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Effects of land use change on forest coffee production in Gomma Woreda, Jimma zone, Oromia, south west Ethiopia.

BY

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Abstract

The main objective of this study is to investigate the effects of land use change on forest coffee production in Gomma woreda, Jimma zone, Oromia Regional State, South West Ethiopia. To meet this objective, explanatory research design with mixed research approaches. The researcher applied both primary and secondary sources of data so that questionnaires and interviews were employed as the data collection instruments. This study was conducted on 120 households who were taken purposively from six kebele such as Goga Kamise, Dehi Kechene, Goga Kilole. Yachi Esa, Koye Seja, and Bulado Choche, of Gomma woreda on the basis of those key farmers who are model for their coffee productions capacity. The collected data was analyzed through frequency, percentage, Mean, and standard deviations. Further, in order to see the relation between the variable liners' regression was also employed. The findings of the study show that, deforestation has a significant effects on the forest coffee production with a P-value of 0.003 which is less than the significant level, as well as the intensification is also significant effect with a P-value of 0.000 which is less than the significant level 0.005 .However, afforestation with a P-value of 0.028 and extensification with a P-value of 0.049 respectively have positively significant effects on the forest coffee productions in the study area. The findings of this study show that unsustainable land use practices, including deforestation and agricultural intensification, pose significant threats to forest coffee cultivation *by degrading soils, diminishing biodiversity, and increasing vulnerability to climate impacts. The researcher recommended that encouraging farmers and stakeholders to adopt conservation practices that protect forest coffee ecosystems, such as sustainable land use planning and the conservation of bio diverse habitats.*

Key Words: *Land use change, forest coffee, coffee production, extensification and intensifications*

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SYMBOLS

1. CAB International ……………… commonwealth Agricultural Bureau
2. CSA………………………………. Community Supported Agriculture
3. FGD ……………………………. Focus Group
4. OM ……………………………… Organic Matter
5. CEC ……………………………. Cation Exchange Capacity
6. AFS …………………………… Agroforestry
7. GWAB…………………………. Gomma Woreda Agriculture Buareua

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CHAPTER ONE

1. Introduction

This section presents about the background, statement of the problem, objectives, basic research questions, significance, delimitations, limitations and organization of the study

1.1 Background of the Study

Coffee is the world's most widely traded tropical product, produced in over 80 developing countries in the world. Even though many species of coffee exist, for commercial production, *Coffea arabica* and *Coffea canephora* took the principal share and more than 60% of global coffee production is based on *C. Arabica* (CAB International, 2006).

Coffee makes an important contribution to socio-economic development and poverty alleviation and it has exceptional importance to exporting countries, some of which rely on coffee for over half of their export earnings. About 25 million smallholder farmers and their families produce 80% of world coffee production, that is an important source of cash income and responsible for significant employment (ICO, 2010). *Coffea Arabica* is believed to be originated from Ethiopia and hence, the country has enormous potential to sustainably supply quality coffee with diverse type to the world market. The coffee types of Ethiopia that are distinguished for their very fine quality, with unique aroma and flavor characteristics include Harar, Sidamo and Yirgacheffe types **(**workafes Woldesatdik and Kassu Kebede, 2000).

Ethiopia is the leading *Coffea Arabica* producer in Africa, ranking the fifth largest Arabica coffee producer and tenth in coffee export worldwide (ICO, 2014). The area of production was increased by 2.49% from 2011/12 to 2012/13 cropping season while its total harvest was decreased (CSA, 2013).

An extensive review of published data on coffee land use change suggests that apart where increases in production are driven by technology, in nearly all countries where coffee production is expanding rapidly, it is deforestation that is the primary source of new coffee lands. The yearly increase is likely to be well in excess of 100,000 ha yr-1. The exact figure is impossible to assess because data is inaccurate or lacking Correia M, et al, (2009)

The global changes are currently unaccounted for in the coffee industry's claims of increasing sustainability. It is very likely that the losses of carbon, biodiversity and other ecosystem services caused by global coffee growth are outstripping the various efforts of local and international efforts to improve sustainability of coffee production.

In future, to substantiate global coffee’s environmental credentials, radically improved understanding and monitoring of its land footprint is urgently needed Ellis et al, (2010).

The impact of human activities on ecosystems has long been recognized and, now, there is increasing evidence to support the hypothesis that we have entered into an Anthropogenic. Human activities have been documented as one of the main driving forces of land use changes and simultaneous changes in natural environments Fogaing (2019).

In turn, changes greatly influence, among others, the spatial pattern of a landscape, the availability of ecosystem goods and services, and increase vulnerability of regional biomes and human well-being to climate change. Continuously studying and monitoring land use changes are particularly important in understanding the dynamics and predicting the patterns and trend of changes in a natural landscape and associated ecosystems at local, regional, and global scales, and to provide evidence-based support to improve land management policies and practices Fongang et al., 2008).

Inappropriate agricultural practices, drought induced migration, high human and livestock population, and government land policy has been frequently reported as the main drivers of land use changes in the country. Remote sensing images and aerial photographs, often supplemented with data from field observations, interviews, and group discussions, have been the major data sources for many of these studies. Linking information obtained through earth observation with social science approaches is helpful in gaining a comprehensive understanding of land use changes Foresta, and Michon (1997).

However, it is often inadequate to quantitatively describe the changes in the structure and pattern of a landscape. Indices of landscape patterns, on the other hand, provide an insight on the effects of land use change in composition and configuration of patches within class or landscape levels. Analyzing and interpreting such data over time plays a critical role in monitoring changes, and facilitates identification of driving forces that bring changes in the landscape.

It has been integrated landscape metrics with land use changes classifications derived from remote sensing images to quantify the patterns of a landscape and relate to the processes driving the land use changes of the forest coffee production Inoussa et al, (2011).Therefore, having saying this , Jimma zone , Goma woreda is also not an exceptional that the need for conducting study on the land use change on forest coffee production in Gomma woreda, Jimma zone , Oromia Regional State, South West Ethiopia is crucial to see problems related with the effects of land use change on forest coffee production of this study area.

1.2 Statement of the Problem

The coffee industry has made notable strides to become more sustainable over recent years and there are strong signs that this process is becoming mainstream, with at least 20% of farms now certified under at least one certification scheme. There is no evidence however that the current global trend towards sustainable coffee is reducing the rate of deforestation for new plantings of coffee Jagoret et al., (2014).

According to Jzardo coffee production from Jimma zone contributes 21% of national export and generates higher cash income for the livelihood of several coffee farm households in the area. Furthermore, there exist favorable_environmental situations for coffee yield and lower as compared to other coffee producer countries intensification and quality improvement Kamal (2002).

