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Impacts of Enset Root Mealybugs (*Cataenococcus enset* William and Matile-Ferrero) on the production of Enset *(Ensete ventricosum (Welw.))* in Kadeda District, Kambeta Zone, Centeral Ethiopia Regional State

M.Sc Thesis

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Impacts of Enset Root Mealybugs (*Cataenococcus enset* William and Matile-Ferrero) on the production of Enset *(Ensete ventricosum (Welw.))* in Kadida District, Kambeta Zone, Central Ethiopia Regional State, Ethiopia

By

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This is to certify that the Thesis prepared by Mengistu MeshamoMeharo, entitled'' Impacts of Enset root Mealy-bugs in Kadida Woreda, (***Cataenococcus enset***)Kembata Zone, Central Ethiopia Regional State'' and Submitted to in Partial fulfillment of the Requirements for the Degree of M.Sc. in General Biology complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by Examining Board.

Advisor's Name; Professor Emana Getu date____ _____Signature_____

Examiner Name; Dr. Melaku Girma date____ _____Signature_____

Chair Person Name; _____ date____ _____Signature_____

Abstract

*This research was initiated with the objective of investigating impacts of Enset(Enseteventricosum) root mealy bug. To achieve this objective the researcher used semi-structured interview and questionnaire. The consequence of Enset root mealybug(**Cataenococcus enset**) with the ultimate goal of helping in constructing the scientific basis for the preservation and sustainable use of the plant in Kembata Zone, Ethiopia. The district, Kadida represents major Agro-Ecological Zones. Six kebeles were purposively selected for this study. Then a total of 100 respondents were included randomly in the study. A total ofonlysixfarmers were interviewed. Questionnaires were distributed to 100 farmers. The data were analyzed using SPSS version 20 as well as Excel 2016 spread sheet. The result shows that more than 65% of respondents believed that Enset root mealy-bug caused losses of pr(**Cataenococcus enset**) oductivity and create food shortage. The effect of Enset root mealy-bug resulted in change (**Cataenococcus enset**) of feeding culture, low income and exposure to climate conditions. Damage was very high during dry and hot periods of the year and majority of the farmers said that symptoms of Enset root mealy bug attack cannot easily be kn(**Cataenococcus enset**) own before severe plant damage occur. Farmers usually prefer preventive measures such as use of clean seedling, sanitation, use of farmyard manure, increasing soil moisture, uprooting the infected plants and burning the hole, removing alternate hosts, control of insect pests and use of tolerant varieties This study confirms that the Kembata Zone is rich in diversity of Enset, but reduction in production and loss of some food and Medical Enset plant disappeared because of different factors. Such as Harshad weather condition over population and size of land*

Key words/ Phrases**: Enset **root Mealy-bug , Ensete, Scientific(Cataenococcus enset)name, integrated pest management

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List of Acronym

CSA: Central Statistical Authority

FAO: Food and Agricultural Organization

IBPGR: International Board for Plant Genetic Resources

IK Indigenous knowledge

EMA Ethiopian Metrological Agency

SPSS: Statistical Package for Social Sciences

Chapter One

Introduction

1.1 Background of Study

Root and tubers are plants yielding starchy root, tuber, rhizomes, corms, and stems. They are used mainly for human food, for animal feed and for manufacturing starch, alcohol including beer (Hildebrand, 2001). Enset *(*Enseteventricosum*]* a perennial herbaceous and monocarpic root crop with long broad leaves and bulky pseudo-stem that originated in Ethiopia. It is widely distributed in eastern and southern Africa but cultivated only in southern and south western parts of Ethiopia as a staple food for about 15 million peoples in mixed subsistence farming systems. The crop has existed for several hundred years as sustainable form of agriculture in country in general and in southern region in particular (Tadesse, 2002).

species of Enset(*Enset ventricosum)* is distributed throughout most of central, eastern, and southern Africa, as well as Asian countries, its domestication and uses as a human and animal food, construction material, medicine and fiber (Azerefegne, 2009). Thus, enset has been cultivated as a food and fibre crop in Ethiopia for several years and over 80% of the production is concentrated in the south and south-western part of the country cultivation has existed for several hundred years as a sustainable form of agriculture in Ethiopia (Brandt, 1997). More than 20% of Ethiopia's population depends upon Enset (a close relative of the banana) for human food, fibre, animal food, construction materials and medicines. It was initially domesticated not for its fruit but for the leaf stalks and underground corm. However, the sustainability of Ense (*Enset ventricosum)*-based agriculture is threatened by a number of factors. The main biotic stresses are bacterial wilt, the Enset root mealybug(***Cataenococcus enset***), nematodes, fungi and other vertebrate pests like mole-rats (Addis, 2006).

Although, the sustainability of Enset [*Enset ventricosum]* agriculture is pressured by a number of biotic and other factors that reduces its yield (Addis, 2006). The main biotic stresses are bacterial wilt, Enset root mealybug(***Cataenococcus enset)***, nematodes, fungi and other vertebrate pests like mole rats (Addis, 2005; Bogale, 2004).

Enset root mealybug Williams and Matil(***Cataenococcus enset***)-Ferrero, 1999) is one of the major pest that the farmer concerns growing the crop. It was first reported in Wonago, Ethiopia in 1988 (Tsedeke,
988). The insect is known to attack Enset in Gedeo, Sidama, Gurage, Kembata,Tembaro, Hadyia, Keffa and Bench zones and Amaro and Yem districts (Addis, 2008). Enset root mealybug(***Cataenococcus enset***) is known by different local names in different areas. It is known as 'Tsete' in Gedeo, 'Chea', 'Churcha' and 'Hufaro', in Sidama, 'Buno', 'Osk', 'Oote' and 'Dachu' in Bench zone. Enset root mealybugs (***Cataenococcus enset***)are found on roots and corms. However, during periods of extreme drought the mealybugs tend to move towards the corm when some of the roots dry out and die (Addis, 2005). Enset (*Enset ventricosum)* plants infested with mealybugs have a retarded growth and dried lateral leaves. It causes stunted growth and the damage appears more severe during the dry season (Azerefegne, 2009). The dispersal mechanism of the pest is facilitated by movement of infested suckers, infected corms, farm implements during cultivation, repeated transplanting operations and association with ants (Addis, 2005; Azerefegne, 2009; Quimio and Tessera, 1996).

To manage the pest use of farmyard manure, application of common insecticides such as Malathion, Dimethoate, Endosulfan, Fenitrothion, Chlorpyrifos and Diazinon , use of insecticidal plant extracts, and repeated ploughing and sanitation of Enset fields has also been reported as a control option for reducing Enset root mealybug(***Cataenococcus enset***)population (Tadesse, 2006). Although attempts have been made to control the Enset root mealybugs [***Cataenococcus enset***] by different institutions/organizations; cost effective, indigenous management and user friendly control measures have not yet been developed. Therefore, this study was initiated with the following objectives: to assess indigenous knowledge of farmer for management of Enset root mealybug(***Cataenococcus enset***) across locations and to document information which can be used in developing integrated management strategy against Enset root mealybugs with the ultimate goal of helping in constructing the scientific basis for the conservation and sustainable use of the crop.

The current researcher focused on the area of Kembatazone specifically Kadida Woreda which was the most experienced with the use of Enset plant. The society used this crop as a staple food. However, Enset (*Enset ventricosum)* plant disease made great influence on production and consumption of this plant. Enset root mealybug(***Cataenococcus enset***) is a major

pest of Enset in Enset growing areas of southern Ethiopia. It has been reported from Wonago as a new record for Ethiopia (Tsedeke 1988). The insect is known to attack Enset (*Enset ventricosum)*in Gedeo, Sidama, Gurage, Kembata,Tembaro, Hadyia, Keffa and Bench zones and Amaro and Yem districts (Addis, 2008a).

The pest attacks Enset (*Enset ventricosum)* plants at any age, with infestations being most serious on 2 to 4 year-old plants (Anonymous, 2001). Mealy-bug-infestetion Enset plants exhibit retarded growth, loss of vigour, dried lateral leaves but green central shoot and eventually plant death (Addis, 2005). Empirical data on Enset yield loss as a result of mealy-bug attack are scanty. According to Addis (2005), more than 30% of the sampled Enset farms were infested with Enset root mealy-bugs.

Generally, mealy-bugs are difficult to control with insecticides due to their cryptic nature, waxy-coat and life-style of forming dense colonies of multiple and overlapping generations (Blumberg and Van Driesche 2001). Also chemical insecticides are often too costly for farmers, particularly in developing countries. These reasons, together with the demand for contaminant-free food had fostered the search for alternative methods of control (Ekesi, 1998).

Enset root mealy-bugs(***Cataenococcus enset)*** are mainly distributed to new regions and farms through infested planting materials. Production of mealy-bug-free planting materials is the key control measure used to manage Enset root mealy-bugs(***Cataenococcus enset***). Enset growers usually produce Enset (*Enset ventricosum)* suckers for planting for their own use, exchange with others, or sale of suckers in the markets (Bizuayehu, 2002). Enset corms used for production of new suckers may be invariably infested with soil pests particularly with Enset root mealy-bugs. Transplanting the contaminated planting materials facilitates their spread. A number of techniques have been developed to decontaminate infested planting materials from pests and pathogens (Speijer, 1999). With hot water treatment seeming amongst the most successful (Tenkouano, 2006).

1.2. Statement of the Problem

Enset root mealybug(***Cataenococcus enset***) is the most insect pest of Enset *Enset ventricosum]* growing areas in Ethiopia. This root mealybug is a generic term for several Pseudo-coccidiae feeding on underground plant parts. It has an elongate-oval body, which is covered with wax secretions on the dorsal and lateral side body parts. The wax secretion gives an appearance of cottony and spine-like projections.

While these waxy secretions are not part of the maybugs' body, they are lost with each moult. This insect pest was first reported in wonago, Ethiopia in 1988. It was known to attack Enset in Gedeo, Sidama, Gurage, KembataTembaro, Hadyia, Keffa and Bench zones, Amaro, and Yem are special area of Enset growing areas of the country. According to the Addis e tal2006 the insect pest can attack the crop at any growth stage, with infestations being most severe on two to four years old plants. Addis was also further investigated the density and distribution of Enset root mealy-bugs(***Cataenococcus enset***) on Enset and reported that most of the insect has found on the upper parts of the corm and the roots within a 20 cm radius of soil. Once the plant has been affected by this disease, it starts to show different and initial symptoms like bacterial ooze in the leaf petioles and leaf sheaths and progressive wilting of the leaves. These critical effects lead to a gradual decline in the production and productivity of the crop.

The different research studies showed that the infection rate of the disease in different parts of the country was higher. Hence, the survey reported from borena mid-altitude on bacterial wilt incidence in both 2014 and 2015 years by Desalegn and Addis 2006 indicated that about 38% and 56% of Enset farms were infected by this disease with a mean incidence of 29.46% and 12.89%, respectively. Also, the survey further showed that an average of 21.17% of Enset stands was lost due to this disease. In addition, the assessed survey was noted that the extent of damage of Enset is equal to the incidence percentages due to the plant certainly dies after infected by the diseases. Therefore, the current researcher intended to fill the gap through conducting effects of Ensetroot mealy-bugs(***Cataenococcus enset***).

1.3. Research questions

The study was to answer which sets of research questions to investigate to answer the aims mentioned above in this study.

1. What effectsthat Enset root mealybugs(***Cataenococcus enset***) bring to inseset production
2. What are the mechanisms used to protect the Enset root mealybugs(***Cataenococcus enset***)at the study area?
3. What is the importance of Enset (*Enset ventricosum)* in the study area?

1.4. Objective of the Study

1.4.1. General Objective

To investigate impacts of Enset root mealybugs (***Cataenococcus enset***)in KadidaWoreda.

1.4.2. Specific Objectives

The specific objective of this study was to:

1. To describe the effects of Enset root mealy bugs(***Cataenococcus enset***) at the study area.
2. To identify preventing mechanisms of the Enset root mealybugs(***Cataenococcus enset***) at the study area.
3. To investigate the importance of the Enset (*Enset ventricosum)* and its by product in the study area.

1.5 Significance of the Study

This study might be provided the necessary input for decision makers and development partners to prioritize among the identified factors that affect food security and design better intervention strategy accordingly. It identifies areas of intervention and provides base for further investigation of the problems and also give an insight about the contributing factors and coping strategies of food insecurity.

CHAPTERTWO

Literature Review

2.1. Biology of Enset root mealy bug(*Cataenococcus enset*)

Enset root mealy-bug(***Cataenococcus enset***) is a generic term for a number of Pseudo-coccidae feeding on underground plant parts. Enset root mealy-bugs(***Cataenococcus enset***) have an elongate-oval body covered with wax secretions on the dorsal and lateral sides. The wax secretions give the appearance of cottony, spine-like projections. While these waxy secretions are not part of the mealy-bugs' body, they are lost with each moult.

