AGENA CONSTRUCTION AND INDUSTRIAL COLLEGE

VALUE CHAIN ANALYSIS ON ENSET IN CASE OF EDJA WOREDA

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AGENA ETHIOPIA

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II.ABSTRACT

Enset is a multipurpose crop of which every part is thoroughly utilized, cultivated as a food and fiber crop only in Ethiopia, particularly in the southern and south western parts of the country. This research was conducted with objective of exploring distribution, cultivation method and farmers' traditional management system of enset cultivars in Guraghe Zone, edja woreda, South Ethiopia. Enset, (Ensete ventricosum Welw) Chessman, plant serves as a staple food for about 20% of Ethiopian population. Processing of enset for food is based on traditional knowledge of the people and varies among different enset growing regions. The objective of the present study was, therefore, to assess and document indigenous knowledge of traditional enset processing method in one of enset growing areas of edja woreda, Guraghe Zone, south Ethiopia. The study was conducted using Participatory Research Appraisal (PRA) system. The major processing steps, including, the traditional tools used, selection of mature enset plants, preparation of fermentation pits and clearing of processing spots, pulverization and decortication, bulla extraction, gamma preparation, storage of processed biomass in the pit were described. Matured enset plants were identified by locally established maturity signs, such as, size of the central shoot, appearance of inflorescence and exposure of the corm. Traditionally, enset fermentation takes place in an earthen pit. October to early December was considered to be the appropriate time for processing. Traditional knowledge of enset processing has been generally owned by women and the processing is normally unthinkable without them, signifying their role in securing food supply for the households. Traditional enset processing is tedious, labor intensive, unhygienic and is done using local tools with a lot of similarities in basic steps of processing among different localities. This age-old processing of enset would require the concerted effort of food microbiologists and food processing technologists to lessen the pressure on women and to avoid spoilage during fermentation in order to produce wholesome products. The important traditional practices of enset processing that have been revealed during the present study could be utilized as an information to improve the traditional processes, thus, eventually contributing to food security.

III. Acronyms and Abbreviation

CSA	**Central Statistical Authority**
FAO	**Food and Agricultural Organization**
FDRE	**Federal Democratic Republic of Ethiopia**
IBPGR	**International Board for Plant Genetic Resources**
IK	**Indigenous knowledge**
EMA	**Ethiopian Metrological Agency**
DAs	**Development Agents**
ETB	**Ethiopian Birr**
FGD	**Focus Group Discussion**
GIS	**Geographic Information System**
Ha	**Hectares**
Km	**Kilometer**
M.a.s.l	**Meters above sea level**
Mm	**Millimeter**
MoA	**Ministry of Agriculture**
NRC	**National Research Council**
NGO	**Non-Governmental Organization**
SARI	**Southern Agricultural Research Institute**
SNNPR	**Southern Nations, Nationalities and Peoples' Region**

Chapter One

1. Introduction

Background of the Study

Agriculture is the backbone of the Ethiopian economy and it contributes roughly more than half of the rural population directly engaged in the sector as an economic activity. In Ethiopia, agriculture is the most essential sector and it accounts for 43% of GDP, 90% of export commodity, 70% of industrial raw materials and 85% of employment covered by agriculture. According to EES (2016), Agriculture's contribution to GDP high, although showing slight decline over the years has remained very high. In most of developing country almost all export commodity are agricultural product and product made from it. Ethiopia is mainly an agrarian country of the world. Smallholder and family farming agriculture remain to be the key and leading sector in overall economic development of many developing countries in the world. In addition to producing staple crops for domestic markets; smallholder farmers produce large shares of traditional exports in these countries. This shows how the economy of many developing countries still reliant on smallholder-based agriculture and smallholder farming accounts for about 75 percent of agricultural production (Salami et al., 2010). Most of the time in developing country smallholder and family level farming face a number of the problems like adverse climatic conditions, lack of appropriate land use system resulting in soil and other natural resources degradation, limited use of improved agricultural technologies, the predominance of subsistence agriculture and lack and/or absence of business oriented agricultural production system (Bezabih, 2010). Enset occurs in wild forms in East, Central and South Africa. Even though the banana fruit is known worldwide Enset (Ensete ventricosum) is only cultivated as a crop in Ethiopia for long time ago. Outside Ethiopia country, the use of Enset is reported from Vietnam, where it provided an emergency food during the Second World War. In parts of north and central Vietnam, the growing point was used as a vegetable crop (Tsegaye and Westphal, 2002). Enset crop grows at a wide range of altitudes however it grows luxuriously at elevation between 2000 and 2750 m.a.s.l, under rain fed conditions and the crop have high drought resistance character (Taye et al., 1984). The crop is grown in many regions but the dwellers of the central and southwestern parts of Ethiopia are the only people who use enset as a staple and co-staple crop (Stanley, 1966). Most part producing area this crop grown for staple food. In south region Dawro, Gurage, Silte, Hadya, Kembata, Kaffa, Wolayita and half part of Shekka, Debub omo, Gamo and Gofa zone and totally part of Konta specially

woreda human use this crop throughout the year for home consumption and income gain. Even though there is a huge demand and potential of agro-ecology for enset production in Ethiopia parts of production area, the farmers are still facing different problems related to, input supply, modern enset farming system, market information for selling enset product in good price and accesses to market and more ever the product is not known in all parts of the country. Therefore, this review is written by studies of enset product value chain analysis indifferent part of Ethiopia. This review paper has one general objective to overview enset value chain in Ethiopia and three specific objectives i) To reviewing the enset value addition and value chain actors with their performance in Ethiopia. ii) To identifying major constraints and opportunities of enset production and marketing in Ethiopia and to assessing the production and marketing of sesame in Ethiopia.

Enset (Ensete ventricosum is a major multi-purpose crop in Ethiopia, which has been identified as the center of origin and diversity of enset. Enset is a perennial, herbaceous and long broad leaves endemic root crop plant to Ethiopia, which belongs to a Family Musaceae. Enset is a multi-purpose root crop and nearly every part of the plant has somewhat usable. The crop is widely grown in the home gardens of central, south and Southwestern part of Ethiopia for its food, forage, fiber, and medicinal uses. This crop contributes to food security (a traditional staple food crop) for more than 20% of Ethiopia's population notably southern and southwestern parts of Ethiopia. Enset is grown and distributed at altitudes between 1600 and 3000 meter above sea level with an average annual rainfall of 1100 to 1500 mm and it is chiefly propagated vegetative. Enset based farming system is an indigenous and sustainable agricultural system that covers large hectares of land assumed to be covered with enset cultivation in Ethiopia. It is one of major economic and socio-cultural importance crop for a wide range of smallholder households in the country's population as staple and co-staple food, and also used as a traditional medicine. Enset has been known to play a role of a barrier food deficit for human and feed for animals during the dry spell and recurrent drought due to its resistance to fluctuating rainfall patterns after establishment. Each plant takes four to five years to mature, at which time a single root will give about 40 kg of food. Due to the long period of time from planting to harvest, plantings need to be staggered over time, to ensure that there is enset available for harvest in every season. Enset will tolerate drought better than most cereal crops. Wild enset plants are produced from seeds, while most domesticated plants are propagated from suckers. Up to 400 suckers can be produced from just one mother plant. Enset can be intercropped with sorghum, maize, and

coffee. As stated by Addis et al., [1] and Mulualem and Walle [20], enset cultivation is suitable for sustainable agricultural systems due to its contribution to soil fertility, long storability, its multiple uses, accessibility at any time, and relatively high productivity depending on edaphic factors, altitude, cultural practices and varietal differences. The crop can withstand relatively long period of drought (about 5 months). It is noted for its tolerance to environmental fluctuations, storability, and for its multiple uses that play a pivotal role in preventing famine. Such uses coupled with cultural values make enset attractive to the people in the enset agro-ecology of the country particularly south and southwest parts [4]. Sizes of Enset plants vary depending upon management, the Enset type/cultivar, soil type and fertility, amount and distribution of rainfall, and altitude of the area. It reaches up to 10.3m in height and the girth at the fattest point can be up to 4m. The corm and the leaf sheathes are the main sources of human and animal feed. The major foods obtained from enset are Kocho and bulla, which are obtained from pseudo stem and leaf petioles and the other type is amicho obtained from the underground corm that is eaten boiled [2, 14]. It is a traditional food major crop, although often supplemented with cereal crops, amongst the indigenous people to southern and southwestern Ethiopia [25]. Despite the ecological and yield potentials, currently the crop is severely affected by disease and pests which gravely devastating cultivar diversity. The resulting losses are evolutionary consequence of crops grown in single variety monocultures and the continuing evolution of new races of pest and pathogens that are able to overcome resistance genes introduced by modern breeding [14]. In the traditional agriculture, farmers have a wealth of knowledge in tackling varieties selection and cultivations, pest and diseases management which are generally well adapted to their socioeconomic and environmental conditions. Since Enset is an indigenous crop, almost all production and processing practices are based on farmers' experiences. The use of indigenous knowledge in propagation, transplanting, inter-cropping, harvesting/ processing, protection from pests and diseases are valuable. As the first cultivators and experts, their knowledge have profound importance for both the recent and the future sustainable use and conservation of enset cultivars or varieties. The exploitation of these farmers' traditional knowledge in association with their center of crop origin has a good sense to analyze the diversity of traditional crop varieties and the disease management strategy. Therefore, this study was conducted to explore the distribution, local varieties selection, cultivation and traditional management system of enset cultivars by farmers in edja woreda, Guraghe Zone, South Ethiopia.

Enset (Ensete ventricosum (Welw.) Chessman, Musaceae) is one of the most important food security crops for about 20 million Ethiopian population [1]. The plant does not produce edible fruit, but its corm and pseudo stem are scraped and fermented to produce the main food product kocho [2]. One of the processing methods of enset involves the fermentation of scrapped corm and pseudo stem in an underground pit [3]. The objective of this study was to investigate the current practices of traditional enset fermentation in Guraghe zone edja woreda highlands of Ethiopia by a survey of the local population.

Enset (Ensete ventricosum) is a multipurpose crop providing a range of services such as food, forage, medicine, ritual, construction and soil protection. The different uses are attributed to the existence of different enset varieties (YemaneTsehaye and Fassil Kebebew, 2006). Enset is distributed in the wild throughout much of central, eastern and southern Africa. However, it is known to have been cultivated (Simmonds, 1958; Taye Bizuneh et al. 1967), domesticated (Brandt, 1996) and the farming system established in Ethiopia (Ehret, 1979). Currently about one-fifth of the Ethiopian population (20 million) depend on this crop mainly in the southern region and adjoining places in Oromia and Gambella Regions.

Despite the important attributes such as the harvest of the crop throughout the year, storage over a long period, high yield per unit area and the enset system having a high human carrying capacity compared to cereal growing regions, the enset agriculture was deprived of the research attention it deserved compared to cereal agriculture.

The corm and pseudo stem of enset plant are traditionally processed into primary food product, kocho. The process is an age-old technique in enset growing regions of the country and is still used without any scientific modification. Some of the steps in the traditional enset processing techniques differ among regions and even among localities (Tedla and Abebe, 1994; Gebremariam, 1993). Thus accurate understanding of these processes in all enset growing regions can help refine, improve, standardize and increase the utilization of the process in order to contribute to food security of the country (Anon, 1992). However, the processing in other parts of the country, especially in Ethiopia has not yet been well studied and, therefore, the present study was undertaken to investigate these processes in southern Ethiopia, Guraghe Zone, edja woreda.

The Ethiopian highlands are a center of genetic diversity for enset, tef, sorghum, barley and finger millet [1]. Enset (Ensete ventricosum (Welw.) Chessman) belongs

to the order stamina, the family Musaceae. The Musaceae family is subdivided into the genera Musa and Ensete [2]. Enset is an important staple crop for about 1/5 (20 million) of the population of the people living in the densely populated regions of South and Southwestern Ethiopia. The crop is grown in mixed subsistence farming systems, often in association with coffee, multipurpose trees, and annual food and fodder crops [3]. Enset is also used for livestock feed, fuel wood, construction materials, containers, and as a provider of shade to intercropped annual or perennial crops [4]. It is cultivated between 1500 and 3100 m above sea level (m.a.sl), where daily average minimum and maximum temperatures are 8 and 27 °C, respectively [5]. The major food types obtained from enset are kocho, bulla and amicho. Kocho is fermented starch obtained from decorticated (scraped) leaf sheaths and grated corms. Bulla is obtained by squeezing out the liquid containing starch from scraped leaf sheathes and grated corm and allowing the resultant starch to concentrate into white powder. Amicho is boiled enset corm pieces, mainly obtained from young enset plants that are prepared and consumed in a similar manner to other root and tuber crops [6]. Studies indicate that numerous enset cultivars were identified in each region and the observed genetic diversity in cultivated enset in a particular area appears to be related to the extent of enset cultivation and the culture and distribution pattern of the different ethnic groups [7]. A clear understanding of the diversity and distribution of enset is important for crop improvement programs and for managing genetic resources. To measure the status of crop diversity in the field the most common method is counting named varieties. There are two main landrace diversity indices, namely: cultivar richness, which represents the number of landraces in a community, and cultivar evenness, representing the relative abundance of the individuals among the various landraces present in the community [8, 9]. For farmers, genetic diversity means varietal diversity, which farmers can clearly distinguish on the basis of agro-morphological traits, phonological attributes, post-harvest characteristics, and differential adaptive performance under abiotic and biotic stresses [10]. Indigenous technical knowledge is the tool by which local people interact with the environment in order to meet needs and goals ranging from survival goals to that of achievement and esteem [11]. It is knowledge, which is unique to a local area, culture, or society, passed down from one generation to the next, usually through oral tradition. Indigenous knowledge has to do with theories, beliefs, practices, and technologies that local people have elaborated without any assistance from the modern, formal and scientific communities and/or institutions [12]. Indigenous people have a long tradition in maintaining biodiversity as a sustainable resource. Farmers have played and still continue to play a tremendous

role in developing and nurturing crop genetic diversity. Many studies have shown that farmers in developing countries have intimate knowledge of environmental processes and make rational resource management decisions based on that knowledge [13]. The southern and southwestern part of Ethiopia has an extraordinary biological and cultural diversity. Recent publication on enset ethnobotany including those by [13, 14] attempt to document farmers' indigenous knowledge on enset in some cultural groups at specific location. However, those documentations are insignificant when compared to the diverse ethnolinguistic communities in the country. This paper seeks to contribute towards filling this knowledge gap, based on an empirical study of enset farmers in Guraghe zone, edja woreda in general in Ethiopia. The paper address the following main question: what are farmers' knowledge associated with the distribution, diversity, and management of enset in the country? The underlying assumption behind this question is that all farmers are equally likely to be knowledgeable about the crop. Hence, the objectives of this study was to identify and document wealth of indigenous knowledge for folk naming, classification, distribution and abundance of enset landraces and understanding the corresponding knowledge related to utilization, management and conservation of enset landraces.