Land use changes in Ethiopia have indicated that the country has experienced rapid and increasingly pronounced land use changes since the second half of the 20th century Ariti et al., (2010) Most of these studies have documented a considerable expansion of cropland at the expense of other land use changes types in the country. Other studies reported that the expansion of cropland at the expense of forest, woodlands, grasslands, and water in the Central Rift Valley Garedew et al (2010).

Similarly, Gashaw et al (2009) reported a reduction of forest, shrub land, and grassland between 1985 and 2015 in Andassa watershed in the Blue Nile Basin as a result of the expansion of cultivated land in the area. Increases in cultivated land at the expense of pastureland, forestland, and woodland were also observed in hilly-mountainous areas in the central highlands.

The study presented here suggests that the unregulated and poorly accounted for expansion of coffee lands undermines progress to true sustainability of coffee at the global scale. In some cases, land use changes have occurred in various environments in response to various situations.

Despite the fact that coffee production in Jimma Zone is well known from early coffee production time and has high potential for coffee production, the coffee yield stacked back and still low. This is might be due to adverse climatic conditions, changes in population, land pressure and changes in socio-economics are among factors that favor or discourage certain changes.

This study was filled gap on the effects of land use change on forest coffee production that most previous study studied on coffee farming, production potential and constraints, factors affecting coffee production, practices and management of coffee insects and pests, but there are a few empirical (previous) studies conducted on the effect of land use change on forest coffee production in Jimma zone, Gomma woreda.

1.3 Basic Research Questions

1. What are the effects of deforestation practices on forest coffee production in the study area?
2. What are the impacts of afforestation on forest coffee production in the study area?
3. How are the intensification agriculture influence forest coffee production in the study area?

4. What are the effects of extensification agriculture on forest coffee production?

5. What is the status of forest coffee production in the study area?

1.4 Objectives of the study

1.4.1 General Objective

The main objective of this study is to examine the effects of land use change on forest coffee production in Gomma woreda, Jimma zone, Oromia Regional State, South West Ethiopia.

1.4.2 Specific Objectives

- To identify the effects of deforestation practices on forest coffee production in the study area

- To find out the impacts of afforestation on forest coffee production in the study area

- To examine the extent to which intensification agriculture influence the forest coffee production in the study area
- To identify the effects of extensification agriculture on forest coffee production in the study area
- To assess the status of forest coffee production in the study area

1.5 Significance of the study

This study has the following benefits:

First and foremost, the result of this study give benefit for the farmers of the study area that, they will aware about the benefits of the land use change in coffee production, after this study they will be able to use multi land use methods to produce the coffee.

The result of this study also helpful for the agricultural extension employee that they may use the finding of this study to guide and help the farmers at their assigned villages, so that the study helps them to draft different techniques of land use change while producing coffee in the study area.

The finding of this study also gives benefits for woreda agriculture office that, they take some pre-condition on how to deliver some important seminars and training for farmers who are producing the coffee in Gomma woreda. Finally, this study helps researchers who will be conducted study on land use change as plat form to conduct detail study on other similar areas.

1.5 Delimitations of the Study

This study was delimited to investigate the effects of land use change on forest coffee production in Gomma woreda, Jimma zone, Oromia Regional State, South West Ethiopia. Geographically, this study was delimited on six high coffees producing kebeles in Goma woreda, which are Oma Funtule, Kada Maye, Bore Mancho, Geta Bore, Kada Masa and Geta Gepa. Conceptually, this study was delimited on land use change as independents variables (deforestation, afforestation, intensification agriculture and extensification agriculture) and dependent variable (forest coffee production) were the scope of this study

1.6 Limitations of the Study

This study was limited only on Gomma woreda that particularly focused on few potential kebeles. Thus, this study lacks to covered many woredas of Jimma zone and only delimited on certain selected Goma woreda and peasant associations. The other limitations of this study were that this study only focused on limited variables of land use change in relation with forest coffee productions.

1.7 Organization of the Study

This research proposal is encompassing five chapters. The first chapter is about introduction, statement of the problem, basic research questions, objectives, significance and delimitation of the study. The second chapter is about review literature, and the third chapter is about research design and methodology that constituted, design of the study, sources of data, sampling technique and sample size, data collection tools, methods of data analysis and ethical consideration of the study. Chapter four is about data analysis, presentation and interpretation. The last chapter is about major finding, discussion, conclusion, and recommendation.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

2.1 Theoretical Review Literatures

2.1.1 The Concept of Land use change

Land use change through deforestation and/or forest cover degradation due to unsustainable agricultural practices emits significant amounts of carbon into the atmosphere (Cortez and Stephen, 2009; Mangion, 2010). Deforestation and land degradation due to unsustainable practices, which have profound impacts on maintaining ecosystem services. Research on land use and land cover change is important at a basic level to explore the dynamics and drivers of change (socio-economic or biophysical) associated with it in order to support conservation planning and policy development (Ellis et al., 2010); the processes and drivers associated with these changes being complex and resulting from the interaction of the human-environment system which is influenced by socio-economic, environmental and political-institutional aspects that can be considered as drivers (Rindfuss et al., 2004; Overmars and Verburg 2005, 2006).

The monitoring of land use and land cover changes in the Congo Basin is necessary in view of the significant decrease in forest area recorded during this century (Karsenty, 2004; Tchatchou et al., 2015). In this regard, forests and agro forests constitute a major component for the maintenance of tree cover (Ellis et al., 2010). Indeed, agroforestry systems (AFS) are recognized as privileged places for biodiversity conservation and important carbon reservoirs (Zapfack et al., 2002).

As recent studies show that the management of agro forests based on perennial crops constitutes a means of afforestation of savannah ecosystems, through the introduction and or preservation of trees for shade and the provision of many other services (Jagoret et al., 2014). In Central Africa, a significant part of agriculture is based on complex AFS, mainly based on cocoa and coffee trees, which contribute to the income and food of millions of rural families. These complex cocoa- and coffee-based AFS are considered intermediate land-use systems between natural forest extraction and modern plantations (Foresta and Michon, 1997; Correia et al., 2008). The conversion of agro forests to non-agroforestry systems can occur if the economic and institutional conditions are not favorable compared to the deforestation process and thus generate similar environmental impacts (Ellis et al., 2010).

2.1.2 Trends and Implications of Changes in Land Use and Land Cover

Land cover is defined by the attributes of the earth's land surface and immediate sub surface, including biota, soil topography, surface and ground water and human structures as in the case for agricultural expansion or deforestation (Lambin, Geist, Lepers, 2003).

The largest conversion of land use in East Africa over the last 50 years has been the expansion of agriculture at the expense of grazing land. Prior to 1950, semi-arid and sub-humid areas were predominantly pastoral with scattered settlement and cultivation. From the 1950s to the present there has been significant transformation of grazing land to mixed crop-livestock agriculture.