Different development stages of Enset root mealy-bugs are recognized: Bright-orange to yellow-orange coloured "crawlers" or rapidly moving first instars, that are creamy white but barely visible, being 0.5 to 2.7 mm long. They greatly resemble the adults but are significantly smaller.

Figure 1: Adult Enset root mealybugs(***Cataenococcus enset***)

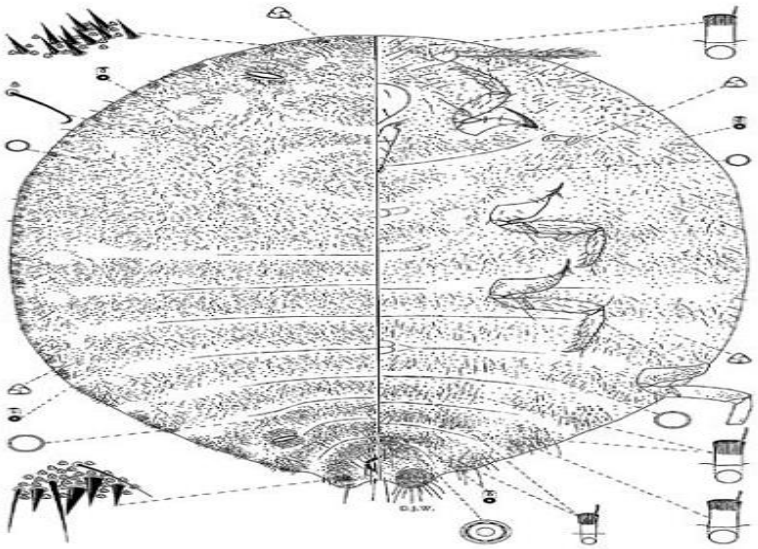

Figure 2. Adult Enset root mealy-bug(***Cataenococcus enset***) (adapted from Williams and Matile-Ferrero, 1999) Second and third instars mealy-bugs begin to develop distinct lateral and caudal spines, increase in body size, and start to produce large amount of honeydew excretion (Addis, 2005; Addis, 2008a).

Adult female mealy-bugs have an elongate-oval body covered with wax secretions on the dorsal and lateral sides (Figure 2). Adult females show pronounced cross wise grooves running down their body and give birth to live young ones on a shallow pile of waxy secretions. Each female mealy-bug produces 56 to 383 nymphs in its life time. The adult life of a mealy-bug is 50.0 + 0.5 days. The total life span of mealy-bugs is 94-113 days. The body size of adult mealy-bugs ranges from 2.8 to 4.0 mm in length and 2.85 to 3.70 mm in width.

2.2. Geographical distribution

Field surveys conducted on peasant farms (Figure 4) showed that more than 30% of the sampled farms were infested with Enset root mealy-bugs. Mealy-bugs were recorded in Sidama, Gedeo, Gurage, Bench, KembataTembaro, Keffa, and Hadyia zones and Amaro and Yem districts (Figure 4). In Sidama, Gedeo, Amaro and Bench respectively 62, 67, 00 and 57% of sites visited were infested by the root mealy-bugs. The Enset root mealy-bug(***Cataenococcus enset***) infestation was found to be most serious at an elevation between 400 to 2200 masl. The highest level of Enset root mealy-bug(***Cataenococcus enset***) infestation was recorded at an elevation between 600-800 masl. Enset root mealy-bugs(***Cataenococcus***

enset) were not recorded at altitudes greater than 2600 masl and below 400 masl (Addis 2005).

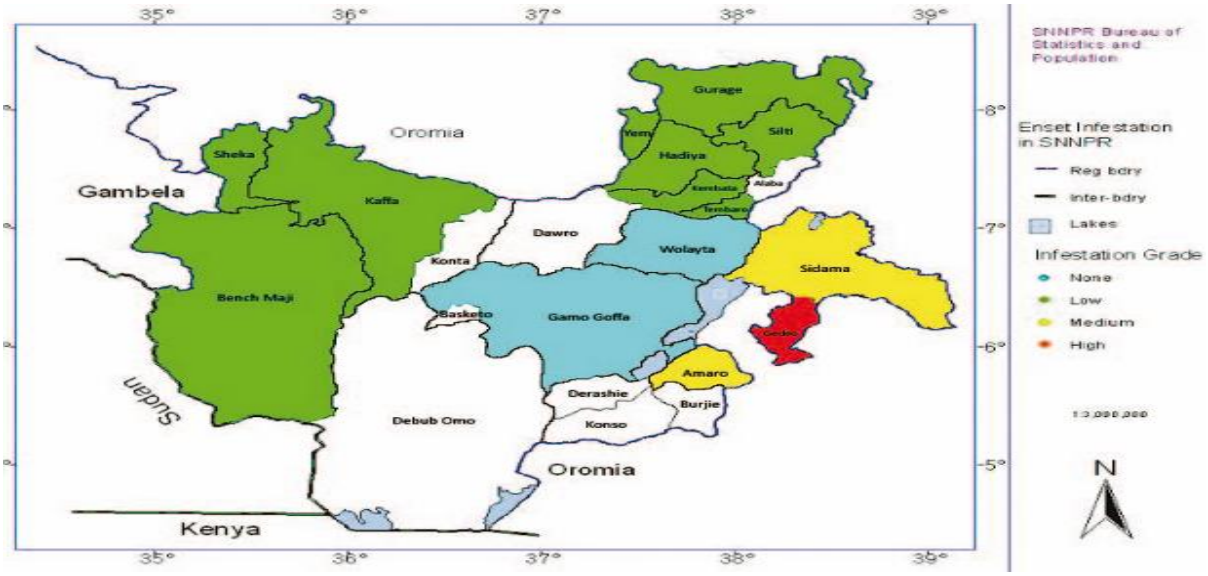

Fig .3, Surveyed areas, Enset root mealy-bug (***Cataenococcus enset***)distribution and degree of infestation in southern Ethiopia.

2.3. Damage symptoms

Enset root mealy-bugs (***Cataenococcus enset***) were found exclusively on the roots and corm of Enset (Plates 2 and 3). Damage by Enset root mealy-bugs(***Cataenococcus enset***) was nonspecific, including common symptoms of slow plant growth, lack of vigour and subsequent death, especially under moisture-stress. Infested plants displayed retarded growth where most lateral leaves were desiccated, but with a green central shoot. All roots were found to be vulnerable to mealy-bugs attack. It was observed that Enset (*Enset ventricosum)* plants attacked by root mealy-bugs have a significantly lower number of roots as compared to healthy plants. In addition, mealy-bug-damaged Enset (*Enset ventricosum)* plants were more easily uprooted.

Fig 4.Enset (*Enset ventricosum)* corm severely infested with root mealy-bugs

Enset (*Enset ventricosum*)roots severely infested with root mealy

Fig 5: Young Enset (*Enset ventricosum)* plants are very vulnerable to root mealy-bugs.

2.4. Nymph 'crawlers'

Crawling first instar nymphs can play a key role in dispersal over the host plant, and can be responsible for spreading the mealy-bug population to new host plants. Occasionally, these crawlers are observed on the lower part of the pseudo-stem just above the soil.

2.5. Infested corms

The main dispersal route is via the distribution of Enset suckers from infested corms, especially in nursery sites established below 2000 masl where there is an environment

conducive to mealy-bug reproduction. Planting material is commonly exchanged between farmers without discrimination of infested suckers, and subsequent transplanting of infested plants leads to further dispersal.

Out of the 163 farms surveyed in southern Ethiopia, more than 30% were found infestation with root mealy-bugs (Addis, 2005). According to Addis (2005) most of the Enset (*Enset ventricosum)* farmers (79%) produce their own suckers for planting. It was observed that it is not uncommon to purchase Enset (*Enset ventricosum)* seedlings from local markets. About 20% of the farmers purchased suckers from local suppliers because they believe that suckers raised on their own farms would not perform well. Few farmers (2%) got suckers freely from government nursery sites. In areas where there was frequent exchange of planting materials among farmers like in Amaro, Gedeo, Sidama and Bench, there was a high level of infestation Enset (100%, 67%, 62% and 57%, respectively). In contrast, in Hadyia, Gurage, KembataTembaro, Keffa and Yem where there was limited exchange of planting materials and farmers depend on self-raised seedlings, the infestation was relatively low (17%, 8%, 25%, 29% and 17% respectively). This study thus showed that exchange of planting materials -in the absence of proper local quarantine services- is an important means for spreading mealy-bugs to new farms and villages

It was observed that some of the Enset (*Enset ventricosum)* nurseries found in southern Ethiopia (Yirgachefe and Wonago districts) were highly infested by mealy-bugs. It has been reported that some development organizations have been procuring suckers from these nursery sites and maintenance fields in order to introduce them to different areas of the country where farmers are trying to adopt Enset (*Enset ventricosum)* production. Thus, the use of infested suckers from such centres has facilitated the distribution and spread of the insect to non-infestation and new Enset (*Enset ventricosum)* production areas.

Plate- 1. Enset (*Enset ventricosum)*plants of different ages - plants are regularly replanted and this enhances the spread of mealy-bugs

The establishment of a quarantine/planting-material certification scheme could help address this problem.

2.6 Ants

Ants' activities have also been implicated in mealy-bug dispersal. The literature documents many examples of the symbiotic relationship between ants and mealy-bugs, in which the ants protect the mealy-bugs to harvest their honeydew. Even though the species of ants that are closely associated with Enset root mealy-bugs(***Cataenococcus enset*** are not yet identified, they were observed in association with the mealy-bug infestation in all places. It is known that ants play a role in the protection and dispersal of root mealy-bugs. Malsch (2000) mentioned that when the mealy-bugs are disturbed at the time of cultivation, weeding, transplanting and harvesting, their attendant ants carry and take them to new plants or root parts. Even though dispersal of mealy-bugs by ants is a short distance, ants help them to find hidden places in the roots and corm, which are very difficult to reach even with insecticides. Before this was commonly known, farmers and others would sometimes attribute crop wilt to the presence of ants, rather than the protection they afforded to the much less obvious mealy-bugs. In this case, controlling the ants can also reduce levels of mealy-bug infestation and consequent wilt (Jahn, 2003).

2.7 Cultivation and transplanting

Finally, mealy-bugs can also be transported by machinery, tools, equipment and soil movement during cultivation and repeated transplanting operations conducted at different times. Thus, appropriate hygiene measures applied to these items may also be an effective way of reducing dispersal.

An Enset (*Enset ventricosum)* plant may be transplanted two to five times before it is finally harvested. During transplanting, farmers pull out and replant all transplants including infestation ones.

2.8. Management of Enset root mealybugs(*Cataenococcus enset*)

2.8.1 **Prevention**

Clean planting material

The first resort for mealy-bugs control is the use of clean planting material (Addis, 2008b). Enset (*Enset ventricosum*)infestation was severe only between 1400 and 2200 masl (Figure 5). So material from altitudes outside this range may offer potential for a mealy-bug-free source of planting material, especially if the production in these areas deploys an integrated approach to further minimise infestation risk.

Extension

Farmers' awareness of the Enset root mealy-bug (***Cataenococcus enset***) damage symptoms, and of management and control options is the key to a successful eradication of this important pest. Farmers also need training in clean Enset (*Enset ventricosum)* seedling/planting material production. Therefore, extension programmes on Enset management and control strategies should be strengthened so that large numbers of farmers can control the insects in established plantations, establish new Enset fields with clean planting materials and stop the distribution of this pest to new Enset (*Enset ventricosum)*production areas.

Quarantine

Quarantine measures could be designed to prevent further spread of the insect to different parts of the region. If practical, a clean sucker certification scheme could be developed, in

which farmers who produce planting materials would be monitored. Areas and localities with a high incidence and severity of the insect should be delineated and a concerted effort should be made to stop the Systems and Agronomy of Enset (*Enset ventricosum)* is cultivated at the backyard of the home followed by *Coffe-arabica and Chat edulis.* The early growth and development of *Enset ventricosum* (Musaceae) are seedlings. Farmers do not plant suckers directly in permanent field. The spacing Varies from phase to phase: the distance between plants is increased at each successive. transplantation until it reaches its final spacing in the permanent location. At each stage of transplanting, Enest has different local names as it indicates the growth stage of Enset (*Enset ventricosu)*(Admasu Tsegaye and Struik, 2001).

2.9. Uses of Enset (*Enset ventricosum)*

Enset (*Enset ventricosum)* is staple food crop for over 15 million people. It provides year round food, fiber, animal feed and medicine .Gives higher yield per unit area (25 years-1) than wheat (AdmasuTsegaye&Struik, 2001). In Ethiopia Enset [(*Enset ventricosum)* is cultivated mainly for food. The edible parts of the plant are formed by the pseudostem and the underground corm (ZerihunYemataw, 2012).