1.1 Uses of "Enset" Plant

"Enset" is a multi-purpose crop. It is used for human consumption, animal feed and for extraction of long fibers ("Kancha") used for making bags, rags, robe, gunny bag, etc. The leaves are used to form the inner lining for the pit in which the decorticated corm and pseudo stem are buried for fermentation (4). Some varieties of "enset" and food from these varieties are also considered to have medical value (7). The following are examples of medical uses of the "enset" plant: food prepared from immature corm of "enset" plant is fed for healing broken bones, gruel or porridge made of bulla is fed to new mothers to clean out the uterus, for milk production, and for strength. Bulla gruel or porridge is given for newly circumcised children. Highly fermented "kocho" in its dry form is also given for treating amoebiasis and for stomach cramps. Edible parts of the "enset" plant are the corm (root part) and the pseudo stem (inner bark).

The parts of the "enset" plant used for human consumption are kocho", "Bulla" and "Amicho". These products of the "enset" plant are used to make different dishes such as the following:

Kocho Kita (thin, unleavened bread)

Bulla Genffo (porridge type)

Bulla Atmit (gruel type)

Bulla or Kocho Ferfer (shredded flake)

Amicho - Located at the base of the pseudo stem and is eaten after boiling like potatoes. The nutritional value of dishes prepared from "bulla", kocho", or amicho" are high in carbohydrate and low in protein (Table 1). Products of the enset" plant are often blamed for causing protein deficiency disease when eaten alone as a staple food. It is true that kocho or bulla contain very little protein (0.5 gm in 100 gm of edible portion). However, it should be mentioned that dishes made out of' enset" products are traditionally served with good alternative protein sources. Information gathered in Guraghe areas indicate that dishes prepared from these products (kocho. bulla, etc.) are supplemented either with milk, meat, or legume which enrich the protein value of the prepared.

1.2 THE PROCESSING OF "ENSET'

The planting and transplanting of "enset" is carried out by men. "Enset" harvesting and processing is the responsibility of women. The harvesting and processing of "enset" for extracting edible and non-edible parts is probably one of the most cumbersome household responsibilities women in enset-culture areas have to carry out. Information gathered from women in two "enset" culture areas of Guraghe zone, edja woreda indicates that the processing of "enset" is the most laborious household activity. The strategy used by women in these areas to reduce the work load is to have a labour pool support system which they call debo(Gez). Small groups of women assist a fellow woman in processing her "enset". The assistance could be free, with payment or in return of labour whenever the woman processes her "enset" (7). Though the house wife gets assistance from the neighbors, the entire responsibility relies on her. The survey done in Guraghe zone edja woreda area indicates that 70% of the household "enset" processing is done by the wife and another 30% is contributed by neighbors.

1.3 Nutritional value of enset

The stability of enset-coffee home gardens depends on enset ability to feed more people per unit area of land than any other crop grown in Ethiopia (Tsegaye, 2002), while providing multiple outputs, and maintaining and improving the resource base through positive ecological effects such as shading, soil erosion control, and improvement of organic matter (Woldu, 1997). Enset is a starchy staple crop, high in carbohydrates, but low in vitamins and protein content, with low levels of

essential amino acids, such as methionine and isoleucine (Kusin, 1973; Besrat et al., 1979). When enough enset plants are available on a farm, poor households do not go hungry, but their diets lack essential nutrients (i.e., protein and vitamins) (Negash and Niehof, 2004). In all enset-growing areas, enset is the most frequently served main meal, with a daily average consumption of 0.5 kg, which provides 68% of the total energy intake, 20% protein, 28% iron, but no vitamin A (Pijls et al., 1995; Negash and Niehof, 2004). Enset is prepared either as kocho (fermented and bread like food, a fermented product of the corm and pseudo stem), bulla (dehydrated juice collected during decortication of the pseudo stem and grating of the corm, thereafter rehydrated from concentrate and prepared as pancake or porridge), or amicho (boiled corm pieces, eaten like potato). Various enset-based recipes include the addition of spices, milk, maize flour, butter, beans or cabbage (Olango et al., 2014). Although there are slight variations between enset-growing regions, the main process of harvesting for the production of kocho includes scraping the parenchymatous pseudo stem and crushing the corm, which is followed by fermentation of the pulp mixture in fermentation pits. During scraping, which is carried out by women, the juice (bulla) will be collected as a moist sticky substance into a small pit lined with enset leaves (Tsegaye, 2002). The corm is grated, using animal bone or a wooden tool, to form smaller pieces, which is then mixed with the scraped pseudo stem and buried in a 1 m^3 pit, lined with enset leaves, to ferment for a period of 2–3 months (Tsegaye, 2002). Urga et al. (1996) reported that kocho fermentation procedures reduce toxicity of plant raw materials, while contributing to flavor. Some loss of protein and dry matter is associated with the fermentation process (Besrat et al., 1979; Tsegay, 2002), possibly due to the permeability of fermentation pit walls and the long duration of fermentation in the pit, which allows leaching of water-soluble proteins and amino acids (Tsegay, 2002). Recommendations from research on fermentation processes and pits (e.g., using plastic containers) have not yet been adopted by farmers. The protein content of unfermented samples ranges from 1.75 to 6.16%, whereas the result obtained from samples fermented for 30 days' ranges between 1.69 and 4.63% (Besrat et al., 1979). Between 16 and 37 kg of kocho and 19 kg of bulla can be harvested per mature 4- to 6-year old plant (Tsegaye, 2002). This is roughly equivalent to an annual yield of 4.5 to 10.3 t ha-1 when taking into account planting density and number of years to harvest. The calorie content of kocho per 100 g of edible material is approximately 200 kcal, or 57% lower than the corresponding value for food grains (tef, wheat, barley and maize), which is estimated at 350 kcal 100 g-1 (Urga et al., 1996). However, the energy yield per area and unit of time for enset (1,450 kcal m-2 year-1) is higher than that of other common

Ethiopian staples such as cereals, Irish potato, sweet potato and banana, but lower than that of cassava (Pijls et al., 1995; Table 1).

1.4 Statement of the Problem

Enset (Enset ventricosum (Welw.) Chessman) is an indigenous, little researched staple or co-staple food crop known for its tolerance to transient drought, high productivity and environmental sustainability. It is estimated that more than 20 percent of the population (about 12-15 million people), concentrated in the highlands of southern Ethiopia depends upon enset for food and non-food application, animal forage, fiber, construction materials, and medicines (SARI, 2014).

Enset is a multi-purpose plant with a range of utilities including social, cultural, economic and environmental significance. Although, many scholars including Olmstead (1975); Shigeta (1996); Gebre (1996); Almaz (2001); Desalegn (2007) have conducted Researched on socio-economic and multipurpose significance of enset in south western Ethiopia. So far, only little researches have been conducted in the Guraghe areas, especially in the study area related with socio-economic and environmental significance of enset.

Furthermore, research findings (Tilahun and Mulugeta, 2005; Asnakech, 1997 and Eyassu, 2003) show that, enset plant has various environmental values such as controlling soil erosion through spongy root system, conserve soil and moisture, builds soil organic matter and soil fertility, buffer against climate change. In addition

it positively affects the physical environment where it is most commonly grown around farm yards or home garden. Enset plays more role than any tree species by providing people, other crops, and animals with protection from strong windbreak destruction by decreasing the velocity of the wind and shadow during extreme sunlight. The other unique feature of enset is its drought tolerant (Dereje, 2009), when it is difficult to survive other cereal and root or tuber crops during harsh climate condition. Hence, enset is unique among other crop plants, due to its socio-economic and environmental values.

Despite of such a major social, economic and environmental roles, enset has received little attention from research and development and also, little focus from concerned bodies (government, research center, NGOs). As a result, the role of enset has been declining in the area due to disease, lack of scientific disease controlling measures and cultivation and management related problems. As stated by Shank and Chernet (1996) among all other factors, enset disease and lack of scientific disease controlling measures are the most economically putting the sustainability of enset in

jeopardy. Thus, it is fair to suggest that the role of enset plant is constrained by different factors in the area.

On the other hand, the farmers' perception towards enset plant is low duet to awareness problem in the study area. As a result, some of the farm households in the area, replacing enset farm by new cash and food crops like, apple tree species, eucalyptus tree and other cereal crops for immediate income. Furthermore, due attention has not been given by concerned bodies (government, research center and non-governmental organizations) in improving the productivity of this precise plant. Therefore, there is gap among government and non-governmental organizations, research institutes and farmers themselves in conserving, cultivating and managing enset plant in edja woreda. Generally, in the study area, the socio-economic and environmental role of enset were not well explored and researched, the socioeconomic and environmental constraints of enset were not assessed, farmers' perceptions towards significance of enset were not examined and the role of concerned bodies on improving enset productivity was not assessed.

Lack of labor and time-saving device is one of the major difficulties which especially rural women are facing in performing their day to day activities (3). The non-availability of improved devices, which contribute for saving time and energy does not affect agricultural production only, but also the well-being and health of family members too. Bosurp, cited by Wudnesh has also stated that when women's time and energy is devoted to heavy work load, less attention is given to child care and family feeding responsibilities (13)."Enset" (Enset ventricosum), which is the main source of food for densely populated areas of southern Ethiopia, Guraghe zone edja woreda is also a type of food source which demands labor intensive processing carried out by women. Unlike the milling of cereals, "enset" has to pass though different processing stages (decortication, pulverization, shredding, fermentation and squeezing) to be ready for human consumption. In addition, the few studies conducted on "enset" plant are directed to its production aspect only, and does not integrate the processing aspect which adds heavy work load on women beside other household and social responsibilities.

1.5 Objective of the Study

1.5.1 General Objective

The general objective of the study is to assess and investigate the current practices of traditional enset fermentation in Guraghe zone edja woreda of south Ethiopia by a survey of the local population.

1.5.2Specific Objectives

Based on the above general objective, the specific objectives are:

- To analyze the factors that influence the productivity of enset plant.
- To examine the perception of farmers on enset plant.
- To assess the role of concerned bodies on improving enset productivity.
- To investigate the enset cultivation and plantation system of the community.
- To identify the constraints during extraction and fermentation of enset products.
- To identify the utilization, management and conservation of enset.
- To assess the socio-economic roles of enset plant.
- To document indigenous knowledge of smallholder farmers associated with ENSET plant in the study area.

1.6 Research Questions

Based on the stated objectives, the research questions spin around the following directions

1, What are the socio-economic and environmental roles of enset plant?

2, what are the major enset cultivation and fermentation methods of the area?

3, What are the factors that influence the production of enset plant?

4, What is the perception of farmers towards enset plant?

5, What is the role played by concerned bodies in improving enset plant productivity?

6, what are the main constraints and hindrances that affect the productivity of enset production?

7, What are the factors constraining enset production productivity in the study area?

1.7 Significance of the Study

Enset plant has played a significant role in the life of the people since ancient time and has great contribution in maintaining the environmental quality. However, currently the people's perception on consolidating enset plant productivity is very less and almost poorly cultivated and managed. Because of this, less attention given by farmers, government and non-governmental organization to improve the productivity of enset. Therefore, improvement of enset plant productivity requires a joint effort of the people, government, non-government and development actors. Moreover, the result of the study has the following significances: It may enable farmers, government bodies, NGOs and other stakeholders take part in the socioeconomic and environmental role of enset plant. Therefore, it could be used as a base line survey for researchers that need data to conduct further study on similar or related topic on same study area or elsewhere.

1.8 Scope of the study

This research is conducted in SNNPR, Guraghe Zone, Edja woreda that Enset has several important food security traits. It grows over a relatively a wide range of conditions, is somewhat drought tolerant, and can be harvested at any time during the year, over several years. It provides an important dietary starch source, as well as fibers, medicines, animal fodder, roofing and packaging. It stabilizes soils and microclimates and has significant cultural importance. In contrast to the other cultivated species in the Musaceae family (banana), enset has received relatively little research attention. Here, we review and critically evaluate existing research, outline available genomic and germplasm resources, aspects of pathology, and explore avenues for crop development. Moreover, the study only covered three Keeble's namely shebraden, kokera and desene. This is mainly because enset plant plays pivotal role in these this kebele, for minimizing financial, time and other constraints as it is a nearby kebele of the researchers and the prior knowledge of the area.

1.9 Limitation of the Study

The researcher did not finish this research without short comings. Some of them were lack of internet access. shortage of time to collect valuable informations from the community and other stakeholders. As a result, a covid-19 disease threat problem occurred which adversely affected the data collection process. The other shortcoming of the study was the lack of secondary recent literature on the topic and absence of documented data on enset at woreda and zonal level. However, the researchers tried to overcome some of those problems by using our own mobile data

internet and finding reference documents about enset production from different sites and we collect data's by taking care of and protect ourselves and others from corona virus.

1.10 Definition of Terms

Amicho (Doysetida Utha) is the fleshy inner portion of the enset corm which may be cooked and eaten separately, testing similar to potato (Admasu, 2007).

Bulla (Itima) is the small amount of water-insoluble starchy product that may be separated from kocho during processing by squeezing and decanting the liquid. It is eaten as porridge (Admasu, 2007).

Clone (variety) is a distinct type or grouping of plants within a separable from other types by some form of heritable trait, be it visual, chemical or other. New plants of clones are usually reproduced asexually without utilizing flowering and seed production (Genet, 2004).

Corm is an enlarged fleshy structure at the base of the plant from which new shoots emerge following destruction of the dominant shoot. (the small round underground part of some plants, from which the new plant grows every year)

Fiber (**Kancha**) is the by-product of enset that is left after decorticating the leaf sheathes. Enset fiber produced after scrapping the pseudo stem. It is used for making bags, ropes, cordage, mats, making strings, and gunny bags ….etc.

Kocho is the pulp of the enset pseudo stem derived by scraping the individual pieces and excluding the fibrous remains. Bulla may or may not be extracted and the Amicho may or may not be included (Admasu, 2007).

Leaf sheath is the basal part of the leaf which is wrapped around other leaf sheaths to the basal form a false plant stem (Genet, 2004).

Pseudo stem is the tree trunk formed by the base of the leaves or leaf sheaths adhering to one another in a concentric fashion (Genet, 2004).

Kocho Kitta -A flat thin bread made out of kocho dough

Koba -A name given for enset in the non-enset culture areas

Woficho -Dehydrated, leaf sheath and petiole

Chapter Two

2. REVIEW OF THE RELATED LITRUTURE

2.1 Origin and Distribution of Enset

Ethiopia is one of the centers of origin and diversity of various agricultural crops such as Teff (Eragrostis), Niger seed (Guizotia Absyssiinica), Enset etc. (Genet, 2004). Among these enset (Ensete ventricosum) is endemic and derived from wild relatives from which Ethiopian highlands to be the primary center of origin (Vavilov, 1957; Westphal, 1975). In line with this idea anthropologists, archaeologists, historians and other scholars have also developed the hypothesis that argued for the domestication of enset in Ethiopia as early as 10,000 years ago (Brandt et al., 1997).