The rate of agricultural expansion appears to be slowing down in several areas (below Mt. Kilimanjaro on both the Kenyan and Tanzanian sides and on the eastern slopes of Mt. Kenya). The slowing is occurring especially where the conversion frontier is in drought-prone land. The rate of rural population growth is also slowing in many places (Campbell, Lusch, 2003). In other areas (e.g., Ugandan sites) the expansion of agriculture is continuing at a rapid pace (Mugisha 2002, Tukahirwa, 2002) Communal land resources including grazing, fuel wood and medicinal herbs disappear, a loss that often affects the poor the most. As land is converted, the patchwork of cultivation and natural vegetation gives way to private, cultivated farmland (Maitima, 2004).

Land-use change is one of the main drivers of environmental change. It influences the basic resources of land, including the soil. Its impact on soil often occurs so creeping that land managers hardly contemplate initiating ameliorative or counterbalance measures. Poor land management has degraded vast amounts of land, reduced our ability to produce enough food, and is a major threat to rural livelihoods in many developing countries.

2.1. 3 Coffee Production Systems

The traditional coffee production system in the area was agro-forestry based system. Agro-forestry is one of the fundamental coffee forest systems in Ethiopia. The unique characteristics of coffee production to other coffee forest areas was the Agro-forestry coffee system which is integrated with tree-crop production system (Zinabu Wolde, 2015). Hence, to increase coffee yield to economically feasible level, planting of shade trees and opening up canopy is inevitable. The plantation of coffee shade trees varies depending on new site plantation and old site plantation in the study area.

It is often assumed that a coffee tree shade system is beneficial ecologically as well as economically this finding is in agreement with the finding of (Tesfaye, Kasahun (2006).

However, a significant decrease in coffee yield has been reported in a high shade-tree density, but the farmers of the study area have their own operational calendar to pollard.

During opening up phase, different agro-forestry tress was managed by farmers as much. There is preferential selection of trees mainly suitable for coffee production. Among the canopy trees, those species with big leaves, decomposable and dense canopy were targeted. This finding was in agreement with (Boffa *et al.*, 2009): the AF species for coffee based *on* farmers indigenous knowledge reflected by the trees selected for various purposes such as soil enrichment or for fuel wood: *Albizia gummifera, Milletia ferruginea* and *Erythrina abyssinic* are used for their soil maintenance and restoration. Most of the trees are fast growers, easily propagated and tolerant of regular pruning (Tadesse Kippie, 2002).

Coffee is grown mainly by smallholders, with farming systems characterized by land fragmentation and many small plots scattered on hillsides. Depending on the number of trees and *Enset* per plot, farmers generally produce coffee in very small fragmented lands. *Enset* inter planted with coffee has been reported to increase coffee yields, with significant yield differences between mono-cropped and coffee–*Enset* intercropping systems in which this result dis-agree with finding of (Van Asten *et al.*, 2011) which says there is significant yield difference in mono cropped and intercropped banana with coffee.

In Agro-forestry coffee systems and other cultivated coffee production systems, farmers choose the coffee types of their preferences and often mix more than one landrace within one field (Personal observation). Each has its own advantages. Some are high yielding; some have good aroma and flavor and some are resistant to diseases

2.1.4 The use of Organic Fertilizer for Coffee Production

In Ethiopia, application of chemical fertilizer for coffee production is almost non-existent. Alternative, organic fertilizers like manure, cover crops, nitrogen-fixing shade trees and coffee pulp are used. In forest and semi forest systems, however, coffee production entirely relies on natural soil fertility from nitrogen fixing trees, though there can be deficiencies in soil nutrients.

Soil fertility depends on many factors, among them the soil OM, because it contributes to an increase in soil CEC which can serve to retain and increase the reserve of solicitations, improves soil structure physics and soil water relations (Torres *et al*, 2006). Soils with higher OM content are associated with increased population and diversity of microorganisms (Brechelt, 2008).

A practice that is beneficial to increase levels of soil OM is the management of shade trees by pruning which is very popular in the area. The application of compost and planting of vegetative cover are other alternatives to improve the supply of OM, therefore the practices of the farmer in the area was the same with concept of this. The Perez *et al* (2008) who is the researcher of Soil Science, highlights the difficulty of balancing a program based solely on organic amendments because the inability to match crop uptake to nutrient supply, this study was not in agreement with this study because farmer of the area practices compost application for the production of coffee which make the unique coffee type. Organic fertilizers are mainly used in coffee farming of the study area; organic fertilizers are usually prepared by mixing grasses, crop residues and/or animal manure in the compost. Farmers of the area prepared compost on the basis of number of coffee tree they have per ha. Organic fertilizer requirement for coffee production depends on the yield level and natural soil fertility, nutrients are removed by harvested of fruits, and additional nutrients are also required for sustaining the vegetative growth. Therefore, the farmer of the study area applies sufficient amount of compost on the basis of fruit bearing capacity of coffee within production year.

2.1.5 Deforestation as Land Use Change

Tropical deforestation has been a prominent issue over the past few decades. A common perception, often held by national and international policymakers, attributes deforestation to a rapidly growing population of poor shifting cultivators who are hungry for new land, while another view, often held by environmentalists, blames corporate greed (Lambin and Geist, 2003). Land-cover change has long been viewed as being continuous, but it is a disjointed process, with periods of rapid change, often triggered by a shock effect (Lambin and Geist, 2001). An example is the unprecedented economic crisis in 1997 that struck Southeast Asia, with Indonesia among the countries most badly affected.

Deforestation is often blamed for having tremendous negative impacts on watershed functions. The watershed functions delivered by forests are often understood to be reduced peak flows, greater dry season flows, landslide prevention, improved water quality and reduced sedimentation of reservoirs and waterways. These functions are commonly used as the main justification for classifying large areas of land as protection forest. In Indonesia alone, protection forest covers almost 15% of the total land area or 20% of the 143 million ha designated as State Forest Land, despite the fact that much of the forest cover has already disappeared. In Indonesia, the classification of land as protection forest is based on criteria such as slope, altitude, rainfall and soil, but not on criteria directly linked to the above-mentioned watershed functions.

Communities that live in the upper areas of watersheds are frequently blamed by government agencies for causing a loss of watershed functions and are asked to alter their land-use practices or to give up their land altogether. In the worst cases, farmers have been evicted when large-scale reforestation projects have been implemented, when dams are constructed. Conventional wisdom prescribes reforestation as the solution to deforestation and the perceived loss of watershed functions. In accordance with this, significant amounts of public or donor funding have been spent on tree planting programs. Yet, such programs are not always based on a sound understanding of the cause effect relationships that exist between land use and watershed functions.