2.9.1. Enset used as a food

The major foods obtained from Enset (*Enset ventricosum)* are Kocho, bulla and Amicho. Kocho is the bulk of the fermented starch obtained from the mixture of the decorticated (scraped) leaf sheaths and grated corm (underground stem base). Kocho can be stored for long periods of time without spoiling. The quality of Kocho depends on the age of the harvested Enset plant, the type of clone (variety), and the harvesting season.

Moreover, within one plant, the quality is influenced by the part of leaf sheath and corm processed. The preferred type is white in colour and is obtained from the innermost leaf sheaths and inner part of the corm, while the lowest grade is blackish and is obtained from the outer leaf sheath and corm. Although many different dishes are prepared from Kocho, pancake-like bread is the most common. Kocho prepared as fermented Ense (*Enset ventricosum)* bread has also become extremely popular at restaurants that serve the Ethiopian delicacy of kitfo (raw ground beef mixed with butter and spices). The combination of Kocho and kitfo is now virtually required at restaurants (ZerihunYemataw, 2014).

Bulla is obtained by: 1) scraping the leaf sheath, peduncle, and grated corm into a pulp; 2) squeezing liquid containing starch from the pulp 3) allowing the resultant

starch to concentrate into a white powder by removing the water by evaporation and 4) rehydrating with water. It is considered the best quality Enset food and is obtained mainly from fully matured Enset plants. Bulla can be prepared as a pancake, porridge, or dumpling.

Amicho is the boiled Enset corm, usually of a younger plant. Enset plants may be uprooted for preparing meals quickly if the amount of Enset harvested is insufficient, or for special occasions. The corm is boiled and consumed in a manner similar to preparation methods for other root and tuber crops. Certain clones are selected for their Amicho production (Brandt, 1997).

2.9.2. Medicinal uses of Enset

Particular clones (or landraces) and parts of Enset (*Enset ventricosum)* plants are used medicinally for both humans and livestock to cure bone fractures, broken bones, childbirth problems (i.e., assisting to discharge the placenta), diarrhoea, and birth control (Brandt, 1997).

2.9.3. Other uses of Enset

enset (*Enset ventricosum)* provides fibber as a by-product of decorticating the leaves sheaths. Enset (*Enset ventricosum)* fibber has excellent structure, and its strength is equivalent to the fibber of abaca, a world-class fibber crop. About 600 tons of nset fibbers per year are sent to factories. In rural areas the fibber is used to make sacks, bags, ropes, cordage, mats, construction materials (such as tying materials that can be used in place of nails), and sieves. (ZerihunYemataw, 2014).

Enset (*Enset ventricosum)* leaves are used as bread and food wrappers, serving plates, and pit liners to store Kocho for fermentation and future use. During Enset harvesting Enset leaves are used to line the ground where processing and fermentation take place. The dried petioles and midribs are used as fuel, and to make mats and tying materials for house construction. The dried leaf sheaths are used as feed and wrapping materials. The pulp from the dried leaf sheaths, petioles, and midribs is used as cleaning rags and brushes, baby cushions/diapers, and cooking pot stands. Dried leaf sheaths are used as wrappers for butter, Kocho, and other items to transport to local markets (Spring, 1996). Enset (*Enset ventricosum)*leaves are an important cattle feed, especially in the dry season when grasses are scarce. Leaves are carried into the house for stall feeding of cattle during the night time (Marsha, 2014).

2.10. Production Constraints and Local Management System

2.10.1. Diseases of Enset [*Enset ventricosum]*

Diseases are collectively the most severe biological problem facing Enset (*Enset ventricosum)*. The damage that diseases can cause and the lack of knowledge about or implementation of preventative strategies contribute to the severity of Enset plant diseases. Diseases are caused by several bacteria, nematodes, fungi, and viruses. Bacterial wilt, caused by the bacteria, Xanthomonas, *campestris and pvmusacearum, are the most threatening to the Enset* [*Enset ventricosum]*. The wilt causes complete death of the plant within weeks of the first symptom, i.e. yellowing and drying of the emerging shoot. Individual plant infection and loss is common but 'hot spot' losses can amount to half of the harvestable plants.

Pathologists and extensionists recommend uprooting and burying of diseased plants as well as fire sterilization of knives, machetes and tools (Awol Zeberga, 2014). Enset is attacked by numerous diseases in addition to bacterial wilt. They include Enset corm rot, Enset (*Enset ventricosum)* sheath rot and Enset dead heart leaf rot, caused by an unknown bacterial pathogen and fungus, respectively, as well as root-knot, lesions, nematodes, and virus diseases. The most important factors responsible for spreading disease of bacterial Wilt include disease-infected planting material, contaminated farming and processing tools, and human and animal vectors. (Daniel Ashagrie, 1969).

The only research-recommended control measures for diseases are cultural measures to prevent the movement of the causal agent. For bacterial wilt, these measures include the use of healthy, disease-free suckers for planting material; destruction and controlled movement of diseased plants; cleaning of equipment that has come in contact with diseased plant material; and rotation of crops (Robert and ChernetErtiro, 2009).

2.10.2. Animal and pest attack

Porcupine, mole rat, and wild pig attack Enset (*Enset ventricosum)* plants in the field. They usually damage the plant by feeding on the corm and pseudo-stem. Among these pests, the mole rat ranks number one. Since these animals are not microscopic like the bacterial and viral diseases, farmers are knowledgeable about them, and many employ effective management practices. These practices include woven fences and ditches around Enset (*Enset ventricosum)* fields, to retard the movement of animals into the field, and traps for catching them (McCabe and Lee, 1996). Wealthier farmers use steel traps to snare wild pigs

and monkeys, and others traps for porcupines and mole rats. Burning coals may be dumped into the rat tunnels. Farmers also protect against porcupines by digging pits around Enset [*Enset ventricosum]* plants so that it is difficult for the animals to get in or to climb up and get away. In some areas, farmers organize themselves on a village basis to hunt wild pests with sticks, spears, and machetes. Insects have been considered a minor problem in Enset [*Enset ventricosum]* cultivation.

However, over the last several growing seasons, mealy bugs have been identified as a serious problem in certain regions (Temesgen and Addis, 2006). Mealy bugs are soft-bodied insects that feed on the corm and roots. Enset plants infected by mealy bugs show stunted growth; the damage appears more severe during the dry season. Because they live underground, their damage often goes unnoticed until serious loss has occurred. As they are slow moving insects, mealy bugs are controlled with methods similar to those used against diseases such as bacterial wilt (FerduAzerefegn, 2009).

2.11. **Weeds**

Weeds can cause greatly reduced plant growth while Enset (*Enset ventricosum)* plants are small, i.e, during the sucker stage and for one or two years after the first transplant. The total land area used for production during these stages is usually relatively small compared to the farm size, and therefore weeding can be accomplished with available labour. As the Enset plants become larger, the perennial leaf canopy and leaf litter on the soil surface prevent most weed growth. In annual crop production, the labour available for weed control can be a serious restriction to production. Although labour data are not available, there is probably much less labour required for weed control per ton of food in Enset than on any annual crop. The reduction in labour for weed control may be offset in part by the additional labor required during harvesting and processing of Enset (*Enset ventricosum)* (Abraham Shumbolo, 2012).

2.12. Enset harvesting and processing

Although Enset (*Enset ventricosum)* is usually harvested just before flowering, the preferred harvesting time is just when the plant flowers. The time duration required to flower depends upon climatic conditions, clone type, and management. Hence, the flowering time varies from 3 to 15 years but is optimally around 6 or 7 years. Enset (*Enset ventricosum)* processing is carried out by women using traditional tools. At harvest, leaves and older leaf

sheaths are first removed from the designated plants. The internal leaf sheaths (commonly up to two meters in length) are separated from the pseudo-stem down to the true stem, which is about a 20 centimetre section between corm and pseudo-stem. Then the true stem is separated or stumped from the underground corm.

The concave side of the leaf sheath is peeled and cut into pieces of about one meter length and split lengthwise in order to shorten the leaf sheath to a workable size. Then the leaf sheath is decorticated using a locally made bamboo scraper while the leaf sheath is held on an incline (at 45 to 80 degrees from the ground) against a wooden plank. In some groups, women may sit on the ground (often on Enset leaves) and use one leg to hold the leaf sheaths in place, while in other areas they bind the sheath to the board and stand to decorticate. The working area used for decortications is covered with Enset leaves (TemesgenMagule, 2014).

2.13. Role of Women on Enset Production and Processing

Gender roles (in terms of the division of labour for all aspects of Enset (*Enset ventricosum)* production and marketing) are of critical importance. Without women to process Enset, there would be no food produced and it would simply be an ornamental plant, as it is in other parts of Africa and Asia. But women's work is often relegated to lesser significance than men's. Both researchers and farmers often believe that women are involved "only" in processing and cooking of the Enset, and rank these tasks below cultivation tasks.

Women, in fact, do participate (in some areas and in some households) in production activities (e.g, manuring and varietal selection), and in households where there are no women knowledgeable about Enset clones and processing, Enset is not eaten unless others are paid to process and cook it (AsnakechWoldetensaye, 1997).

Tesfaye Habte-Wolde (1996) argue that women farmers know a great deal about the different landraces of Enset, and that "when men and women of the same household were interviewed together, women tended to dominate discussion about landraces, contrasting and comparing them and saying what should be harvested at different Ages.

CHAPTER THREE

Research Methodology

3.1. Description of the Study Area

This study was conducted in Kembata Zone (Kedida Woreda),in Centeral Ethiopia Regional State. Kembata Zone is located between 06'-0.7^{0}'N latitude and 37^{0}45$^{'}$E longitude. The Zone has 8 administrative Woreda. All of them are classified as Agrarian. Kembata zone shares common boundaries with Kembata Zone such as Halaba zone in East direction, Hadiya Zone in North East, Wolayita Zone in South and Tembaro Special woreda in south west, respectively.

Kembata zone is located in Central Ethiopia regional state. It is situated 305 K.M south East of Addis Ababa. Based on the 2010 Census conducted by the Central Statistical Agency of Ethiopia (CSA), this Zone has a total population of 1,304,235, of whom 712,543 are men and 591,692 are women.The Kembata people live an active life based on agriculture, involving a complex system of crop rotation and transplanting. Enset (*Enset ventricosum)* is their main staple crop, but other cash crops are grown, which include coffee, chat and Ginjer. Animal husbandry is practiced, but mainly for milk supply and manure.

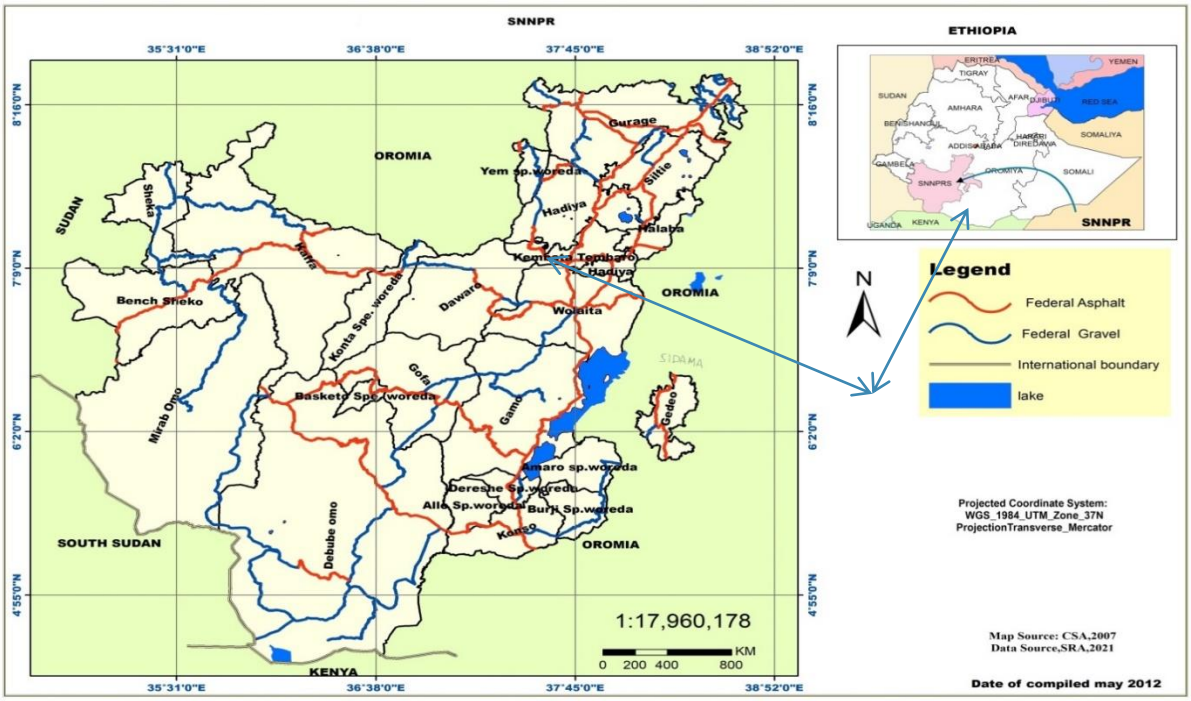

Figure 1. Map of the study area.