The wild form of enset plant is common and widespread in tropical Africa from Kenya and Uganda, south to Mozambique, and west of the Democratic Republic of Congo and Cameroon (Simmonds, 1958). Enset (Ensete ventricosum) is also native to the highlands of south and southwestern Ethiopia (Simmonds, 1960 and Rodin, 1997). In south and southwestern parts of Ethiopia, farmers have countless numbers of varieties and there are even wild enset plants in forests, river gorges and near streams (Brandt et al., 1997). In any ways all authors agree that Ensete ventricosum is the only cultivated species in Ethiopia and has great socio-economic and environmental values but, it's not known outside Ethiopia as food crop. Given the restricted geographic distribution of domesticated ENSET and the degrees of complexity and variability in contemporary ENSET agricultural systems, agronomists and bio geographers have long considered the Ethiopian highlands to be the primary center of origin for ENSET agriculture (Brandt, 1991). Anthropologists, archaeologists, historians, and other scholars have also developed theories that argue for the domestication of ENSET in Ethiopia as early as 10,000 years ago. Today, the vast majority of ENSET farmers live in southern Ethiopia. However, historical evidence suggests that ENSET may have once played a much more important role in the agricultural practices of central and northern Ethiopia (Awol Zeberga et al., 2014). The plant seems to have no difficulty growing in lands beyond the seas and (at least in principle) Ethiopian immigrants in Israel and parts of the United States might try cultivating it. However, it seems unlikely that ENSET will ever make it onto the crop production lists in any non-African nation. The immigrants are overwhelmingly from central and northern Ethiopia where ENSET as a food is unknown. And getting the plant to produce food takes time, and perhaps tradition. Ensete ventricosum, in Ethiopia, is concentrated in the southern highlands,

but also grows in the central and northern highlands around Lake Tana, the Semien Mountains, and as far north as Adigrat and into southern Eritrea (Simmonds, 1958).

2.2 Taxonomy, Morphology and Ecology of Enset

2.2.1 Taxonomy (ዝርያ ጥናት የእንስሳት ና የእፅዋት)

Enset is a monocot that belongs to the order Schistaminae and family Musaceae and genus Enset. It is related to and has a physical resemblance to the banana plant as a result, it is sometimes known as a false banana or Abyssinia banana (Solomon, 2008). However, enset belongs to the family Musaceae, and the genus Enset. Banana is the same family as enset, but it is classified in the genus Musa. It was Chessman (1947) who separated enset from banana on the basis of differences in pseudo stem morphology and chromosome numbers. Other than Ensete ventricosum, there are species in the genus Ensete but there is some ambiguity regarding their number. Chessman (1947) revised the Musacearum family and transferred about 20 species from the genus Musa to the genus Ensete and listed 24 species which are distributed in Africa and Asia. But other researchers recognized 6 or 7 species under this genus. Taye (1984) has also stated that 7-8 species are known in the genus. This shows that further research is needed on the taxonomy and distribution of enset species (Genet, 2004).

2.2.2 Morphology (ስነ-ቅርፅ የእንስሳት ና የእፅዋት)

Enset looks like a large, thick, single stemmed banana like plant. Both enset and banana have an underground corm, a bundle of leaf sheaths that form the pseudo stem, and large leaves (Urga et al., 2006). But enset is usually larger than a banana and 6-12 meters tall (Admasu, 2007). The leaves are 5-7 meters tall and 1 meter in diameter and are more erect than a banana plant (Kefale and Sandford 1991; Brandt et al., 1997). The stem has three parts: the pseudo stem, which is made of tightly clasping leaf sheaths, is 2-3 meters in height and with an average of 1-meter diameter with an edible pulp and quality fiber Admasu and Struik (2001), and the underground corm is an enlarged lower portion of the stem with an average of 0.7 meter lengths and diameter. The fibrous rooting system of enset grows out from this part. The true stem is between the pseudo stem and corm near the ground. Usually it grows up during maturity and initiates a single flower head, which forms multiple flower, fruits and seeds. The small banana like fruits produce several irregularly shaped black seeds.

2.2.3 Ecology of Enset (የእንሰት ስነ-ምህዳር)

Enset is usually grown in moist woina dega (mid-altitude) and dega (highland) environments. Enset cultivation is restricted at altitudes ranging from 1500-3100 meter above sea level (Admasu, 2002). The study conducted by Brandt et al. (1997) stated that, domesticated enset is planted at altitudes ranging from 1200 to 3,100 meters above sea level. However, it grows best at elevations between 2,000 and 2,750 meters above sea level; while the wild enset is distributed at an elevation of 1,200 to 1,600 meters above sea level in Ethiopia (NCR, 2006).

Most enset-growing areas receive annual rainfall of about 1,100 to 1,500 millimeters, the dominant precipitation of which falls between March and September (Genet, 2004). The average temperature of enset growing areas is between 10 and 21 degrees centigrade, and the relative humidity ranges from 63 to 80 % (NCR, 2006).

Enset grows well in most soil types, as long as they are sufficiently fertile. Neither roots nor corms tolerate water logging for long. For that reason, the crop is usually grown in well-drained soils without high water tables. The ideal soil seems to be a moderately acidic to slightly alkaline (pH 5.6 to 7.3) with 2-3% organic matter (Dereje, 2009).

2.3 Propagation and Planting of Enset

Ensete ventricosum is usually propagated by suckers from an immature corm, but propagation by seeds is occasionally practiced in some parts of Ethiopia to increase genetic diversity (George, 2004). Scarification and pre-soaking or temperature treatment of up to 40°C is needed to enhance germination. In vegetative propagation, an immature enset plant is cut 10–15 cm above the junction of the pseudo stem and corm. The corm is then split into 2–4 equal parts and the apical bud is removed to break apical dominance and induce the formation of several buds from the mother corm. The split corms are planted immediately or stored in shade for 2–3 days if there is rain. They are planted 1 m apart and 50–150 new suckers appear 4–6 weeks later (NCR, 2006; Admasu, 2007).

In the traditional cropping system, suckers are separated from the mother corm after 1 year or more, and are planted in a well-matured nursery. Plants are subsequently transplanted yearly into new nurseries until they are finally planted in the field where they are left until harvest. The number of transplanting varies depending on the region and farm, but can be up to four. Where land is less scarce, enset suckers can

be planted directly into their final location at spacing of 2–3 m between rows and 1–1.5 m within rows (Endale, 1997)

Enset (Ensete ventricosum (Welw.) Cheesman) is a large perennial monocarpic herbaceous plant, similar in form to the related bananas of the genus Musa (Figure 1). The two genera, together with the monotypic Musella (Franch.) C.Y. Wu ex H.W. Li, form the family Musaceae within the Monocot order Zingiberales (Figure 2A). Like banana, enset has a pseudo stem of overlapping leaf sheaths, large paddle-shaped (oblong-lanceolate) leaves and produces a massive pendulous inflorescence with banana-like fruits. However, unlike sweet and starchy banana (with the latter called plantain in some contexts, although there is no botanical distinction between banana and plantain), which are widely farmed for their fruits, it is instead the swollen pseudo stem base, leaf sheaths and underground corm that provide a year-round dietary starch source, typically harvested 4-7 years after planting. Despite a widespread distribution in eastern, central and southern tropical Africa (Baker and Simmonds 1953; Lock (1993), enset has only been domesticated in Ethiopia (Brandt et al. 1997). Here, hundreds of landraces are found in diverse climatic and agro ecological systems (Birmeta et al. 2002; Tesfaye and Lüdders 2003; Yemataw et al. 2014a) where they provide the staple food source for approximately 20 million rural people (Figure S1 - see Supplementary Information for population estimation methods).

Enset has historically been ascribed as a ‘tree against hunger’ (Brandt et al. 1997), due to the domesticated plant having important attributes that support the food security of communities that cultivate it. These attributes were evident during the devastating famines of the 1980s, where enset growing communities reported little-to-no food insecurity (Dessalegn 1995). Most significant is the apparent ability of enset to withstand environmental stress, including periods of drought (Quinlan et al. 2015). Enset can also be harvested at any time of the year and at any stage over several years (including when it is immature), and enset-derived starch can also be stored for long periods (Birmeta 2004). Enset also supplies fibers, medicines, animal fodder and packaging material (Brandt et al. 1997). It stabilizes soils and microclimates (Abate et al. 1996) and is culturally significant (Kanshie 2002; Negash and Niehof 2004; Tewodros and Tesfaye 2014). Enset has a complex management system supported by extensive ethnobotanical knowledge (Borrell et al. 2018, in prep). In a comparison of starch crops, enset has been reported to produce the highest yield per hectare in Ethiopia (Tsegaye and Struik 2001; Kanshie 2002) with relatively low inputs and management requirements. Enset therefore has the

ability to support a larger population per unit area than regions relying on growing cereals (Yirgu 2016). As a result of these qualities, enset farming provides a long-term, sustainable food supply capable of buffering not only seasonal and periodic food deficits, with minimum off-farm input, but also demonstrates potential that exceeds its current utilization in South-West Ethiopia. Despite the current and potential importance of enset, relatively little is known about its biology and ecology. In this review we aim to 1) Summaries the existing knowledge and current research effort both nationally in Ethiopia and internationally; 2) Identify critical knowledge gaps in the ecology, diversity and distribution of enset to direct future research effort; and 3) Catalyse the development of resources needed to enable the sustainable exploitation of enset diversity as a resilient climate-smart crop of the future. Concurrently, we also acknowledge the importance of local ethnobotanics knowledge, management and plant processing; these topics are reviewed in Borrell et al. (in prep). Finally, we introduce the online resource www.enset-project.org to make various tools and data available to researchers both in Ethiopia and internationally.

2.4 Socio-Cultural and Economic Role of Enset

2.4.1 Socio-Cultural Role of Enset

People in the south and Southwestern parts of the country, depend on enset for different purpose such as food, income and also consider it as part of their cultural heritage. They have a strong attachment to the plant and the land. Thus, many farming households grow enset for economic as well as non-economic purposes. According to Gebre (1996) and Almaz (2001), a system of social, economic and ritual practices has developed around the cultivation of enset plant. The Gurage people, for example, use enset for different purposes such as traditional medicinal purpose, compensation payment, and ritual offerings (Shack, 1966). Among the Ari the newly born baby is given water squeezed from pseudo stem until the breast of mother starts to give milk, this water is given as a supplementary for breast feeding (Gebre, 1996). Moreover, certain rituals associated with birth in Gamo Highlands use, particular enset varieties to solve birth related problems (Olmstead, 1974). Therefore, enset is considered not only as the principal crop for subsistence or food, but also for various cultural, ritual and social functions in enset growing area.

In addition, according to traditional knowledge of enset growers, some varieties and parts of enset plants are reported to have traditional medicinal value for both humans and livestock (Endale, 1997; Tadesse, 2002; Nyunja et al., 2009). These varieties are claimed to heal bone fractures, for treatment of diarrhea, abdominal pain and

delivery problems, i.e. assisting to discharge the placenta of humans as well as animals (Spring et al., 1996). Even some farmers believe that eating bulla from clones like Boliae in Wolayita after taking traditional medicines against tapeworm protects the liver from the side effect of the medicine (Olango, et al, 2014). Hence, enset and its parts are medicinally important in enset growing region.

Furthermore, enset serves as an indication of status symbol and prestige crop in the enset growing community. Households with many matured and immature enset plants in the farm yards are socio-culturally considered to be rich, feel proud, superior and respected persons in enset growing area (Gebre, 1996; Almaz; 2001; Olango et al., 2014). The people in the community use several criteria for classifying farmers as being either rich, medium or poor, and a general difference is made on the basis of the number and types of enset. The study conducted by Tsedale (2009) in Gurage Zone stated that, the enset crop garden of a rich farmer is large in quantity and in quality or 30-50 matured and immature enset in the garden, well managed and attractive to see. Rich farmers do not need to use the plants before they mature, for the sake of having food and the plants can spend more time maturing. In contrast, the garden of a poor farmer is small in quantity and quality or 5-15 matured and immature enset in the garden and also less well managed. Therefore, the social status and wealth status of a household, particularly in the enset growing areas, is measured partly in terms of the size and variety of enset plants grown in the garden (Pankhurst, 1996). Thus, it can be said that the production of enset is influenced by a combination of social, cultural and economic motives in enset growing area.

2.4.2 Economic role of Enset

Enset is a multi-purpose plant with a range of utilities including food, feed, construction and medicinal uses. It serves as staple or co-staple food for about 17 million people in Ethiopia, which accounts for 20% of the more than 82 million people (Abraham et al, 2012). It is a good source of starch. As stated by Kefale and Sandford (1991) the corm and the pseudo stem of enset are the most important sources of food for human being. The types of food from these parts are known as ‘Kocho’, ‘Bulla’ and ‘Amicho’ (Spring et al., 1996). Kocho is the bulk of the fermented starch obtained from the decorticated (scraped) leaf sheathes and grated corm. Bulla is obtained by squeezing out the liquid containing starch from scraped leaf sheathes and grated corm and allowing the resultant starch to concentrate into white powder. Amicho is boiled corm of young enset plants known for best quality of corm. It is prepared and consumed in a similar manner to preparation of other root

and tuber crops (Brandt et al., 1997). As a result, enset plays a central role in the economic life of the Southern and Southwestern people, who depend up on it.

Apart from being important source of food for human being, enset is also most important source of feed for livestock during dry as well as wet season. Fresh enset leaves are selectively cut from the standing crop and fed to livestock during feed shortages. Leaves for livestock feed can also be obtained as byproducts during the entire enset plant harvest (corm and pseudo stem processing and fermentation into starch food). As a result, it can be said to be the whole parts of enset plant are used for livestock feed (Shigeta, 1996).

Furthermore, it's one of the major crops that can significantly help to ensure food security in a country like Ethiopia (SARI, 2014). According to Atnafua and Endale (2008), the average yield of refined enset product kocho ranged from 35 to 51 tons/ha/ year in early maturing enset clones. Additionally, according to National Research Council (2006), a normal-size mature plant is said to give 26 to 42 kg of food, in regions where enset is the staple crop, people consume 0.43 to 0.7 kg of kocho daily. Similarly, the study conducted by Teshome (2016) in Gamo highlands showed that, on average, one plant of 5year old enset can yield up to 50kg dry kocho. Thus, from aforementioned point of view, enset guarantees food security and stability to the household economy in that the processed products can be stored for a long time in pits for long periods of time (for 10 years and even more) without spoiling.

Moreover, enset is rich in carbohydrate and mineral substances like calcium and iron (Shigeta, 1990). The energy yield of enset is by far higher than that of several cereals. A mature enset plant could yield 20x106 Cal / ha/ year which is 20 times higher than that of barley (Terefe, 1991). Enset energy yield was also reported to be higher than potato, sweet potato and banana (Pijls et al., 1995). Thus, this shows that cultivation of enset can significantly improve food security at household and at national level.

2.4.3 Enset as Multipurpose Crop

Enset is not only a food crop, but is a multipurpose crop of which every part of the plant is utilized, for food or several non-food applications (Shigeta, 1996). Enset fiber is the main byproduct resulting from decortications of the pulp from leaf sheathes of the pseudo stem. According to Taye (1984), enset fiber strength is found to be equivalent to the important fiber crop Musa textiles (abaca). Thus, enset fiber is used for making bags, ropes, twines, cordage, mats, etc. where the variety, the age

of the plant and the way in which the fiber is extracted and stored determine its length and quality (Kefale and Sandford, 1991).