2.1.6 Consequences of Land Use Change

Conversion of primary land cover to cultivation replaces natural vegetation cover with crops either planted as mixed cropping or planted and maintained as monoculture. In addition to planting food-crops there are fields planted with pastures for livestock grazing, woodlots for shade and fencing and homesteads. Within the cropped areas there are many types of crops planted and each type could have different management practices and therefore will affect the land differently.

Changes in land use are here reported to reduce plant species numbers and percentage cover for all vegetation categories and all land use types. Land use in monocultures cropping system results to more loss on species numbers than mixed cropping system.

Land use change causes habitat fragmentation there by reducing habitat for wildlife. This has created restrictions on wildlife movements and their access to key resources like water, dry season grazing areas and in general the spatial grazing range. As a result, especially the increased contact with humans the animal numbers and the species diversity has reduced in the affected regions. In all the study sites wildlife is reported to decline.

We have observed remarkable decline in soil nutrients (also described as a decline in soil productivity in terms of crop yields) due to deterioration of chemical, physical and biological properties. The main reasons for the decline besides soil erosion are decline in organic matter (soil organic carbon), degradation of soil structure and reduction in availability of major nutrients

(N, P, K) and micro elements and increase in toxicity due to acidification and salinization especially in irrigated farming systems.

Farming, grazing and settlements have expanded at the expense of native vegetation. As native vegetation is lost, indigenous plant and animal biodiversity and plant cover are lost. Sometimes, there are more species of birds, small mammals and plants in places where people used land in a moderate fashion. However, large mammals are universally lost as cultivation expands. As croplands expand, soil fertility and moisture drop and soils erode more easily. As plant biodiversity falls, soil erosion increases. Soils in dry lowlands are less fertile and contain less organic carbon than highlands soils. As farming and settlement expands, less water is available for people, and livestock.

Irrigation for crops pollutes water sources. It has been established that in the Lake Victoria basin non point pollution caused by agricultural chemicals in the uplands is far more significant than even pollution from municipal wastes. Farmers who grow many crops conserve native plant species better than those who grow only one crop. Some farmers cope with land degradation by increasing crop diversity.

2.1.7 Major Coffee productivity package practiced

2.1.7.1 Mulching

Mulching consists of covering the topsoil with organic residues to protect the soil from erosion caused by heavy rainfall, to retain moisture and to decrease surface soil temperature. This is particularly beneficial for agro forestry-based coffee farm in the study area during dry periods due to high biomass obtained from the practices.

Mulching enhances soil moisture status through improved infiltration, farmers of the area practices this by using the grasses which grown within coffee field they apply mulch at the beginning of a rainy season in order to aid infiltration, rather than at the end of the rains to reduce the rate of drying out during the following dry season this is in agreement with the study of (Pereira and Jones.1954) showed mulching alternate rows before the rains gave better yields than mulching all rows after the rains.

The use of mulch in coffee farms of the study area has been increasing from time to time especially during the first few years after planting, they practice shoveling three times annually and replaces the removed grasses as mulch. Through experience, farmers know the direct relationship between mulching and better yields, this practice was in agreement with (Pereira and Jones., 1954). One of the main beneficial effects of mulching is weed control or suppression. Mulching replaces nutrients removed by the coffee crop

Pruning is required to supply good healthy wood for the next season's crop; maintain the correct balance between leaf area and crop; prevent overbearing and dieback; reduce biennial bearing; maintain good tree shape. Farmers of the area practices De suckering to maintain a single stem system and avoid competition from suckers. A regular rejuvenation pruning is needed (normally at six to seven years depending on tree vigor and yield pattern), to maintain a source of new fruiting wood. Unless trees are renewed, yield will decline over the following years.

2.7.2 Composting

The art of composting is purely based on scientific facts and a thorough knowledge of soil microbiology. Composting can be defined as a microbial process in which organic wastes are converted into humus by the activity of microorganisms.

Both organic and chemical fertilizers are used in coffee farming in most coffee producing country, but in case of Ethiopia not yet used inorganic fertilizer, farmers produce organic coffee mainly using organic fertilizers usually prepared by mixing grasses, crop residues and/or animal manure in compost. It has been proved beyond doubt that continuous use of inorganic fertilizer in coffee makes the soil sick and this can result in a significant fall in the production levels (Anand. and Geeta, 2004).

Every coffee producing farmer in the area was owner of a small herd of cattle, primarily for the purpose of preparing compost. Generally, the cattle urine, dung, ash, soil and coffee husk are mixed thoroughly and lead into a pit which is mixed with greens and refuse straw from the cattle shed and made into heaps

2.7.3 Weeding

Weeding is one of the regular annual management operations carried out by all farmers. Farmers operate weeding operations varying from farmer to farmer, which also depends on the proximity of the coffee farm to the home village of the owner. The two major weeding seasons are beginning of the rainy season and beginning of the harvesting season. Few weeks after onset of the main rainy season, most herbaceous vegetation, emerge and compete with coffee and should be cleared. During harvesting as well, weeding is must to create access to pick coffee cherries from the trees, and also to allow picking of early maturing coffee cherries dropped to the ground. Along with herbaceous vegetation, small seedlings of trees, climbers and shrubs are also cleared, but they have been reused as mulch.

2.2 Theory of Land use change

With regard to the wide divergence between perceptions of watershed functions and the measurements made of these functions, the so-called _environmental issue cycle offers an excellent theoretical framework. The cycle consists of seven consecutive stages (Tomich et al., 2004). During the first three stages, awareness of the seriousness of a certain environmental problem gradually grows, and the pressure placed upon the authorities to take action increases. The effectiveness of existing government policies and/or agencies is often called into question, and a debate is often begun about the validity of the available evidence of causes and effects.

Once a cause effect chain has been established unequivocally (stage 4), options for mitigation of the problem can be considered, negotiated and implemented during the remaining three stages. The latter half of the environmental issue cycle depends upon the debate on causes and effects being resolved decisively. The process can come to a halt if gaps exist in either the understanding of the problem or in the measured impacts of the problem. Different interest groups may then apply evidence selectively and advocate a position which serves their own interests (Tomich et al., 2004). Deforestation in the tropics, and particularly its effect on low flows, represent a case in point, with seemingly mutually exclusive viewpoints being expressed not only by different interest groups but also by different representatives of the scientific community.

Saberwal (1998) pictures aptly how differently this issue cycle_ evolved in the USA and in India. In the 1920s and 1930s, the USAs Forestry Service had to change its rhetoric about the link between the disappearance of forests and the occurrence of droughts and floods, when it was confronted with scientific evidence (such as evidence obtained from paired catchment experiments) presented by meteorologists, geologists and engineers. The opposition from these groups initially led to an even more alarmist discourse, but, ultimately, to the Forestry Service adopting an increasingly quantitative approach.

