



**MATTU UNIVERSITY**  
**COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES**  
**DEPARTMENT OF BIOLOGY**  
**BOTANICAL SCIENCES**  
**ECOLOGICAL IMPACT ANALYSIS OF TEA (*Thea*  
*sinensis* L.) PLANTATION, IN ALE DISTRICT, ILU**  
**ABBA BOR ZONE, OROMIA REGION, SOUTHWEST**  
**ETHIOPIA**

**By : ETSEGENET DENBEL**

**Advisor: FIKRU MOSISA (M.Sc. ASSISTANT PROFESSOR)**

**JUNE, 2023**  
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**SCHOOL OF GRADUATE STUDIES**

**Advisors' Approval Sheet**

This is to certify that the thesis prepared by Ms. Etsegenet Denbel entitled “Ecological Impact Analysis of Tea Plantation in Ale District, Ilu Aba Bor Zone, Oromia Region Southwest Ethiopia” submitted in partial fulfillment of the requirements for the degree of Master's in Department/School of biology with field of specialization in botanical science and as thesis/dissertation research advisor, I hereby certify that I have read and evaluated this thesis/dissertation prepared under my supervision. Therefore, I recommend the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

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We, the undersigned, members of the Board of Examiners of the final open defense examination, we certify that we have read and evaluated his/her Thesis/dissertation entitled “Ecological Impact Analysis of Tea Plantation in Ale District Ilu Aba Bore Zone Oromia Region Southwest Ethiopia” prepared by Mrs. Etsegenet Denbel and examined the candidate. Thus, we recommend that the thesis/dissertation has been accepted in partial fulfillment of the requirements for the degree of Master's in Botanical Science field of study.

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I hereby declare that this Thesis/Dissertation entitled Ecological impact Analysis of Tea Plantation in Ale District Ilu Abba Bor Zone, Oromia Region, Southwest Ethiopia ” was prepared by researcher, with the guidance of my advisor. The work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted, in whole or in part, for any other degree or professional qualification.

**Name Student**

**Signature**

**Date**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Name of advisor**

**Signature**

**Date**

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## Abstract

*The study was conducted in Ale District Ilu Abba Bore Zone with the aim of ecological impact analysis of tea plantations. Sampling techniques were used purposely for site selection considering the oldest age of tea plantation in Ethiopia and four kebeles were renowned as tea growers with their land. Tools employed in data collection were questioners, laboratory analysis, satellite images, and climate conditions from the National Meteorological Agency of Ethiopia and analysed by excel, Satellite images of Landsat8 (OLI-TIRS) 7 (ETM+), 5(TM) and SPSS version (24) model of two-way of (ANOVA). A total of 73 informants and 40 soil samples were selected by simple random sampling technique to collect from 30cm depth. Tea plantations have advantages in generating employment and immediate income source besides their negative effects to decrease plant species, honey products eviction of local inhabitants. Its effect on LULCC is conversion from, forest, shrubland wetland, 65.46, 67.26, 185.13, 192.66 and 218.50-hectare tea plantations respectively. Regarding climate change from (1990-2021) maximum and minimum temperatures rose by 0.25 °C and 0.3°C respectively. The average value of soil parameters at different age levels found under tea plantations indicates for pH values extremely acidic, electric conductivity (non saline) Phosphorus, Potassium, Calcium Magnesium under low fertility, however, total nitrogen and cation exchange capacity has medium concentration. The Soil under the control group pH value strongly acidic, Electric conductivity was slightly saline, cation exchange capacity, organic carbon, Total nitrogen, potassium, exchangeability of calcium and Magnesium were found under medium fertility class, and except electric conductivity all parameters significant difference for experimental and control group. Generally, Tea plantations greater negative effect on socioeconomic, land use system, climate conditions, and depletion of soil nutrients so, all stockholders and authority over environmental issues, and must take conservative measures.*

**Keywords/ Phrases:** Ale District, impact, tea plantation, soil parameters

## **List of Abbreviations and Acronyms**

ADAO: Ale District Agriculture Office

ANOVA: Analysis of Variance

BTB: Bangladeshi Tea Board

CCKP: Climate Change Knowledge Portal

CEC: Cation Exchange Capacity

CTDMA: Coffee and Tea Development and Marketing Authority

EC: Electrical Conductivity

ECTDME: Ethiopian Coffee and Tea Development and Marketing Enterprise

EFCCC: Environment, Forest and Climate Change Commission

EIAR: Ethiopian Institution of Agriculture Research

EPA: Environmental Protection Authority

Ethio: Agriceft Ethiopian coffee and tea; food crops; flowers;

FAO: Food and Agriculture Organization

GTED: Gumaro Tea Enterprise Development

IBC: Institution of biodiversity conservation

IPCC: Intergovernmental Panel Climate Change

LULCC: land use land cover change

MCTD: Ministry of Coffee and Tea Development

MCTD: Ministry of Coffee and Tea Development

MDPI: Multidisciplinary Digital Publishing Institute

MEFCC: Ministry of Environment, Forest and Climate Change

NBE: New Business Ethiopia

OC: Organic Carbon

PH: Potential Hydrogen

PLC: Private Limited Company

RTRS : Regional Tea Research Stations

SNNP: South Nation Nationality and People

SPSS: Statistical Package for social science

TN: Total Nitrogen

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# 1. INTRODUCTION

## 1.1 Background

In the world, more than three billion cups of tea are consumed every day worldwide, making it one of the most popular and least expensive drinks. Tea is consumed by people of all ages and social classes (Phong *et al.*, 2016). China and India were the original home countries of tea. Tea thrives in the wild best in warm, humid environments with at least 100 millimeters of annual precipitation. The ideal soil for the plant is deep, light, acidic, and well-drained. Given these general parameters, tea can be grown everywhere from sea level to 2,100 meters above sea level (FAO, 2002). Although having its origins in the southern Chinese hills, tea (*Camellia sinensis* L.) is now grown all over the world, particularly in Asia, Africa, and South America (Hicks, 2001). A total of 0.579 million acres are dedicated to tea cultivation, which accounts for 21% of the world's total tea output (FAO, 2008).

Ethiopia has a history dating back more than 50 years of producing tea leaves. However, the development of tea production has been consolidated and organized for the past three decades. With official assistance, tea leaf production started in 1984, although only 2,000 hectares were produced between 1984 and 1996. In Ethiopia, tea is mostly grown in the highland dense forest regions where the soil is fertile, resulting in relatively little fertilizer need (Woldegebriel Danil, 2007). Ethiopia is gifted with a wealth of natural resources, including an abundance of forest resources. However, due to the country's long history of irresponsible use of its natural resources, the quantity of forest cover left in the country is extremely minor and limited to the southwest. However, agricultural expansion, both through shifting cultivation and large-scale investment, is the primary source of natural forest destruction (Amogne Asfaw, 2014).

The main drivers of deforestation around the globe, according to experts, are agriculture (with significant investment), growth of infrastructure, and wood extraction. He claimed that rather than natural factors, human action is what causes the majority of modern change in this evolving planet (Elija, 2007). They believe that there is abundant land on the continent, that labour costs and land rents are low, and that there are few legal barriers preventing production and export has also contributed to investors' desire for land in Africa.

The transition to large-scale agriculture and the commercialization of land are seen as crucial steps toward agricultural modernisation and increased productivity (Amogne asfaw, 2014). Tea plantations are developed at the expense of natural forests, destroying the soil's, biodiversity and causing the extinction of several species (Van der Wal, 2008).Habitat destruction is the primary negative environmental impact of the tea production. This is especially true for tea because a large portion of the habitat used for cultivation is frequently situated in more rocky and remote places, which tend to have the highest biodiversity. Another environmental expense is the consumption of energy for drying tea need the processing of tea generates some waste, conversion of habitat the same is true for every crop produced in isolation or in a monoculture systems (Chaudhuri, 2002).

Large agricultural investment projects have direct positive socioeconomic effects, such as: - boosting agricultural productivity by using better agricultural inputs like seeds, fertilizer, and capital or by implementing technologies that raise yields and reduce postharvest losses and educating employees and farmers as well as investing in irrigation schemes that could lead to more efficient use of existing resources, enhancing marginal land by melioration (improve) pastures (Smalley, 2013).

However, if agricultural production operations are not managed sustainably, they have a negative impact on the environment through their negative effects on water, soil, air, and biodiversity. Reduced food security in the poor country when food crops are not available for local consumption, unequal benefit distribution that could spark social conflicts, and an increase in local and regional unemployment when labor-intensive mechanization is used are some of the negative effects of large farm projects (Hufe and Heuermann, 2017).

The primary problem is the annual clearing of the natural forest to make way for a new agriculture. In the three primary forested regional states of Oromia, Southern Nations, Nationalities, and Gambella alone, the extent of natural forest degradation was projected to reach currently roughly 59,000 ha per year. When the government moves forward with land agreements including forests, prudence is required due to limited capacity to oversee administrative and regulatory aspects of foreign investments, pervasive tenure uncertainty, and rural livelihood insecurity (Kathleen Guillozet and Bliss, 2011).

Ethiopia is home to some of the world's rarest plants and animals, but due to habitat loss and misuse, insufficient economic policies have created inequality, intensified poverty, and

encouraged rural communities and others to exploit biodiversity at unsustainable rates (IBC, 2005). The region of southwest Ethiopia, where tea is grown on both large-scale private farms and surrounding small-scale out-growers, is ideally suited for tea production. Similar to this, the natural conditions in Southwest Ethiopia are likewise ideally suited for the ongoing growth, multiplication, and distribution of a wide range of weed species (Tadesse Engida *et al.*, 1998).

## **1.2 Statement of the problem**

Economic development can have major impacts on the environment by degrading soils, polluting bodies of water, altering landscapes and threatening biodiversity, in some cases driving species into extinction. In turn, environmental impacts can impose significant economic and social costs on society, especially concerning human health. However, can predict development's negative effects and reveal strategies to avoid and mitigate them, and EIA can also point to possibilities to enhance the positive effects of development activities ( Mellese Damtie and Mesfin Bayou, 2002).

The rush for land in Africa by investors has also been driven by the assumption that land is abundant in the continent, land rents and labour costs are low, and there are few regulatory roadblocks restricting production and export. The commercialization of land and the shift to large scale agriculture is taken as an essential measure for agricultural modernization and the improvement of productive efficiency. As a result, total transfers of land from the late 1990s to the end of 2008 to both domestic and foreign investors in Ethiopia reach almost 3.5 million hectares mainly in southwest part of the country (Amogne Asfaw, 2014).

Forest grabbing for investments (tea plantation) settlements, poor law enforcement, shifting cultivation and land tenure policy has been significant drivers in southwest Ethiopia. On the other hand, the multifaceted nature of the change drivers and their implications are often poorly understood and scarce in some regions. Furthermore, the national level investigations about the wide ranges of drivers and magnitude of LULCC and its implications are inadequate (Wakjira Takala *etal.*, 2020). The cultivation of tea in Ethiopia has been practiced by very few private large scales under limited locations and the most proportion about 99.95% of potentially suitable tea lands is left unexploited till presently (Mohammed ZAKir,2020).

According to reports from NBE (2020), Ethiopia has 6 million hectares of land suitable for growing tea. The main regions in Ethiopia with the potential for commercial tea cultivation are the western regions of Gambella, Jimma, Kaffa, Wellega, Illubabor, and some sections of the Amhara region. But In Ethiopia through time tea plantations per hectare of land is showing increase dramatically. This is a striking illustration of how, in the appearance of scientific advancement and a realistic economic approach, poorly designed modern development programs, mostly of foreign origin, have negated or destroyed environmentally beneficial traditional land use and occupational patterns. Estimated Potential Area of Tea by Region (ha) identified and turned over to interested companies: Oromia, SNNP, Amhara, and Gambella 55000, 75000, 5000, and 15000 respectively (MARD, 2009).

The Biosphere Reserved Area (Kafa Sheka in SNNP and Yayo in Oromia) is situated in southwest Ethiopia. Furthermore, this area is home to all currently operating tea plantations (WushWush in SNNP Chewaka in Southwest and Gumaro Oromia ) that are most likely to be developed. When the Gumaro tea plantation was established in Ale District's Ilu Abba Bor Zone, various ecological impacts were anticipated. Therefore, this study aimed to investigate the degree of ecological impacts on socioeconomic activities, land use land cover change, climatic condition and soil fertility status by selected soil parameters and found appropriate management solution and to recommend concerned bodies to take action.

### **1.3 Research Questions**

1. What socioeconomic effects does the plantation on the area?
2. How many hectares of land converted from other land use systems to tea plantations?
3. Is there any climate change after tea plantation?
4. What is the effect of long term plantation of tea on soil pH, OC, TN, K, P, EC, Mg, Ca and CEC?

### **1.4 Objectives**

#### **1.4.1 General Objective**

To investigate the ecological impacts of tea plantation in Ale District Ilu Aba Bor zone of Oromia Region Southwest Ethiopia

#### **1.4.2 Specific Objectives**

- ❖ To identify socioeconomic impacts of tea plantation;
- ❖ To analyse the effects tea plantation on land use land cover change ;
- ❖ To evaluate the phenomenon of climate change ;

❖ To examine soil fertility change in pH,OC,TN, K,P,EC Ca, Mg, and CEC.

### **1.5 Significance of the study**

This study quantifies and identifies the primary socioeconomic opportunities, negative aspects of the environment, such as the land use system, the climate, and the soil fertility state, as well as potential alternatives to mitigate the negative effects of tea plantations. It will be used to as a secondary source of information other researchers.

## 2. REVIEW LITRATURE

### 2.1 Origin and History of Tea Plant

Tea is a tiny, perennial, cross-pollinated plant that naturally reaches heights of up to 15 meters. To harvest the delicate leaves, which has continued for more than a century, a bush height of 60 to 100 cm must be maintained under cultivated conditions( Mondal *et al.*, 2004). Tea is a perennial monocrop that, with good management, can continue to produce profitably for up to 100 years. By trimming the cultivated tea plant (*Camellia sinensis* (L.) O. Kuntze) every three to five years, a plucking table that makes it simple to remove the immature shoots is created. The pruned material is left on the soil, which encourages recycling of nutrients and organic matter, improving the mineral balance of the soil-plant system and reducing erosion in young plantations (David, 2008).

The region of Southeast Asia, also known as "the major center of origin" of tea, is situated close to the Irrawaddy River's source at the intersection of the nations of Northeast India, North Burma, Southwest China, and Tibet. Due to its discovery in roughly 2700 BC, it is one of the oldest drinks in the world (FAO, 2015). Tea (*Camellia sinensis*) (LO. Kuntze, belong to the Theaceae family and are native to East Asia. However, these perennial plants have now been cultivated all around the world, in tropical and sub-tropical areas (Meegahakumbura *et al.*, 2018).