Enset leaves are used for baking bread, for wrapping, for shade or protection from heat and rain, for production of string and rope for tying, for making mats and sheets on which to sleep and sit, and for making women's skirts. Also, the fresh and dried leaves of enset have various uses. They are used as food wrappers, serving plates and pit liners during kocho storage. Dried petioles and midribs are used as fire wood, to make mats and tying materials (Brandt et al., 1997). In general, farmers in the enset growing areas therefore describe the role of enset by saying" enset is our food, our cloth, our bed, our house, our plate; it means everything to us"(Brandt, 1996).

2.4.4 Environmental Role of Enset

As discussed above, the enset plant and its products have played enormous, social, cultural, medicinal, and economic as well as a multipurpose role in enset growing regions. Besides the socio-cultural and economic roles, environmental roles also cause enset to be important in the enset growing societies. Thus, the environmental roles of enset plant include: control soil and water erosion, conserve soil and moisture, increase soil fertility through the continuous manure application, balance soil nutrients, act as wind breaker or sheltering the family members, their plants and their animals from the wind and sun and buffer against climate change.

2.4.5 Enset Control Soil Erosion and Conserve Soil Moisture

Enset plant can reduce soil erosion, runoff and land degradation with its canopy leaves and with its complex root system (Chakoro and Mekuria, 2015). The length of the enset roots on average five meter and single matured enset plants can have 350 roots on average (Tadesse, 2002). With this, fibrous and long spongy root systems forming a matte-like structure in the root zone that minimize soil erosion, runoff and land degradation.

Furthermore, the perennial canopy of the enset capture rain water with its funnel shaped leaves stores it in the tank like structure formed by interlocking leaf sheaths and releases it slowly. In fact, any drop of rainwater that falls on an enset leaf is directly led by gravity to the basal part of the pseudo stem (Tadesse, 2002). Thus, the erosive capacity of the raindrops is considerably reduced, there is less erosion. As a result, according to Admasu (2002), problem of soil erosion and land degradation are rarely seen in enset growing areas. Additionally, a study by Kena (1993), showed that enset fields when compared to other cop fields are less subject

to erosion. Therefore, enset is an excellent erosion barrier, particularly when it is planted on the top of the farmyard or homestead.

Although, both under and above ground enset parts play an important role in moisture or water and soil conservation (Tadesse, 2002). It also, conserves soil and moisture in and around the enset plantations. Thus, vegetables and short annual crops enjoys the always available moisture because of its broad leaf canopy coverage. According to Melese et al (2014), the dense enset plantation and the leaf canopy conserves soil moisture and suppresses weed growth and reduces organic matter decomposition by reducing soil temperature. Enset plants are reputed for their rainwater collection and conservation (Kippie, 1994b), each compartment of enset (pseudo stem pocket) according to the work of Tadesse (2002) in Gedeo Zone can store from 0.25 liter to 1liter of rain water. Thus, farmers use the water stored for washing after farm work.

2.4.6 Enset Increases Soil Fertility and Balances Soil Nutrient

Enset is a soil building crop. Because of the practice of manuring, household waste composting and enset residue mulching. Enset has highly degradable parts such as leaf midribs, pseudo stem sheath and pseudo stem core which is used to maintain soil fertility Chakoro and Mekuria (2015) and builds soil organic matter. Therefore, enset culture builds soil organic matter and soil fertility. According to Shank and Chernet (1996) reports, the soil structure, organic matter and fertility differ greatly in the enset plantation as compared to adjacent fields or even pastures. In many cases plant residue from weeding and thinning/pruning of enset are used as plantation mulch further raising organic matter and reducing erosion. Hence, the decayed leaves, stem and residues of enset are integrated into the soil to reach or to maintain high fertility. Furthermore, due to intense tillage, enset has a positive impact on soil fertility and micro climate and shows soil preserving capabilities (Zippel, 2002).

Moreover, enset also balances nutrients in the soil. As Elias et al., (1998) pointed out that, enset contributes to the local environment by improving the nutrient balance in soil. Hence, unlike cereal and other root and tuber crops, soil under, enset production is known to display the nutrient balance, making the crop suitable for sustainable agriculture (Asnakech, 1997). Thus, a nutrient balance study in the area has found a significant loss of soil and nutrient to erosion in non-enset field while nutrient losses to erosion was zero in the homestead garden field (Eyasu, 2002).

2.4.7 Enset Positively Affects the Environment

Another important role of enset plant is it likely to affect the macro-environments of an area in a positive manner (Admasu, 2002) because; it is organic farming system using only farmyard manure, with no external chemical fertilizer, herbicides and insecticides. As a result, it is said to be an environmentally friendly plant. And also it fulfills an aesthetic requirement for the home garden and more importantly, enset beautifies the landscape, creates a sense territory, and gives shape to the human settlements encircled by magnificent flourishing green vegetation (Brandt et.al 1997; Admasu, 2002; Olango et al., 2014). It also has profound importance as a windbreak by decreasing the velocity of the wind. Thus, it protects the farmers' local houses and fences from strong wind destruction and shad for small vegetables, medicinal, and other crop species in homesteads during extreme sun light (Engdawork, 2012). Thus, a dense enset plant around the house cover hidden activities of the household

The other important role of enset is carbon dioxide sequestration (Eyassu, 2002). In the global carbon cycle, the enset broad leaves are regarded as a carbon sink. In enset ecosystem, through the mechanism of photosynthesis, enset broad leaves turn carbon dioxide into organic carbon and stores it as their structures. Obviously, all plant species absorb CO2 but the ability and capacity depends on the woody biomass the plant produces. Thus, study by Admasu (2007), explained that as in all green plants, enset leaves are the main photosynthetic organ for biomass production. Due to its great potential for rapid biomass production, enset plant is a significant net sink for global carbon dioxide (Eyassu,2002). Hence, enset is an excellent input for the country's climate change resilient green economy development and climate change mitigating strategies.

2.4.8 Enset Tolerates Drought

The other salient feature of enset plant is its drought tolerant crop as compared to the other tree and crop species. Thus, the drought resistance characteristics and sturdiness of enset plant resembles that of a 'camel' in the case of pastoralism (Mulugeta, 2014). The study conducted by Tadesse (2002: 75) noted that, 'through its funnel-like leaves, enset collects rainwater towards a barrel-like pseudo stem' and conserves its body structure for longer periods' of time. Hence, even during drought periods when other cereals easily succumb to drought, enset can survive and maintain its green and lush appearance. Although, several authors (Shack, 1966; Dereje, 2009; Mohamed et al, 2013) are agreed that, enset plant tolerates drought that has serious damage on annual crop species. Through, a deep roots system, it store water in fibrous roots, pseudo stem and leaves. Moreover, its water contain was

high, about 85-90% of enset body are full of water (Mohamed et al, 2013). Thus, it uses this water at drought period. As, a result, it is said to be a plant against drought (Shack, 1966) and the area is one of the least affected by drought in Ethiopia and have rarely experienced famine and starvation (Pankhurst, 1985; Desalegn, 2009). According to farmers', "enset is the enemy of hunger and human and livestock life is impossible without it" (Admasu, 2002).

2.4.9 Enset Diseases

Enset diseases are the major problems of enset production in Ethiopia. Thus, enset is attacked by many fungal, bacterial, viral and nematodal diseases, which attack different parts of the plant. The roles of enset decrease when the part of the plant attacked by disease. Bacterial wilt of enset, caused by Xanthomonas campestris, is the most serious disease of enset. The pathogen destroys enset plants resulting in total yield loss and threatening the livelihoods of millions of people who depend on enset as a staple or co-staple food source (Teshome, 2016).

Although, fungal foliar diseases are numerous and widespread in all enset growing regions. Some are destructive on suckers, seedlings, young transplants and rapidly growing plants up to two years old. However, infected plants normally tolerate these diseases and recover as they grow older. The study conducted by Mesfin (1996) stated that, mature plants do not have serious foliar diseases. Moreover, fungal leaf spot diseases are also common in enset-growing regions, which commonly affect suckers, seedlings and young plants, are caused by Phyllostica sp., Pyiricularia sp., and Drechslera sp. In older plants, leaf spots are due to Cladosporium sp. and to some extent Deightoniella sp. Mycosphaerella musicola, which, cause destructive leaf spot on enset (Quimio and Mesfin, 1996). Nevertheless, little is known about the fungal diseases affecting enset roots, corm and pseudo stem. Sclerotium wilt and root rot, caused by Sclerotium rolfsii, on young seedlings and transplants are rarely common. Bacterial corm rot is widely distributed and kills both young and mature plants. The causative agent has not been identified so far by unidentified agent (Quimio, 1992).

Enset is also attacked by nematodal disease. Thus, the common nematodes that attack enset are the root lesion nematode, Pratylenchus goodeyi and the root knot nematode, Meloidogyne sp. Pratylenchus goodeyi is mostly found in association with bacterial wilt of enset and thus may play a role in development and severity of bacterial wilt of enset disease or it may increase the susceptibility of the plant by damaging the root of the plant or may have a role in the transmission of the pathogen

(Quimio and Tessera, 1996 as cited in Admasu, 2002). The leaf nematode disease of enset, caused by Aphelechoides sp., was reported in 1991 (Quimio, 1992). It attacks leaves of suckers and young seedlings and it is characterized by linear black leaf streaks usually occurring on leaf margins and near the base of the newly expanded leaves (Quimio and Mesfin, 1996).

Diseases are collectively the most severe biological problem facing ENSET. 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 pvmusacearum, is the most threatening to the ENSET. 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 et al., 2014).

ENSET is attacked by numerous diseases in addition to bacterial wilt. They include ENSET 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). 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 Chernet Ertiro, 2009).

2.4.10 ENSET harvesting and processing

Although ENSET 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 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 centimeter 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. (Temesgen Magule, 2014)

2.4.11 Role of Women on ENSET Production and Processing

Gender roles (in terms of the division of labor for all aspects of ENSET 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 (Asnakech Woldetensaye et al, 1997). Tesfaye Habte-Wold et al. (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

2.4.12 Food uses of ENSET

The major foods obtained from ENSET 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 color 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 ENSET 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).

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 et al., 1997).

2.4.13 Medicinal uses of ENSET

Particular clones (or landraces) and parts of ENSET 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).

2.4.14 Other uses of ENSET

ENSET provides fibber as a byproduct of decorticating the leaves sheaths. ENSET fibber has excellent structure, and its strength is equivalent to the fibber of abaca, a world-class fibber crop. About 600 tons of ENSET 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). ENSET 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 et al, 1996). ENSET 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 et al., 2014).

2.5 Enset Value Chain in Ethiopia

2.5.1 Overview of Enset production and value chain in Ethiopia

Enset also known as "false banana" due to its striking resemblance to the banana plant, Enset (Ensete Scitamineae) is a traditional staple crop in many parts of densely populated south and south-western Ethiopia. Enset has been grown in Ethiopia for more than 10,000 years. Indigenous hunter/gatherers of southern Ethiopia are thought to have been the first to cultivate Enset, and later introduced it to the Cushitic-speaking people of the northern highlands, only for it to be replaced by cereal based crops due to the migration of the Semitic people (Tsegaye, and Struik, 2002). Enset (Ensete ventricosum) is a drought tolerant crop, traditionally grown in Ethiopia. It has many usages: food, fodder, fibers and traditional medicine. Being perennial, enset improves local climate and soil conditions. It could contribute to improved food security in several drought-prone parts of the world. The aims of enset crop production were to reveal the amino acids of Enset corm, which can be cooked as a root crop, and to increase the general knowledge regarding chemical composition and energy values of different enset fractions. Water content was high, 85 to 90%, which is beneficial when used as fodder during dry periods (Demeke, 2011). Enset corm contained 17 of 20 amino acids and had similar or higher concentration than potato of 12 of these. Leaves had 13% protein, among the highest available in Ethiopia, 20% crude fiber and 10% sugar; a good fodder and suitable for ensilage. The pseudo stem, the main food source, was rich in soluble carbohydrates (80%) and starch (65%), but had low protein content (4%). An enset based diet should be supplemented with protein and complementary amino acids; for example, from beans, which are suitable to intercrop with enset (Olanlg et al., 2014). According to Areka agricultural research enset (Ensete ventricosum is a herbaceous monocot, large banana like plant that grows 4-8m (some time 7- 11m)

in height. Enset traditionally ranked first in importance as cultivated staple food crop in The high lands of central, south and south western Ethiopia. The main food product from it is obtained by fermenting the mixture of the scraped pulp of the pseudo stem, pulverized corm and stalks of in florescence and is locally known as 'kocho'. Most of the time the area where enset is used as staple food are characterized by high density of human population, which cannot be supported with any other type of land use (Olango et al., 2014). Enset yield is relatively high compared with yields of other food crops. Brandt et al., (1997) suggested that the huge volume of harvested yield from on Enset plant and from an area, particularly compared to cereals, contribute perception among both farmers and scientists that the yield of Enset is tremendous. There are many enset clones in different agro ecologies. Farmers classify their landraces and give them different names based on several attributes that distinguish the landraces from one another. The names given by farmers to the different enset clones separate the landraces linguistically, phenotypically and in terms of their utilization value (Tsegaye, 2000). The Enset products are used for human and animal feed in different form. In southern region in Guraghe zone and edja woreda Product of Enset used in the form of Kocho Kita, Genffo" amicho" Bulla and other forms of food for humans. The products of Enset in this area used as holiday food(bulla) and cultural food for mothers during new baby born time (Alemayehu, 2017). In Ethiopia 20 million people cultivate the crop as a staple food or as a co-staple with cereals and root and tuber crops (Tsegaye and Struik, 2002). Ethiopia is a country, which has high production of enset plantation than all African countries (Chiche, 1995). Enset (Ensete ventricosum (Welw.) Cheesman) which contain more than 100 varieties is a perennial herbaceous monocot banana-like large (grow 4 to 8m which even sometimes reach up to 11m in height) plant belonging to the family Musaceae, genus of banana of which none is found cultivated in other part of the World. Enset is native to Ethiopia and the greater concentration of this species is found in the South and Southwest part of the country and the area coverage under this crop is rapidly increases time to time. Enset cultivation occupies a central position in the agricultural systems of the Ethiopian high land area of south and Oromia region and every farming household cultivates enset in its home garden. In most part of enset producing area are maintained in home garden ring in poly-varietal perennial plantations without any crop rotations and land fallowing. Sometimes, farmers maintain enset landraces intercropped with perennial tree crops, such as coffee (Coffee Arabica L.), avocado (Perseaamericana Mill.), guava (Psidiumguajava L.), and annual and biennial crops, such as maize (Zea mays L.), Ethiopian kale (Brassica carinata A. Braun) and yam (Dioscorea spp.). Enset is one