By contrast, in India, there was little opposition from professionals in other scientific fields such as engineering, meteorology and geology to the proclamations of the Indian Forest Department that deforestation led to erosion and desiccation.

Saberwal (1998) used the term _desiccation_ to incorporate a larger body of ideas, centered on the connections between deforestation and increased erosion, flooding, and overall aridity. Instead, the efforts of the Forest Department to gain greater departmental control over forest land (and its revenues) were met with a great deal of opposition from the Revenue Department. Its continued opposition drove the Forest Department to use increasingly more alarmist rhetoric (which, from the Forest Departments perspective, was politically valuable).

The Revenue Department lacked the training to question the scientific rigor of the beliefs of Indian foresters, who were able to portray potentially disastrous environmental situations in the making, through selectively reporting scientific developments from the USA.

Because of the potential political fallout of such disasters, the Revenue Department and the British colonial government felt forced to accept the views of the Forest Department. Bruijnzeel (2004) reports a similar debate that occurred in Indonesia and took place on the pages of the forestry journal of the former Dutch East Indies (Tectona) 256 B. Verbist et al. Agricultural Systems 85 (2005) 254–270 in the 1920s and 1930s. Protagonists of the sponge theory (which stated that tree roots, forest litter and soil hold water in the wet season and slowly release it during the dry season) vigorously opposed the infiltration theory (which stated that base flow is governed predominantly by geological substrate rather than by the presence or absence of forest cover).

Others took an intermediate position, emphasizing the positive influence of forests with respect to the prevention of soil erosion and floods rather than their effect on dry season flows. A paired catchment experiment was set up in West Java in 1931, but most of the experimental results were lost during World War II, effectively halting the debate for many years. In the turbulent years after Indonesias independence in 1945, little scientific research and public discussion occurred on these issues.

In terms of watershed functions, the type of land use that replaces forest is more important than deforestation itself: if the infiltration and water-holding capacity of the soil are reduced, it is likely that dry-season flows will be affected. As forests have higher evapo-transpiration rates than most other land use types, including agroforestry systems, the balance between reduced evapo-transpiration on one hand, and lower infiltration on the other, will determine the final outcome of deforestation and land-use change (Calder, 1998; Bruijnzeel, 2004). According to

Calder (1998), deforestation has probably only a slight effect on large-scale flooding and regional rainfall.

He states that landslides and water quality, including its sediment load, are the result of various processes, and are not due to land use alone. In many places, urbanization and the construction of roads generate more sediment in the rivers than agricultural activities (Enters, 1998; Nagle et al., 1999). With regard to land use change in the tropics and the factors driving such change, the conceptual framework developed by Geist and Lambin (2002), based on the analysis of 152 case studies of tropical forest cover loss, is probably the most comprehensive

2.3 Empirical Review Literatures

Several studies have systematically modeled the process from land use decisions to environmental impacts. These studies can be categorized into conceptual and empirical (or simulation) studies. The conceptual dimensions of land use and water quality have been explored in several studies, including Hochman and Zilberman (1978), Sharp and Bromley (1979), Shortle and Dunn (1986), Just and Antle (1990), and Opaluch and Segerson (1991).

These studies show that agricultural and resource policies can affect agricultural production at both the intensive margin (changes in input use and management practices) and the extensive margin (changes in cropping patterns) and the resulting effects on water quality depend on physical attributes. These studies, however, do not provide quantitative estimates of the effects. The empirical studies that model both land use decisions and their impact on water quality can also be classified into disaggregate models and aggregate models. The disaggregated models are generally site-specific and model micro-unit decisions and the water quality effect of these decisions at the farm or watershed levels (Jacobs and Casler 1979; Braden et al. 1989; Johnson et al. 1991; Taylor 1992; Wu et al. 1994; Helfand and House 1995). Because these studies are site-specific, regional and/or national policy impacts cannot be easily derived from these studies without conducting similar analyses over other resource settings and aggregating to a larger scale.

A number of studies have examined the impact of agricultural land use and practices on water quality at the field, farm, or watershed levels (DeRoo, 1980; Hallberg 1989; Gilliam and Hoyt 1987; Tillman et al. 2002). These studies have linked water pollution to land use, fertilizer and chemical application rates, crop management practices, and topographic and hydrological characteristics. In DeRoo (1980), nitrate concentrations in wells around and in shade tobacco tents and turf plots on two Connecticut farms were monitored. At one farm, less fertilizer was used. Nitrate concentrations averaged 2.5 mg/L in groundwater entering the farm and 4 mg/L leaving. After rainfall, concentrations in the downstream wells were found to be over 10 mg/L. At the other farm, intensive fertilizer application resulted in average year-round nitrate concentration of 20 mg/L. DeRoo (1980) concluded that over-fertilization on easily leachable soils led to high nitrate concentration in well water downstream from the crop land.

As Gilliam and Hoyt (1987) examined nitrogen movement under different management practices. After an extensive literature review, Gilliam and Hoyt (1987) concluded that under no-till practices the amount of nitrogen in soil is higher than under conventional tillage practices. Thus, the use of no-till practices instead of conventional tillage increases the possibility of leaching. Conservation tillage practices, however, reduce nitrogen loss from surface run-off.

2.4 Conceptual Frame work of the Study

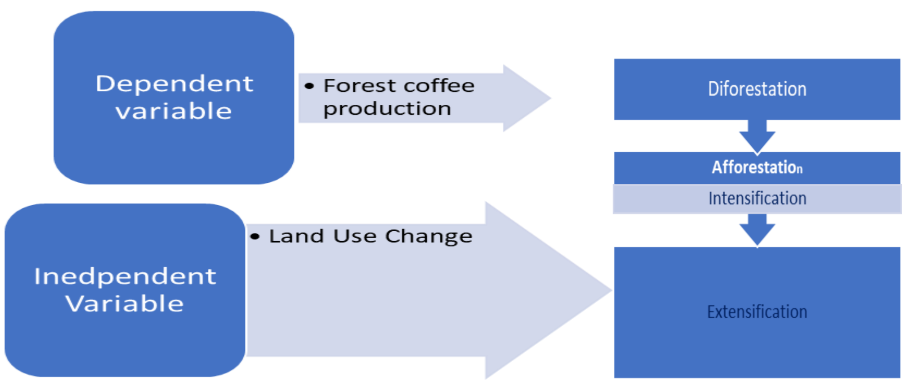


Figure 1: Model relationship of variables adapted from (Ellis, 2010)