East Asia is the traditional home of tea (*Camellia sinensis* (L) O. Kuntz. In tropical and sub-tropical regions, these perennial plants are now, nonetheless, widely cultivated (Meegahakumbura *etal.*, 2018). The crop flourishes best in regions where the annual rainfall is at least 1500 mm with mean air temperature of 18-20°C, average humidity of 70-90% and five hours of sunlight per day (Owuor *et al.*, 2008).

The tea plant was initially referred to as "*Thea sinensis*" by Linnaeus in the first edition of the "Species Plantarum" in 1753. The term "*Thea sinensis*" was dropped in the second edition of the book, and Linnaeus described two varieties: one with six petals was called "*Thea bohea*," and the other had nine petals and was called "*Thea viridis*." But eventually, these names also were abandoned and tea was named as '*Camellia thea* Link'. A uniformly in nomenclature has now been acknowledged internationally and tea has been ultimately identified botanically as '*Camellia sinensis*' (Chaudhuri, 1978; Kirtikar *et. al.*, 1981; Naif, 1984; Kochhar, 1981).

## 2.2. Environmental Requirements for Tea Production

Tea thrives well within the latitudinal ranges between 45° N and 34° S that cross about 52 countries. Environmental and climatic conditions determine the rate of shoot expansion and tea yield. Various components of the environment influence the growth and productivity of tea to a different extent. Light, Carbon dioxide, temperature and water availability are the most important factors determining tea productivity. The intensity of these climate impacts on tea production will likely vary across the major tea growing regions, in low- up- and mid-country areas (Wijeratne *et al.*, 2007). Many of the acidic soils found in the tropics are ideal for growing tea. The pH of the soil, which should be between 3 and 6, should be moderate to low for tea growing (Minh, 2002).

Tea is also grown across a range of altitudes, from sea level up to about 2200 m above sea level. The tea plant requires a minimum rainfall of 1200 mm per year, but 2500-3000 mm year<sup>-1</sup> is considered optimum. Tea is grown in soils that differ from one country to another, with the most important feature being the soil pH. The optimum soil conditions recommended for tea growth include a well-drained, deep and well-aerated soil with more than 2% organic matter (de Silva, 2007). Tea plants growing in shallow and compacted soils are likely to suffer from drought and water logging during the rainy months. The harvested leaf yield of tea, i.e. 'made tea', can generally reach 4-5 t ha<sup>-1</sup> year<sup>-1</sup> under favourable climatic and soil conditions with proper management (TRFK, 2002).

Numerous tropical regions' acidic soils are ideal for growing tea. pH levels between 3 and 6 in the moderate to low range are crucial for the growth of tea in soil (Minh, 2002). Majority of the tea producing countries are located in the African tea growing countries are located mostly around the tropical regions where Kenya, Malawi, Rwanda, Tanzania, Uganda are major producers. continent of Asia where China, India, Sri Lanka are the major producers. Tea was introduced to East Africa in the beginning of the twentieth century, which led to commercial production in the 1920s and 1930s in Kenya, Tanzania and Uganda. (Mondal *et al.*, 2004).

## **2.3 World Wide Tea production**

Tea is grown in more than 50 countries, mostly as plantation (Ambachew Zerfu , 2018). The main tea producing countries in terms of area planted are China (898,000 ha), India (438,000 ha), and Sri Lanka (180,000 ha). The area in these three countries represents more than 65 percent of all land planted to tea globally and nearly 61 percent of all production. Other significant producers include Kenya (113,000 ha), Indonesia (110,000 ha), Turkey (76,800 ha), Myanmar (66,908 ha), and Vietnam (7,300 ha). These five producing countries hold 19 percent of all land planted to tea and produce 20 a percent of the world's tea (FAO, 2002). Globally, the top five tea producing countries in 2017 were China, India, Kenya, Sri Lanka and Vietnam, while the top five tea exporters were Kenya, India, Sri Lanka, Argentina and Vietnam (IISD, 2018).

The major tea-producing countries in Africa include Kenya, Malawi, Tanzania, Zimbabwe and South Africa, together producing about 25% of the world exports amounting to some 250,000 tons of tea per year. Most recently, Eastern Africa has emerged as a major force among tea growers producing excellent teas, which are used for blending all over the world. In Ethiopia, during 2004–2005, a total of 5,387 tons of black tea was produced, which constitute only 0.14% of the world tea production. Of the 5,387 tons of tea produced, 56.7% was consumed domestically, while 43.3% was exported for world market (Buchmann, 2005).

### **2.3 Tea production in Ethiopia**

Historically tea plant was brought from South India by Majid Abud, a Lebanon citizen, who lived in Gore town for a long period of time . In 1927, the first Ethiopian tea garden was established at Oromia Region, Ilu Aba Bora zone in Ale district around Gore town (Yemane *etal.*,2008). The introduction of tea in Ethiopia is a recent phenomenon between the end of 19th and beginning of 20th centuries (Melaku Adisu and Kifle Belachew, 2017). In Ethiopia, tea (Assam type) is introduced for the first time in 1927 and grown in Southwest part of a country

In Ethiopia though trial tea plantation was started beginning from 1960s during the regime of emperor Hailesilassie but, the production of tea leaves in organized way under the leadership of government was begun in 1984 during the regime of military Darg until 1996 in Ethiopia the total land coverage with tea plantation not exceeds to 2000 hectares. In Ethiopia tea plantation growing and production is running around dense forests areas of Southwestern

Ethiopia by clearing trees, bushes and bushes where fertile soil is allocated due to the availability of humus. With the fertility of soil of the area, the use of fertilizer is very small (Fekadu Melaku, 2009).

Tea is a new crop to Ethiopia which introduced in the early 19th century. The main government objectives to be self-sufficient domestic consumption and save the foreign exchange spent for importing tea, to supply for export market by increasing the production and quality of tea through time and, to create employment opportunity for the citizens. Currently, there are three tea plantations and number of tea processing and packing factory in Ethiopia which are owned by private investors (MCTD, 2001).

The Ethiopian government allowed and engaged tea plantation and production due to factors such as to supply domestic tea needs, to save foreign exchange spent for tea importing, to export tea, and to create employment opportunity in the country. Nowadays in Ethiopia there are three tea producing estates (private tea plantations) namely WushWush and Gumaro owned by (Ethio Agri-Ceft PLC) and Chewaka owned by (East African PLC). All these are located in the South Western part of the country following the fertility of soil. In their nearby there are also tea-out growers who are producing and supplying green tea leaves to them. (Mohammedsani Zakir,2017).

Currently, the three estates are producing tea on 2660 hectares of land, with 437 hectares going to out-growers. In the past five years (2011/12 to 2015/16), the three estates produced 34,126.1 tons of tea for the domestic market and 4570.78 tons for export. The tea industry in Ethiopia has given 575 out-growers, 7139 temporary workers (labourers who perform and are paid for certain activities during a short period of time), and 1157 permanent workers at tea plantations or gardens options for income and employment (EIAR, 2017).

### **2.3.1 Gumaro Tea Plantation**

At the first time tea plantation inter to Ethiopia by foreign citizen of Arab called Mujid inserted by his shoes three plants species (*Camilla sinensis* L., *Hevea brasiliensis* and *Pisidium guajava* by his land establish during emperor Hailesilase. There is no well documented reason the entry of these plant species. During socialist period (1974-1991) expanded to commercial purpose Preparation of nursery site from proportion ratio of 3:2:1 of black soil, fertilizer and sandy soil. The labor forces are come from Fiche Selale, Wolayta, Kembata and Yayoto prepare nursery site in cost of 60 cent per day.

It began when Kegnazmach Mejid Abboud, a Lebanese expatriate, started the first commercial tea plantation within Gumaro in 1957. At that time the tea plantation covered 25 hectares. In 1964, Kegnazmach Mejid made a lease to 12 associated individuals, and to Mr. J B Hissette who later established a private limited company in 1966. Eventually, the Agricultural and Industrial Development of Ethiopia and the British Common Wealth Corporation formed the Gumaro Tea Plantation Share Company in 1969 to succeed the Private Limited Company. In 1976 the new proprietors only planted 13 hectares of tea (Workineh Kelbessa, 2005).

In 1981 the Government started an expansion plan and developed it to its present size of 860 hectares. Indigenous people of Gumaro (Oromo peasant farmers) had been evicted from their conventional houses in Gumaro Abo area, in Ilu aba bor, via way of means of the authorities to set up Gumaro tea plantation. The inhabitants have harassed that the status expansion of during Gumaro Tea Plantation in Ilu aba bor has contributed to forested area depletion. It commenced whilst Kegnazmach Mejid Abboud, a Lebanese expatriate, began out the primary industrial tea plantation inside Gumaro in 1957 (Workineh Kelbessa, 2005).

However, the military government nationalized the plantation and handed it over to the Coffee and Tea Development and Marketing Authority (CTDMA) within the Ministry of Agriculture ( ECTDME). In 1995 Gumaro is privatized / sold to the Ethiopian born Saudi Billionaire, Sheikh Al Amoudi company Ethio Agriceft. Ethio Agriceft bought the farm after the current government, which came to power federal democratic republic of Ethiopia (FDRE).

To improve the soil's fertility, tea seedlings utilize urea and DAP. In addition to chemical fertilizers, Ethiopian government imports Guatemala grass (*Tripsacum andersonii*) from North America (Cuba) to maintain soil fertility. The environment was suitable for the locals way of life since it allowed for good animal and crop husbandry, easy access to fodder and water for their livestock, and access to forest honey and coffee. However, the establishment of tea plantations severely hampered their way of life, forced them to sacrifice their possessions, and forced them to leave their own land for a meagre sum of money.

During the reign of Emperor Haile Selassie in 1928, a foreign Arab person by the name of Mujid inserted a tea plantation into Ethiopia. There isn't a well-known, legitimate purpose to enter. During the socialist era (1974–1991), it was enlarged for commercial use. Gumaro Tea Enterprise Development spans a total of 7099.5 hectares and has the capacity to produce an

average of 13904865kg per year, with 76% of that quantity going to the local market and 24% going to export, while also providing 3500 employees. The labour force receives 1 Birr and 1.50 Birr for local and export harvesting, respectively, in accordance with the quantity of tea leaves per kg/day. However, employees are paid in accordance with their status and positional scales. The out growers proffered to the main project price of 6 birr to export harvesting and 4 birr to locally prepared tea leaves per kilogram.

(ADAO, 2021).

## **2.4. Socio Economic Impacts of Tea Production**

Large agricultural investment project is considered to be one of the sectors absorbed more labour force and improved the living condition of local people in the region. In addition, large agricultural investment project had failed to transfer technology, provided social services (Logan *et al.*, 2020).

Millions of farmers and workers around the world depend on tea for their living. In several African and Asian countries, tea is an economically important crop contributing significantly to foreign exchange earnings and rural development. The tea industry also provides employment and a direct means of livelihood for many other people. Tea is produced both on large plantations and small plots of land; however, there are limitations on land availability in both commercial and smallholder sectors. Further increases in production will, therefore, arise largely from the intensification of production from existing tea stands, or from further planting in the more marginal areas where climate or soil conditions may be the limiting factors (FAO, 2015).

According to studies (Baumgartner *et al.*, 2015; Deininger and Xia, 2016; Hufe and Heuermann, 2017), large-scale agricultural investments have the potential to increase input consumption, accelerate the adoption of new technologies, and generate employment. According to Jeremie (2017), land grabbing, investments, and indigenous peoples' rights to land and natural resources all have a negative impact on food security. Significant agricultural investments may result in the loss of land rights family food security (cotula *et al.*, 2014). Large-scale agricultural investments, on the other hand, may have a detrimental influence on the environment, natural resources, and conflict in host countries due to the loss of land rights (German *et al.*, 2013).

According to Beza Erko *et al.*,( 2021), Plantations that use only one type of crop could deplete the soil, resulting in erosion and degradation (Baltodano, 2000). Due to the lack of

roots at the surface, single-species plantations are also ineffective at retaining nutrients, which may cause significant nutrient loss from the harvest sites. Felton *et al.*, (2010) analyzed the detrimental ecological and environmental effects of monoculture spruce plantations and demonstrated that these plants had inferior tolerance to biotic and abiotic disturbances made worse by changing climatic conditions. These plantations have an increase in acidity in their soils, which has long-term negative effects on biodiversity and other land uses. But with careful preparation and sound management of monocultures, potential dangers can be reduced (Bowyer, 2006; Kelty, 2006).

Other members of the community, in particular those who lose their land, are at risk of losing their income, especially if job options are scarce, investment opportunities are scarce, or traditional livelihood activities compete with them. Other times, businesses may need to hire outside help because anticipated jobs do not materialize. In other instances, notably for more highly skilled labor jobs, they provide their own labor (Anseeuw *etal.*, 2013). For subsistence farmers, the tea plantation is of little value.

However, large-scale agricultural investments also have an adverse impact on food security. A large-scale agricultural investments can lead to a loss of land rights, threatening household food sovereignty (Cotula *etal.*, 2014; Daniel; 2011).

## **2.5 Environmental Impact of Tea Plantation**

The ecological sustainability in agricultural production is an important subject in the context of large-agricultural investment projects. Applying exhaustive agricultural production has an impact on biodiversity, carbon stocks, and soil as well as water resources (Rahmato, 2011).The Earth is currently dealing with some serious issues, including the unsustainable use of resources, the rapid depletion of freshwater reserves, the premature exhaustion of conventional energy sources, carbon emissions that exceed the planet's capacity to absorb them, and soil degradation that cannot be remedied. All of this has finally resulted in global warming, which is causing extreme weather, rising sea levels, massive wildfires, and other harmful consequences (Yitebitu Moges *etal.*, 2010).

On the other hand, as a result of the ongoing population growth, tea consumption is consistently rising. As a result, there is an urgent need to support agriculture and food production in a way that preserves and enhances soil fertility, safeguards water quality and availability, protects biodiversity, and is produced and consumed in a manner that is socially,

environmentally, and economically sustainable (Munasinghe *et al.*,2013). Monoculture plantations as supposedly having several negative social and environmental impacts in spite of the recognized economic benefits (Erskine *et al.*, 2006; Alem *et al.*, 2015). Regarding the social impacts, the introduction of large scale plantations often leads to the change in the ownership from local communities to large private companies, hence, resulting into a loss of traditional goods and cultures, customary rights, and livelihoods associated with forced resettlement and unequal distribution of resources (Baltodano, 2000).