3.1.1 Agro-Ecology

Kedida Woreda is an area of great physiographic diversity. The altitude of the area is between 2000-2700 meters above sea level which can be categorized as Dega and WoyinaDega climate. This wide area is found in the south west and eastern parts of the woreda. The high lands (over 2500 meters above sea level) are found in Southern, central and Western and some of the highlands of Kambeta Zone with an altitude over 2700 meters above sea level is the known mountain is Ambaricho Mountain.

3.1.2 Economic Activity

Over the last three decades, the total area covered with the Enset (*Enset ventricosum)* crop has grown from 65,000 ha (Stanley, l965) to about 300,000 ha (CSO, 2009/2010). The Southern and Oromia Regions produce close to 80% of the crop. The kocho and bulla yield of Enset (*Enset ventricosum)* clones seem to vary considerably. Traditional farming system is the most common economic activities and some of the people engaged in trade activities in the woreda. Limited number of populations engaged on rearing of livestock, but most of the population are depending on traditional farming system and the rest population were depending on trade activities. Crop production and animal rearing are the most important source of food and income to lead their livelihoods in the zone. Cereal Crops (like Maize, Teff, Wheat, and Barley), Pulses (like Haricot Bean, and Peas), Root crops (like Cassava, Sweet Potato, Potato, Boyina), Enset (*Enset ventricosum)*, and Coffee, as well as rearing of animals (like cattle, Goat, Sheep) are some of the major crops and animals produced in the woreda and are the major source of income and food. Enset and maize are the staple food in most parts of the woreda and coffee and chat are the most important cash crops in the areas.

3.1.3 Natural Resources

The woreda enrich in natural resources like man-made and natural forests. The forest includesbahirZaf, Tsid, Zigiba, Wanza, Sholla, Koricha,Kosso,Girari and so on.It is play a vital role of ecology, soil conservation, wild life and soon, but this forest is being degraded because of expanding farm land. The contribution of those natural resources to the existing population as well as to the future generation is very huge if they are used wisely and properly.

There are also plants and vegetations like Enset [*Enset ventricosum]*, Banana, Godare, Boyina, and Ayina.Enset is one of a perennial herbaceous and monocarpic root crop with long broad

leaves. It is widely cultivated in the study area. The society have used Ensetas a staple food.They are used mostly for human food, for animal feed and for manufacturing starch.

3.2. Research Methodology

3.2.1 Study approach

In this study the researcher used quantitative data through questionnaire, and the qualitative data through semi-structured interview (.Kothari (2004). It is a method of securing information concerning an existing phenomenon from all or selected number of household who are included in sampling to give information on Enset root mealy-bug(***Cataenococcus enset***), while semi structure interview facilitates to have or to get in-depth data on Enset root mealy-bugs(***Cataenococcus enset***). In line with this, the qualitative approach will incorporate in the study to validate and triangulate the quantitative data. Therefore, the researcher will use mixed approach methods to conduct this study.

3.2.2. Study survey

In this study descriptive research survey was employed. Because the major goal of this study was to identified the effects of the Enset root mealy-bug(***Cataenococcus enset***) at the farmers and economic level at present and it is also relevant to gather detailed information concerning current status of the challenges.

3.3. Data Gathering Instruments

The current researcher used Primary data in this study. The primary data was collected through close-ended questionnaire and semi-structured interview. It is stated as follows:

3.3.1. Interview

The essential information on production of Enset (*Enset ventricosum)*, how Enset would be cultivated, intercropped, used and prevented from root mealy-bugs are systematically interviewed. The local perspectives on dominant crops production, root mealy-bugs, and soil type of the study area was identified through personal feeling and discussion with local experts. This data gathering instrument is the most important, especially; the researcher selected to use this instrument to crosscheck the responses of the farmers or subjects from the questionnaire by conducting their practices during cropping Enset and bacterial wilt ,enset root mealybug(***Cataenococcus enset***) ,nematode and fungi.

3.3.2. Questionnaire

Close-ended questionnaires was used to gather information on local name of the crop and root mealy-bugs, time of cultivation and harvesting, traditional management practices, cropping system, uses and market value of the crop, root mealy-bug which affect production rate of Enset (*Enset ventricosum)*, disease, pest and have short maturity time, planting material exchange system and production constraints and perception of the farmers towards the crop. The respondents were asked to put only a tick (√) in the column of their choice or that represents their perceptions the rating scales. The rating scales range from one up to five (strongly agree up to strongly disagree) where 1 = strongly agree, 2 = agree, 3 = not decided, 4 = disagree and 5 = strongly disagree. A quantitative research methodology is used to complement and confirm findings of the qualitative interview. The utilization of a range of data sources in such a study is a means of data triangulation (Patton, 2002).

3.4. Sampling Techniques and Size Determination

A three stage sampling procedures were used to select sample size for this study. In the first stage, Kedida Woreda is purposively selected from eight (8) administrative Woredas of Kembata Zone as it is a dominant Enset producer of the zone. In second stage, from the total of 14 kebeles, 6 kebeles were also selected purposively. In the third stage, a total of 400 representative households were selected using purposively sampled. From this population 100 respondents were included through lottery method to collect questionnaire data.

3.5. Method of Data Analysis

Descriptive statistics was used to analyze data obtained through questionnaire and field observation. The data was analyzed by entering in to SPSS and excel spread sheet and summarized by calculating means, standard deviations, and ranges. Descriptive statistics such as frequency, percentage, mean, cross tabulation and standard deviation were used to determine impact of Enset root mealy-bugs(***Cataenococcus enset***).

The qualitative analysis was done as follows. First, organizing and noting down of the different categories were made to assess what types of themes may come through the instruments to collect data with reference to the research questions. Then, transcribing and coding the data to make the analysis easy. Also the result is triangulated with the quantitative findings.

The study was used computer software of Statistical Package for Social Science (SPSS version 20.0) for analysis. For this study, a five percent (0.05) level is determined as the accepted level of significance for statistical analysis.

3.6. Organization of theStudy

The first chapter discussed about introduction, statement of the problem and objectives of the study. The second chapter focuses on the literature reviews. Chapter three describes the study area description, methods and materials used for the study, chapter four discussed about data analysis and discussions, chapter five focused on conclusions and recommendations. Finally, list of reference materials used for conducting the study and questionnaire questions and interview questions wereannexed at the end.

3.7. Ethical Considerations

In the light of the confidentiality nature of the information obtained in this research, and the possible legal consequences of any gap of confidentiality should be assured to maintain a high professional standard. The researcher gave Consideration for the ethical considerations

CHAPTER FOUR

RESULT AND DISCUSSION

4. Result and discussion

4.1 Demographic characteristics of the Respondents

This aspect of the analysis deals with the basic data on the respondents of the interview and questionnaires provided for them. The fundamental data involved the respondents gender, and age. The table below shows the details of the respondents' demographic data.

The above table shows us the total number of respondents were 100 in number. Some of thspondents were resigned themselves to answer interview and questionnaire. the researcher distributed for selected respondents from each kebele's. Finally, more than 80% of respondents filled and returned the questionnaire properly.

Table 1. Demographic characteristics of the respondents

Parameter		frequency	percentage	Cumulative percentage
Zato kebeles	Male	11	68.75	69
	Female	5	31.25	31
	Total	16	100	100
Fulasa Kebele	Male	11	64.70	65
	Female	6	35.30	35
	Total	17	100	100
Lalo kebeles	Male	11	64.70	65
	Female	6	35.30	35
	Total	17	100	100
Kasha kebele	Male	11	64.70	65

	Female	6	35.30	35
	Total	17	100	100
Ambaricho Zuria Kebele	Male	11	64.70	65
	Female	6	35.30	35
	Total	17	100	100
Zararo kebeles	Male	12	75	75
	Female	4	25	25
	Total	16	100	100

Table 2 distribution of respondents by gender composition reveals that both male and female respondents were involved in this study, from the total of 100 (one hundred) population 67 (67%) respondents were male and the rest 33 (33%) respondents were females. This might indicate most male farmers involved in Enset cropping activities rather than females. If females involve in cropping Enset it is better perform in the society. Therefore, we should give more chance to females to produce and manage Enset crop in order to produce more.

Table.2. Gender distribution of Respondents

Gender		Frequency	Percent	Valid percent	Cumulative percent
Valid	Male	67	67	67	67
	Female	33	33	33	33
	Total	100	100	100	100

4.2. The result and discussionof selected farmer's Interview

The researcher used semi-structured interview to collect data from the study area according methodology part of the study. Accordingly, a total of six interviewee were selected from each kebeles. As a result the researcher involved one interviewee from each kebeles.

For the sake of clarity and convenience the researcher gave the following codes to the respondents of the interview:

- Res.ZK.1 = Respondent of Zato Kebele one
- Res.FK.1= Respondent of Fulassa Kebele one
- Res.LK.1= Respondent of Lalo Kebele one
- Res.KK.1 = Respondent of Kasha Kebele one
- Res.AmZk.1 = Respondent of Ambaricho Zuria Kebele one
- Res.Zrk.1= Respondent of Zararo Kebele one

4.2.1. Enset root mealy- bug

Five of the respondent's responded that they knew Enset root mealy-bug during cropping Enset plant in their gardens. Their understanding regarding to Enset root mealy-bugs was good. However, Res.ZK.1 respondent said that he did not know about Enset root mealy-bugs(***Cataenococcus enset***) at all. Therefore, most of respondents had enough understanding towards enset root mealy-bug.

Moreover as the respondent's information indicated that many farmers had information about Enset root mealy-bug in study area, so we can perceive selected area had good experience to prevent Enset root mealy-bug

4.2.2. . Effect of Enset root mealy-bugs(*Cataenococcus enset*) on production and consumption of fibber

Fourout of six respondents responded that mealy-bug had direct negative effect on production and consumption of fibber .In order to maximize the production of food and fibbers the farmer should keep Enset crop from different pests.

4.2. 3. Causes of Enset root mealy-bugs(*Cataenococcus enset*)

Five out of six said that they encountered some leading reasons for infection of Enset crop. These mean using shared sharp metals during cropping, cutting leaf and stem for animal feeding and using man made fertilizers and the like. However, the Res.Fk1 responded that he did not identify the causes of Enset root mealy-bug. Therefore, it is possible to conclude most respondents could differentiate the causes of Enset root mealy-bugs. It is recommended to avoid using shared materials, animal beat, artificial fertilizers and the like.

4.2. 4. Production of Enset in study area

Four out of six responded that the Enset plant widely produced and used crop in the society. The society used Enset as a main food for humans and animals. As a result they produced widely as compared to other crops. Nonetheless the Res.Zrk1 and FK1 respondents said that the production ofEnset plant in the area were declined due to some factors like more population, replacing cash crop (cooffe, chat, ginger etc.) and insect and insect disease infection problem.

Therefore, from these respondents' opinion we can understand that the production of Enset was unquestionable because the society had not enough land plot to produce some other plant. The farmers can produce much more Enset plant in small land plot comparing with others.

4.2.5. Threats of Enset (*Enset ventricosum)* variation farm land

Almost allrespondents responded that there were some hitting threats like harsh weather condition, pest outbreak, over population and size of land. These threats made great pressure on farmer economy. Therefore, the farmers should search solution to overcome these threats.

Thus from these respondents opinion we can judge that the study area affected by weather condition, pests, and lack of enough land plot. The farmers should use some strategies to minimize these threats.

4.2. 6. Kind of pests and diseases that affect Enset (*Enset ventricosum)* Plant

Almost all respondents responded that the Enset root mealy-bug(***Cataenococcus enset***) was very serious pests which affect both on the roots and corms of the Enset plants. This pest widely affectEnset root and corn. Then the Enset (*Enset ventricosum)* growth and production rate were under question.

Some studies conducted on the Musasp. Root system indicated that the number of cord roots (i.e. adventitious roots) varied considerably upon the health status of the plant (Summerville, 1944; Robin and Champion, 1962; Beugnon andMeans followed by the same letter within a column are not significantly different according to x test at 5% probability level.

