	Acacia abyssinica	Bazragirar	Tree	100				
5	Oleaeuropaea	Weira	Tree	10				
6	Grewiaferrugi nea	Alengo za	Shrub	150				
	TOTAL			500				
1	Dodoneaviscosa	Kitkita	Tree	150	Kola simulation	• Ethiopia greenery development and landscapers association	22/11/2011	
	TOTAL			150				
1	Crotalaria exaltata	Abacenane	Shrub	100	Dega simulation	• HOAREC staff member	22/11/2011	
	TOTAL			100				
1	Phoenix reclinata	Zemba ba	Tree	100	United nation garden	• United nation staff member	22/11/2011	
2	Podocarpusfalcanus	Zigba	Tree	40				
3	Grewiaferrugi nea	Alengo za	Shrub	65				
4	Rhusglutinosa	Embus		60				
5	Oleaeuropaea	Weira	Tree	30				
	TOTAL			295				
1	Phoenix reclinata	Zemba ba	Tree	3		• Eritrea embassy diplomats		
2	Acacia abyssinica	Bazragirar	Tree	3				
	TOTAL			6				
1	Podocarpusfalcanus	Zigba	Tree	35	Ambassador garden	• European union ambassador and staff	22/11/2011	
2	Oleaeuropaea	Weira	Tree	20				
3	Rhusglutinosa	Embus		50				

4	Cordiaafricana	Wanza	Tree	25		member		
5	Phoenix reclinata	Zemba ba	Tree	25				
6	Grewiaferruginea	Alengo za	Tree	100				
7	Hageniaabyssinica	Kosso	Tree	20				
8	Millettiaferrgunia	Birbira	Tree	20				
9	Guva	Zayetona	Tree	20				
10	Persieaamericana	Avocado	Tree	25				
	TOTAL			340				
1	Rhusglutinosa	Embus		400	At the back side ofHORAC along river side and degraded land	• GBG horticulture directorate yearly plan	1/11/2011	
2	Grewiaferruginea	Alengo za	Tree	500				
3	Syzygiumguineense	Dokema	Tree	100				
4	Dodoneaviscosa	Kitkita	Tree	200				
	TOTAL			1200				
1	Albiziagummifera	Sesa	Tree	50	Along the fence	• Women's group (e.gedir)	22/11/2011	
2	Maytenusaddat	Atati	Shurb	200				
	TOTAL			250				
	Grand total			*4627*				

No	Scientific name	Local name	Habit	No of seedling planted	Plantation site	Institution or groups to be planted	Plantation date
1	Acacia abyssinica	Bazragirar	Tree	1100	Near EEP substation(acacia wood land)	• Consolidated engineering service and research plc	22/11/2011
No	Scientific name	Local name	Habit	No of seedling plante	Plantation site	Institution or groups to be planted	Plantation date

				d			
1	Grewiaferruginea	Alengoza		200	Woinadega simulation	• Ethiopia charters • AAU • Ethiopia academy of science • Women's groups Amanuel church children organization	
2	Olea europaea	Weira		100			
3	Rhusglutinosa	Embus		100			
4	Cordiaafricana	Wanza		100			
5	Acacia abyssinica	Bazragirar		100			
	Total			600			

No	Scientific name	Local name	Habit	No of seedling planted	Plantation site	Institution or groups to be planted	Plantation date
1	Oleaeuropaea	Weira		2	Woinadega simulation	Baheran and his friends	
2	Podocarpusfalcanus	Zigba		2			
3	Acacia abyssinica	Bazragirar		70			
4	Grewiaferruginea	Alengoza		10			
5	Millettiaferrgunia	Birbira		2			
Total				86			

No	Scientific name	Local name	Habit	No of seedling planted	Plantation site	Institution or groups to be planted
1	Syzygiumguineense	Dokma		100	Woinadega simulation	Addis media network
2	Phoenix reclinata	Zenbaba		40		
3	Millettiaferrgunia	Bibira		100		
4	Acacia abyssinica	Bazragirar		100		
5	Oleaeuropaea	Weira		10		
6	Grewiaferruginea	Alengoza		150		
Total				500		

Annex 2

figure 2, The natural habitat of Gullele botanical garden

figure 3.The site of planted tree seedlings.

a)

b)

c)

d)

Figure 4, The planted tree seedlings of a) *Phoenix reclinata* (Zenbaba), b) *Grewia ferruginea* (Alengoza), c) *persea americana* (Avocado) and d) *Millettiaferrgunia (*Birbira).

Figure 5, The diagram of workers working in the garden

Annex 3

Interview questions

List of questions for interview with GulleleBotanical Garden Administrators.

Questionnaires for Administrators.

This que.

There are no sources in the current document.stionnaire is for the purpose of academic interest to get information about the management practice of conserving and protecting Gullele Botanical Garden (GBG), so I appreciate your collaboration for filling the questionnaire by giving your limited time at the management practice of protecting and Conserving Gullele botanical garden in the masters of Science in biology.

1 How many trees were planted in the campaign of Hamle 22/ 2011 E.C.?
2 Is there any protection?
3 Did the planted trees watering regularly?
4 What are the main of the administrators in the management practice of protecting and conserving the botanical garden?
5 Which governmental body supports your work? In what way?
   A) Money B) Training C) Materials.
6 How do you organize the works in the management protecting and conserving the botanical garden?.
7 What are the major interaction with government officials in the protecting and conserving the botanical garden?
8 What are the most important strength, weakness, opportunities and threats? Regarding the Gullele botanical garden management practice of protecting and conserve

Declaration

I, the under signed declare that this thesis is my original work and all source of materials used to this thesis have been duly acknowledged.

Name	Signature	Date
Ewinet Ayele	_____	_____

Date of submitted_____ This thesis has been submitted for examination with my approval as research advisor.

Name	Signature	Date
Dr. Bikila Warkeneh	_____	_____
		Date of approval