### **2.5.1 Effects on Land use Land Cover Change**

Habitat destruction is the primary negative environmental impact of the tea industry. This is especially true for tea because a large portion of the habitat used for cultivation is frequently situated in more rocky and remote places, which tend to have the highest biodiversity. The effects of producing tea in a rough natural environment are numerous ( Jeremie, 2017).

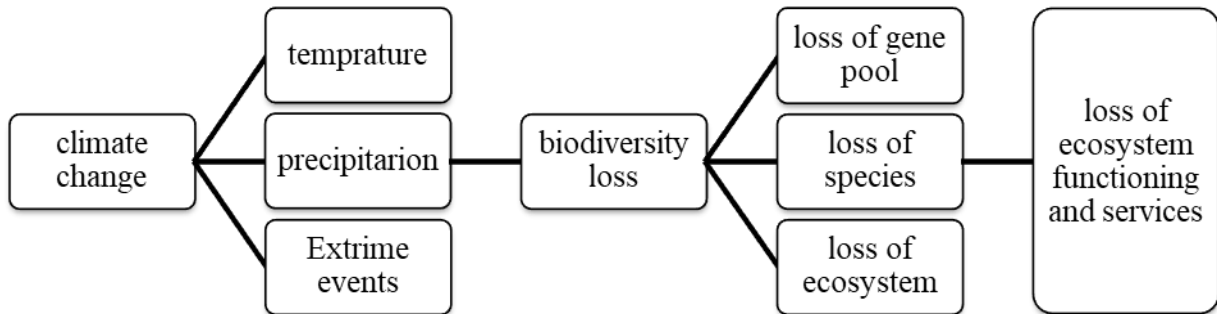
The LULC has the potential to influence the biological processes, and alter the provision of ecosystem services (Gibson *et al.*, 2018; Kishtawal *et al.*, 2010).The human and livestock population, different agricultural practices, urbanization, drought prevalence, and poor land-use planning have been reported as the main drivers of LULCC in Ethiopia. (Matheos Muke, 2019). Land use and land cover change (LULCC) are associated with large negative impacts on ecosystems observed at local, regional and global scales. High rates of water, soil and air pollution are the consequences of observed LULCC. Biodiversity is reduced when land is changed from a relatively undisturbed state to more intensive uses like farming, livestock grazing, selective tree harvesting (Ellis, 2011).

### **2.5.2 Biodiversity Loss and Climate Change**

The Earth is currently facing some critical problems, such as unsustainable use of resources, rapid decline in freshwater reserves, hasty exhaustion of conventional energy sources, carbon emission beyond the planet's absorption capacity, and degradation of soil beyond reclamation. All of this ultimately has led to global warming, manifested by tsunamis, decreases in groundwater levels, melting of icebergs, and other negative effects (Lennan, 2011).

Replacement of natural forests by monocrops tea plant , together with introduced exotic tea plantations are established at the expense of natural forests, resulting in the destruction of biodiversity and soil (Van der Wal, 2008). According to (Dejene Workineh, 2018),the

monoculture nature of tea plantations aggravates this issue as they are usually lacking natural enemies and heavily dependent on chemicals to protect the tea bushes and to achieve higher productivity (Van der Wal, 2008).



(Source:Dejene W. Sintayehu, 2018).

Climate change causes wide-ranging effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity. Changes in rainfall pattern are also likely to lead to severe water shortages and/or flooding. Rising temperatures also will cause shifts in crop growing seasons which affects food security and changes in the distribution of disease vectors putting more people at risk from diseases such as malaria. Temperature increases will potentially severely increase rates of extinction for many habitats and species (FIRST, 2001)

When establishing a tea crop, all the other vegetation is uprooted and the soil is rehabilitated to prevent soil-borne pest and disease infestations. During this uprooting of vegetation, the soil is loosened resulting in significant soil erosion. Also during the crop establishment period, that is, the first two to three years, there is a high possibility the land will be exposed and become eroded (Van der Wal, 2008).

### 2.5.3 Pollution and Soil Quality Decline

The tea industry that is deleterious to the environment is its waste. Most tea estates in the developing countries do not possess effluent treatment plants, so after every manufacture of tea, the contaminated water is thrown out. The effluents are rich in biological oxygen demand, chemical oxygen demand, lignin, and theaflavins, among other waste, and all of them are hazardous to the environment (Clay, 2003). The soils in those plantations become more acidic and subsequently generate unfavorable outcomes for biodiversity and other land uses in the long term (Kelty, 2006).

Monoculture plantations may deplete soil, causing soil erosion and degradation (Baltodano, 2000). According to Yan *et al.*, (2003), reported that the direct impact of soil erosion on the environment can be on-site as well as off-site. On-site impacts are a thinning soil layer, deterioration of soil structure and decreased soil nutrients whereas; the off-site impacts are the pollution of water bodies. These eroded topsoils accumulate in water bodies reducing their capacities due to sedimentation. Ultimately, it will lead to flooding and its consequential environmental hazards. The eroded fertile topsoil also causes algal bloom and eutrophication of water bodies which disturb the aquatic biota.

## **2.6 Soil Fertility and Acidity**

### **2.6.1 Soil Fertility Indicators**

It is evident that soil quality is important to sustainable agriculture and has a big impact on an ecosystem's production as well as its environmental integrity. However, it is challenging to measure and keep track of soil quality unless its basic properties are determined (Minh, 2002). According to Doran and Parkin (1994), Markers of soil quality Physical (texture, bulk density, color depth, etc.), chemical (pH EC, CEC, availability of key elements), and biological (soil fauna and flora) characteristics of the soil are the minimum suitability criteria. In another study, common soil chemical characteristics used to describe the quality of agricultural soils included OM, pH, CEC, and mineralogy (Heil and Sposito, 1997).

Indicators of soil nutrients including N, P, and K were crucial in identifying the nutrients available for plant growth, and their depletion is related to the decline in organic C as a result of farming. Older tea soils showed deteriorating soil fertility with cultivation due to the loss of soil nutrients, especially total N, K, and P. The level of soil acidity or alkalinity brought on by a specific chemical, mineralogical, and/or biological environment is referred to as soil response, also known as actual or active acidity (often stated as pH value). Root development, microbial activity, and root toxicity are all impacted by soil reactivity (Foth and Ellis, 1997).

Cation exchange capacity (CEC) refers to a soil's capacity to absorb and exchange cations (Brady and Weil, 2002). The cation exchange capacity of the soil, a crucial soil characteristic, governs the soil's fertility, resistance to leaching of nutrients, and environmental behavior. The chemical activity of the soil is often determined by its CEC. The soil can produce more nutrients if it can hold more cations, have a larger negative charge, and have a higher CEC

(Samuel *et al.*, 2000). Organic carbon enters the soil through the decomposition of plant and animal leftovers, root exudates, living and dead microbes, and soil biota making up around 58% of the total carbon contained in soil (White, 1997). Because of its influence on other soil parameters, soil organic C is an important indication of soil quality (Reeves, *etal.*, 1997).

**Table 1.** General critical value of NPK, CEC EC and pH for optimal 90% plant growth

S/No	Soil reaction		Soil Electrical Conductivity( EC)	
1	Soil acidity	pH value	Soil salinity	EC value
2	Extremely acidic	<4.6	Salt free	0-2
3	Strong acidic	4.7-5.5	Slightly saline	4-8
4	Moderate	5.6-6.5	Moderate saline	9-15
5	Slightly acidic	6.6-6.9	High saline	>15
6	Neutral	7		
7	Moderate alkaline	7.1-8.5		
8	Strong alkaline	>9		

Source (Booker tropical 1991).

**Table 2.** General critical value and fertility Class of NPK, CEC, OC,TN, Mg, and Ca for optimal 90% plant growth

Soil parameters	Fertility classes				
	Very high	High	Medium	Low	Very low
N (%)	>1	0.5-1.0	0.2-0.5	0.1-0.2	<0.1
P (meq/kg)	>25	18-25	10-17	5-9	< 5
K (meq/kg)		>0.5	0.5-0.25	<0.25	
Mg( meq/kg)	>40	25-40	12-25	12-6	<6
Ca (meq/kg)	>40	25-40	12-25	12-6	<6
CEC (meq/kg)	>40	25-40	12-25	12-6	<6
Organic carbon( %)	>20	10-20	4-10	2-4	<2

Source (Booker tropical 1991).

### 2.6.2 Main Causes of Soil Acidity

The hydrogen ion activity ( $H^+$ ) in a soil solution is determined by the pH of the soil. Soil pH lowers as  $H^+$  activity rises. The most beneficial crop nutrients become less available as the soil pH drops, while other, frequently unfavorable, nutrients become more accessible and may even reach hazardous levels (Ristow *et al.*, 2010).

**Effect of Soil Acidity:** The best soil pH for plant growth is one that is slightly acidic because at this pH soil microorganisms are most active and plant nutrients are most accessible. This delicate equilibrium is upset at extremes of high (alkaline) and low (acid) pH, and plant nutrients that were in sufficient supply can either become insufficient or poisonous for plant growth (Slattery *et al.*, 2000).

**Rainfall and leaching:** Acidic soils are more common in humid climates. The crucial components (calcium, magnesium, sodium, and potassium) in the soil profile that prevent soil acidity are slowly washed away by excessive rainfall. The basic soil cations (Calcium, Magnesium, and potassium) are gradually depleted and replaced by cations held in colloidal soil reserves in situations where rainfall exceeds evapo-transpiration (leaching) for the majority of the year, resulting in soil acidity. In fact, excessive rainfall is a problem brought on by soil acidity (Slattery and Hollier, 2002).

**Crop Production and Nutrient Removal:** The harvesting of crops from high-yielding crops is the primary cause of the increase in soil acidity. Crops absorb fundamental elements like calcium, magnesium, and potassium to meet their nutritional demands as they grow. Due to the manner that plants assimilate nutrients, alkalinity is partitioned into the plant as dry matter and acidity is absorbed into the soil. Ash alkalinity and the impact of export soil acidification on ash are adversely connected (Nelson *et al.*, 2007).

**Nitrogen fertilizer:** The application of N fertilizers, particularly those with high ammonium contents, is the principal cause of soil acidity because nitrification produces hydrogen ions. Since pH expresses acidity as the negative logarithm of  $H^+$  concentration because nitrification generates hydrogen ions, soil pH drops as acidity increases (Pagani, 2011).

**Organic matter decay/dissociation:** Although organic matter improves soil structure and has many other positive benefits, an increase in organic matter may cause the soil to become more acidic. Acidity is caused by  $H^+$ , which is a byproduct of decaying organic matter. When water and carbon dioxide (Carbon dioxide) from decomposing organic matter react in the soil, carbonic acid, a weak acid, is created (Slatter and Hollier, 2002).

### 3. MATERIAL AND METHOD

#### 3.1 Description of the study area

##### 3.1.1 Geographical location

The study was carried out in the Ale district , Ilu Abbabor Zone of Oromia Regional State. The political hub of Ale District has been Gore Town since 1970. It is 637km from Addis Ababa and 22 km from Mattu, the zone's capital. Three districts surround it: Sayilem to the South, Nono to the west, Bure to the North, and Mattu to the East. Situated at an elevation of located between 1800 and 2200 meter above sea level (YihuneTsegaye, 2018).located between 8°7'30" and 8°10'0" North and 35°25'30" and 35°30'0" East (Arc GIS, 2021).

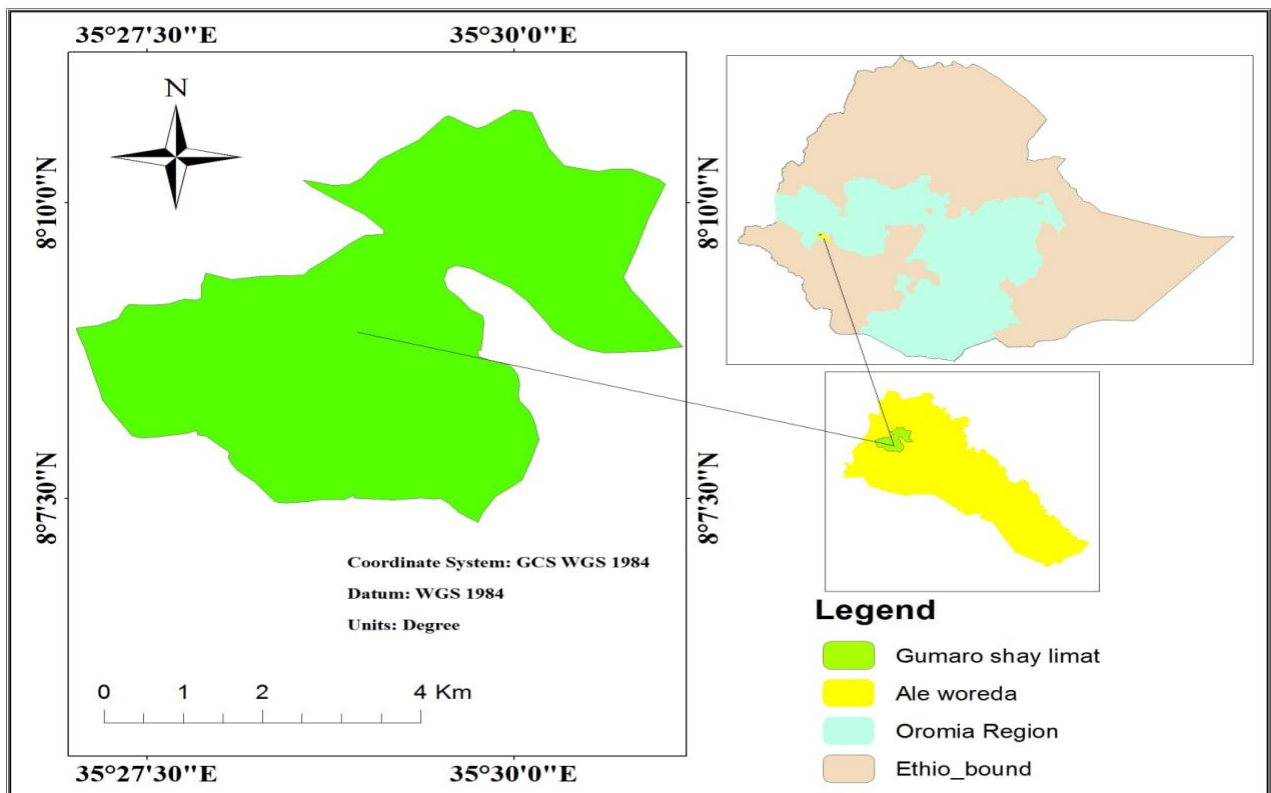


Figure 1. Map of study area (source: Arc GIS, 2021)

##### 3.1.2 Geology and Soil

Black and red basaltic soil makes up the majority of the soil types in the area. Red basaltic soil is mostly found in combination with ecological surfaces like grazing land and cultivated land in moderately elevated parts of the district. Mechi, Kundi, Kedi, and Segi constitute the major hills. The principal rivers are Kabar, Baki, and Wages, while the streams are Dukur, Gagi, Cogara, Dikine, Qeer, Gatano Konor, Yubi, and Gumaro (Yihune Tsegaye, 2018).