4.2.7. Common methods to protect Enset root mealy-bug(*Cataenococcus enset*)

Five out of six respondents responded that they used some common methods to prevent Enset root mealy-bugs(***Cataenococcus enset***). These were: clean planting material, extension, affordable management, isolation, sanitation and ant control, farmyard manure, hot water treatment, and cultivation. However, Res.LK1 forwarded his opinion differently as his idea he did not have any experience to prevent Enset from any pest.

Therefore, from these respondents response we can understand that the farmers could use different strategies to manage Enset root mealy-bug(***Cataenococcus enset***) except limited number of farmers. It is necessary to give awareness to farmers to use different mechanisms of protecting Enset root mealy bug(***Cataenococcus enset***)

4.2.8.Kinds of fertilizers

Almost all respondents responded that Use farmyard manure and ash was also considered as one of management options of Enset root mealybug(***Cataenococcus enset***). Farmers responded that fertile soil can improve performance of a plant and make the plant more resistant to Enset root mealybug(***Cataenococcus enset***) attack. In addition to this when there is infestation farmers usually apply fresh manure (preferably goat or sheep manure) mixed with water equal proportion with the manure around the plant. Selected area farmers used farmyard manure for centuries, most importantly improve soil fertility. Farm yard manure contributes to better plant performance through improved crop nutrition (mostly nitrogen (N), but also possibly potassium (K), and even sulphur (S). More robust plants are able to ward off pests and diseases and the manure could directly inhibit mealybug development (Azerefegne et al., 2009). Farm yard manure can also improve the soil and root health conditions. So, natural fertilizers have great power to prevent enset root mealy bug and improve the fertility and health conditions of Enset (*Enset ventricosum)* root.

4.2. 9. Limitations in the cultivation and utilization of Enset (*Enset ventricosum)*

Five out of six respondents responded that diseases can cause and the lack of knowledge about or implementation of protective strategies contribute to the severity of Enset (*Enset ventricosum)* plant diseases. Diseases are caused by several bacteria, fungi, and viruses. However Res.LK1 said that constraints which affect Enset (*Enset ventricosum)* cultivation

were production area problem, using shared sharp material, and animal attack. Therefore, these constraints had direct impact on utilization Enset as a food and medical purpose.

Individual plant infection and loss is common but 'hot spot' losses can amount to half of the harvestable plants. Pathologists and extensions recommend uprooting and burying of diseased plants as well as fire sterilization of knives, machetes and tools (Awol Zeberga et. al., 2014).

Enset is attacked by numerous diseases in addition to bacterial wilt. They include Enset (*Enset ventricosum)* corm rot, Enset sheath rot and Enset dead heart leaf rot, caused by an unknown bacterial pathogen and fungus, respectively, as well as root-knot, lesions, nematodes, and virus diseases. The most important factors responsible for spreading disease of bacterial wilt include disease-infected planting material, contaminated farming and processing tools, and human and animal vectors. (Daniel Ashagrie, 1969).

4.2.10. Importance of the Enset crop

All respondents responded that the Enset is main food crop for most people and animals. It provides year round food, fiber, animal feed and medicine. The major foods obtained from Enset are Kocho, bulla and Amicho. Kocho is the substance of the fermented starch obtained from the mixture of the decorticated (scraped) leaf sheaths and grated corm (underground stem base). Kocho can be stored for long periods of time without spoiling. The quality of Kocho depends on the age of the harvested Enset (*Enset ventricosum)* plant, the type of variety, and the harvesting season. Kocho prepared as fermented Enset (*Enset ventricosum)* bread has also become extremely popular at restaurants that serve the Ethiopian delicacy of kitfo (raw ground beef mixed with butter and spices). The combination of Kocho and kitfo is now virtually required at restaurants (Zerihun Yemataw et al., 2014).

Particular Enset (*Enset ventricosum)* plants are used medicinally for both humans and livestock to cure bone fractures, broken bones, childbirth problems (i.e., assisting to discharge the placenta), diarrhea, and birth control (Brandt et al., 1997).

4.3. Questionnaire Result and discussion

Figure 1 respondent's data analysis shows that 65.3% of respondents agree and 15.8% of the respondents strongly agreed with the statement of 'Enset root mealy- bugs makes loss of production. However, 2. % of respondents undecided with the given idea. Moreover 8.9% of

respondents were disagree and 6.9% of respondent were strongly disagreed with the given statement. This implied that the most respondents agree and strongly agree on the given statement. The questionnaire data agreed with interview result. . Therefore, farmers be awarded on negative effects of Enset root mealy bug to improve production of Enset.

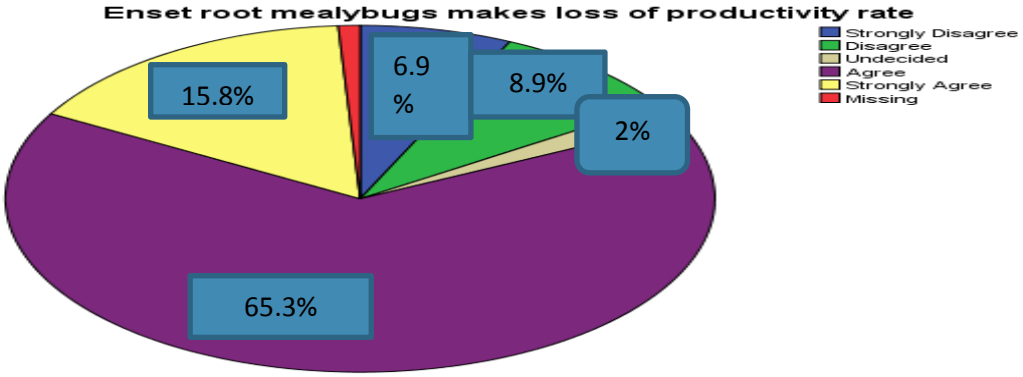

Figure 1.**Enset root mealybugs(*Cataenococcus enset*) production loss**

Table 3 that 58.4% of respondents agreed and 16.8% of the respondents strongly agreed with the statement of 'Enset root mealy- bugs creates great economic pressure on farmer life. However, 12.9 % of respondents disagreed with the given idea. Moreover,10.9% of respondents strongly disagreed with the given statement. This implied that the most respondents were agreed and strongly agreed on the given statement. In addition to the data collected from respondents through interview result showed that the respondents understand Enset root mealy-bugs(***Cataenococcus enset***)creates great economic pressure on farmer life.

Table 3:Enset root mealy-bugs[*Cataenococcus enset*] effect on farmers economy

Response		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	11	10.9	11.0	11.0
	Disagree	13	12.9	13.0	24.0
	Agree	59	58.4	59.0	83.0
	Strongly Agree	17	16.8	17.0	100.0
	Total	100	99.0	100.0	
Missing	System	1	1.0		
Total		101	100.0		

Table 4 shows that 37.6% of respondents agreed and 23.8% of the respondents strongly agreed with the statement of 'Enset root mealy- bugs(*Cataenococcus enset*) minimizes consumption and production of fibbers. However, 18.8 % of respondents disagreed with the given idea. Moreover 10.9% of respondents strongly disagreed with the given statement. This implied that more than half of respondents agreed and strongly agreed on the given statement. In addition to the data collected from respondents through interview result showed that the respondents understand Enset root mealy-bugs minimizes consumption and production of fibbers. Here below the table, the data were analysed as follow

Table 4:Enset Root mealy-bugs (*Cataenococcus enset*)minimize consumption and production of fibbers

Response		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	11	10.9	11.0	11.0
	Disagree	19	18.8	19.0	30.0
	Undecided	8	7.9	8.0	38.0
	Agree	38	37.6	38.0	76.0
	Strongly Agree	24	23.8	24.0	100.0
	Total	100	99.0	100.0	
Missing	System	1	1.0		
Total		101	100.0		

Figure2. 43.6% of respondents responded root mealybug directly affect consumption of the society and 18.8% of the respondents strongly agreed with the statement of 'Enset root mealy- bugs(***Cataenococcus enset***) shift feeding culture of the society. However, 17.8 % of respondents dis agreed and 10.9% of respondents were strongly disagreed with the given idea. Moreover 7.9% of respondents were undecided with the given statement. This implied that more than half of respondents were agreed and strongly agreed on the given statement. In addition to the data collected from respondents through interview result showed that the respondents understand Enset root mealy-bugs(***Cataenococcus enset***) minimizes consumption and production of fibbers. This is because of population growth and shortage of land which lead them to food shortage and they forced to grow short season crop instead of Enset (*Enset ventricosum)*. This agrees with recent reports on the vulnerability of agricultural systems and agro-biodiversity in Southern Ethiopia by (Tenaye Abebe, 2009)

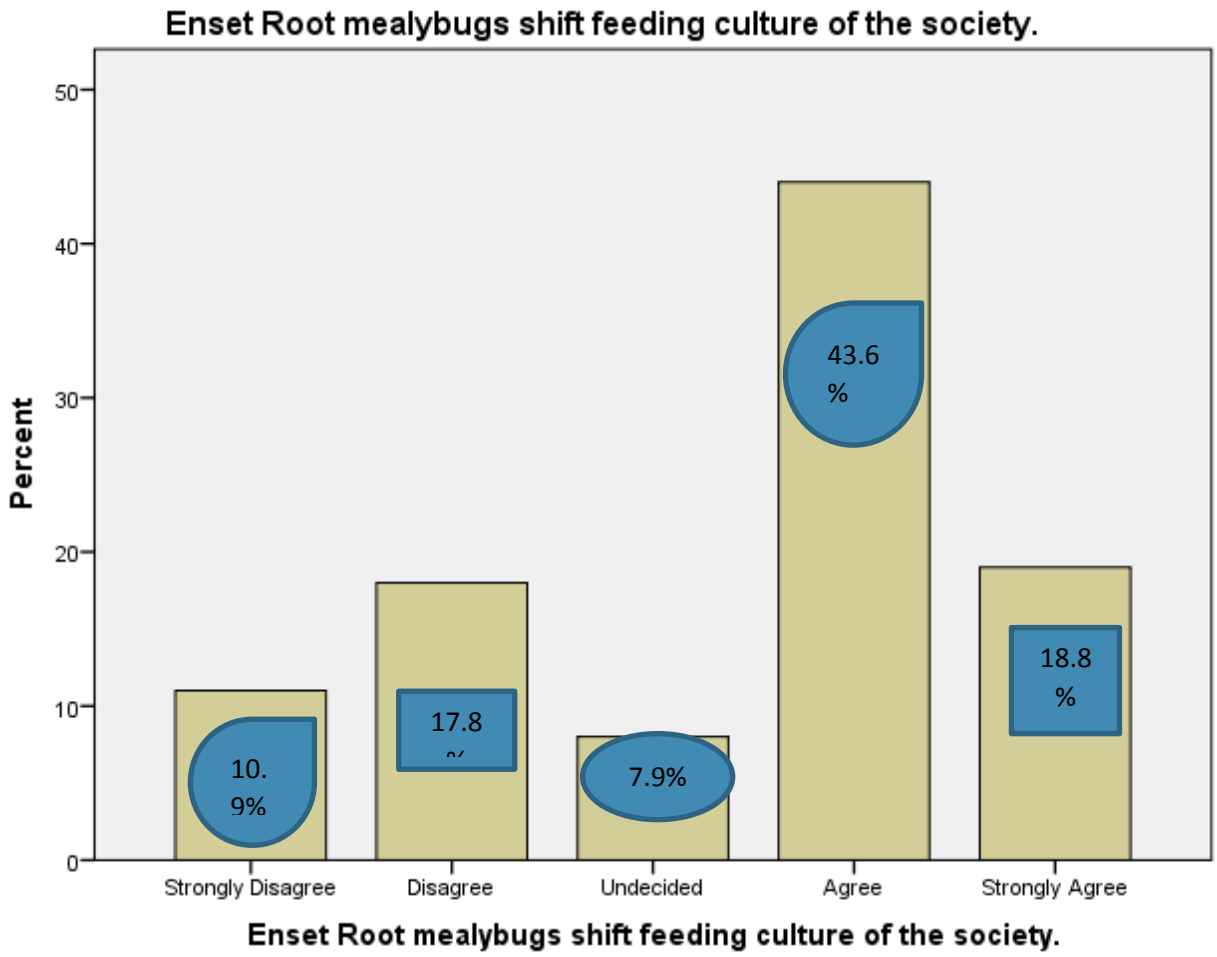

Figure 2: Enset root mealybugs shift feeding culture of the society

Figure 3 55% of respondents responded Enset root mealybug(***Cataenococcus enset***) directly affect medical uses of Enset (*Enset ventricosum)* and 21% of the respondents strongly agreed with the statement of 'Enset root mealy- bugs reduce medical utilization of Enset. However, 13 % of respondents responded that they did not support the idea of Enset root mealybugs reduce medical usage and 5% of respondents e strongly disagreed with the given idea. Moreover 6% of respondents were undecided with the given statement. This implied that more than half of respondents were agreed and strongly agreed on the given statement.