CHAPTER THREE

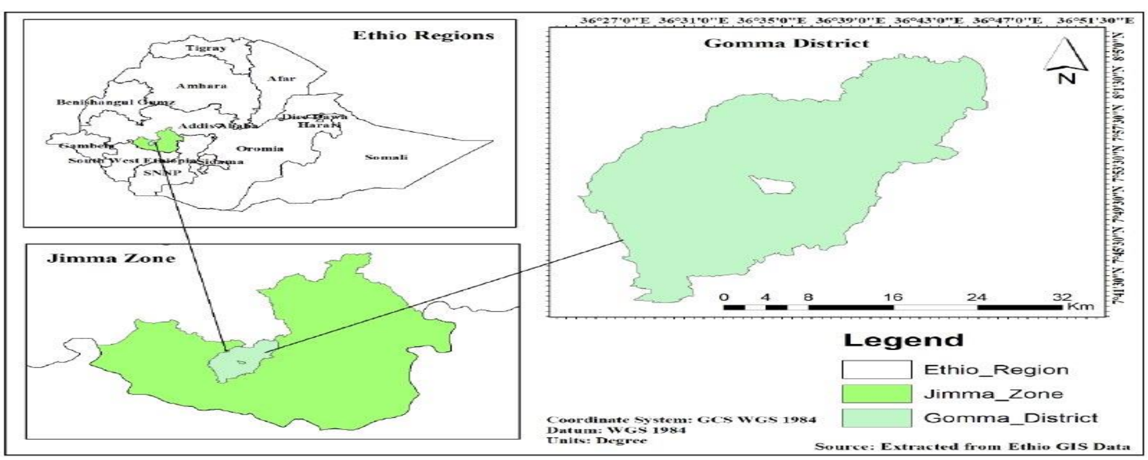
3. METHODOLOGY OF THE STUDY

3.1 Description of Study Area

Gomma Woreda is one of the 17 Woredas in Jimma Zone known for predominantly growing coffee. It is located 403 km south west of Addis Ababa and about 50 km west of Jimma town. One of the coffee biodiversity centers in Ethiopia is found in this Woreda. There are 39 peasant associations and 3 urban peasant associations. The number of agricultural households in the Woreda was 45,567 (35,533 male headed (78%)) and 10,034 females headed (22%) while the total population of the Woreda was 216,662 from which 110,448 are males and 106,174 females (CSA, 2009). Gomma is the second most densely populated Woreda in Jimma Zone with a size of 96,361.72 ha (94.4 km2) including the two coffee state farms which cover an area of 2704 ha (IPMS, 2007).

The average annual rainfall of the district is 1524 mm with low variability. It is bimodality distributed in which the small rains are from March to April and the main rainy season from June to October. Hence, crop and livestock production is not constrained by the amount and distribution of rainfall.

Altitude in Gomma ranges from 1387 to 2870 meters above sea level (masl). Most parts of the Woreda lay between 1387 and 1643; and 1849 and 2067 masl. However, few of the areas in the Woreda have altitudes ranging from 2229 to 2870 masl. Nitosols is the most abundant covering about 90% of the Woreda. These soils are young soils and are generally acidic soils. However, farmers grow crops that are acid tolerant. The pH of the soils in Gomma ranges between 4.5 and 5.5. However, the commonly observed problem related to aluminum and magnesium toxicity as a result of low pH is minimal. There are about 5 rivers in the Woreda. Even though available land and water resources offer high potential for irrigation development in Gomma, the present utilization level is very poor (IPMS, 2007)



3.2 Design of the Study

This research was conducted through explanatory research design with descriptive research describes a condition qualitatively (Trevor, 2010). Descriptive research assists in providing answers to such questions such as what, who, where, when, and how about specific problems of research though it does not fully give answers to why question. Descriptive research is preferring since it gives current information on the subject under study and illustrates the conditions in a situation.

The explanatory research design is use to see the effects of independent variables on the dependent variables, and important to see the relationship between the variables. Therefore, this research design answers questions of why the relation is existed and why not insignificantly affecting the given variables on the others. This research design facilitates a better understanding of the effects of the land use change on forest coffee production in Gomma woreda forest coffee production.

3.3 Sources of Data

For the purpose of this study, both primary and secondary sources of data were employed. Primary sources of data were collected through household survey with structure interview, questionnaire and focus group discussion from framers, agriculture extension employee, woreda agriculture bureau experts while secondary data was collected both from published and unpublished source.

3.4 Approach of the Study

Considering the purpose of the research and the nature of the phenomenon mixed research approaches were implemented which was used both quantitative and qualitative research approach (Creswell, 2007).

The study problem is more likely to be answered through a combination of qualitative and quantitative approach in order to reduce the limitation and increase the quality and flexibility of the data (Robinson, 1998). Both qualitative and quantitative methods were applied in data collection and analysis. This is because this study was primarily focus on the data collected through questionnaires and interview to give condensed pictures of the data by using SPSS for inferential statistics. Further, these studies also use qualitative approach for descriptive findings with word impression and texts.

3.5 Population of the Study

This study was comprised the peasant association, who were taken from each six kebeles, the agricultural extension employees, Gomma Woreda Agriculture Bureau leaders, and key stake holders that supposed to take from each kebeles (GWAB).

3.6 Sampling Technique and Sample Size

This study was employed the multi-stage sampling techniques. The study was ultimately comprising high coffee producing kebeles in Goma woreda, which are: Goga Kamise, Dayi Kachane, Goga Kilole, Yachi, Koye Seja and Bulado Choche. In the first stage, the districts were selected purposively based on coffee production potential from the all woreda. To get representative information, respondents from the six peasant associations were selected by systematic sampling technique. Therefore, from each six kebeles, twenty households, who are highly producing coffee in the selected kebeles were included in the study. So that, the study was carried out on (120) peasant association who were taken from Gomma woreda selected kebeles. Further, the study was also included six development agent and twelve key stake holders and two individuals from Gomma woreda agriculture bureau (GWAB).

3.7 Methods of Data Collection

3.7.1 Questionnaire

Questionnaire will prepare for the peasant association of the selected kebeles. Various questions will ask on farm productivity and land use changes including the adjustment strategies and the range of options available to indigenous farmers and immigrants to adjust to changes. Farmers' responses will important in gathering data on field types and land use changes in time and space.

Both open and ended questionnaire was distributed for the households. The questionnaire was categorized in to different sections: the first section is about the demographic characteristics of the respondents. The second section is about influence of deforestation on forest coffee production, third section is the impacts of afforestation on the forest coffee production, the fourth section is about the effects of intensifications on forest coffee production and the last section address about extent the extensification affects forest coffee production. To make clear the questions, the questionnaire was translated in to the mother tongue language of the respondents (Pritha Bhandari 2023).