### 3.1.3 Climate Condition

#### 3.1.3.1 Teperature

The district's primary rainy monthes runs from March to October. The district's altitude ranges from 1,699 to 2,070 above sea level with an average year temperature of 0 to 21.2 degrees Celsius. Additionally, there is a temperature range of 12.3 °C at the low and 29°C at the high during the all over year

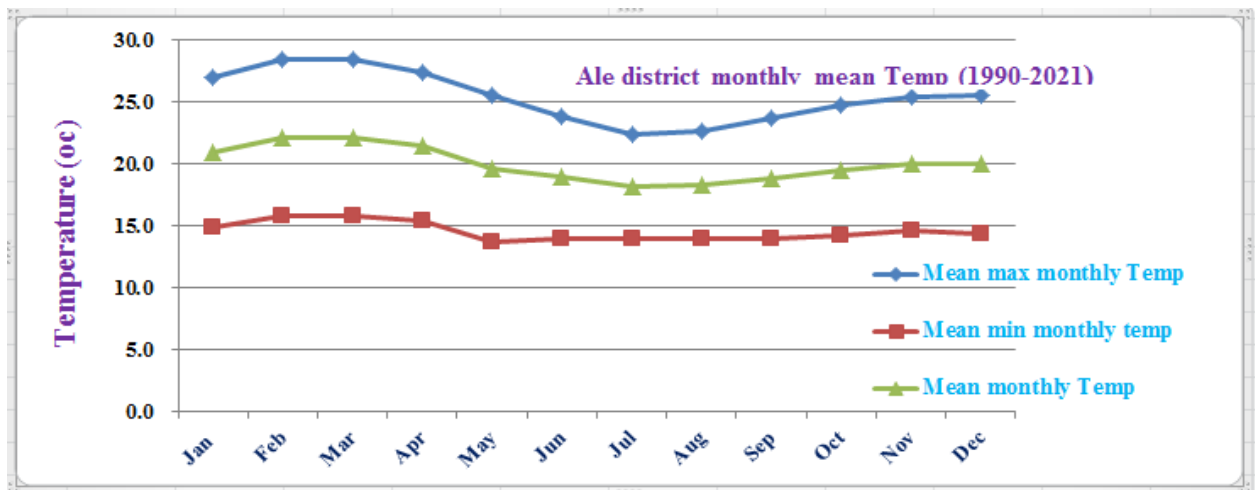
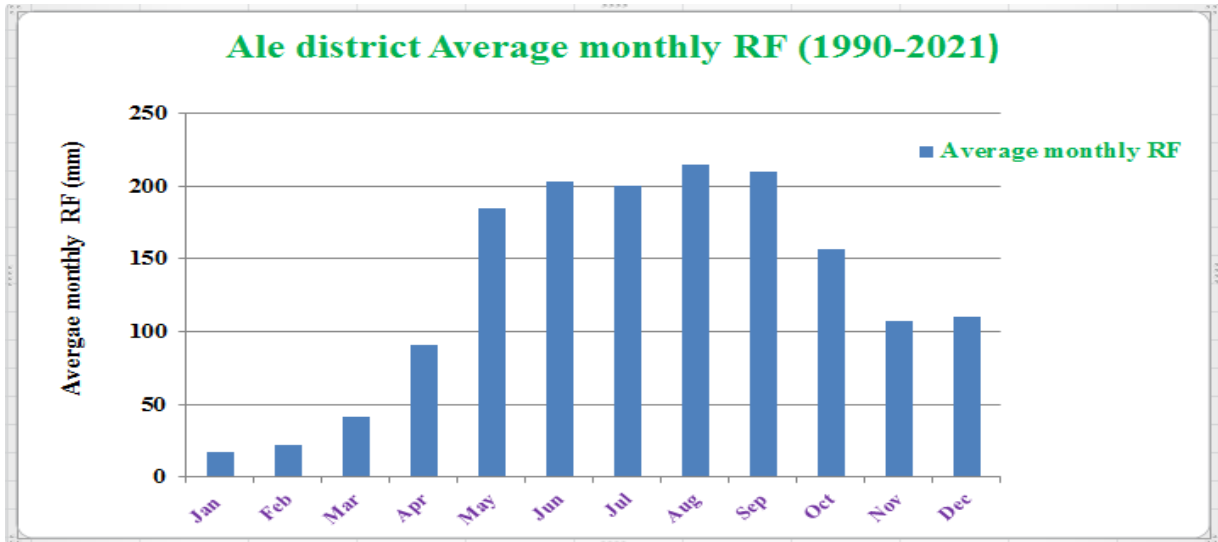


Figure 2. Mean maximum and Minimum Temperature

#### 3.1.3.2 Rainfall

The major dry seasons are November, December, and January, February; March and April receive the lower rain fall on average (1088.7 mm) and rainy months are May, June, July, August, September, and October receives average minimum (2,050 mm) with maximum of (2695.8 mm) per year.



**Figure 3.** Average Monthly Rain Fall

### 3.1.4 Animals

Monkey, ape, Columbus monkey, pig, hyena, and other animal species are some of the animals that can be found in the Ale District. Cattle, sheep, goats, horses, donkeys, poultry, dogs, and cats are examples of domestic animals (ADAO, 2021).

### 3.1.5 Vegetation

Ale district is found in Woina Dega refers to midlands between 1,500 and 2,300 meters, in which predominant plant species include *Zea mays* L. *Cordia africana* Lam. *Sorghum bicot* L. *Coffea arabica* L. *Schefflera abyssinica* (Hochst.ex A *Echinops kebericho* Mesfin, *Allium Cepa* L., *Eragrostis tef*(Zucc.) *Allium cepa* L., *Brassica oleracea* L. (Dereje Gorfu and Eshetu Ahmed, 2003).

### 3.1.6 Study Population

Ale district had a total population of 64,266 people as of the 2007 National Census, 32,034 males and 32,232 female. There were 55,218 (85.91%) rural and 9,048 (14.09%) urban residents, respectively, of the total population. 87.55 % of the population identified as Oromos, 5.98 % as Amhara, 3.98 % as Kafficho, and 2.49 % as belonging to other ethnic groups. Afan Oromo, spoken by 91.78 % of people, was the most common language, followed by Amharic with 4.54 %, Kafa with 2.16 %, and other minor languages by 1.52 percent (ALDAO, 2021)

### **3.1.7 Tourism and Livelihood activities**

In Ale District, there are several tourist attractions sites: The Battle of Sambe the British Consulate (later the Sudan Consulate), Kundi Hill, Gumaro Tea Plantation, Bokicha Abba Dame, Gudo Cave, and Jeto Qollo are a few examples of these heritage . These heritage sites are important from an archaeological, historical, ecological, and cultural standpoint (YihuneTsegaye, 2018). Agriculture and trade are the primary sources of income for the majority of people. The majority of the agricultural products produced in the district are cereals, oilseeds, and pulses. The district also produces honey, dairy products, meat, coffee, and tea (ALDAO, 2021).

## **3.2 Research Design**

### **3.2.1 Reconnaissance Survey**

Reconnaissance survey was done in November 10-20/2021 to identify the major ecological parameters which highly affected by the Tea plantation and to design appropriate research techniques to examine scope of the impact.

### **3.2.3 Site Selection**

Gumaro Tea Enterprize Development is Ethiopia's first and oldest, tea plantation among other tea plantation found in Ethiopia, taking into consideration its age the study site selected purposely to identify the impacts of tea plantation on socioeconomic activity, LULCC, climate change, soil fertility, of the district. Among 19 kebeles found in Ale district four kebeles are selected purposely by recommendation of the district's indigenous residents and administration and of renowned to tea producing within farmers land. These are (Jeto, Agelo, Gumaro Abo, and Onga ) converts from different varieties of crop to tea plantation because of enforcement and motivation from the government.

### **3.2.4 Sampling Technique and Sample Size**

From total of (2279 ) households ( 73 ) respondents were selected simple random sampling by using sample size determining formula (Daniel, 1999).

Sample size determine by formula has used (Daniel, 1999) as follow.

$$n = \frac{NZ^2pq}{(d^2(N-1) + Z^2pq)}$$

Where, n=sample size

N=Total population

d=Margin of error

z=confidence level (95%) which is equal to 1.96

P=population

q= 1-p= 0.05

$$n = \frac{2279(1.96)^2 (0.95) (0.05)}{(0.05)^2 (2279-1) + (1.96)^2 (0.05)^2}$$

$$415.862804/5.7046$$

$$n = 72.899 \approx 73$$

**Table 3.** Total House hold in Sampled Kebele with Respective Sample Size

Sample Kebeles and Households					Sample size		
S/no	Kebeles	M	F	Total	F	M	Total
1	Jeto	736	99	835	4	22	26
2	Agelo	391	64	455	0	15	15
3	Gumaro Abo	392	58	450	2	12	14
4	Onga	454	85	539	5	13	18
	<b>Total</b>	<b>1973</b>	<b>269</b>	<b>2279</b>	<b>11</b>	<b>62</b>	<b>73</b>

### 3.2.5 Soil Sampling Techniques

A critical step in obtaining accurate soil tests is collecting representative samples in the field. According to NRCS (2007) soil sample from monocrop field (uniform) should be sampled in a simple random pattern across the fields five (5) equal size sampling depth 30cm soil has the most root activity and fertilizer applications are restricted to this depth. Measurements of organic matter, phosphorus, potassium, pH, CEC, and salt levels are performed at this depth. The quantity of the soil cores that were collected for each sampling depth must be thoroughly mixed. Individual soil samples from 5 different places maximum of 1kg for each sampled year should be thoroughly combined in a clean plastic container. Soil samples stratified into four age group namely 1930 begging (90 year) 1984 major expansion of at commercial level (37 years), In 2010 start of tea out grower in the district year 2019 used to compare non harvestd tea farm (2) year and 20 soil sample from non plant area by mono crop tea and non fertilized plant for control groups.

### 3.3 Data Collection

#### 3.3.1 Primary Data

Household questionnaire was distributed by simple random sampling technique from purposely selected kebeles in proportional approach, land sat image were received from the United States Geological Survey (USGS) at <https://earthexplorer.usgs.gov/>. Also experimental data source used soil sample from Agricultural Research Institute Bedele Agricultural Research Centre (BeARC) to evaluate soil change in pH, OC, TN, P, EC, CEC, exchangeability of Mg, Exchangeability of Ca availability P, percentage of TN, and similar soil sample send to Mattu University chemistry lab, to evaluate availability potassium (K) in different year of tea planting year.

#### 3.3.2 Secondary Data Source

Secondary data source climate condition from National Meteorological Agency of Ethiopia to detect climate change in last three decade, socio demographic data, general environmental information's, published articles, journals, books and recorded data in Ale district agricultural office and selected kebeles.

### 3.4 Data Analysis

#### 3.4.1 Socio- Demographic and Socio -economic

Socio demographic socio economic data analysed Microsoft Office excel 2007 was employed to process, analyze and interpret the data presented in descriptive statistics such as table, pie chart and bar graph.

#### 3.4.2 Satellite image

Two sets of Landsat model Thematic Mapper (TM) imagery and one set of Landsat 8 Operational Land Imager and Thermal Infrared Sensor (OLI-TIRs) image obtained from USGS at <https://landsatlook.usgs.gov/> were used for the analysis of land use land cover

**Table 4.** Satellite image used for LU/LC change analysis and their characteristics

Satellite image	Sensor	path/row	Acquisition date	Resolution (m)	Source
Landsat8	OLI-TIRS	171/54	02/Feb/2021	30*30	USGS
Landsat7	ETM+	171/54	28/Jan/2001	30*30	USGS
Landsat 5	TM	171/54	03/Mar/1990	30*30	USGS

### **3.4.3 Climate Data**

Methrological data were manipulated in spread sheet of Microsoft excel and presented by bar graphs.

### **3.4.4 Soil Data**

Soil data analysed by SPSS statistical software version (24) model of two-way analysis of variance (ANOVA) test which is a powerful tool for analyzing data and display relationships between a dependent variable soil properties,(pH soil, TN, Mg, Ca, K, P,OC,EC,CEC) and two different independent variable site(experimental, control) and year level(90,37,10,2)

In the laboratory the soil samples were oven dried at 105<sup>0</sup>c for 24 hours to reduce the moisture content and to increase the concentration of the nutrients prior to chemical analysis. Then, they were passed through a 2 mm pore sieve for homogenization before they were analyzed for various contents. Nitrogen (TN) was analyzed using Kjeldahl method Potassium (K) detected by flame photometer, Phosphorous was extracted olsen method and Carbon was analyzed using method of Walkley-Black. Measurements of soil pH and electrical conductivity were done with 1:5 soils: water ratios conductivity meter in soil to water suspension. Cation exchange capacity (CEC) Extracted by using ammonium acetate.

### **3.4.5 Ethical consideration**

The district agriculture office, the tea development company, and the respondents all gave their permission for the data collection process, which respected their private well being. The respondents were informed of the study's purpose and given the opportunity to give their consent, with the understanding that the data would be kept private and used only for research. Tools of data collection.

## 4. RESULTS AND DISCUSSION

### 4.1 Results

#### 4.1.1 Demographic Characteristics of Respondents

There are 73 household informants in total, 93% of whom are men and 7% of whom are women. The age ranges of the informants are 18–44 (31%), 45–60 (61%) and over 60 (only 8%). All are married, but 5% are divorced, and the majority has families of 1 to 5 people or more. Most of them (94%) are literate and engaged in farming (71%), employment with the government (23%), and other activities. The majority (70%) has lived there since birth, and immigrants make up 23% of the population. The majority of the land is between 0.5 and 5 hectares in size, with only 5% of it being larger.