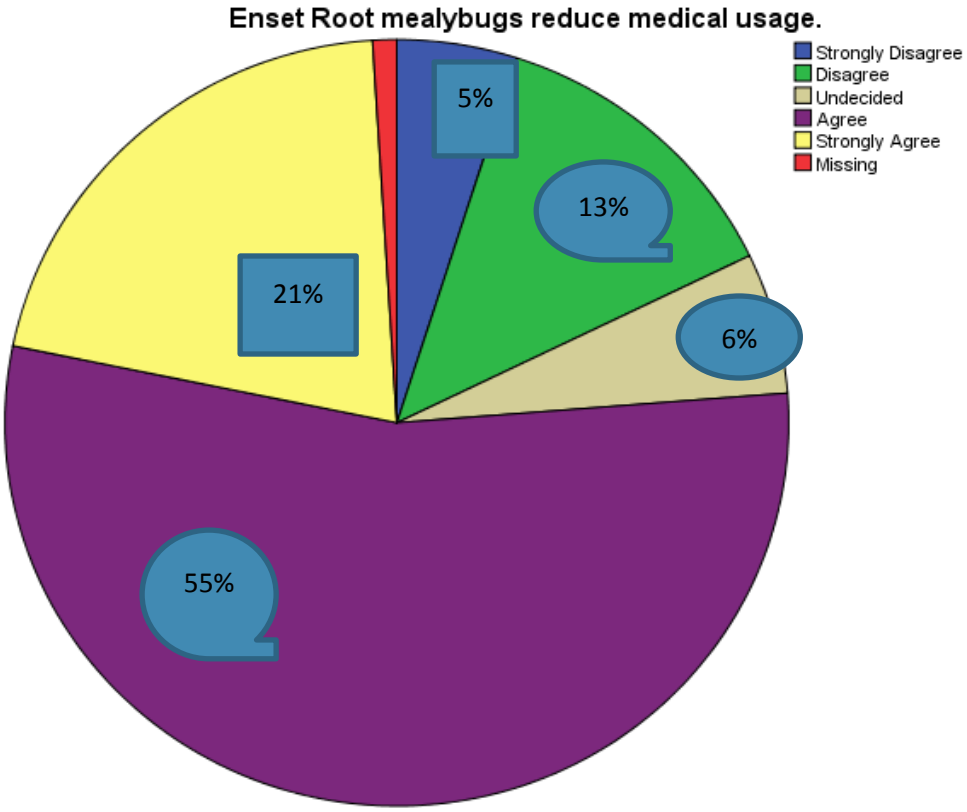

Figure 3: Enset Root Mealy-bugs(*Cataenococcus enset*) reduce medical usage

Figure4. 47% of respondents responded that they often used traditional and modern prevention techniques of Enset root mealybug(***Cataenococcus enset***) and 17% of the respondents reported that they used traditional and modern prevention methods of Enset root mealy-bugs very often. In addition to 17% of respondents responded that they sometimes used traditional and modern prevention of the Enset root mealy-bug(***Cataenococcus enset***). However, 9 % of respondents responded that they rarely used traditional and modern prevention methods of the Enset root mealybugs(***Cataenococcus enset***) and 10% of respondents reported that they never used traditional and modern prevention methods of the Enset root mealy-bugs. This implied that more than half of respondents had experience on traditional and modern prevention methods of the Enset root mealy-bugs(***Cataenococcus enset***). Thus more farmers have experiences to use mixed techniques of prevention of the enset root mealy bug. This is advisable to control ensat root mealy bug(***Cataenococcus enset***).

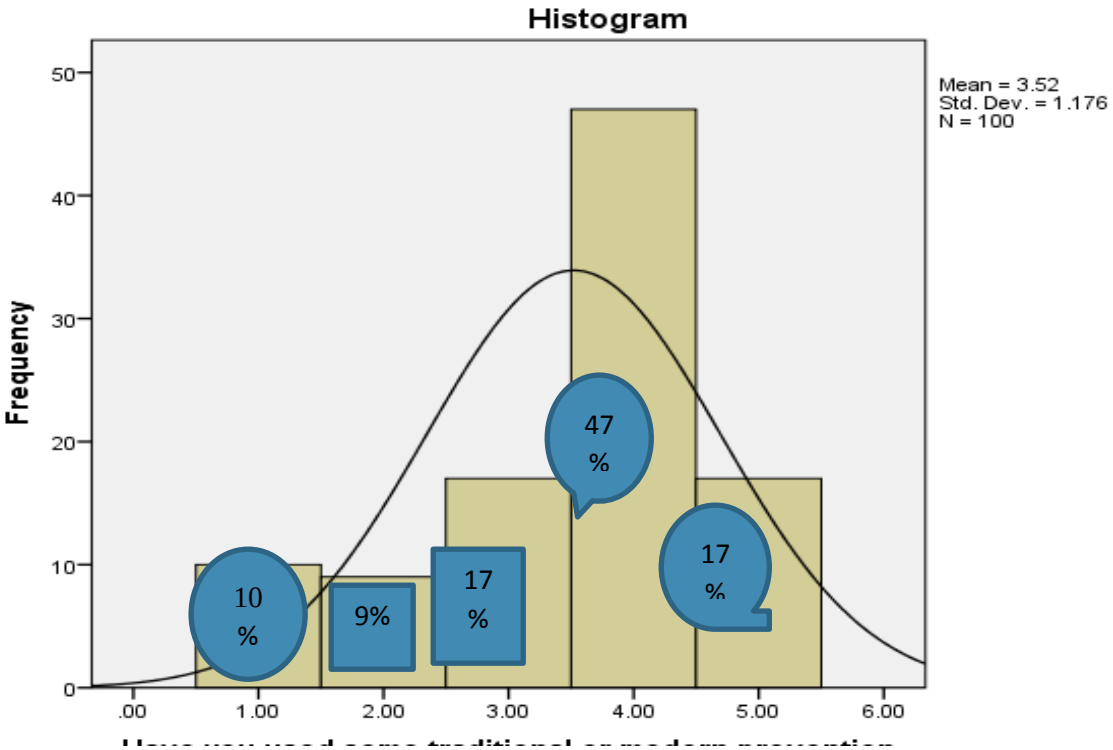

Figure 4: Some traditional and modern prevention methods of Enset root mealy-bugs(*Cataenococcus enset*)

Table 5. 42% of respondents responded that they often used fertilizers like compost and fresh manure to crop Enset and 24% of the respondents reported that they applied fertilizers to produce Enset (*Enset ventricosum)*. In addition to 4% of respondents responded that they sometimes used fertilizers to produce Enset. However, 20% of respondents responded that they rarely used fertilizer to crop Enset and 10% of respondents reported that they never used fertilizers to crop Enset (*Enset ventricosum)*. This implied that the most respondents used fertilizer to harvest Enset (*Enset ventricosum)*. Therefore, it is recommendable to use fertilizers to maximize production rate Enset (*Enset ventricosum)* crops.

Table 5: Application of fertilizer

Response		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	10	9.9	10.0	10.0
	Rarely	20	19.8	20.0	30.0
	Sometimes	4	4.0	4.0	34.0
	Often	42	41.6	42.0	76.0
	Very often	24	23.8	24.0	100.0
	Total	100	99.0	100.0	
Missing	System	1	1.0		
Total		101	100.0		

Figure 5. 62% of respondents responded that they often used chemical treatment to control Enset root mealy-bugs and 17% of the respondents reported that they applied chemical treatment to control Enset root mealy-bugs very often. In addition to 7% of respondents responded that they sometimes used chemical treatment to control Enset root mealy-bugs. However, 10% of respondents responded that they rarely used chemical treatment to protect Enset root mealy-bugs and 4% of respondents reported that they never used chemical treatment to protect Enset root mealy-bugs.From this data analysis we understood that the most respondents used chemical treatment to prevent Enset root mealy bugs.

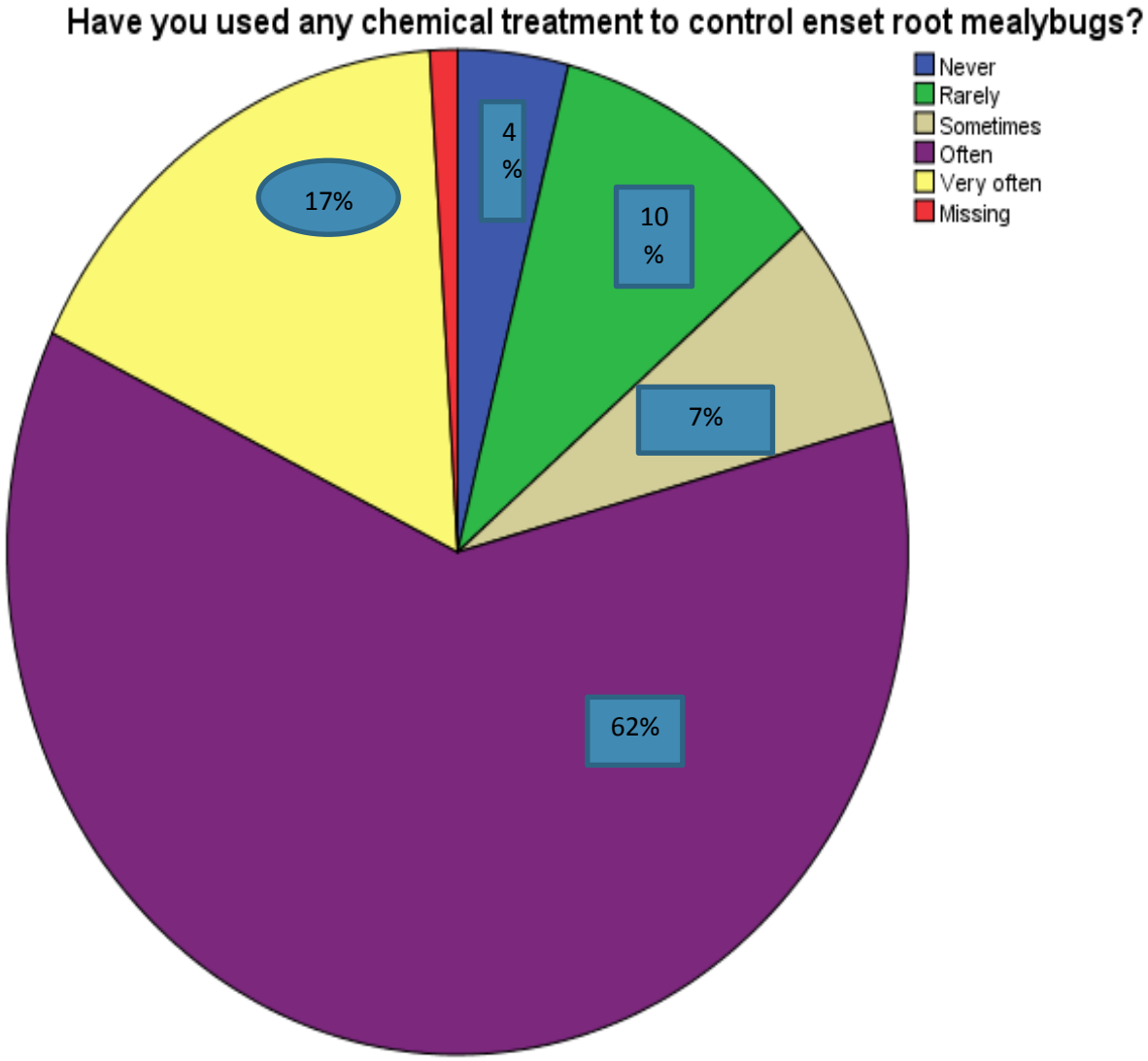

Figure 5: Chemical treatment to control Enset root mealy-bugs(*Cataenococcus enset*)

. Table 6 . 52% of respondents responded that they often used separate sharp material during Enset cropping to reduce mealy-bugs and 11% of the respondents reported that they used very often separate sharp materials during Enset harvesting to control Enset root mealy-bugs(***Cataenococcus enset***). However, 29% of respondents responded that they rarely used separate sharp materials during enset cropping and 8% of respondents reported that they never used separate sharp material during harvesting of Enset (*Enset ventricosum)*. From this Table 6 data analysis we understood that the most respondents used separate materials during harvesting of Enset (*Enset ventricosum)* crop.