of the most widely cultivated crop in Guraghe zone and edja woreda primarily in midland and highland areas. Although it covers a relatively smaller area per unit of production compared to cereals and pulses. When asked about the importance of enset, producer indicated enset for a multipurpose crop available all year round and that needs only household produced inputs for its production. The producing communities and Department of Agricultural and Rural Development define enset as the most important crop for livelihoods and food security in the producing area (Habte-Wold et al., 1996). The `corm' or juncture of root and stem of an old plant is cut into pieces and planted in the nursery, producing 50 to 350 new shoots. These are broken off and transplanted in rows using one square meter per plant for the next two years. New enset plants are transplanted at least twice during the growth period in order to save space. After Journal of Resources Development and Management www.iiste.orgISSN2422-8397 An International Peer-reviewed Journal Vol.65, 2020 two years the plants are dug up roots and leaves trimmed and transplanted into 2.25 meter squares for the 3rd through 5th years. The final transplanting is to 7-9 meter squares again disturbing the roots and reducing the leaf area to minimize wilting. They remain in the squares for the 6th year until harvest which may be in the 7th to 9th years depending upon the needs of the family (Tsegaye, 2000). Throughout this time the soil is tilled for weeding and the incorporation of manure. The importance attached to the growing of enset is seen by the clean weeding or mulching of the plantation. Intercropping the bare areas is not practiced but plantings may occur where individual plants are harvested or have died from disease or transplanting shock. Other than the nursery for starting plants, all the manure of the farm is incorporated into the enset plantation. Soils in this area are inherently acidic, with heavy clays that retain high levels of organic matter when applying manure, and give good nitrogen fertility that would benefit further from liming and phosphorus (McCabe and Lee, 1996). Suckers are transplanted using a hand hoe, usually to an area that has been well prepared with added animal manure. Transplanting is usually done in the dry season due to the heavy nature of the soil which would turn into hard pieces if compacted under wet conditions. Nevertheless, considerable growing time is lost and the plants suffer wilting damage. Different research indicated that averaged over four different varieties, the pseudo stem length was 0.7 and 1.4 meters shorter with 1 and 2 transplanting respectively as compared to direct planting of shoots. Research into the size of the hole for transplanting and the amount of root/leaf trimming was aimed at minimizing these stresses. Moist loose soil around the base and minimal leaf transpiration were found to be advantageous to rooting establishment of transplants (Alemu and Sandford, 1991). The crop is grown in

many regions but the dwellers of the southern and southwestern parts of Ethiopia are the only people who use Enset as a staple and co-staple crop (Stanley, 1966). These regions are among the most densely populated in the whole of Ethiopia and are inhabited by more than 11 ethnic groups, which show great variation in culture and agricultural practices (Tsegaye and Struik, 2002). The Ethiopian Central Statistical Agency (2011) indicates that 3,020.143 km2 of land is covered by Enset crop and about 6.9 million quintals of Enset yields were produced in 2010/11 production season.

2.6 History of enset in Ethiopia

2.6.1 The Genus enset: evolution and systematics

Ensete Bruce ex Horan. is a monophyletic genus (Li et al. 2010) with seven described species in Africa and Asia Whilst first reported by Bruce (1790) during travels in Ethiopia, and formally described by Horaninow (1862) it was not until almost a century and a half later that Chessman (1947) elevated the informal 'giant bananas' group within Musa to re-establish genus Ensete. Of the 20 reported synonyms, 65% relate to Ensete ventricosum (Welw.) Cheesman. The sister genus Musella (Li 1978) was originally placed under Musa and Ensete (Cheesman 1947; Simmonds 1960). Whilst the sole species of this genus, M. laisocarpa (the golden lotus banana), occupies a unique geographic distribution, drier and cooler than any other member of the family, there is continuing debate as to whether it should be treated as a member of Ensete or as its sister (Liu et al. 2003; Li et al. 2010). Currently, Ensete (7 species) and the sister genera Musa (~70 species) and Musella (1 species) belong to the Musaceae within the order Zingiberales, together with eight tropical plant families (Figure 2B, Table S1), some including genera known for their medicinal properties and ornamental use. APG IV (Chase et al. 2016) has confirmed the position of Zingiberales as a monophyletic order within the monocots, placing it in the commelinoid clade, as sister group to Commelinales, but has not addressed the interfamilial relationships of the other families belonging within the order (Fig. 2B). Understanding the relation and genomic organization of Ensete as sister to Musa may provide novel insights into the evolution of the globally important Musaceae family. Like the other Musaceae genera, Ensete originated in northern Indo-Burma during the early Eocene, likely followed by a single African colonization via gradual overland dispersal during a more mesic climate period (Janssens et al. 2016). The presence of Eocene Ensete fossils in North America (Manchester and Kress 1993) establishes that the genus also reached the New World. Ensete differs from bananas in being mainly African in distribution, monocarpic,

having large seed size (up to 18mm compared to 10mm) and an apparent adaptation to cooler and drier environments than most Musa species (Cheesman 1947; Baker and Simmonds 1953). Musa and Ensete can be further distinguished by the presence of 'T' shaped embryos and granulose papillose pollen grains in Ensete, and their absence in Musa (Bekele and Shigeta 2011). Ensete does not normally produce suckers, whereas Musa does — although a small number of suckering E. ventricosum landraces are known to occur in Ethiopia (provenance unknown). In the field, Ensete are perhaps best distinguished from Musa by their more rigid and upright leaves (pers. obs.). A further distinction is that Ensete is currently only reported to be diploid with 2n=2x=18 (Westphal 1975; Diro et al. 2003) and this is consistent with flow cytometry measurements in ten individuals (J.S. Heslop-Harrison and P. Tomaszewska pers. communication and chromosome counts (Figure 3). By contrast, Musa has species with x=7, 10 and 11 at various ploidy levels; domesticated varieties are commonly sterile, parthenocarpic triploids (2n=3x=33) (Bartoš et al. 2005). Species in the genus Ensete have a relative small DNA content, reported to be about 620Mb per haploid genome for E. livingstonianum (measured by flow cytometry, Bartoš et al. 2005) and 547Mb for E. ventricosum (estimated from whole genome sequencing, Harrison et al. 2014). This is similar to the genome size of haploid Musaspecies, ranging from 580-800Mb measured by flow cytometry (Bartoš et al. 2005), and the lower estimates from whole genome sequencing of 523Mb for M. acuminata (D'hont et al. 2012). Ensete species have n=9 chromosomes (Westphal 1975) and the karyotype consists of 7 mainly bi-armed chromosomes of similar size, each slightly bigger than those in banana (Figure 3). Musa species from the section Eumusa which includes the bananas M. acuminata and M. balbisiana, all have n=11. Other Musa species outside the section Eumusa (in sections Australimusa and Rhodochlamys) have n=9 and n=10. Molecular cytogenetics of E. ventricosum localised 5S rDNA sequences at the short arm of a medium pair of chromosomes (Figure 3) adjacent to the secondary constriction harbouring 45S rDNA. In Musa species that 5S and 45S rDNA are usually adjacent to each other and this has also been observed in E. livingstonianum (Bartoš et al. 2005). The latter has been reported to have additional minor 5S sites, that are either lost in E. ventricosum, or more likely varietal differences exist. Whilst phylogenetic relationships within genus Ensete, and to other genera within the Zingiberales are poorly known (Figure 2), there does appear to be support for a distinction between African and Asian Ensete lineages (Li et al. 2010; Janssens et al. 2016). In Musa there are over a thousand landraces with high genetic diversity, indicating multiple origins from different wild M. acuminata and its hybrids with M. balbisiana (Heslop-

Harrison and Schwarzacher 2007). The movement and interactions of various human groups have played an important role in generating this diversity (Perrier et al. 2011). Most landraces arise via selection (by farmers) of spontaneously occurring mutants with parthenocarpic fruit production. These are brought under cultivation, multiplied and distributed by vegetative propagation. Extensive hybridization has occurred, including between diploid wild species or genotypes, involving unreduced gametes, and perhaps residual fertility of triploids (Heslop-Harrison and Schwarzacher 2007). Due to the high levels of domestic diversity indicated in genetic studies (Tobiaw and Bekele 2011; Olango et al. 2015) and the overlapping spatial distribution of wild and domesticated enset, it seems likely that there were also multiple domestication events in enset, and/or frequent local introgression from wild populations. However, unlike Musa, we hypothesize that all domesticated enset landraces arose from a single species, E. ventricosum, as this is the only member of the genus present in Ethiopia or the surrounding region. More detailed diversity studies of wild and domestic enset in Ethiopia are required to elucidate the number of domestication events and population structure. Among communities in Ethiopia, E. ventricosum is unusual in that human-enset interactions currently span the entire spectrum of domestication intensity, from wild procurement to full domestication (Hildebrand 2001). As such, there is limited evidence to elucidate the timeline of domestication, not least since the crop has never moved outside its center of origin and diversity. Nevertheless, whilst wild enset is considered largely inedible, except during periods of severe food insecurity, smallholders report that domesticated landraces are more palatable. There is no data about the presence and genetics of secondary products that may be eliminated during domestication. Several authors have suggested that enset was first cultivated by growing wild plants in the terminal Pleistocene or Early Holocene (Brandt 1984; Hildebrand 2001). Though there is little evidence for this, it would compete with, or predate, the first evidence of intense Musa cultivation (~6500 years before present) in the New Guinea Highlands (Denham et al. 2003). Evidence from Uganda and Cameroon dates Musa cultivation in Africa to at least 2500 years before present (Mdiba et al. 2001; Lejju et al. 2006), although these data have not met universal acceptance (Neumann and Hildebrand 2009). There is limited evidence that enset, although not used today, may have been historically consumed in northern Uganda (Thomas 1940; Hamilton et al. 2016). It has also been suggested that Ensete once formed an 'Ensete belt' in East Africa from north-east Lake Victoria south-east to the Usambara Mountains, Tanzania (Langhe et al. 1994) and was used in times of food scarcity. This is largely consistent with the data presented in Figure 4, and we note that genetic characterization of these populations would provide

crucial insights on their history. Furthermore, among some communities (outside of Ethiopia) enset is reported to maintain a cultural significance (Philippson 1990). It has been suggested that this ancient care of Ensete in Africa contributed to the rapid and widespread adoption of the bananas arriving from Asia, with the oldest names relating to banana apparently derived from those in use for Ensete (Langhe et al. 1994). Elsewhere outside Africa, Ensete is reported to have been used as an emergency food source in Vietnam during the Second World War, with the growing point used as a vegetable (Oyen and Lemmens 2002). Similarly, parts of E. glaucum are consumed in New Guinea, particularly the ripe fruits which are eaten raw (Kennedy 2009) suggesting additional potential among underexploited wild relatives.

2.7 The distribution of wild and domesticated Ensete

Ensete consists of three very widespread species (E. ventricosum and E. livings tonianum in Africa; E. glaucum in Asia) and five other localised endemics or near-endemics (Figure 4). Three species have been formally assessed for the IUCN red list of which two (E. ventricosum and E. livingstonianum) are 'Least Concern' and one (E. perrieri) is 'Critically Endangered'. Although not assessed, E. superbum would probably meet the criteria for 'Endangered', and all other non-cultivated species could be considered 'Data Deficient'. Musella lasiocarpa may be extinct in the wild (Liu et al. 2003). Ensete ventricosum is the only Ensete species in Ethiopia (Brandt et al. 1997), occurring in the South and South West (Tsegaye et al. 2002) across the Southern Nations, Nationalities and People's Regional (SNNPR) region, as well as the neighboring regions of Oromia and parts of Benishangul-Gumuz (Figure 5). In this manuscript hereafter, we refer to E. ventricosum as enset and we distinguish wild from domestic landraces. Spelling of regions, zones and other place names follow Davis et al. (2018). Wild enset in Ethiopia is considered by some researchers to be range restricted and declining (pers. comm. S. Demissew) although there is a paucity of data to support or refute this. Birmeta et al. (2004) report that wild enset occurs mainly around the city of Bonga (SNNPR region; Kaffa zone) and in a smaller area by the Omo river (SNNPR region; Gamo Gofa zone) whilst Garedew et al. (2017) report wild enset widely distributed in Sheka forest (SNNPR region; Skeka zone). Herbarium records indicate historical presence in Metekel (Benishangul-Gumuz region), West Wellega (Oromia region), Kefa and Sidama zones (SNNPR region). Observations of wild enset are further complicated by escaped domestic enset occurring on the periphery of villages or in neighboring forests (e.g. a cluster of 15 enset plants closely resembling domestic varieties in

Harenna forest, several hundred meters from the nearest habitation; J Borrell pers. obs.). As a forest species, the wild enset distribution will be affected by regional rates of forest loss. Ethiopia currently has less than 4% forest cover, down from a potential climax vegetation maximum of 25-35% (Reusing 1998; Moat et al. 2018). It is possible that wild enset has become extinct in some areas, for example, in the Rift Valley area around Hawassa (SNNPR region; Sidama zone), where an estimated 82% of forest has been lost since 1972 (Dessie and Kleman 2007). This area has a strong and diverse enset culture, and is considered by some the origin of enset domestication (Simoons 1965), yet there is no contemporary evidence of wild enset. By comparison, domesticated enset is considerably more widespread in Ethiopia, suggesting substantial niche expansion for the cultivated crop. The distribution of domesticated enset appears to reflect both amenable ecological conditions, population density (Yemataw et al. 2014b) and the presence of ethnic groups for which it is a staple (Tsegaye and Struik 2002; ethnobotanical aspects also reviewed in Borrell et al. in prep). Enset is a highland crop cultivated at altitudes ranging from 1200 to more than 3100 meters a.s.l. (Simoons 1965; Brandt et al. 1997; Tsegaye et al. 2001, 2002) and is reported to perform best at elevations of 2000-2750 m (Brandt et al. 1997). According to Bezuneh and Feleke (1966) the soil type of enset cultivation areas is moderately acidic to slightly basic (pH 5.6-7.3), with 0.10–0.15% total nitrogen and 2–3% organic matter. Similarly, Shank (1994) reported that enset often performs best in acidic, heavy clay soils that retain high levels of organic matter when manured. Preferred climatic conditions are reported to be an average air temperature of 16-20°C and an annual rainfall of 1100-1500mm, evenly distributed throughout the year (Brandt et al. 1997).The suitability of environmental conditions for enset cultivation across the domestic distribution clearly differs, as yield, age to maturity and maximum obtainable size vary considerably (Tsegaye et al. 2001; J. Borrell and A. Davis, pers. obs.), although this is likely confounded with agriculture practice and landrace selection (Shumbulo et al. 2012). At the upper elevation limit, low temperatures and frost has been hypothesised as a constraint; at the lower limit, water availability (Brandt et al. 1997). Various authors have defined enset as a drought tolerant (Shumbulo et al. 2012; Harrison et al. 2014) and it is widely regarded as ‘drought-resistant’ in Ethiopia (Birmeta 2004) although there is a lack of rigorous evidence to demonstrate this. The geographical range of wild enset (in Ethiopia) is more limited, perhaps due to more specific ecological requirements or alternatively loss of habitat (Figure 5). According to several authors it is restricted to 1200–1600 m a.s.l. (Brandt et al. 1997). Baker and Simmonds (1953) described enset as a species of swamps, river banks or forest clearings, at middle altitudes,

rarely or never in dense shade. Across its regional distribution, they record altitudes ranging from 1300 m to 2300 m. Contemporary wild populations have been reported in humid forest, frequently along river banks, often consisting of 10–200 plants (Birmeta et al. 2004). It therefore seems that distribution and environmental tolerance of domesticated enset, relative to its wild progenitor, has been expanded through the domestication process.