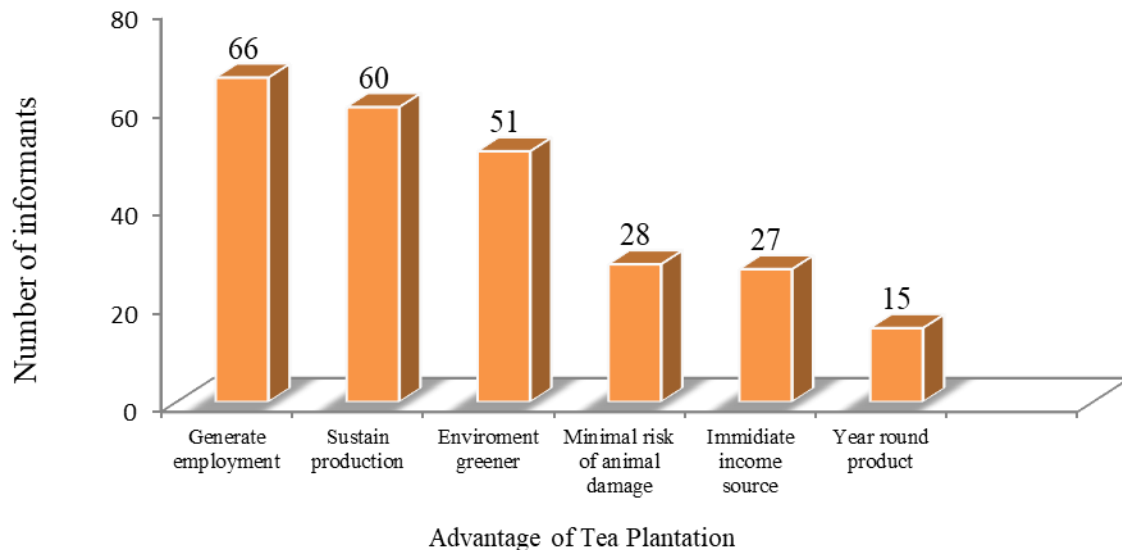
**Table 5.** Socio Demographic Characteristics of Informants

S/No	Variables	Categories	Frequency	Percentage
1	Sex	Male	68	93
		Female	5	7
2	Age	18-44	23	31
		45-60	44	61
		Above 61	6	8
3	Marital status	Married	69	95
		Divorced	4	5
4	Family size	1-5	50	69
		6-8	19	26
		Above	4	5
5	Educational Level	1-4	24	33
		5-8	29	40
		9-12	12	16
		Above	8	11
6	Occupation	Uneducated	5	6
		Crop and livestock	21	29
		Livestock and diary product	30	41
7	Leaves on the area	Government employer	16	23
		Other activity	5	7
		Since birth	51	70
7	Leaves on the area	Less than 20 years	6	7
		More than 20 years	19	23
8	Land size/ hectare	0.5-2	40	55
		3-5	29	40
		Above 5	4	5

## 4.1.2 Socioeconomic Impacts

### 4.1.2.1 Advantage and disadvantage of After Tea Plantation

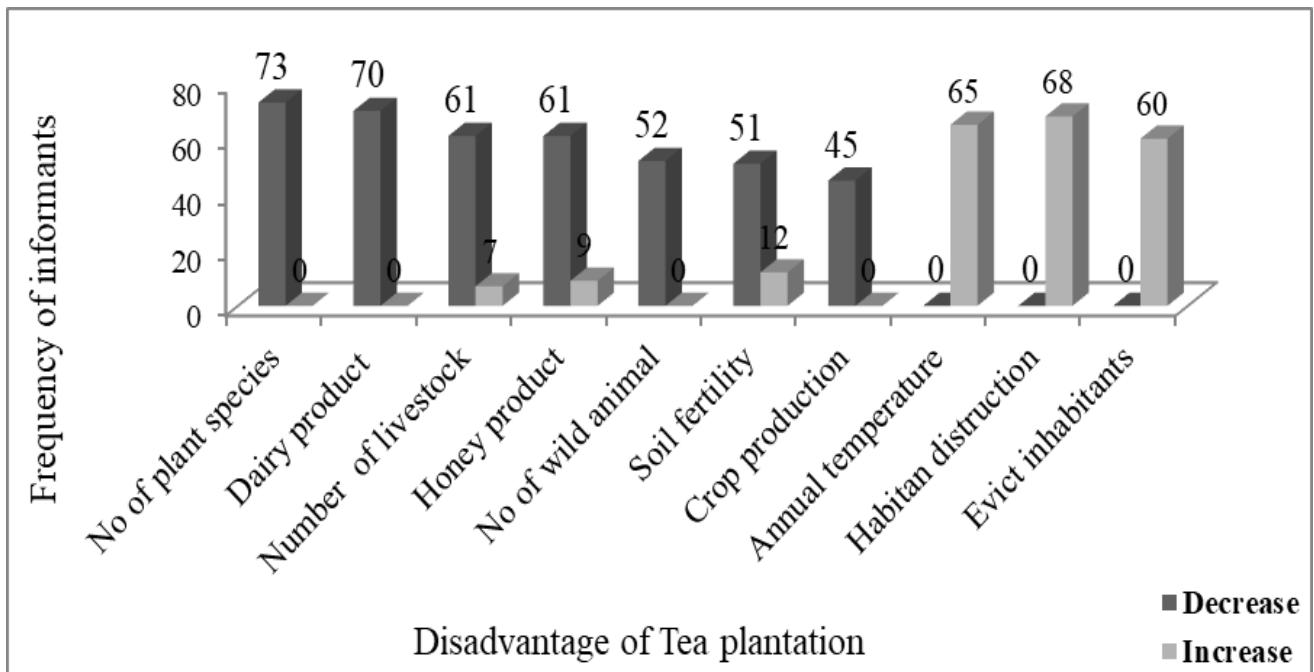
Gumaro tea plantation has advantage for local community for different purpose . Some benefits are generating employment immediate income source and year round production can be harvested on average twice a month .



**Figure 4.** Advantage of Tea Plantation

### 4.1.2.2 Disadvantages of Tea Plantation

Although agricultural investments offer many advantages, they also have negative effects on the socioeconomic development of humans and the sustainability of the environment.



**Figure 5.** Disadvantages of tea plantation

#### 4.1.2.3 Change of Livestock in Different Year

There is no periodically and appropriate registered livestock data. When livestock damage is close to a tea plantation, there are severe penalties. As a result, the owners decrease their livestock numbers, their production and put their properties up for sale, so significantly reducing the number of people who was benefited from their goods

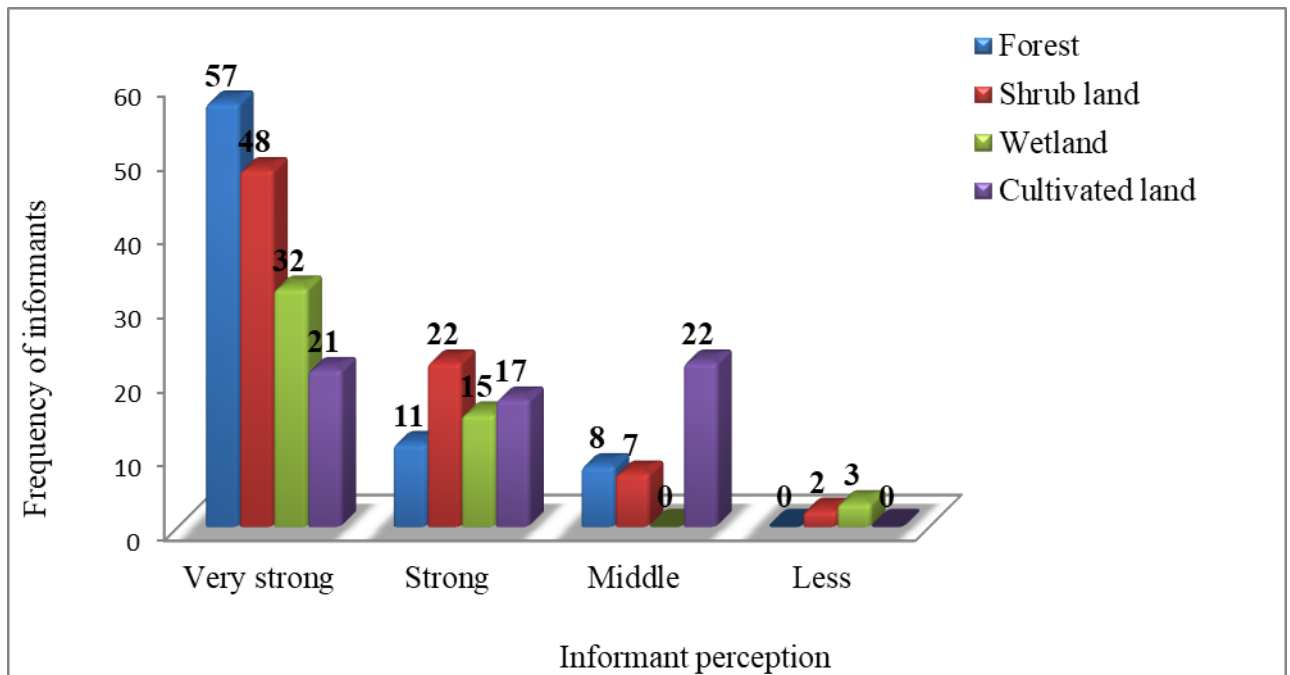
**Table 6:** The Number of Livestock Decrease in Different Year

S/n	Kebeles	Year	No of Livestock	Changes	Percentage
1	Jeto	2001	4670	Decreased by 2048	44
		2014	2622		
2	Agelo	2006	15699	Increased by 1341	8
		2014	17040		
3	Onga	2007	7690	Decreased by 2850	37
		2014	4840		
4	Gumaro Abo	2009	11386	Decreased by 3197	28
		2014	8189		

#### 4.1.5 Perception of local community about Land Cover Change by Tea plantation

According to informant perception, different land use systems because experience varying degrees of damage. Of the informants the forest was very highly damaged (57), strongly (11), and moderately affected (8), while shrub land very strongly damaged (48) strongly, (22) moderate (7) and (2) less damages. In terms of wetland observations, (32) of informants are

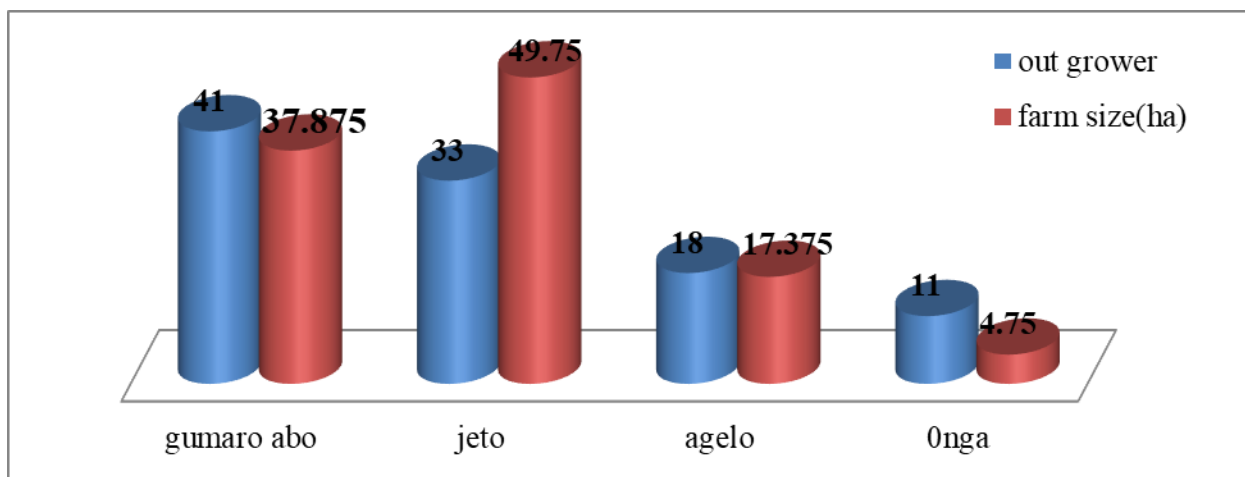
very strong, 15 are strong, and 3 are less affected. Cultivated land does the least damage, cultivated land (21) is very strong, (17) are moderately affected, and (22) are less affected.



**Figure 6.** Informant perception Land use land Cover change

#### 4.1.6 Tea out Grower and Tea Farm Size

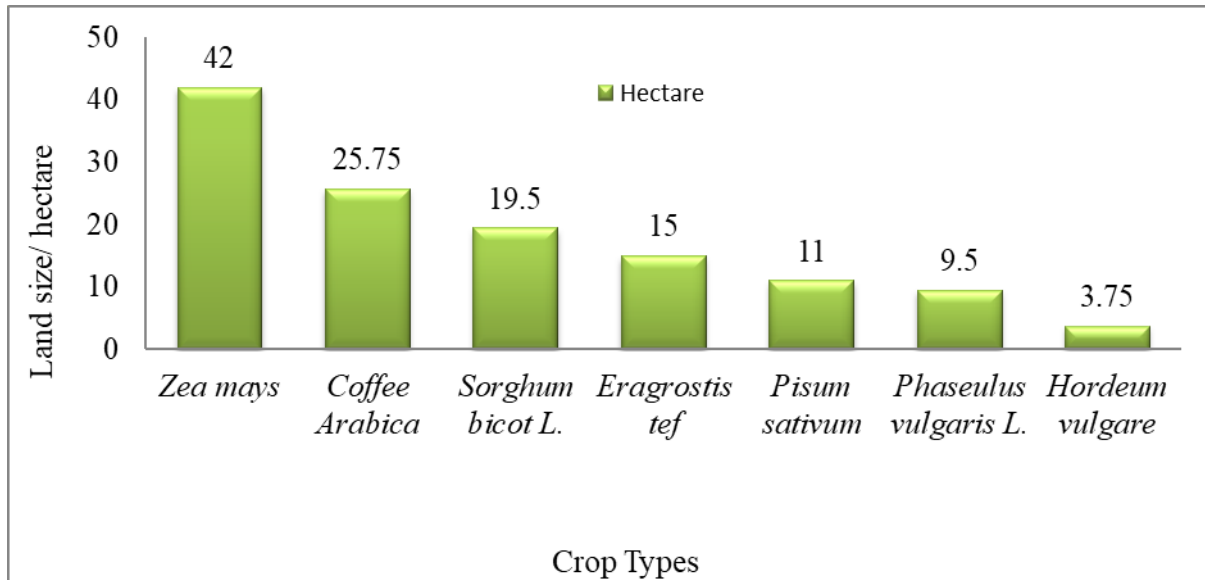
Among the 19 kebeles found in Ale district, four are well-known for tea farming by farmers on their own land. They have land ranging in size from 0.5 to 3 hectares. Gumaro Abo has 37.875 hectares of tea produced by 41 out growers, and Jeto has 49.75 hectares produced by 33 farmers. Agelo 17.375 hectare was produced by 18 farmers, and Onga 4.75 hectare was produced by 11 farmers.