3.7.2 Interview

Structured types of interview questions were used to interview Gomma woreda agriculture bureau leaders under study. The purpose of this interview was found how the agricultural bureau of Gomma woreda assist the farmers on land use change on forest coffee production. Therefore, to triangulate data that were taken from peasant association with agricultural experts of Gomma woreda, ten interview questions were prepare for the participants (Gate, 2002).

3.7.3 Focus Group Discussion

The other important method of data collection is focussing group discussion. The focus group discussion questions were designed for extension employee and the key stakeholders of the Gomma woreda. The aim of using FGD is also to cross check the data that were taken from questionnaire and interview and it also help to find a better conclusion of the study. Therefore, fifty different total questions were designed for extension employee and key stake holders of this woreda

3.7.4 Transect walks and Historical Records

Key informants were accompanied researchers during visits to selected routes. These were transecting deem most representative for each village and are those from which changes on land use can be depicted in detail by most members of the age groups.

Information was recorded from farmers of same age groups from the older age groups to the youngest. In most cases the older farmer’s information was more reliable than the younger farmer groups. In each age group a selection was made of ten knowledgeable farmers from each village. The main assumption was individuals in the same age group have common knowledge of understanding the various social and other issues, which have taken place during their lifetime. It was with this consideration that the farmers from the age groups were interview to provide information on land use changes in time and space for the given area. The information was also gathered from these farmers were used to supplement information was collected from the selected households.

3.9 Methods of Data Analysis

Once the data was collected, the quantitative data was analyzed using inferential analysis frequency, percentages, mean and SD and the data that was collected through qualitative data was analyzed using thematic analysis in which data was analyzed non-numerically. The Pearson correlation analysis was used to establish with statistical significance of the existing relationship between the independent variables and dependent variables. Therefore, Logistic Regression was used to analyze the effects of land use change on the forest coffee productions that the researcher develops regression model with two sets of variables, independent variables (deforestation, afforestation, intensifications and extensification) and dependent variable (forest coffee production).

3.10 Ethical Consideration of the Study

In this research, the researcher expects all participants should voluntary and they could withdraw at any time their names and the data that they report and their institutions kept confidential.

The researcher was also attached the granted permission letters from the university /advisor/ in order to conduct this study, the information sheet that included the aims of this study explained and was sent to all participants before conducting the interviews. Participant consent forms obtained for this study. Thus, the consent also clearly inform that the collected data was stored securely, confidentially and only used for this study.

No participant personal contact detail is asked for in the final section of the consent forms, the interviewees informed that if they have any concerns or queries regarding the nature of conducting research project, they free to contact the researcher's advisor directly.

During this research, the researcher was promised to kept the participants identities confidential, tell them over all purpose of the research, and request informant's full consent to use the given information. Therefore, the researcher was informed the purpose of this study, and how the study was conducted for academic and try to find the possible solution for the existed problems.

CHAPTER FOUR

4. Result and Discussion

4.1 Background Information of Respondents

Table 1. Characteristics of the Respondents

Characteristics of the Respondents		Count	Column N %
Gender	Male	96	80.0%
	Female	24	20.0%
Age	26-30	13	10.8%
	31-35 years	82	68.34%
	36- 40 years	21	17.5%
	41-50 Years	4	3.34%
Marital Status	Married	71	59.2%
	Single	30	25.0%
	Divorced	19	15.8%
Year of experience	< 5 years	61	50.8%
	6 – 10 years	20	16.7%
	11 – 15 years	18	15.0%
	16-20 years	16	13.3%
	Above 20 years	5	4.2%
Educational status	Literate	14	11.7%
	Illiterate	20	16.7%
	primary school	82	68.3%
	High school	4	3.3%

As table 1 show that the study investigating the effects of land use change on forest coffee production in Gomma Woreda, Jimma Zone, Oromia Regional State, South West Ethiopia, surveyed 120 respondents. The majority of the respondents were male, comprising 80.0% (96 individuals), while females made up 20.0% (24 individuals). The age distribution of the participants was predominantly within the 31-35 years range, accounting for 68.3% (82 individuals). Other age groups included 26-30 years at 10.8% (13 individuals), 36-40 years at 17.5% (21 individuals), and 41-50 years at 3.3% (4 individuals). Marital status data revealed that 59.2% (71 individuals) of the respondents were married, 25.0% (30 individuals) were single, and 15.8% (19 individuals) were divorced. The experience in forest coffee production varied, with 50.8% (61 individuals) having less than 5 years of experience. Those with 6-10 years of experience represented 16.7% (20 individuals), 11-15 years accounted for 15.0% (18 individuals), 16-20 years made up 13.3% (16 individuals), and those with over 20 years of experience were 4.2% (5 individuals).

Educational status showed that a significant portion of the respondents had completed primary school, making up 68.3% (82 individuals). The remaining respondents were distributed among illiterate individuals at 16.7% (20 individuals), literate individuals without formal education at 11.7% (14 individuals), and those who had attended high school at 3.3% (4 individuals). This demographic profile highlights the diversity in gender, age, marital status, experience, and educatIonal background among the study participants.

Table 2. The effects of deforestation on forest coffee production

The effects of deforestation on forest coffee production	strongly agree	agree	neutral	disagree	strongly disagree	Mean	SD
The producers use digging a little deeper of land to decrease forest coffee production	20	70	16	2	12	2.30	1.09
	16.7%	58.3%	13.3%	1.7%	10.0%		
The farmers use cleaning the land for farming or livestock damage the forest coffee production	42	23	6	38	11	2.61	1.46
	35.0%	19.2%	5.0%	31.7%	9.2%		
The Farmers use slash-and-burn agricultural products directly influencing coffee production	44	29	6	25	16	2.50	1.49
	36.7%	24.2%	5.0%	20.8%	13.3%		
The producers deliberately use cutting, cleaning, and removal of rainforest for pasture purposes to reduce the composition of coffee forest	39	26	3	40	12	2.67	1.47
	32.5%	21.7%	2.5%	33.3%	10.0%		
The farmers use cleaning forests for personal needs like fuel, hunting, and agriculture	41	15	10	35	19	2.80	1.55
	34.2%	12.5%	8.3%	29.2%	15.8%		
The farmers are shifting agriculture, livestock production, and fuel	34	43	15	23	5	2.35	1.20
	28.3%	35.8%	12.5%	19.2%	4.2%		
There is the practicing logging, natural disasters, urbanization, and mining purposes	34	23	14	35	14	2.77	1.43
	28.3%	19.2%	11.7%	29.2%	11.7%		

Table 2 indicated that the study on the effects of deforestation on forest coffee production revealed several key insights from the respondents. The producers' practice of digging deeper into the land was perceived to decrease forest coffee production, with 16.7% strongly agreeing, 58.3% agreeing, 13.3% neutral, 1.7% disagreeing, and 10.0% strongly disagreeing. This statement had a mean score of 2.30 and a SD of 1.09.