Table 6:Usage of separate sharp materials during harvesting

Response		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	8	7.9	8.0	8.0
	Rarely	29	28.7	29.0	37.0
	Often	52	51.5	52.0	89.0
	Very often	11	10.9	11.0	100.0
	Total	100	99.0	100.0	
Missing	System	1	1.0		
Total		101	100.0		

Figure 6. 56% of respondents responded that they often used hot water to control Enset root mealy-bugs(***Cataenococcus enset***) and 8% of the respondents reported that they used very often to control Enset root mealy-bugs(***Cataenococcus enset***).In addition to 8% of respondents responded that they sometimes used hot water to control Enset root mealy-bugs. However, 16% of respondents responded that they rarely used hot water to protect Enset root mealy-bugs and 12% of respondents reported that they never used hot water to protect Enset root mealy-bugs. From this data analysis we understood that the most respondents used hot water to prevent Enset root mealy bugs. Therefore, using hot water was one of the methods to protect Enset root mealybugs. As interview data result implied that the most farmers were used it.

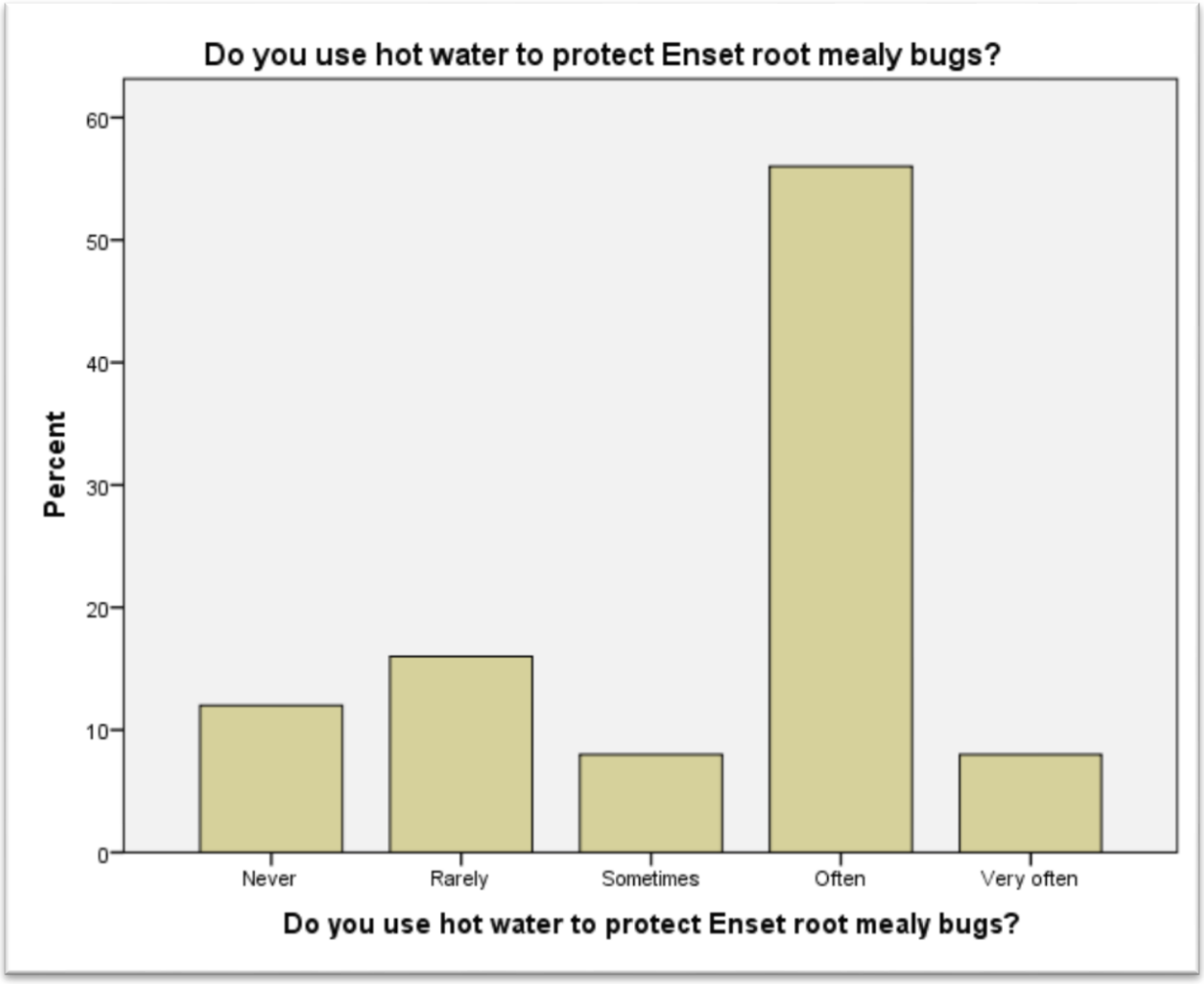

Figure 6 Use of Hot Water to Protect Enset Root Mealy-bugs

Table 7. 55% of respondents reported that they agreed on the statement of the 'Enset used as a staple food for human and animal' and 16% of the respondents reported that they strongly agreed on the given idea. However, 24% of respondents responded that they disagreed on the statement of the 'Enset (*Enset ventricosum)* used as a staple food for human and animal and 5% of respondents reported that they strongly disagreed on the given idea. From this data analysis we understood that the most respondents agreed on the given statement. Therefore, Enset (*Enset ventricosum)* plant used as a staple food for human and animal. As interview data result implied that the most society used as staple food.

Table 7: Enset (*Enset ventricosum)* used as a staple food for human and animal

Response		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	5	5.0	5.0	5.0
	Disagree	24	23.8	24.0	29.0
	Agree	55	54.5	55.0	84.0
	Strongly Agree	16	15.8	16.0	100.0
	Total	100	99.0	100.0	
Missing	System	1	1.0		
Total		101	100.0		

Figure 7. 58% of respondents reported that they agreed on the statement of the 'Enset (*Enset ventricosum)* used as a medical purposes and 10% of the respondents reported that they strongly agreed on the given idea. In addition to 10% of respondents responded that they undecided on the given statement. However, 19% of respondents responded that they disagreed on the statement of the 'Enset (*Enset ventricosum)* used as a medical purposes and 3% of respondents reported that they strongly disagreed on the given idea. From this data analysis we understood that the most respondents agreed on the given statement. Therefore, Enset (*Enset ventricosum)* plant used as a medical purposes. As interview data result implied that the most society used as a medical purposes. On this study, the different Enset (*Enset ventricosum)* parts corm, pseudostem, and leaf were used for medicinal purpose for human and livestock. As a report of farmers there were no recommended dosage known, one can use (ate) until he/she/it become cure from the disease. Particular clones and parts

of Enset (*Enset ventricosum)* plants are used medicinally for both humans and livestock to cure bone fractures, broken bones, child birth problems (i.e., assisting to discharge the placenta), diarrhoea, and birth control (Brandt et al., 1997).

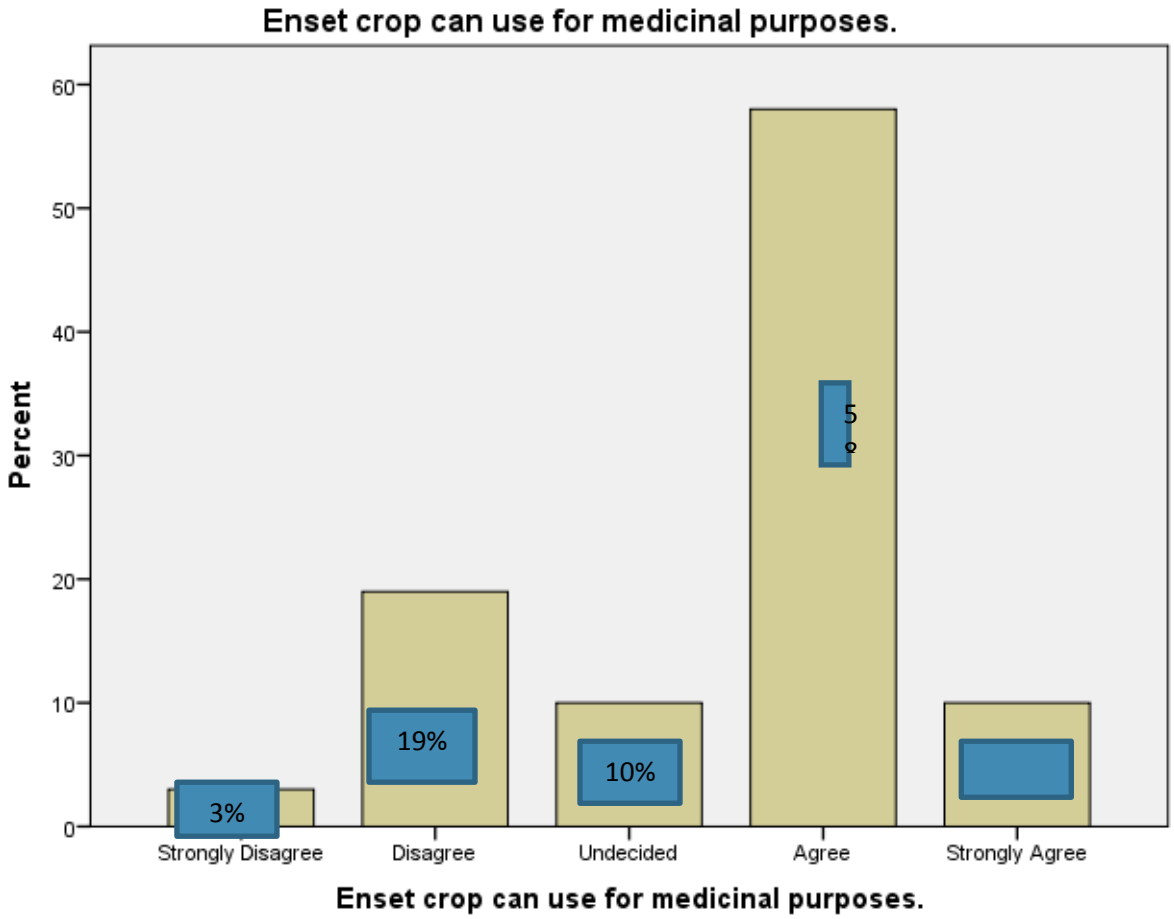

Figure 7: Enset (*Enset ventricosum)* crop can use for medical purposes

Figure 8. 52% of respondents reported that they agreed on the statement of the 'Enset [*Enset ventricosum]* is used for fibber production and 17% of the respondents reported that they strongly agreed on the given idea. However, 25% of respondents responded that they disagreed on the statement of the 'Enset [*Enset ventricosum]* is used for fibber production and 6% of respondents reported that they strongly disagreed on the given idea. From this data

analysis we understood that the most respondents agreed on the given statement. Therefore, Enset [*Enset ventricosum]* plant used for fibber production. . The fibber used for house construction and material construction. On this study almost all farmers of study area were not producingEnset for income generation they sell if they have enough product only. Enset was not produced purposively for fibber. Fibber and leaves for material and house construction were the by-products of Enset. This study goes hand in hand with Abraham Shumbolo et al. (2012).

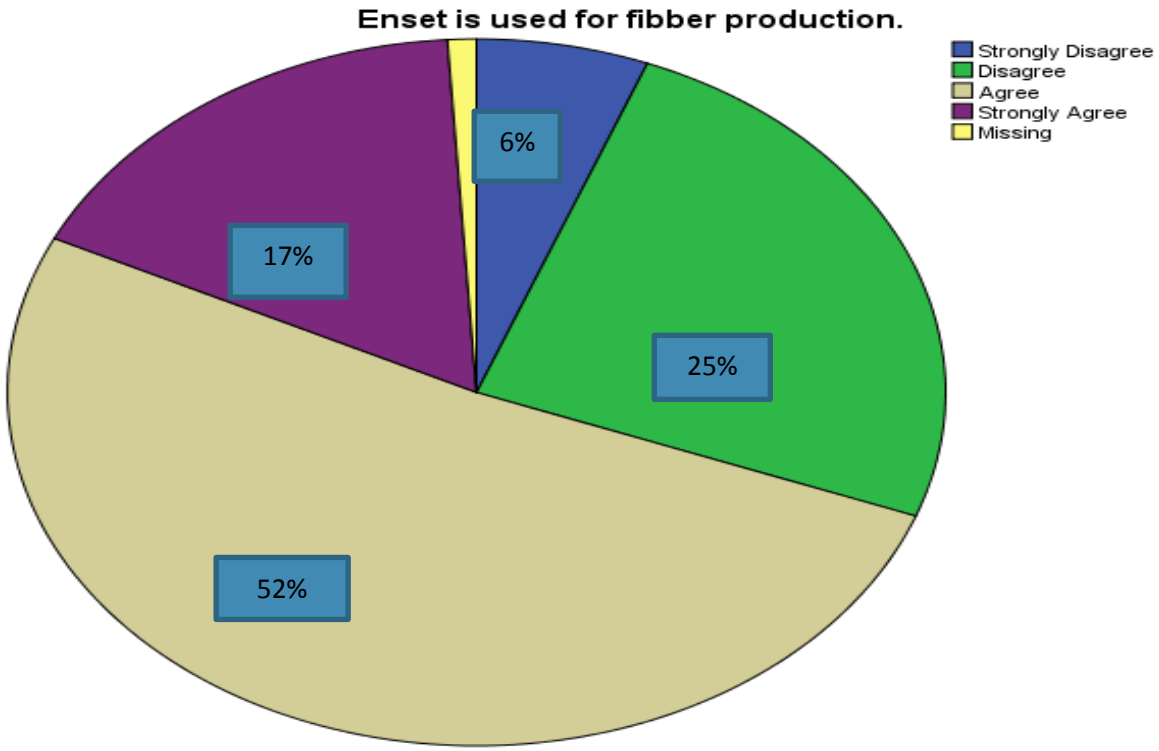

Figure 8:Enset (*Enset ventricosum)* **is used for fibber production**

Table 8 . 46% of respondents reported that they agreed on the statement of the 'Enset is used for different purposes and 18% of the respondents reported that they strongly agreed on the idea. However, 20% of respondents responded that they disagreed on the statement of the 'Enset (*Enset ventricosum)* is used for different purposes and 8% of respondents reported that they strongly disagreed on the idea. From this data analysis we can understand that the most

respondents agreed on the given statement. Therefore, Enset [*Enset ventricosum]* plant used for different purposes. As the data result implied that the most society used enset for different purposes. Enset (*Enset ventricosum)* provides fibber as a by-product of decorticating the leaves sheaths. Enset (*Enset ventricosum)* fibber has excellent structure, and its strength is equivalent to the fibber of abaca, a world-class fibber crop. About 600 tons of Enset (*Enset ventricosum)* fibbers per year are sent to factories. In rural areas the fibber is used to make sacks, bags, ropes, cordage, mats, construction materials (such as tying materials that can be used in place of nails), and sieves. (Zerihun Yemataw et al., 2014).