**Figure 7.** Tea out Grower and Tea Farm Size

#### 4.1.7 Major Crop Type Before Produced

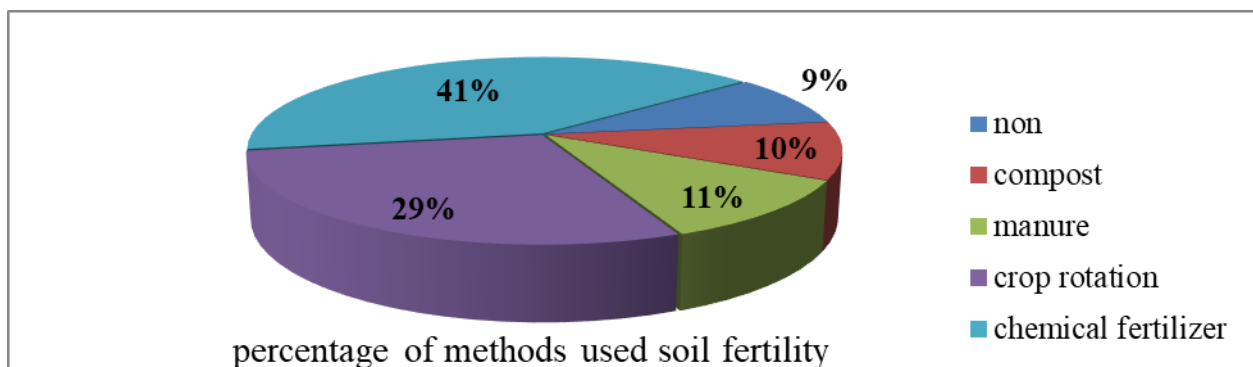
Alle found in mid land (weyna dega) favourable to grow different types of crop. Before tea expansion on the study area major crops grown are *Zea mays* (42 ha) *Coffee arabica* (25.75 ha), *Sorghum bicot L.* (19.5ha), *Eragrosis tef* (15 ha), *Pisum sativum* (11ha), *Phaseulus vulgaris L.*(9.5ha) and *Hordium vulgare* in (3.75 ha) covers. Now day decrease their production by attracting to tea work and different environmental factors.



**Figure 8.** Major Crop Type Before produced Produced

#### 4.1.8 Soil Fertility Improvement Methods Prior to Tea Plantation

Farmers on the research area were used various methods to preserve soil fertility previously crop production.



**Figure 9.** Methods used to maintain soil fertility before tea plantation

## 4.1.9 Analyse of Land Use Land Cover Change

### 4.1.9.1 Land Use Land Coverage in 1990

Ale district has a total area of 67512.2 hectares that is divided into various land use groups.

**Table 7.** Area coverage of each class of Ale district in 1990-2021

Class Name	Area_Ha			Area- Km <sup>2</sup>			Area_%		
	1990	2001	2021	1990	2001	2021	1990	2001	2021
Cultivated Land	32021.6	29103.5	33791.2	320.2	291.03	337.9	47.4	42.6	50.1
Forest	25011.2	28961.1	19420.9	250.1	289.6	194.2	37.1	42.5	28.8
Gumaro Tea prod	9231.3	8129.34	7099.6	92.3	81.3	71	13.7	12.1	10.5
Shrub Land	963.5	965.8	6908.6	9.6	9.6	69.1	1.4	1.4	10.2
Wetland	284.6	352.8	292.2	2.8	3.5	2.9	0.4	0.5	0.4
<b>Total</b>	<b>67512.2</b>	<b>67512.54</b>	<b>67512.5</b>	<b>675.1</b>	<b>675.03</b>	<b>675.1</b>	<b>100</b>	<b>100</b>	<b>100</b>

### 4.1.9.4 Rate of Change of Ale District (1990, 2001 And 2021)

Between 1990 and 2021, the rate of LULCC within total of Wetland 9.6 km<sup>2</sup>, 3.5 km<sup>2</sup>, Forest 320.2 km<sup>2</sup> 289.6 Km<sup>2</sup> 194.2 km<sup>2</sup> and shrub land 92.3 km<sup>2</sup>, 81.3 km<sup>2</sup> and cultivated land and Gumaro tea production grew by 250.1km<sup>2</sup> 291.03 km<sup>2</sup> 337.9 km<sup>2</sup> and 2.8 km<sup>2</sup>, 9.6 km<sup>2</sup> 71 km<sup>2</sup> form their area coverage. In general LULCC (1990–2021) the tea plantation changed quickly (grew), followed by the cultivated land. The forest, shrub land, and wetland all demonstrated a declining trend. Over the previous three decades, the rate of change in wetlands (-0.31%), forests (-3.8%), and shrub lands (-0.8%) has all dropped. Despite this, cultivated area and tea production have increased by 3.1% and 1.8%, respectively.

**Table 8.** Coverage of LULCC of Ale District 2021

Class name	1990 (Area km <sup>2</sup> )	2001 (Area km <sup>2</sup> )	2021 (Area km <sup>2</sup> )	Rate of change km <sup>2</sup> /years		
				1990 to 2001	2001 to 2021	1990 to 2021
Wetland	9.6	3.5	2.9	-0.3	-0.01	-0.31

Forest	320.2	289.6	194.2	-1.4	-2.4	-3.8
Shrub Land	92.3	81.3	69.1	-0.5	-0.3	-0.8
Cultivated Land	250.1	291.03	337.9	1.9	1.2	3.1
Gumaro Tea Production	2.8	9.6	71	0.3	1.5	1.8

#### 4.1.9. 6 Land Use Land Cover Change Matrix from 1990 to 2021 of Ale District

Land can transition from one use system to another or be exchanged. As a result of this study, wetland 192.66 ha, cultivated land 65.46 ha, forest 67.25 ha, and shrub lands 185.1332 hectares are all converted to tea plantations.

**Table 9.** Land Use Land Cover Change Matrix from 1990 to 2021 Of Ale District

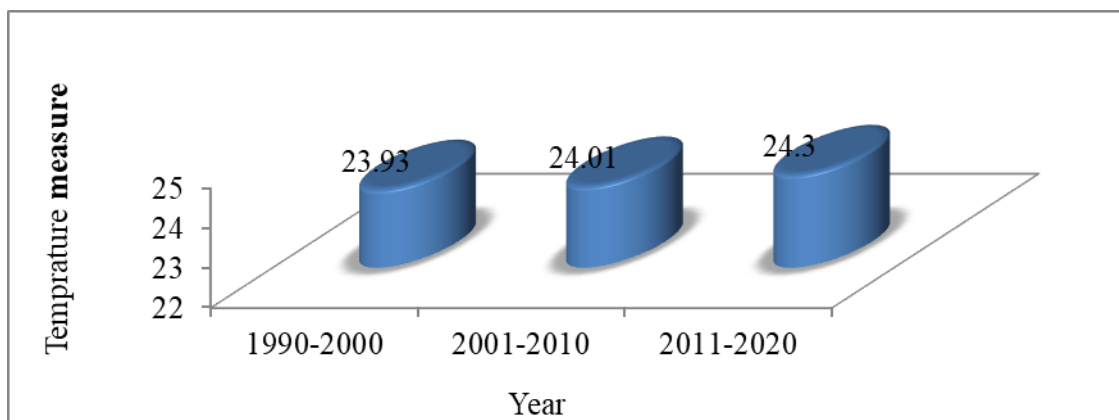
LULC Class		LAND USE 2021					
		Cultivated Land	Forest	Shrub Land	Wetland	Gumaro Tea	Grand Total
LAND USE 1990	Cultivated Land	<b>21792.27</b>	1501.246	1305.547	365.8759	65.46143	<b>25619.55</b>
	Forest	7788.03	<b>16832.29</b>	7211.369	121.5032	67.25668	<b>32020.45</b>
	Shrub Land	3579.437	989.6065	<b>4020.855</b>	623.2106	185.1332	<b>9398.242</b>
	Wetland	566.4657	57.21755	343.5219	<b>278.7277</b>	192.6585	<b>1438.591</b>
	Gumero Tea	52.71802	15.8176	94.46687	125.0538	<b>218.4864</b>	<b>506.5427</b>
	<b>Grand Total</b>	<b>33778.92</b>	<b>19396.17</b>	<b>12975.76</b>	<b>1514.371</b>	<b>1318.149</b>	<b>68983.37</b>

*N.B the diagonal magnitude of land classes is not changed.*

#### 4.1.10 Climate Condition

##### 4.1.10.1 Average Maximum Temperature

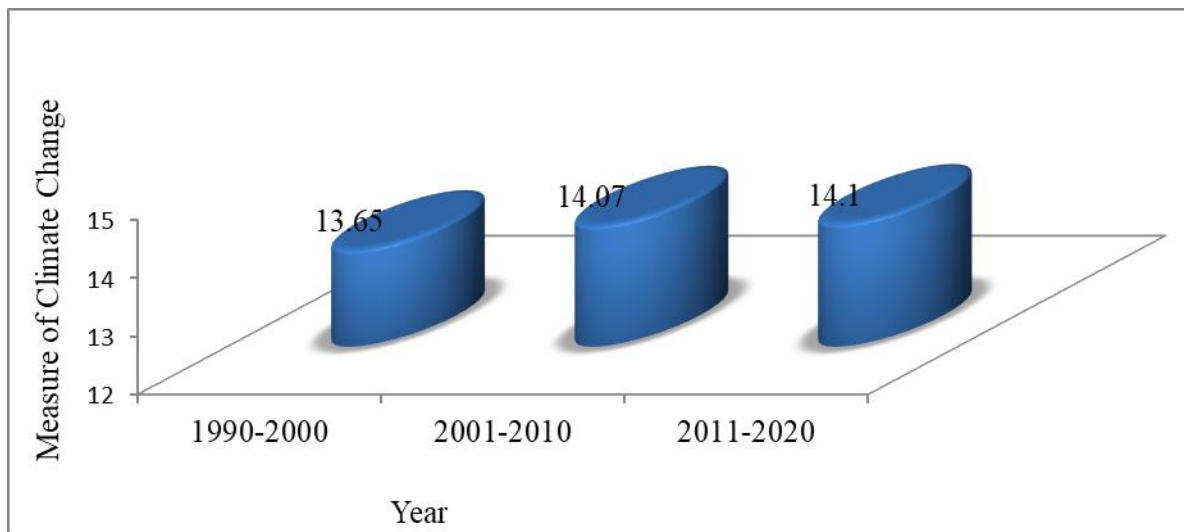
Trees and other types of vegetation act as carbon sinks. When vegetation is burned for fuel or land is cleared for agriculture, emissions are released back into the atmosphere, causing temperatures to rise. The temperature recorded in the past decade shows slightly increment.



From 1990, 2000 and 2020 increased by 0.08, 0.39, 0.29 respectively on average increased by 0.25°C.

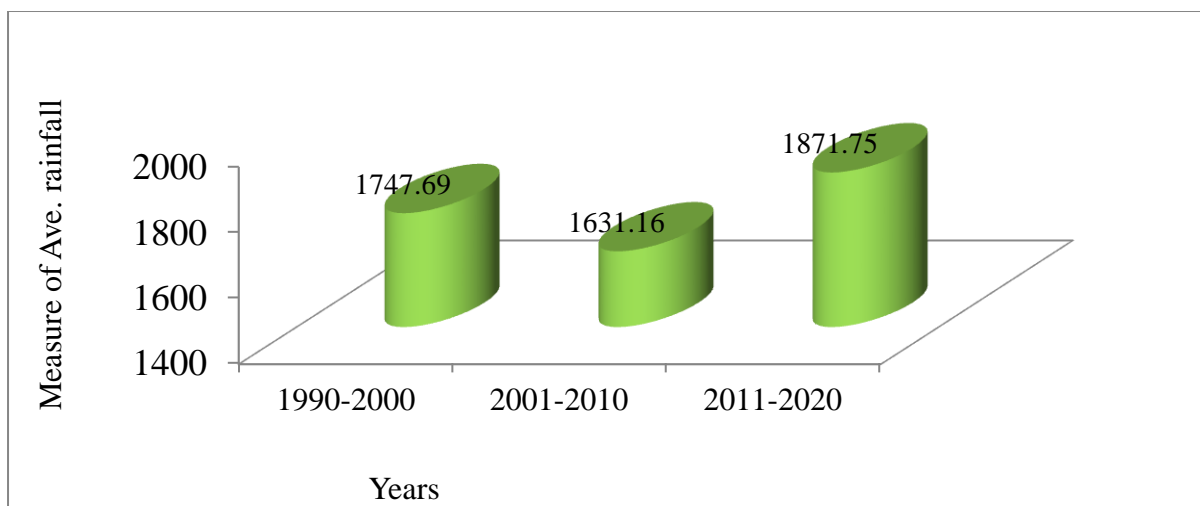
**Figure 10.** Maximum temperature 1990-2020

Minimum temperature most probably happened during summer (rainy season) range from 13.65-14.1 degree celsues. There in increment shows. When 1990-2000 was 13.65 increased by 0.42, 2000-2010 increased by 0.03 from 1990-2020 increased by 0.45°C.



**Figure 11.** Minimum Temperature 1990-2021

The average annual rain fall of the study area 1990-2001 indicates 1747.67mm; 2001-2010 shows some decrement 1631.16 and from 2011- 2021 rise to 1871.75 mm. The average amount of precipitation has increased along with the mean temperature rise. According IPCC (2013) to be expected since when the temperature rises, the amount of evaporation increases, and the increased evaporation requires an increase in precipitation .



**Figure 12.** Minimum Temperature

#### 4. 1.11 Evaluation of Soil Fertility

##### 4..11.1 Status of soil parameters at the begging of Tea Plantation

The oldest age of soil (90 years) under tea plantation has an average value for PH (3.73) which extremely acidic, in which most of indigenous plants would not gown, the average value of electrical conductivity ( 3.99) non saline measure of soluble salt content which yield of many crops are favourable like corn bean, total nitrogen (0.299) medium/ optimal range for most plant growth, availability of phosphorus (11.54) medium is favourable to indigenous plant growth, availability of potassium (0.126) low concentration in the soil, organic carbon (4.82) medium which is sufficient for plant growth including tea plant and cation exchange capacity (10.56) low ability to hold /attract positive ions.

**Table 10. Result from Soil Parameter Analysis in 90 Year Tea Plantation**

S/No	Soil parameters	Minimum	Maximum	Average	Evaluation
1	pH	3.61	3.84	3.73	Extremely acidic
2	Electrical Conductivity	0.47	13.3	3.99	Non saline
4	Total Nitrogen	0.26	0.34	0.296	Medium
5	Availability of phosphorus	3.7	17	11.54	Medium
6	Availability of Potassium	0.07	0.17	0.126	Low

7	Organic Carbon	2.4	6.4	4.82	Medium
8	Cation Exchange Capacity	5.78	17.38	10.56	Low
9	Exchangeability of Magnesium	5.56	8.95	7.19	Low
10	Exchangeability of Calcium	2.33	3.56	2.82	Low

#### 4.1.11. 2 Status soil fertility of tea at commercial level

During socialist era (1974-1991) Gumaro tea plantation expanded to from 25-860 hectare for commercial purpose The average value of soil parameters in 37 years older tea plant pH (4.1) extremely acidic in similar acidity range from the initial soil, regarding electric conductivity/soil salinity (0.83) non saline can support most plant species except salt loving plants, Total nitrogen (0.288), Availability of phosphorus (15.06), percentage of organic carbon (5.32), and cation exchange capacity (18.92) medium availability similar value with the above table (11). Also low available of potassium (0.186) in the soil.