2.8 Enset varieties

The use of enset and its products for different purposes such as food in the form of amicho (inner part of the corm eaten boiled), kocho (fermented material obtained from a mixture of decorticated leaf sheath and corm), bulla (water insoluble starchy product obtained by squeezing the scrapped leaf sheath and corm), medicine, ritual and construction purposes could have attributed to the existence of various different enset varieties in the Bonga in situ conservation site. These are identified, named and categorized by the farmers in the area based on pseudo stem, petiole and midrib color, size (width and length), and various end use and disease resistance characteristics. Enset-grow ers in the study area distinguished more than 65 different types of enset varieties with their respective local names (unpublished report) of which only 42 are used in this particular study. Any one farmer usually grows a mix of several different types in a given farm.

To facilitate the understanding of the challenge of variability, diversity, and clearly define and develop scientifically acceptable biological classification, Awegechew (1996) argues that both folk botanical and scientific taxonomy should be taken into consideration. Although folk botanical nomenclature is not guided by a set of written rules, there are striking similarities in the way that plants are named by local people around the world (Martin 1995). Enset vernacular names are often quite consistent in the study area. Some of these have descriptive meaning while others are just simply names. In most of the villages the common names are shared among the people. In addition to other morphological and end-use characters, midrib color and pseudo stem color (both in some varieties or one of them in others) are the most important characters used by the farmers to classify enset clones into sub-clones and to differentiate among enset clones in the study area. Though, it would seem very difficult to determine which varieties belong to cultivated or wild groups for non-enset growing farmers, the enset grower farmers easily distinguish between the two on the basis of color, shape, and many other characteristics.

2.9 General characteristics of enset

Characteristics	Enset
• Growth form of plant	Perennial
• Habit	Herb
• Agro-ecological cultivation	Midland and highland (15002250masl)
• Habitat nature	Home garden and main field
• Drought resistance	Yes
• Fertilizer requirement	Low requirement
• Compost requirement	High
• Growing habit on swampy, waterlogged soil, Planting material	No
• Maturity period	3-5 years
• Storage time in ground	Short
• Post-harvest storage life	Long

2.10 Challenges of Enset Crop Production

The major challenges in enset production in Ethiopia that recurrent lack of enough research in enset Production and marketing, drought, disease, lack of improved clones in terms of yield, lack of disease resistant variety, shortage of training to producers how to cultivate, lack drought tolerance variety; lack of improved processing and storage technologies, improper or traditional agronomic practice, long time maturity and food shortage/starvation. Poor agronomic and traditional cultural practice such as frequency of transplanting, spacing, fertilization, pruning and so on are done blanketly that significantly affects both production and productivity of enset in the area. Once again frequent transplanting and cultivation also has direct relation to crop maturity, productivity and efficient utilization of labour, land and time as well. More over the farmers in the area do not have any know how about the amount, type and method of fertilizer application that significantly affects its production since the crop by nature highly respond to applied fertilizers be it organic or inorganic (Abrham et al., 2012). There are a number of factors influencing enset popularity among farmers in Ethiopia. These factors are

geared toward independent household survival in farming systems that have been fraught with pests, surprised by erratic rainfall and scourged by government urbanization. Enset cultivation has been undeveloped by independent farmer investigation and enset crop have been utilized to provide consistent food availability to smooth over the rough times of household food security. Absence of commercial farming system, less attention to crop by government, lack of wide research on crop and reliable documents are also main problems to the sector. Self Help Development Agency is an Irish-based development agency, involved in the implementation of long-term development projects in Africa. The agency has field offices in Ethiopia, Malawi, Eritrea, Kenya and Uganda (Demeke, 2011). There have been obstacles facing those engaged in promoting the propagation of enset, the most fundamental being it takes three to five years for the plant to achieve maturity. While a five-year-old plant can yield 40 kg of food, farmers who harvest after a single year can expect a yield of just one kg from the pseudo stem - the bowl of the tree which is processed for food. Although it is estimated that there are currently upwards of 10 million people in southern Ethiopia consuming enset in their diet, there are historic and cultural reasons why others in the country do not. During the reign of Emperor Haile Selassie (1930-1975), the Ethiopian Ministry of Agriculture launched major initiatives to increase food production. The emperor gave strict instructions to focus on cereal crops and income-generating crops, such as coffee, while the enset plant was ignored. The situation for enset did not improve under the subsequent Socialist Derg regime (1975-1991), whose research projects had insufficient funds, and did not examine the potential of a crop (FDRE, 2008).

Chapter Three

3. Methodology

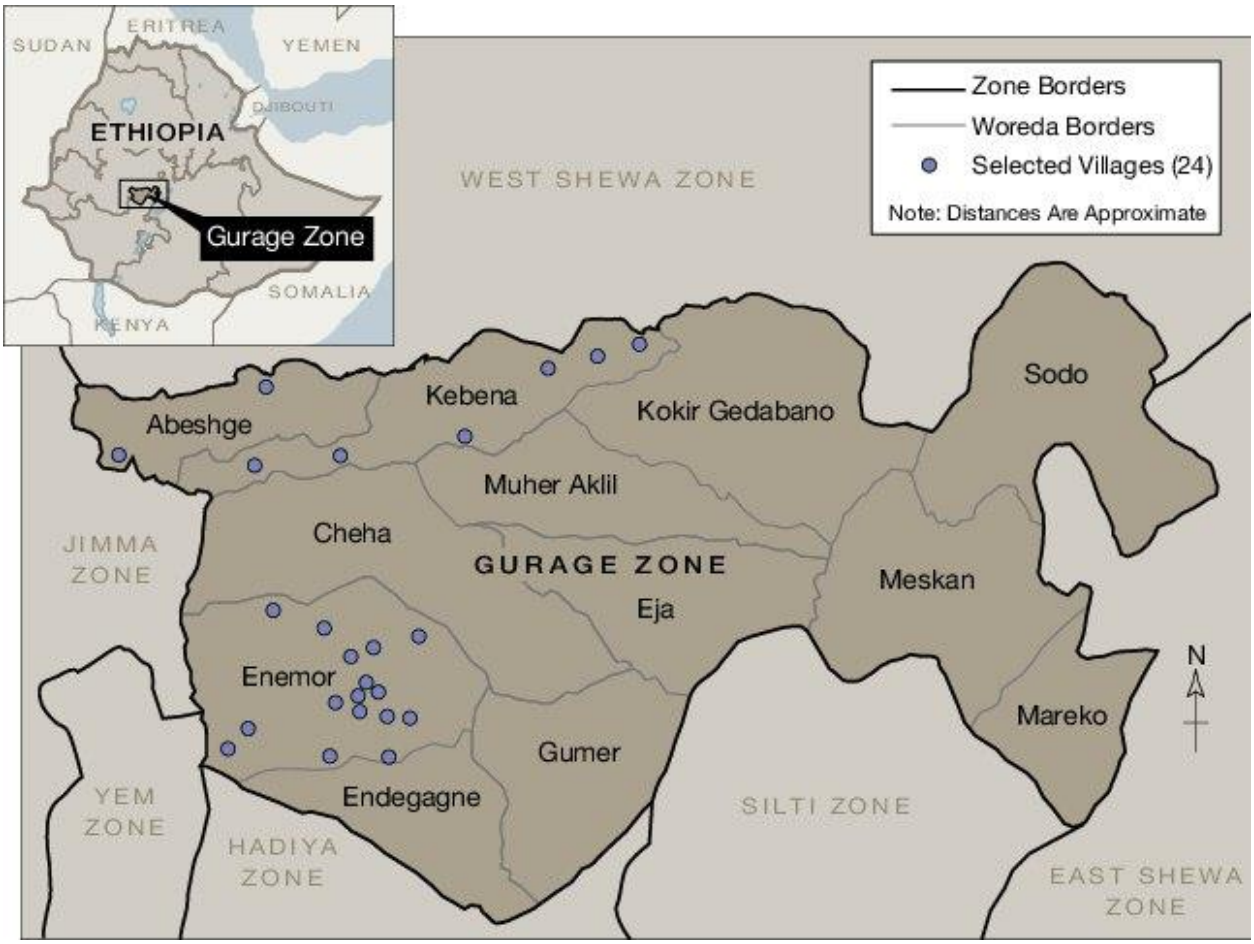
3.1 Area Description

Gurage is a Zone in the Ethiopian Southern Nations, Nationalities, and Peoples' Region(SNNPR). This zone is named for the Gurage people; whose homeland lies in this zone. Gurage is bordered on the southeast by Hadiya and Yem special woreda, on the west, north and east by the Oromia Region, and on the southeast by Silt'e. Its highest point is Mount Gurage. Wolkite is the administrative center of the Zone; Butajira is the largest city in this zone. The population of the study area is almost entirely of the Gurage ethnic group (82%). The Gurage people live a sedentary life based on agriculture, involving a complex system of crop rotation and transplanting. ENSET is their main staple crop, but other cash crops are grown, which include coffee and chat. Animal husbandry is practiced, but mainly for milk supply and dung.

The study area, Ezha Woredas is found in Gurage Zone of Southern Nations Nationalities and Peoples (SNNP) Region. It is found at a distance of about 197 km south of Addis Ababa. And 40km from Wolkite. The Woreda comprises 28 Kebele administrations. Among these, three of them are urban areas and twenty five of them are rural kebeles.

Its weather condition 37% High land, 53% temperate zone, 10% low land. Its annual rain falls 1200mm (Higher) & 500mm (lower). Its air condition $27C^0$ (higher) and $10C^0$ (lower).

3.2 Guraghe zone map



3.3 Data collecting tools and methods

The study was conducted in edja woreda of the Guraghe Zone in Southern Ethiopia. A detailed survey and field observations were conducted to generate information on traditional enset fermentation practices, storage conditions, the use of a starter culture, fermentation time, sensory properties of the fermented enset and the tools used to process enset. A total of 30 enset producing households were assessed using an open-ended and semi-structured questionnaire. In addition, the processors were interviewed in their native language for additional information.

The study sites were selected based on areas that have high production of ENSET and those ENSET landraces which play economic and cultural roles. Based on the above selection criteria the study was conducted on three purposively selected three kebeles from Edja. From each Kebele 10 households were selected bringing the total number of sampled households to 30 informants having different ethnic, religious,

age and sex categories were interviewed. From the total informants, 20 were randomly selected from general informants and 10 were purposively selected key informants who were very interested and those who were recommended by elders, local authorities, and local farmers.

3.4. Method of Data Collection and Sources of Data

Both primary and secondary data were used in this study. The primary data were collected through semi-structured interview, field observation and questionnaire's. Secondary data were collected from different district offices and different written material.

3.5 Ethnobotanical Data Collection

Ethnobotanical data were collected in order to know the indigenous knowledge of participants or farmers on ENSET. Different qualitative and quantitative ethnobotanical data collection methods like field observation, guided field walk, semi-structured interview, and market surveys were used in order to get needed information from the participants. Semi-structured interview was used to gather ethnobotanical information on local name of the crop and landrace, time of cultivation and harvesting, traditional management practices, cropping system, uses and market value of the crop, landraces which survive drought, disease, pest and have short maturity time, planting material exchange system and production constraints and perception of the farmers towards the crop.

Table 1 Region, zone, districts, kebeles and number of informants used in the study

Region	Zone	Districts	Kebeles	Number of informants
SNNPRS	Guraghe	Edja woreda		
			Shebraden	10
			kokera	10
			Desene	10
Total				**30**

Chapter four

4. Results Discussion and Analysis

Results and Discussion

የዕድገትና ትራንስፎርሜሽን ዕቅድ ዘርፎች

1	**ግብርና**
1.1	ሰብል ልማት የእንሰት ምርት
2	**ኢንዱስትሪ ልማት**
2.1	ጨርቃ ጨርቅና አልባሳት
2.2	ቆዳና የቆዳ ውጤቶች
2.3	ስኳርና ተጓዳኝ ምርቶች
2.4	ሲሚንቶ
2.5	ብረታ ብረትና ኢንጂነሪንግ
2.6	ኬሚካል (ፋርማሲቲዩካል፣ ሀትመት፣.....)
2.7	አግሮ ኘሮሰሲንግ የማር ምርት ማቀነባበሪያ
3	**ማዕድን**
4	**ኢኮኖሚ መሰረተልማት**
4.1	መንገድ ግንባታ
4.2	ባቡር ትራንስፖርት
4.3	መንገድ ትራንስፖርት
4.4	ባህር ትራንስፖርት
4.5	አየር ትራንስፖርት
4.6	ኢነርጂ
4.7	ውሃና መስኖ
4.8	ቴሌኮሙኒኬሽንና አይሲቲ
4.9	ከተማ ልማትና ሀንፃ ኮ/ን
5	**ንግድ**
6	**ጤና**
7	**ባህል፤ ቱሪዝምና ስፖርት**
8	**ማህበራዊ**