Table 8:Enset (*Enset ventricosum)* **is use for Different Purposes**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	8	7.9	8.0	8.0
	Disagree	20	19.8	20.0	28.0
	Undecided	8	7.9	8.0	36.0
	Agree	46	45.5	46.0	82.0
	Strongly Agree	18	17.8	18.0	100.0
	Total	100	99.0	100.0	
Missing	System	1	1.0		
Total		101	100.0		

Figure 9 . 47% of respondents reported that they agreed on the statement of the ‘Enset (*Enset ventricosum)* is used to prevent drought and 18% of the respondents reported that they strongly agreed on the given idea. In addition to 3% of respondent responded that they

undecided on the idea. However, 24% of respondents responded that they disagreed on the statement of the 'Enset (*Enset ventricosum)* is used to prevent drought and 8% of respondents reported that they strongly disagreed on the idea. From this data analysis we understood that the most respondents agreed on the given statement. Therefore, Enset (*Enset ventricosum)* plant used to prevent drought. That means the Enset (*Enset ventricosum)* plant can survive drought and the people use it as a staple food in such season.

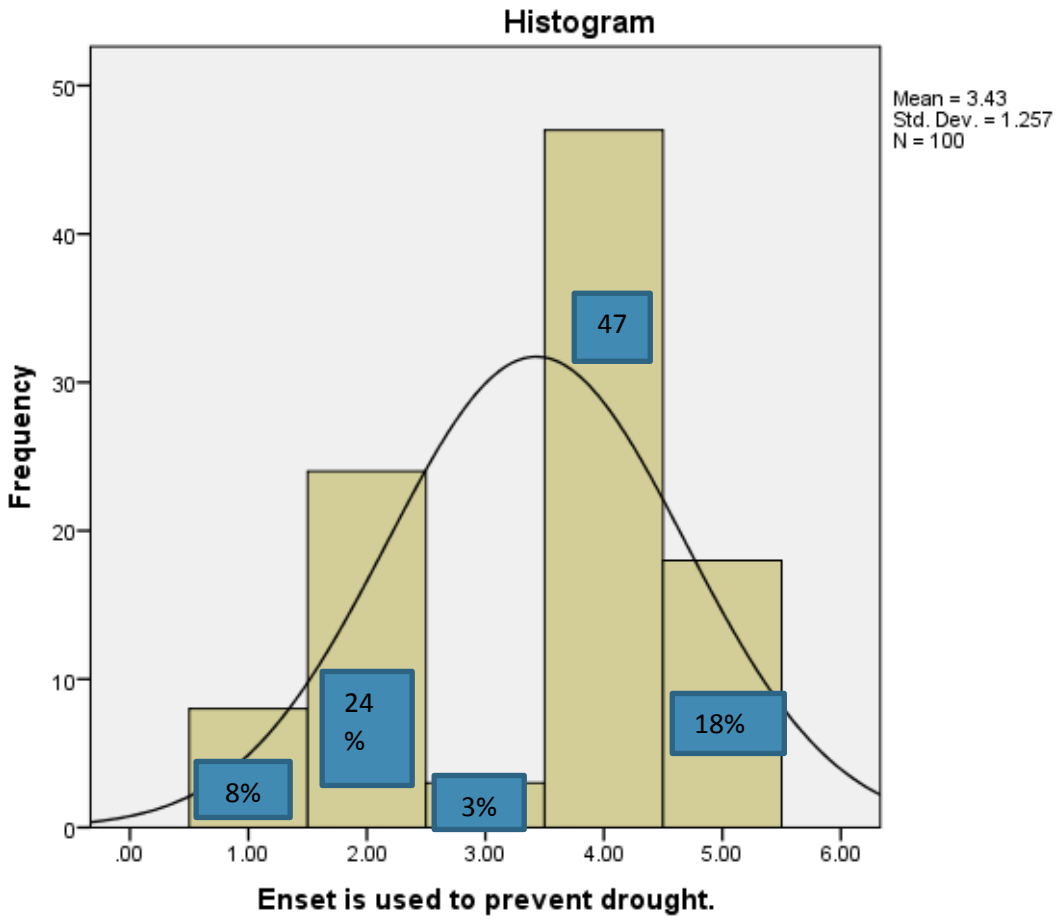

Figure 9:Enset (*Enset ventricosum)* **is used to prevent Drought**

CHAPTER FIVE

5. CONCLUTION AND RECOMMENDATION

5.1. CONCLUSION

Six kebeles were identified from all areas to conduct this study. Enset root mealy-bug(***Cataenococcus enset***)had effects on socio-economic of communities many. All of farmer had been using these Enset (*Enset ventricosum)* primarily as source of food, which is followed by animal feed, medicine, and fibber, and only few of them use it as income generation.

Enset (*Enset ventricosum)* is one of the root crops, which has been used as a staple food for many Ethiopians. Despite its largest production status in the southern and south-western parts of the country, the production and productivities of enset have been challenged by different biotic and abiotic factors. Bacterial wilt disease, insect pests, nematodes and insect(termites) are the most important production constraints of Enset growing areas. Enset bacterial wilt is the major Enset disease causing stunted growth, which delays the maturity and affecting productivity and even leads up to crop loss in Ethiopia.

Also, the root mealybug is a major insect pest that affects the Enset growth and yield especially in the southern parts of Ethiopia. However, the Enset producers are managing their farms from Enset bacterial wilt disease and enset root mealy-bug through practicing the 'integrated pest management systems' which includes planting a resistant enset (*Enset ventricosum)* genotypes, practicing the cultural pest management system, using biological control method and using the chemical controlling methods as final management options.

This study confirmed that the role that local farmers play great role on care of their Enset (*Enset ventricosum)* was somehow good. Farmers have their own planting material selection, multiplication, and management system. The result of this study was indicated that, Out of many protection methods employed to manage the Enset root mealy bug(***Cataenococcus enset***) safe cropping system was more preferable for more production and quality products.Therefore, farmers should know how to manage and produce Enset plant safely.

5.2. RECOMMENDATION

In generallybased on the above conclusions, the following recommendations are forwarded

- Promoting a better technique for controlling Enset root mealy-bug(***Cataenococcus enset***). Such as farmyard manure ,cultivation ,sanitation and ant control
- If females involve in cropping Enset it is better perform in the society. Therefore, we should give more chance to females to produce and manage Enset crop in order to produce more.
- avoid using shared materials, animal beat, artificial fertilizers and the like are important to prevent causes of enset root mealybug(***Cataenococcus enset***).
- .Expanding Enset plants because they are used medicinally for both humans and livestock to cure bone fractures, broken bones, child birth problems (i.e., assisting to discharge the placenta), diarrhoea,
- Providing extension service and training have to be given by government for local farmer.

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Appendix

Appendix A

1. Interview Questions

Addis Ababa University

Department of Biology

I. General Information

Date_____

Informant's Name_____Age_____ Sex _____

Location: Region _____Zone _____ Wereda _____ Kebele____

Altitude _____Latitude _____Longitude _____

II. **Interview for Selected farmers**

1. Do you know Enset root mealy bug(
2. ***Cataenococcus enset***)s? What is it? _____

2. Is there any effect on production and consumption of fibber due to cause of Enset root mealybugs(***Cataenococcus enset***)?

   _____

3. What are the causes of Enset root mealybugs(***Cataenococcus enset***)?

_____

4. How about productivity rate of Enset (*Enset ventricosum)* in your area?

_____

5. What are threats of Enset variety in your farm land? _____

6. what kind of pests and diseases is Enset (*Enset ventricosum*) affected in your farm land? _____

7. What are the common methods to protect Enset root mealy-bug(***Cataenococcus enset***)?

_____

8. What kind of fertilizer do you use? _____

9. Are there limitations in the cultivation and utilization of enset in your locality?_____

10. What are the importance of the enset (*Enset ventricosum)* crop in your area?

_____

Appendix B

Addis Ababa University

Department of Biology

A Questionnaire to be filled by selected Farmers

Dear Farmers,

This questionnaire is designed to collect information that will be used for my MSc research entitled "Impacts of Enset Root mealybugs(***Cataenococcus enset***)". Its purpose is to understand your perception about the impacts of Enset Root mealybugs(***Cataenococcus enset)*** your own experiences to prevent enset root mealybugs(***Cataenococcus enset)*** in your area. Hence your genuine response to the different questions counts much to the success of this project.

In the questionnaire, there is Likert scale questions divided into different themes which will describe the main impacts of the Enset Root mealybugs(***Cataenococcus enset***). Please answer each question based on the instruction provided space.

Part I: Background information

Instruction: Please mark your answer in the appropriate box

1. Sex: ☐ Female ☐ Male

2. Age: ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ Above 60

A/ Effects of the Enset root mealybugs

Instruction: Read each item and use the rating scale 1-5 to express your agreement or disagreement by putting a tick mark (√) in the table.

Key: 1= Strongly Disagree, 2= Disagree, 3= Undecided, 4= Agree, 5= Strongly Agree

No	Items	Rating				
		1	2	3	4	5
1	Enset root mealybugs makes loss of productivity rate					
2	Enset Root mealybugs(***Cataenococcus enset***)creates great economic pressure on farmers life					
3	Enset Root mealybugs(***Cataenococcus enset)*** minimize					

	consumption and production of fibbers.					
4	Enset Root mealybugs(***Cataenococcus enset)*** shift feeding culture of the society.					
5	Enset Root mealybugs(***Cataenococcus enset***) reduce medical usage.					

B/ Mechanism of preventing Enset Root mealybugs[*Cataenococcus enset*]

Instruction: Read each item and use the rating scale 1-5 to express how often you do the following by putting a tick mark (√) in the table.

Key: 1= Never 2= Rarely, 3= Sometimes, 4= Often, 5= Very Often,

No	Items	Rating				
		1	2	3	4	5
6	Have you used some traditional or modern prevention techniques of Enset root mealybugs(***Cataenococcus enset***)?					
7	Do you use fertilizers like DAP, urea, compost and fresh manure?					
8	Have you used any chemical treatment to control enset root mealybugs(***Cataenococcus enset***)?					
9	Do you use separate materials during harvesting?					
10	Do you use hot water to protect Enset root mealy bugs(***Cataenococcus enset***)?					

C/ Importance of the Enset

Instruction: Read each item and use the rating scale 1-5 to express your agreement or disagreement by putting a tick mark (√) in the table.

Key: 1= Strongly Disagree, 2= Disagree, 3= Undecided, 4= Agree, 5= Strongly Agree

No	Items	Rating				
		1	2	3	4	5
11	Enset(*Enset ventricosum)* is used as a staple food for human and animal.					
12	Enset (*Enset ventricosum)* crop can use for medicinal purposes.					
13	Enset (*Enset ventricosum)* is used for fibber production.					
14	Enset is used for different purpose.					
15	Enset (*Enset ventricosum)* is used to prevent drought.					

Thank you for your cooperation!