**Table 11.** Soil Parameter Analysis in 37 Planting Year

S/No	Soil Parameters	Minimum	Maximum	Average	Evaluation
1	pH	3.92	4.25	4.098	Extremely acidic
2	Electrical Conductivity	0.47	1.36	0.83	Non saline
3	Total Nitrogen	0.22	0.36	0.288	Medium
4	Availabilityof Phosphorus	9.3	22	15.06	Medium
5	Availabilityof Potassium	0.08	0.32	0.186	Low
6	Organic Carbon	3.7	8.3	5.32	Medium
7	Cation Exchange Capacity	13.6	22.9	18.924	Medium
8	Exchangeability of Magnesium	8.5	13.5	10.87	Low
9	Exchangeability of Calcium	4.6	8.9	6.72	Low

#### 4.1.11.3 Status of Soil Parameter 10 Planting Year

The average value of soil parameters under 10 year's old tea plant strong acidic pH of (4.6) most local and exotic plant species can grow because of the study area available strong acidic soil, electric conductivity (2.42) non saline, and medium availability of Total nitrogen (0.37),

phosphorus (0.37), potassium (0.34), organic carbon (6.08) and cation exchange capacity (18.3) the condition suitable for most plant species can grow.

**Table 12.** Soil parameter analysis in 10 planting year

	<b>Soil parameters</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Average</b>	<b>Evaluation</b>
1	pH	4.27	4.93	4.6	Strong acidic
2	Electrical conductivity	0.58	5.01	2.42	non saline
3	Total nitrogen	0.29	0.44	0.37	Medium
4	Availability of phosphorus	8	22	16	Medium
5	Availability of potassium	0.26	0.45	0.34	Medium
6	Organic carbon	4.65	7.33	6.08	Medium
7	Cation exchange capacity	12.54	23.9	18.3	Medium
8	Exchangeability of Magnesium	8.86	15.5	11.46	Low
9	Exchangeability of Calcium	5.98	18.6	10.29	Low

#### **4.1.11.4 Soil from Under Two Year Young Tea Plant**

Tea plants which have 2 years old and do not harvest the leaves have on average values of pH of 4.97 strong acidic, electric conductivity (5.95) slightly saline and medium availability of total nitrogen 0.364, potassium 0.40 cation exchange capacity 24.2. In compare to the other older age soil high concentration of organic carbon 10.6 and phosphorus 17.2 in the soil sample.

**Table 13.** Soil parameter analysis in 2 planting year

<b>S/No</b>	<b>Soil Parameters</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Average</b>	<b>Evaluation</b>
1	pH	5.4	5.56	4.97	Strong acid
2	Electrical Conductivity	4.07	7.9	5.954	Slightly saline
3	Total Nitrogen	0.29	0.41	0.364	Medium
4	Availability of Phosphorus	14	21	17.2	High
5	Availability of Potassium	0.31	0.52	0.402	Medium
6	Organic Carbon	6	15	10.6	High
7	Cation Exchange Capacity	12	28	24.2	Medium

8	Exchangeability of Magnesium	14.76	16.7	15.5	Medium
9	Exchangeability of Calcium	11.67	17.76	14.96	Medium

#### 4.1 .12 Soil Parameters Experimental verses control group

##### 4.1.12 Correlation of soil pH Values under age of plantation

Soil parameters measured in this study (nitrogen, phosphorus, potassium, magnesium and calcium) showed significant difference between control and experimental group site ( $P < 0.05$ ). also strongly differed significantly across different years level 90, 37,10 and 2 ( $P < 0.01$ ). Further analysis of the possible relationship between year level and site group interaction nitrogen, potassium, magnesium calcium and phosphorus were highly significant ( $P < 0.01$ ). On other hand soil pH, (CEC) and OC record strong significant variation across year level 90,37,10& 2 ( $P < 0.01$ ), while EC recorded insignificant difference across the year level ( $P = 0.16$ ) and site group( $P = 0.989$ ). The Macro nutrient concentration of Mg, Ca , N , P and K measured in this study were also found to be lower in experimental group site than control group site.

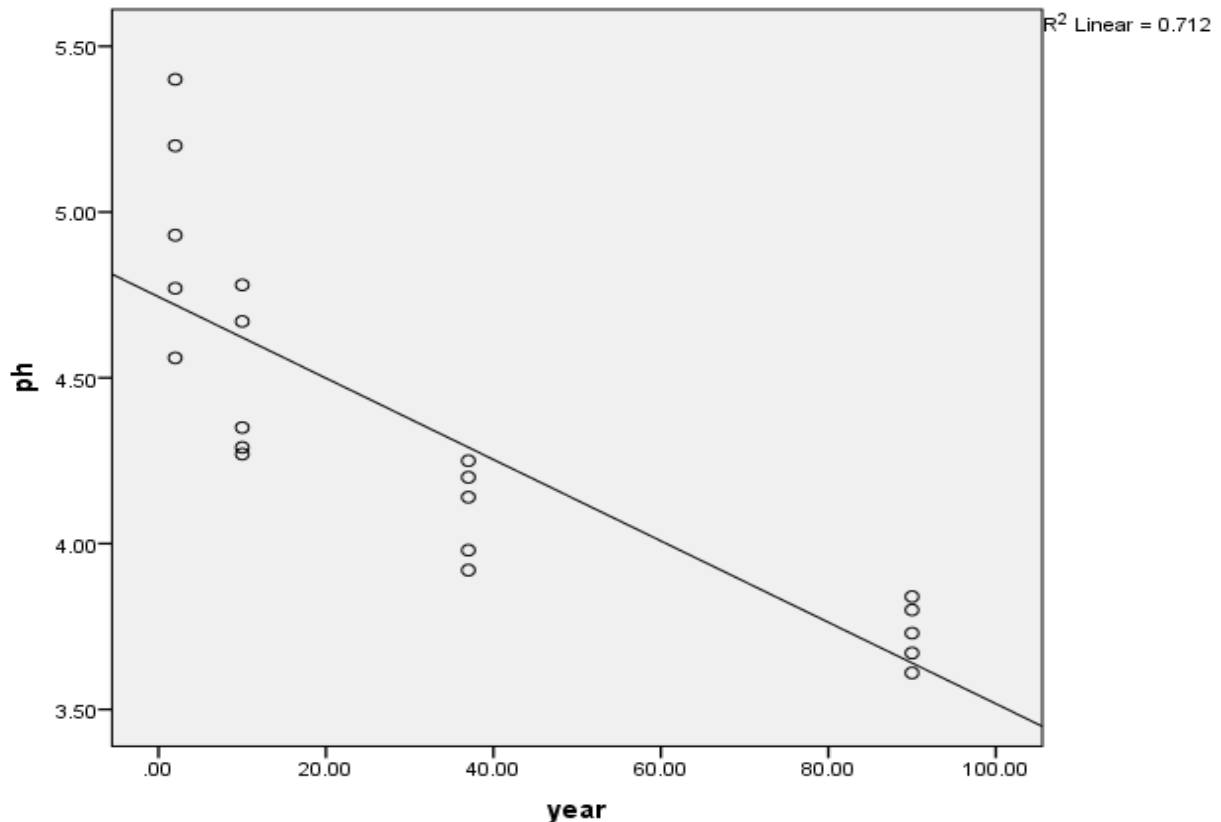
**Table 14.** ANOVA Summary Result Of Soil Properties In Experimental And Control Group Site

S/No	Soil Parameters	Summary ANOVA			Site group (mean±sd)	
		Sites (S)	Years (Y)	Site X Year Level	Control Groups (n=20)	Experimental Groups (n=20)
1	Soil pH	***	***	Ns	5.31±0.475	4.32±0.520
2	EC(ppm in mmh/cm)	Ns	Ns	Ns	4.05±4.17	3.89±3.87
3	TN (%)	***	***	***	0.39±0.07	0.31±0.07
4	P(meq/kg)	***	***	***	9.67±6.2	6.29±2.72
5	K(meq/kg)	***	***	***	0.37±0.10	0.26±0.13
6	Ca (meq/kg)	***	***	***	12.6±3.95	8.7±5.33
7	Mg+	***	***	***	13.14±2.18	11.26±3.34
8	OC (%)	***	***	***	7.02±4.25	5.48±1.92
9	CEC (meq/100g soil)	***	***	***	21.78±5.05	18.06±6.82

(\*\*\* significance , ns not significance)

#### 4.1.12.2 Correlation of soil age ,pH , EC, CEC OC . TN, P, K, Ca and Mg

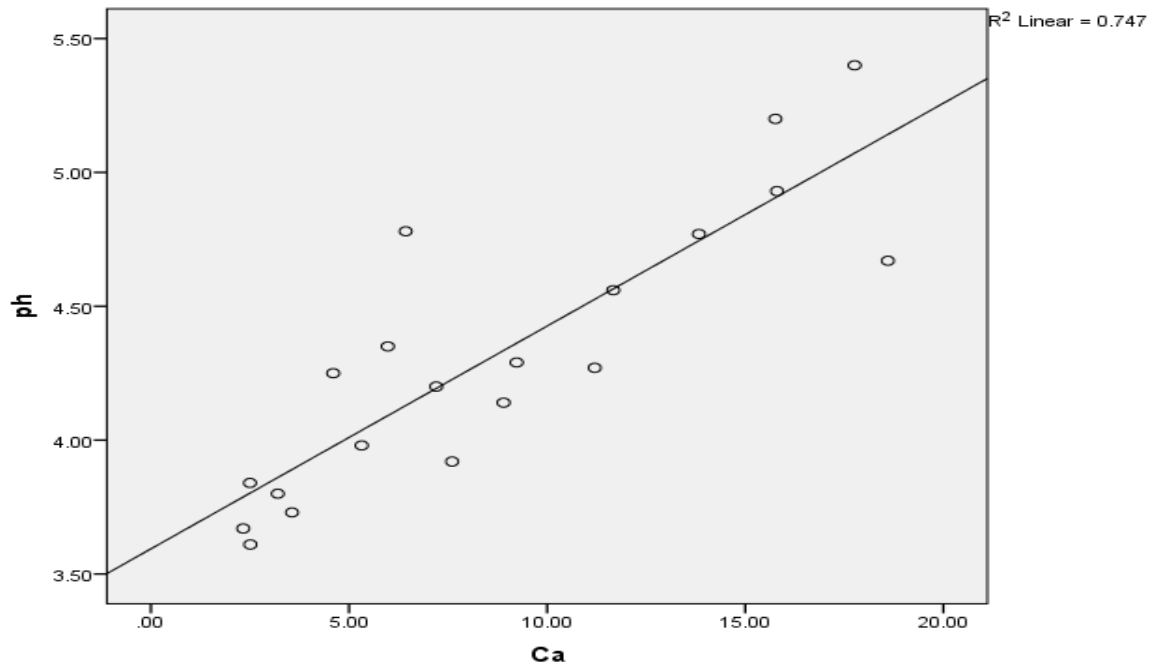
The scatter plot display an inverse between pH value of soil and planting year. When the soil age increase the pH value decrease with increasing soil acidity. similarly K, Ca, Mg, P, OC and CEC become decreasing all year level.



**Figure 13.** Correlation of pH Value with Age of Soil

#### Correlation of pH of soil with Ca,Mg, K, TN, CEC,ON, P and EC

pH has different interaction with other soil parameters, on the study its value become decrease with the age of tea plant increase. This out come led to decrease the concentration of Ca,Mg, K, TN, CEC,ON, P in different strength of correlation value however there is no change in concentration of EC for every year level .



**Figure 14.** Correlation of pH Value of Soil with Ca

## 4.2 Discussion

### 4.2.1 Advantage of Tea plantation

Tea is an economically important crop. Gumaro tea plantation has advantages of generating employment (66), long life (60), environmentally attractive (51), and low risk of hazard from natural and human activities (28), immediate income source for labour force (27) and year round production. Further Study of Beza Erko *et al.*, (2021) on Ale and Gimbi tea plantation similar similar finding opportunities of low risk of animal and thief (37), ) frequent income(25), generate employment (10 ) and long life crop (9) if new investment or new business activities establish can have advantages either local or national level and also Chetana, H.C (2012) Ghats, India tea plantation has work opportunities and abandoned land s changes into usable form

### 4.2.3 Disadvantage of Tea Plantation

Conversion of natural habitats, most of which are rich in biodiversity, into vast tracks of tea plant monocultures result in decreasing the animal and plant species. The number of plant species, dairy products, livestock, honey products, and wild animals has decreased since the Gumaro tea expansion on Alle District. According to several informants, soil fertility, honey production, the eviction of residents, annual temperature, and habitat destruction and

livestock numbers have all increased. Agree with finding of (Clay J.W., 2003). The reason for tea producing environments are typically found in more rugged and remote areas, which tend to have the most local activities are disturbed. The conversion of such environments results in the extinction of species. According to Azeb W. Degife and Wolfram Mauser's (2017) investigate large-scale agricultural investment in the Gambella region results in forced displacement. Farmers and locals lose revenue and livelihoods. Thousands of indigenous people are losing their lush land and ability to generate their own food, leading to food insecurity.

#### **4.2.4 Land Use Land Cover Change**

The main negative environmental impact of tea planting is a habitat conversion. Tea Plantation that have been formed as a result of transitioning from other land use systems to tea plantations include 185.1332 hectares of shrub land and 192.66 ha of wetland. According to this study, the highest land convert to tea plantation is wetland 192.66 hectar, followed by shrubland 185.13 hectar, forest 67.25668 hectar, and cultivated land 65.46143 hectar. In contrast to Workaferahu Ameneshewa (2015), LULCC between 1987 and 2015 chewaka tea eastate the highest land convert to tea plantation forest 987.7 ha, wetland 24.5 17.6 ha shrub land 32.9 ha and cultivated land 10.9 hectares.