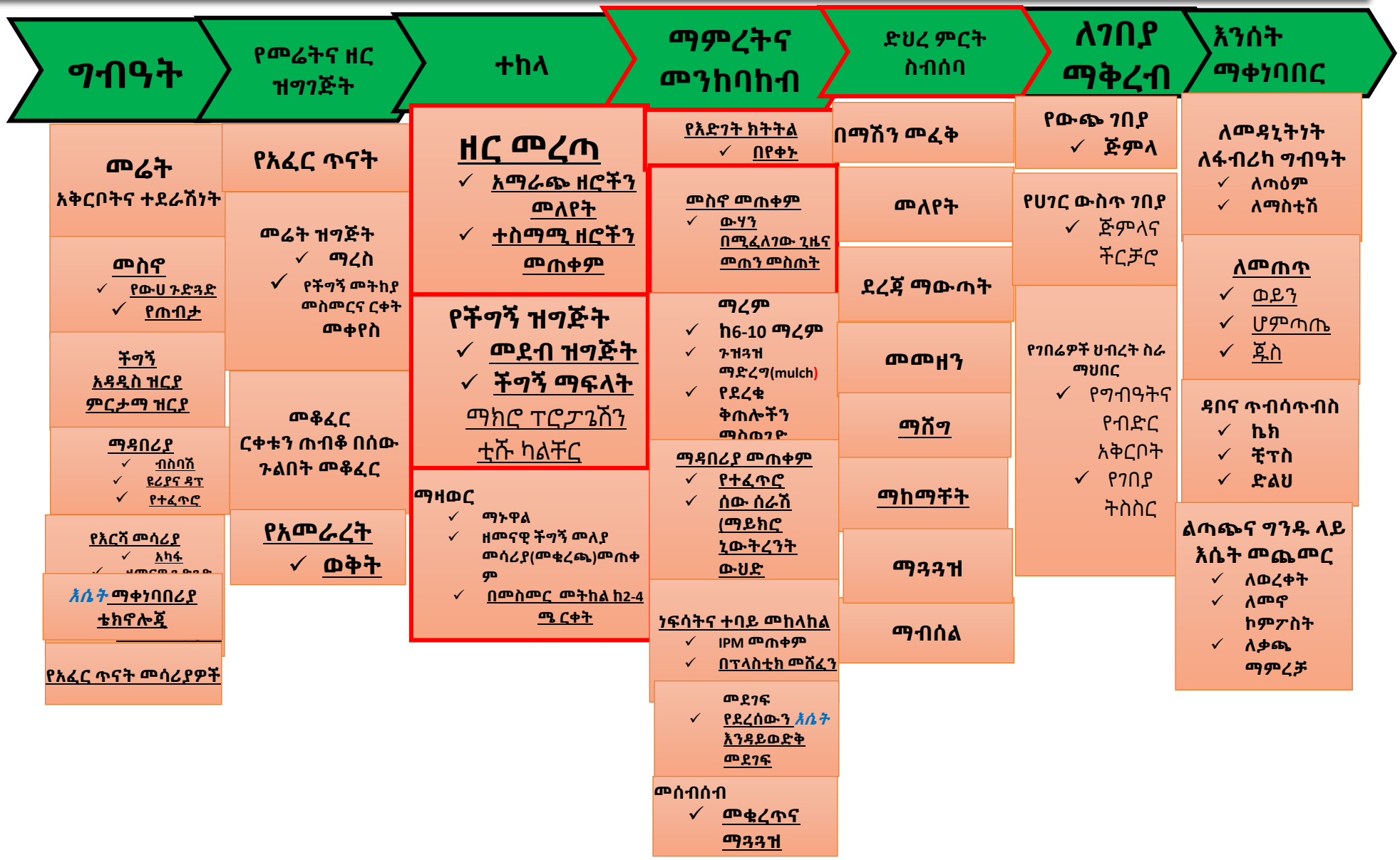
Facts and figure on enset production

No	Zone	Hectares	kocho (mt)	Bulla (mt)	Feber (Qtl)
1	Gurage	52,400	786,00	78,600	366,800
2	Hadiya	18,013	210,752	52,218	108,078
3	N.omo	55,609	706,234	72,292	389,263
4	Kembata	11,689	136,843	19,883	93,568
5	Yem	5.020	62,750	2,008	10,040
6	Sidama	43,334	940,347	86,668	476,674
7	Amaro	4,000	32,000	NA	16,000

የእንሰት ምርት የእሴት ሰንሰለት የአሁኑ አሰራር

የመሬት ዝግጅት	የዘር ዝግጅት	ተከላ	ማምረትና መከባከብ	ድህረ ምህርት ስብሰባ	ለገበያ ማቅረብ
ጉድጓድ መቆፈር	ምርጡን ዘር መምረጥ	ቆፍሮ መትከል	እድገቱን መከታተል	መንቀል እና ለምግበነት መፋቅ	ከጉድጓድ አዉጥቶ ለምግብነት ማዋል
እበት መጨመር	አስተካክሎ መቁረጥ	ከፀሀይ መከላከያ ማልበስ	የደረሰዉን መለየት	ለምግብነት የሚዉለዉን መለየት	ለገበያ ማቅረብ
	መሀሉን መበርቦር	እበት መስጠት		ጉድጓድ ቆፍሮ መቅበር	
	ፍግ መጨመር				

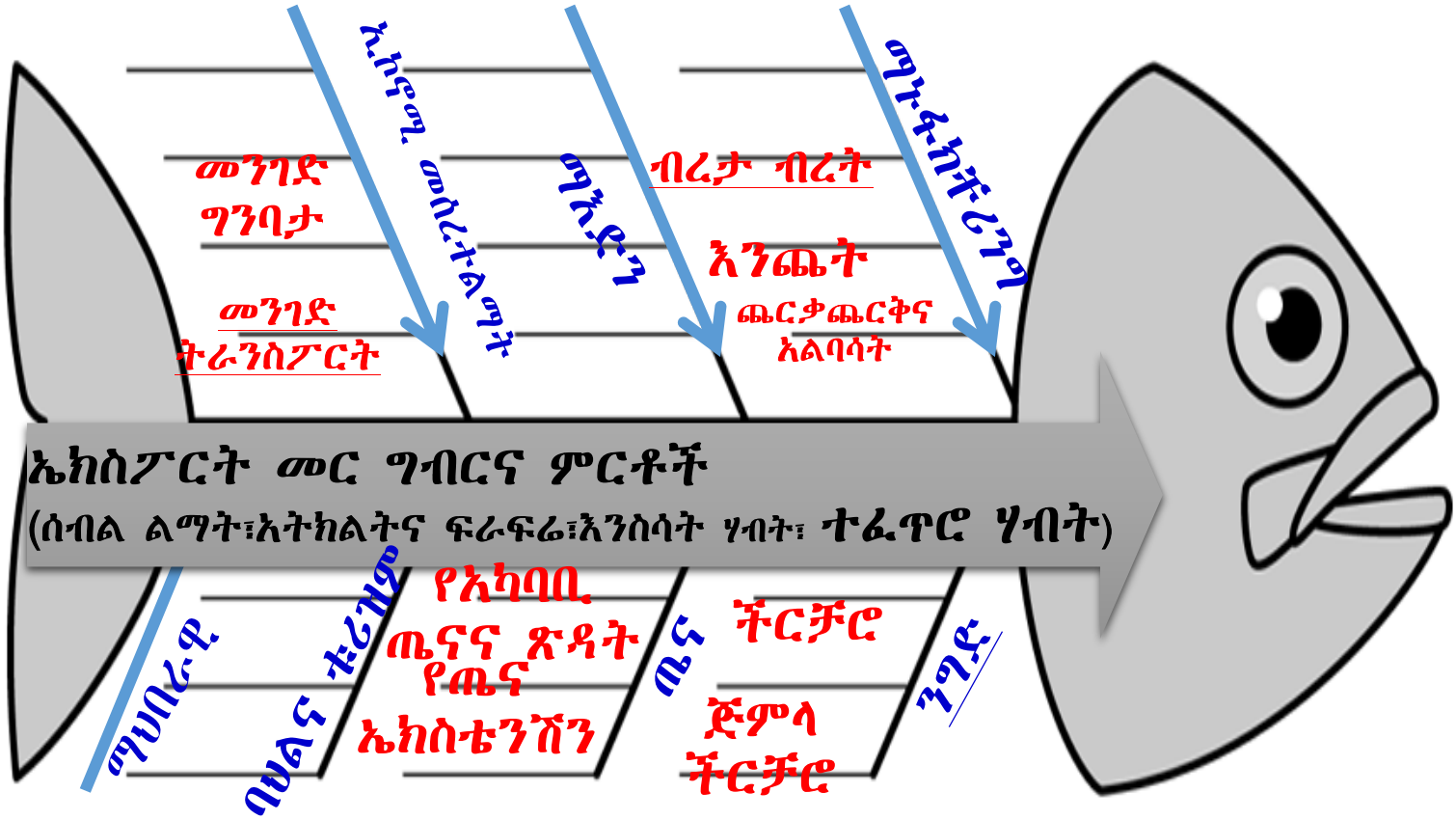
የእንሰት ምርት እሴት ሰንሰለት መሆን ያለበት



የእንሰት ምርት ሂደት የተለዩ ቴክኖሎጅዎች

No	Techno-ware	Human-ware	Info-ware	Orga-ware
1	እንሰት መፋቂያ ማሽን በኤሌክትሪክ የሚሰራ	እንሰት መፋቂያ techniques, Safetyand health knowledge (awareness)	እንሰት መፋቂያ processing manual -Promotion -Documents	እንሰት መፋቂያ technology Laboratories
2	እንሰት መፋቂያ ከእንጨት የሚሰራ	እንሰት መፋቂያ techniques -Safety and health -knowledge (awareness	እንሰት መፋቂያ processing manual -Promotion -Documents	እንሰት መፋቂያ technology Laboratories
3	ቡላ መጭመቂያ ከእንጨት የሚሰራ	Use bulla pressing system -operate bulla pressing technology	Manual of bulla press technology -Manual of bulla press technology	Packaging unit -storing unit
4	ቡላ ማድረቂያ ማሽን በኤሌክትሪክ የሚሰራ	ቡላ ማድረቂያ ማሽን techniques -Safety and health -knowledge (awareness)	Documents -user manual	Market linkage -Storage place -observation
5	ለከብቶች ኮባ መከትከቻ ማሽን	Machine operation technique	Machine operation manuals	Organized animal food storage center
6	አምቾ መፋቂያ	Annual operation technique	operation & maintenance manual	Organized food storage area
7	ዳብየ መጋገሪያ ማሽን	Machine operation technique	Machine operation manuals and safety manual	Market linkage -Storage place -observation

1) ግብርና


ኤክስፖርት መር ግብርና ምርቶች
(ሰብል ልማት፣አትክልትና ፍራፍሬ፣እንስሳት ሃብት፣ ተፈጥሮ ሃብት)
ኢንዱስትሪያል
ማኑፋክቸሪንግ
መንገድ ግንባታ
መንገድ ትራንስፖርት
ብረታ ብረት
እንጨት
ጨርቃጨርቅና አልባሳት
ማህበራዊ
ባህልና ቱሪዝም
የአካባቢ ጤናና ጽዳት
የጤና ኤክስቴንሽን
ጤና
ችርቻሮ
ጅምላ ችርቻሮ
ንግድ

Analysis and Interpretation

The researcher prepares 30 questioner paper to collect data and gather informations from selected kebeles and out of 30 papers the 28 papers are filled out properly by respondents and the rest 2 papers are not returned.

No	Item	No of respondent	Percentage %
1	Educational background of respondents		
	Diploma	1	3.57%
	Degree	5	17.85%
	MA	0	0
	Elementary	20	71.42%
	other	2	7.14
	Total	28	100

As the above table shows that 3.57% of respondents are diploma whereas the 17.85% of respondent's educational background is bachelor degree(BA) and the highest number or about 71.42% of the respondent's Educational background is elementary (Grade 1-8) &the other 7.14 % of respondents are stated as no educational background. Generally, the figure shows that the most and the highest number of the respondent's educational background is dropout from elementary.

1.The average enset productivity that the farmers will harvest from one hectare in quintal. how much quintal per hectare?

Out of 28 respondents about 57.14% of respondents are absolutely not know how much quintal enset product are harvest from one hectare, whereas the rest respondents are just give a hypothesis figure of how much quintal are will gain from

per hectare but in general we conclude that most of the respondents are that much don't know how much quintal enset product are harvest from one hectare.

2.How do You rate the productivity of enset in your woreda?

Around 90 % of respondents are given their answer that the productivity of enset in this woreda are very less because there is very low supply of enset fertilizer, and a shortage sufficient natural compost, the occurrence of enset disease, lack of attention from the farmers, stakeholders and the government, less use of technology, outdated and backward method of farming and production system, the weather condition specially around highland or cold zone parts of the woreda, these mentioned the above and others reasons are the main factors behind the decrement of the productivity.

3.How seems like the usage of technology on the cultivation production process of enset?

All respondents are respond that there is no usage of technology to improve and increase the productivity of enset product and their reason for this response is lack of attention from governmental and non-governmental organizations.

4. How is the demand of the farmers on the usage of technology to improve the production process of enset?

According to the respondent's response the almost all farmers demand and want on the technologies that will simplify the work and increase the productivity and quality of enset product is very high.

5. What do you expect from stakeholders and others bodies to increase the **productivity of enset production?**

According to the respondents response all stakeholders such as governmental and non-governmental bodies, private sectors, TVET institutions and other concerned bodies should encourage and support the farmers in different ways like: by supplying fertilizer, introducing innovating new technologies that simplify and increase the productivity, giving training for farmers to improve and modernize their way of farming and planting, and also giving a possible solutions for enset disease and way of prevention and controlling the disease before destructions and conducting more and more researches to asses and identify the overall challenges and opportunities of enset production as a whole.

6. Is there enset disease occurs in edja woreda?

From 28 respondents about 82.15% of the respondents respond that the enset disease affect and decrease their enset productivity and quality on the other hand about 17.85% respondents are replied that there is no enset diseases occur in their enset farm. Generally, most of the respondents believe that there is a disease that

highly affect the production of enset in edja woreda. No scientific solution has been found or sought from anybody until now. We tried all our best to overcome the disease with our traditional means to control it.

7. If your answer is yes how do you know when the enset plant is affected by and what are the symptom of affected plant?

The respondents whose answer is yes on the question 6. They will identify and know that when the enset plant is affected by disease, these cue identification systems are gained and inherited from their ancestors these cues and symptoms are like: The affected enset plants are show a bacterial wilt on their leaf, there will be a liquid that seems like a pus on their leaf (koba), and also the affected enset plant leaf will shrink and eventually dried up.

8. When do you observe and check your enset farm?

According to respondents all respondents are replied that they are observe and check the situation of their enset farm on their garden daily.

9. How do you report and inform to agriculture extension professionals when enset disease occurs in your farm?

According to the respondent's response, most of the respondents replied that they tend to inform and report the happening of enset disease to agriculture extension

professionals orally, and the rest respondents said that they are not inform and report the occurrence of enset disease to extension professionals.

10. Do you use technology to identify the enset disease previously?

All respondents replied that they do not use any technology to identify the enset disease all farmers are practiced traditional way of identify the cue of enset disease symptoms. as we mentioned above these traditional ways of enset disease symptom identification system experienced and inherited from their ancestors. No scientific solution has been found or sought from anybody until now. We tried all our best to overcome the disease with our traditional means to control it.

11. What kind of method do you use control the enset disease?

All respondents replied that their enset disease control method is traditional, because there is no opportunity to train and adapt how to control the disease in modern and improved way of controlling and also no new technologies introduced and innovated that is better than traditional way.

13. Does the farmer and community feel happy by working on producing and planting of enset production?

According to respondent's response all respondents are replied that they are much happier by working and producing enset production because enset is their main staple crop as well as it is draught resistant food plant and also they can harvest the

product throughout the year, on the other hand "Enset" is a multi-purpose crop. It is used for human consumption, animal feed and for extraction of long fibers ("Kancha") used for making bags, rags, robe, gunny bag, etc. Because of the above mentioned reasons all farmers are feel happy and proud of cultivating enset product.

14.What should be the role of TVET institutions to increase the productivity of enset?

All respondents replied that the TVET institutions should support and encourage the farmers in different ways such as by innovating and introducing new technologies and new way of farming that lead to productivity, should give training and create awareness for farmers how to produce enset production with quality and they should give training for farmers how to prevent the enset from disease and how to control the disease after the occurrence. Generally, the Tivet institutions should play a pivotal role on the minimization and elimination of community problems and producing new technologies to overcome identified problems and to ease the community way of life.

15. What kind of constraints and problems do you face during the harvesting period/time of enset product?

According to all respondent's response there are many hindrances and constraints that faces the farmers during the harvesting time of enset production, such as:

wastage of product may occur, deterioration of the last product quality and quantity, wastage of human resource and money, shortage of human resource and finance because it needs more time and financial capacity to harvest the product, and wastage of time and other constraints are faces for farmers.

16. What are the challenges and problems you are facing on the overall process enset production, from the beginning to the last product or output of enset?

All respondents replied that they are faces many constraints and problems throughout the production process such as: enset disease and lack of awareness how to prevent and shortage of supply of disinfectants to control the disease, shortage of fertilizer, the production process takes more time, the fluctuating behavior of weather condition may affect the productivity, lack of attention from stakeholders and any other concerned bodies.

17. If you have any suggestion and opinions on enset product and production process?

Most of the respondents suggest and recommend that in Edja woreda that Enset has several important food security traits. It grows over a relatively a wide range of conditions, is somewhat drought tolerant, and can be harvested at any time during the year, over several years. It provides an important dietary starch source, as well as fibers, medicines, animal fodder, roofing and packaging. so all stakeholders such

as governmental and non-governmental bodies, private sectors, TVET institutions and other concerned bodies should encourage and support the farmers in different ways like: by supplying fertilizer, introducing and innovating new technologies that simplify and increase the productivity, giving training for farmers to improve and modernize their way of farming and planting, and also giving a possible solutions for enset disease and way of prevention and controlling the disease before destructions and conducting more and more researches to asses and identify the overall challenges and opportunities of enset production as a whole.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1, Conclusion

Enset is uniquely adapted to highly populated regions in Ethiopia where rainfall and temperatures are adequate. It provides food security, it is drought tolerant, it can be stored over the long-term, and it is more efficient in terms of energy per unit space and time than any other staple crop in Ethiopia. The ability of farming households to grow sufficient enset depends in some extent on the wealth status of the household, and market access will strongly influence decisions to plant annual staple crops or invest in cash crops other than coffee. Although annual crops may not provide as much food and income security in the long-term, they may allow easier access to household income.

The finding clearly indicated that Enset plays various social roles, its act as cultural identity food crop, as status symbol, medicinal purpose, an indicator of wealth and an asset for farmers. Furthermore, it plays a great economic role, as primary food source for humans, source of livestock feed, source of income and non-food uses for a wide range of small holder households in the study area.

This study implies that in Guraghe zone, Edja woreda that Enset has several important food security traits. It grows over a relatively a wide range of conditions, is somewhat drought tolerant, and can be harvested at any time during the year, over several years. It provides an important dietary starch source, as well as fibers, medicines, animal fodder, roofing and packaging.

The major factors that hinder the socio-economic and environmental role of enset were disease of enset, poor cultivation and management, lack of disease controlling measures, expansion cash oriented crops on enset farm, impact of climate change and low awareness towards its role.

As we understand from the analysis the study concludes that there are many hindrances and constraints that faces the farmers during the harvesting time of enset production, such as: wastage of product may occur, deterioration of the last product quality and quantity, wastage of human resource and money, shortage of human resource and finance because it needs more time and financial capacity to harvest the product, and wastage of time and other constraints are faces by farmers.

In general, the unique features of the enset among others include: it has multipurpose roles such as social, cultural, economic and environmental roles. Therefore, the current study in the area calls for the involvement of government officials, research professionals and research centers, development organizations (GOs and NGOs), development agents and farmers give more attention and exploit the multipurpose potential of enset and to expand its roles and production to other non-producing areas.

5.2 Recommendations

Based on the analysis and discussion made, the following recommendations are drawn:

- All stakeholders such as governmental and non-governmental bodies, private sectors, TVET institutions and other concerned bodies should encourage and support the farmers in different ways like: by supplying fertilizer, introducing and innovating new technologies that simplify and increase the productivity, should provide trainings for farmers to improve and modernize their way of farming and planting, and also giving a possible solutions for enset disease and way of prevention and controlling the disease before destructions and conducting more and more researches to asses and identify the overall challenges and opportunities of enset production as a whole.
- Enset has multipurpose role; social, economic and environmental roles. Hence, concerned bodies (GOs, NGOs research centers, development agents and research professionals) should strongly work on enset and exploit the multipurpose potential and expand its roles and production to other non-producing areas.
- The finding of this study reflects that most of the farmers in the study area have more questions towards the improvement of traditional way of farming enset. Therefore, concerned bodies such as development agents, woreda agricultural experts, NGOs and research organizations should strongly work to create awareness, train and educate farmers to give attention and increase the productivity of enset plant.
- The attention given by government organizations, NGOs and research centers to improve the productivity of enset was low in the study area. Hence, policy makers should enact various policies and strategies that encourage the productivity of enset plant

- As far as enset is concerned, farmers should at least be made aware and advised on preventing the transmission of the enset disease especially bacterial wilt until scientific solution to be found by research centers.
- There is no scientific solution delivered to enset disease. Hence, further study need from research centers, government bodies and NGOs working in the area in order to control enset disease.
- The existing traditional methods of enset processing are labor intensive, tedious, time consuming and exploit women's labor and may also have an impact on the quality of the product. Research towards the production of modern and time consuming processing technology is important. It should be able to meet women's needs and it will reduce the workload of women's.

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7. APPENDIXES

Agena Construction and Industrial College

A value Chain Analysis on Enset production and productivity in case of edja woreda

A Questionnaire prepared for edja woreda selected kebeles enset producer farmers and consumers

This questionnaire is prepared to gather information about Enset production and productivity in case of edja woreda.

Dear: sir/madam

The researchers believe that your kind cooperation and honesty in giving your responses will help the researchers in conducting a research about Enset production and productivity in case of edja woreda.

1.the average enset productivity that the farmers will harvest from one hectare in quintal. how much quintal per hectare?

2.How do You rate the productivity of enset in your woreda?

High ……. Low……. Medium……

3.How seems like the usage of technology on the cultivation production process of enset?

4. How is the demand of the farmers on the usage of technology to improve the production process of enset?

5. What do you expect from stakeholders and others bodies to increase the productivity of enset production?

6. Is there enset disease occurs in edja woreda? Yes _____No……

7. If your answer is yes how do you know when the enset plant is affected by and what are the symptom of affected plant?

8. When do you observe and check your enset farm?

9. How do you report and inform to agriculture extension professionals when enset disease occurs in your farm?

A, Orally B, by phone C, other option

10. Do you use technology to identify the enset disease previously?

11. What kind of method do you use control the enset disease?

A, Modern B, Traditional method C, If any other …

12. If you use traditional way of disease controlling method please mention it……
……

13. Does the farmer and community feel happy by working on producing and planting of enset production?

14.What should be the role of TVET institutions to increase the productivity of enset?

15. What kind of problems do you face during the harvesting period/time of enset product?

16. If you have any suggestion and opinions on enset product and production process?

17. What are the challenges and problems you are facing on the overall process, from the beginning point to the last product or output of enset?

አገና ኮንስትራክሽን እና ኢንደስትሪያል ኮሌጅ

በእጣ ወረዳ ላይ የተሰራ የእንሰት ምርት እና ምርታማነት እሴት ሰንሰለት

ለእጣ ወረዳ በተመረጡ ቀበሌዎች ለእንሰት አምራች አርሶ አደሮች እና ተጠቃሚዎች የተዘጋጀ መጠይቅ

በአገና ኮንስትራክሽንና ኢንደስትሪያል ኮሌጅ በ2012 ዓ.ም በእንሰት አመራረት ዙሪያ እሴት ሰንሰለት ለማዘጋጀት ታስቦ የተዘጋጀ መረጃ መሰብሰቢያ መጠይቅ

ሀ. አድራሻ

ወረዳ----------ከተማ----------ቀበሌ----------

መረጃውን የሞላው ስም----------የሙያ ዘርፍ----------

1. **የት/ት ደረጃ ☐ ዲፕሎማ ☐ ዲግሪ ☐ ማስተር ☐ ሌላ**

   መጠይቁ የተደረገበት ቀን----------

1. **በወረዳው የእንሰት ምርታማነት ሁኔታ በአማካይ በሄክታር ስንት ኩንታል ቡላ ይገኛል?----------**

2. **በወረዳው የእንሰት ምርታመነት መካከለኛ/ዝቅተኛ ከሆነ ምክንያቱ ምንድነው? ------**

   ----
3. **በወረዳው አ/አደሩ በእንሰት አመራረት ዙሪያ የቴክኖሎጂ አጠቃቀም ሁኔታ ምን ይመስላል? ----------**

   ----
4. **አ/አደሩ በእንሰት አመራረት ዙሪያ ቴክኖሎጂን ከመጠቀም አንጻር ያለው ፍላጎት**
   1. **ከፍተኛ** 2. **ዝቅተኛ**

5. **የእንሰት ምርትና ምርታማነት ለማሳደግ ከማን ምን ይጠበቃል ይላሉ? ----------**

----

6. **በወረዳው የእንሰት በሽታ ይከሰታል? ----------**

7. **መልስዎ አዎ ይከሰታል ከሆነ እንሰቱ በበሽታ መጠቃቱን ለማወቅ ምን አይነት ሂደት/ዘዴ ትጠቀማላችሁ ? ----------**

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8. የእንሰት ማሳ ማየት/መጎብኘት በስንት ጊዜ/ቀን/ሰዓት ታከናውናላችሁ? ----------

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9. መልሳችሁ አከናውናለሁ ከሆነና የበሽታ ምልክት ካለ ለግብርና ኤክስቴንሽን ባለሙያ መረጃ በምን መልክ ታስተላልፋላችሁ?

☐ በቃል ☐ በስልክ ☐ በትራንስፖርት ☐ ሌላ ካለ----------

10. ከዚህ በፊት የእንሰት በሽታ ለመለየት የምትጠቀሙበት ቴክኖሎጂ/ፈጠራ ካለ ይገለጽ

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11. የእንሰት በሽታን ለመከላከል/ለመቆጣጠር የምትጠቀሙት ዘዴ

☐ ዘመናዊ ☐ ባህላዊ ☐ ሌላ ካለ ይገለጽ ----------
---

12. የምትጠቀሙት ዘዴ በባህላዊ ዘዴ ከሆነ ምክንያቱ ይገለጽ ----------
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13. አ/አደሮች በእንሰት ስራ ተሰማርተው ሲሰሩ ደስተኛ ናቸው? ወይስ አይደለም? ይብራራ ----------
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14. የእንሰት ምርትና ምርታማነትን ከፍ ለማድረግ ከቴክኒክና ሙያ ተቋማት ምን ይጠበቃል?

15. በእንሰት ምርት ስብሰባ ወቅት ምን ምን ችግሮች ያጋጥማሉ
.....

16. በእንሰት ዙሪያ ሌላ ተጨማሪ አስተያየትና ሀሳብ ካለ----------

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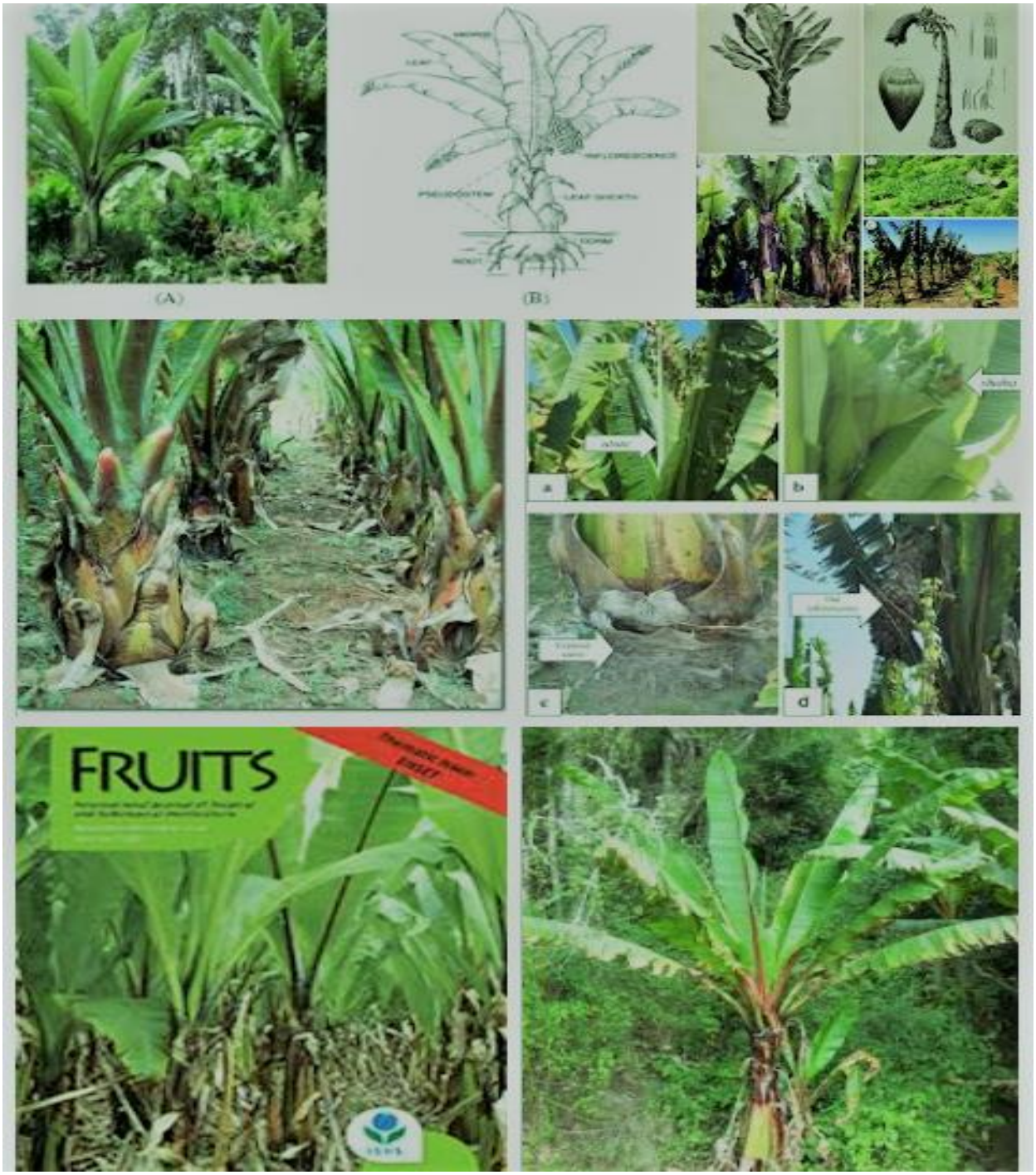
17. ከተከለው ጀሚሮ እስከ መጨረሻ ምርት ድረስ የሚያጋጥሙ ችግሮች ካሉ ----------

ለመልካም ትብብርዎ እናመሰግናለን!!!!

Enset Photos



Fiber (**Kancha**) is the by-product of enset that is left after decorticating the leaf sheathes**.**