#### **4.2.5 Climate Change**

The factory of tea in Alle district uses fuel wood for drying purpose of tea leave.on other hand the forest covers with high density of canopy decreased which are use to shading and cooling the environment before replacing low density of tea plant. and other factor the area become more hot and increase temprature by 0.08, 0.39, 0.29 respectively on average increased by 0.25 °C. Climate change is expected to raise temperatures in Africa's tea-growing regions. Temperature increases of 1 to 3 °C by mid-century and 2 to 5 °C by end-of-century are possible in Kenya, Malawi, and Rwanda (Araujo *et al.*, 2016, Mittal *et al.*, 2017, Finney *et al.*, 2019). According to the World Bank Group (2021), (CCKP), and Anju (2011) studies, temperatures have been rising over time due to a variety of variables.IPCC (2007).From three decade climate data reveal increasing of both maximum and lowest temperature and precipitation. Comparatively climate changes on the area shows less increment from average of the country and other developed countries.

#### 4.2.6 Soil Fertility Analysis

Tea being a perennial monoculture plant, its long-term cultivation induces variable amount of parameters however there is some modification and related each other in different point. When the acidity of soil increased concentration of total nitrogen, availability of phosphorus and potassium, amount decline within in older age. However, organic carbon and cation exchange capacity increased with rise of pH value electric conductivity no effect within age and acidic soil.

Different authors discover causes for soil acidification some of them Crop Production and Nutrient Removal (Nelson *et al.*, 2007), nitrogen fertilizer (Pagani, 2011), organic matter dissociation (Nelson *et al.*, 2007). Study of (Owuor *et al.*, 1990), indicates Continuous application of NPK contain fertilizer increase acidity of soils. There are many causes of acidity soil however, mainly this study focus on monocrop production for longer period of time on the same area using of urea and DAP ( Diamonia phosphate) fertilizer. Soil sample taken from 90,37, 10 and 2 years year as control group to compare the the effects of tea age on soil pH and other parameters. Average pH value measures on these years 3.73,4.1, 4.6, 4.97 ,OC 4.82, 5.32,6.08, 10.6 and total nitrogen 0.296, 0.288, 0.37, 0.364.

In order to finally understand how plant age affects soil acidity Recent planting area soil pH measurements from soils under a tea plantation (2 years) range from strongly acidic 4.77, 4.93, 4.56 values to mildly acidic 5.2 and 5.4 values. This result is agree with the study by Junhong (2018). Soil pH, (5, 10, 20, 30) year level 5.40, 4.90, 4.60, 4.70 dropped by 0.50, 0.3 increase up by 0.10 lower on average 0.175. organic carbon Total nitrogen declined by (0.02,0.05,0.02)% whereas the numbers 2.23, 2.57, 2.98, and 3.12 increased by 0.34, 0.41, and 0.14 respectively. Other study of (Minh Van Dang Fall,2002) there is fluctuate result of pH, OC and TN with increasing year. Year levels of (14,29,43,76 ) olders of tea plant on soil mesuared PH of 4.01, 4.5, 3.93,3.85 , rised by 0.49, decreased by 0.57,0.08 organic carbon 3.59, 3.65, 3.54, 3.29 and total nitrogen 0.33, 0.39, 0.39 and 0.33 but shows signifigance difference for every year levels on soil parameters.

## 5. CONCLUSION AND RECCOMANDATIONS

### 5.1 Conclusion

Gumaro Tea Plantation has positive and negative impacts on the socio-economic activities of local people, and. causes LULCC, by rising in the local temperature and depletion of soil nutrients. Some advantages of creating employment, having a long lifespan, having little risk of danger from human or natural activity, and providing an immediate source of revenue through year-round work. Other negative effects include the destruction of habitat, eviction of residents who participate in cultural practices, a decline in cattle, honey production, soil fertility, and a huge but short life expectancy for the community. From 1990–2020 from other land use system transfers to tea plantation are cultivated land, forest, shrub land wetland and tea farm 65.46143, 67.25668, 185.1332, 192.6585 and 218.4864 hectares respectively. The maximum temperature recorded in the past three decade shows slightly increment. From 1990, 2000 and 2020 increased by 0.08, 0.39, 0.29 respectively on average increased by 0.25 degree Celsius and minimum temprature When 1990-2000 increased by 0.42, 2000-2010, 0.03 and 1990-2020 by 0.45 degree Celsius. Soil from tea farm pH (4.32), EC( 3.89 ), P( 0.31), K (6.29) TN (0.26), Ca (8.7), Mg (11.26) OC (5.48) and CEC (18.06 While the control group shows pH (5.3)1, EC (4.05), TN (0.39), P (9.67) , K (0.37), C(12.6), Mg (13.14) OC (7.0 )and CEC (21.78). According critical value of average soil parameters found under tea farm plant different age indicate pH extremely acidic, EC non saline P, K, Ca Mg included under low soil fertility class TN and CEC has medium fertile soil. Also from the control group pH strong acidic , EC slightly saline, CEC, OC , TN, , K, Ca Mg found under medium fetility class while the concentration of P shows low. Exept EC all parameters have significance difference between experimental group and control group.

## 5.2 RECOMMENDATIONS

### **Depending on this study the following recommendations are forwarded:**

- Local engagement is vital for the conservation of natural resources and the preservation of healthy environments for the future.
- The area desires to utilize organic fertilizer to improve soil fertility
- Forest and Climate Change Commission, Ministry of Agriculture and Natural Resources, Environmental Protection Authority, Regional Environmental Agencies and the Sectoral Environmental Units work together to avoid undesired damage to natural resources and to balance the environment.
- Impact Assessment has to be done before starting of any investment activities. prevent
- Farmers need to cultivate of Maize (*Zea mays* L) and other acid tolerant plants.
- Institutions of biodiversity conservation must identify the impacts of alien species before permit to enter and practice the environment.
- Researchers need to find out the status of aluminum iron, microbial activities, misplaced plant and animal species in the study area.

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## 7. APPENDICES

### Appendix 1. Lists f Questioner

MATTU UNIVERSTY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES  
DEPARTMENT OF BIOLOGY (BOTANICAL SCIENCE STREAM)

Instruction: Dear respondents, First of all I would like to give advanced thanks for your time to fill the questions. The gathered information will keep secrete and be used only for research purpose.

#### I. General Information on Respondents

Locality \_\_\_\_\_ District \_\_\_\_\_ Kebele \_\_\_\_\_

Residence area / Village \_\_\_\_\_ Date \_\_\_\_\_

1. Name of the respondent: \_\_\_\_\_
2. Age \_\_\_\_\_
3. Sex \_\_\_\_\_
4. Family size Number of family \_\_\_\_\_

#### Encircle your appropriate answer

5. Marital status

A. single /unmarried B. married C. widow D. Divorced

6. Educational background of the respondent \_\_\_\_\_

- A. not formally educated B. 1 to 5<sup>th</sup> grade C. 5 to 8<sup>th</sup> grade  
D. 9 to Cert12<sup>th</sup> grade E. . degree and above

8. How long have you lived in the area?

A. Since birth B. for the last 20 years C. for the last 10 years D. for less than 10 years

#### II. Information on tea farm plantation

9. Occupation /main job

- A. Livestock production C. Crop production  
D. Both livestock and crop production E. Other (specify): \_\_\_\_\_

10. Are you an employer in tea Farm Company?      A. yes                      B. No

12. Are tea plantation harmful / useful aspects of tea farm in your area?

A. yes                      B. No                      C. Both                      Reason out why it is so

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13. What are the main advantages and disadvantage that local/community tea farm?

Advantages	Disadvantages

15. What are the quencequense after the conversion of forest area to tea plantation?

S/N	Items	Decrease	Increase
1	Dairy product		
2	Honey product		
3	Crop production		
4	Number of livestock		
5	Annual income		
6	Soil fertility		
7	Annual temperature		

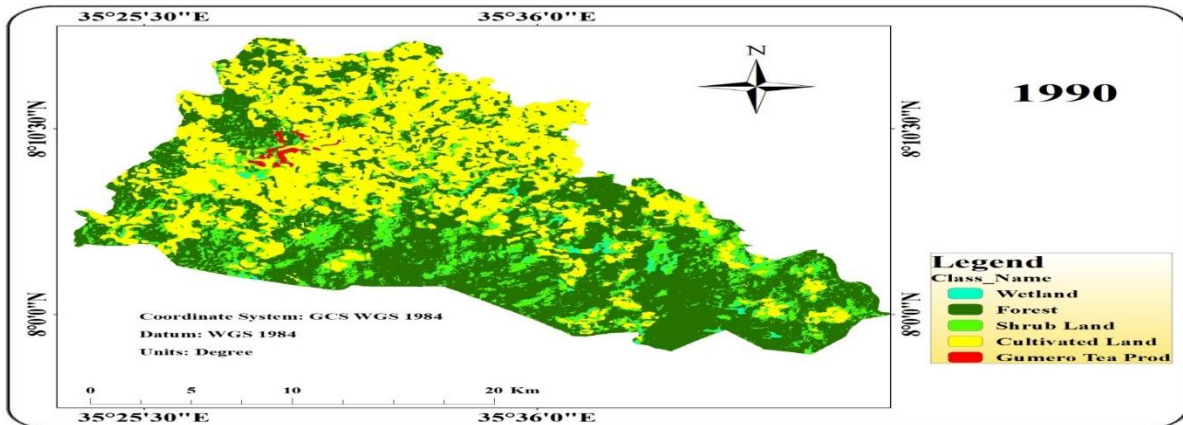
16. what extent the ecosystems are affected

Sector	Very strong	Strong	Middle	Less
Forest				
Shrub land land				
Wetland				
Cultivated land				

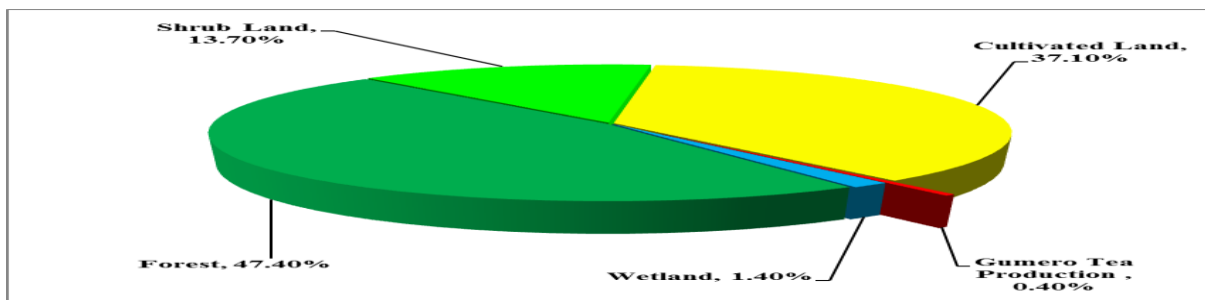
**Appendix 2.** Accuracy assessment for the classified image

Year	Overall Classification Accuracy	Overall Kappa Statist
<b>1990</b>	92.00%	0.8040
<b>2001</b>	88.00%	0.8145
<b>2021</b>	91.00%	0.8681

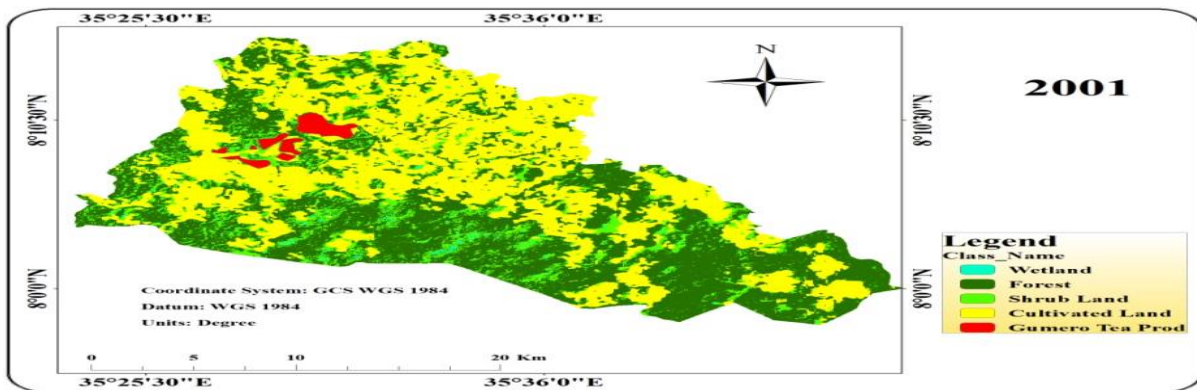
**Appendix 3.** Map of land use classes in 1990



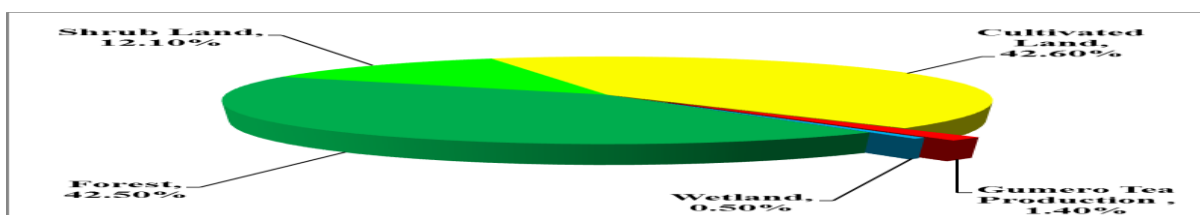
**Appendix 4.** piechart percentage of different land use classes in 1990



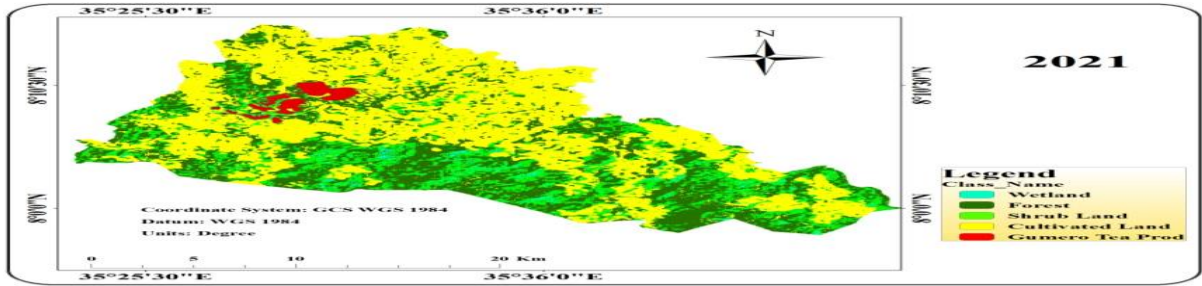
**Appendix 5.** Map of land use classes in 2001



**Appendix 6.** piechart percentage of different land use classes in 2001



**Appendix 7.** Map of land use classes in 2021



**Appendix 8.** piechart percentage of different land use classes in 2021