When asked about cleaning land for farming or livestock damaging forest coffee production, 35.0% strongly agreed, 19.2% agreed, 5.0% were neutral, 31.7% disagreed, and 9.2% strongly disagreed, resulting in a mean of 2.61 and a SD of 1.46. The influence of slash-and-burn agricultural practices on coffee production was strongly agreed upon by 36.7% of respondents, with 24.2% agreeing, 5.0% neutral, 20.8% disagreeing, and 13.3% strongly disagreeing. This had a mean of 2.50 and an SD of 1.49.

The deliberate cutting, cleaning, and removal of rainforest for pasture purposes and reducing the composition of the coffee forest was strongly agreed upon by 32.5% of respondents, with 21.7% agreeing, 2.5% neutral, 33.3% disagreeing, and 10.0% strongly disagreeing, resulting in a mean of 2.67 and a SD of 1.47. The use of cleaning forests for personal needs such as fuel, hunting, and agriculture was strongly agreed upon by 34.2%, with 12.5% agreeing, 8.3% neutral, 29.2% disagreeing, and 15.8% strongly disagreeing, producing a mean of 2.80 and a SD of 1.55.

Shifting agriculture, livestock production, and fuel usage were strongly agreed upon by 28.3% of respondents, with 35.8% agreeing, 12.5% neutral, 19.2% disagreeing, and 4.2% strongly disagreeing. This had a mean of 2.35 and a standard deviation of 1.20. Finally, practices such as logging, natural disasters, urbanization, and mining were strongly agreed upon by 28.3% of respondents, with 19.2% agreeing, 11.7% neutral, 29.2% disagreeing, and 11.7% strongly disagree, resulting in a mean of 2.77 and a SD of 1.43.

Overall, the findings indicate a variety of perceptions regarding how different deforestation practices impact forest coffee production, reflecting the complexity and multifaceted nature of this issue.

Table 3. The effects of afforestation on forest coffee production

The effects of afforestation on forest coffee production	strongly agree	Agree	neutral	disagree	strongly disagree	Mean	SD
The farmers use planting new trees where no forest stands	44	30	6	25	15	2.48	1.47
	36.7%	25.0%	5.0%	20.8%	12.5%		
The farmers use planning trees where the forest is depleted	38	26	6	42	8	2.63	1.41
	31.7%	21.7%	5.0%	35.0%	6.7%		
The farmers use the restoration and regeneration of forest	49	15	1	38	17	2.66	1.60
	40.8%	12.5%	.8%	31.7%	14.2%		
The farmers afforested trees by choices of species to be planted	34	43	15	23	5	2.35	1.20
	28.3%	35.8%	12.5%	19.2%	4.2%		
Farmers use planning of trees to encapsulate the planting of the right trees at the right places	32	50	16	19	3	2.26	1.10
	26.7%	41.7%	13.3%	15.8%	2.5%		
The farmers use afforestation aiming to transform the landscape that has been occupied.	42	40	14	15	9	2.24	1.26
	35.0%	33.3%	11.7%	12.5%	7.5%		
The farmers use it to rebuild the damaged and depleted forests.	18	50	19	24	9	2.63	1.18
	15.0%	41.7%	15.8%	20.0%	7.5%		

The study on the effects of afforestation on forest coffee production of table 3 in the study area gathered insightful responses from the participants. When considering the impact of planting new trees where no forest previously stood, 36.7% of respondents strongly agreed, 25.0% agreed, 5.0% were neutral, 20.8% disagreed, and 12.5% strongly disagreed. This statement had a mean score of 2.48 and a standard deviation of 1.47.

Regarding planting trees in areas where the forest is depleted, 31.7% strongly agreed, 21.7% agreed, 5.0% were neutral, 35.0% disagreed, and 6.7% strongly disagreed, with a mean of 2.63 and a standard deviation of 1.41. The practice of restoration and regeneration of forests was strongly agreed upon by 40.8% of respondents, 12.5% agreed, 0.8% were neutral, 31.7% disagreed, and 14.2% strongly disagreed, resulting in a mean of 2.66 and a standard deviation of 1.60. Afforestation through the choice of species to be planted saw 28.3% strongly agreeing, 35.8% agreeing, 12.5% neutral, 19.2% disagreeing, and 4.2% strongly disagreeing. This had a mean of 2.35 and a standard deviation of 1.20. Planning to plant trees in the right places was strongly agreed upon by 26.7% of respondents, 41.7% agreed, 13.3% were neutral, 15.8% disagreed, and 2.5% strongly disagreed, with a mean of 2.26 and a standard deviation of 1.10.

Afforestation aiming to transform landscapes that have been occupied had 35.0% of respondents strongly agreeing, 33.3% agreeing, 11.7% neutral, 12.5% disagreeing, and 7.5% strongly disagreeing, resulting in a mean of 2.24 and a standard deviation of 1.26. Finally, using afforestation to rebuild damaged and depleted forests was strongly agreed upon by 15.0%, with 41.7% agreeing, 15.8% neutral, 20.0% disagreeing, and 7.5% strongly disagreeing, producing a mean of 2.63 and a standard deviation of 1.18.

Overall, the responses indicate a generally positive perception towards various afforestation practices and their potential benefits for forest coffee production, although there is some variability in the level of agreement among the participants.

Table 4. The effects of Intensifications of agriculture on forest coffee production

	strongly agree	Agree	neutral	disagree	strongly disagree	Mean	SD
The farmers are use seeds for forest coffee production	17	12	11	60	20	3.45	1.28
	14.2%	10.0%	9.2%	50.0%	16.7%		
The farmers are exposed to use fertilizers to increase level of yield of coffee production	40	15	10	38	17	2.81	1.52
	33.3%	12.5%	8.3%	31.7%	14.2%		
The farmers use pesticides to protects the coffee production	37	15	13	38	17	2.86	1.50
	30.8%	12.5%	10.8%	31.7%	14.2%		
The farmers use technologically advanced skill during harvesting coffee	18	43	27	27	5	2.65	1.11
	15.0%	35.8%	22.5%	22.5%	4.2%		
The farmers use irrigation and modern harvesting methods to increase the coffee production.	27	22	21	39	11	2.88	1.33
	22.5%	18.3%	17.5%	32.5%	9.2%		
The farmers' deliberately use changes in vegetation in reducing numbers of crops species and varieties.	35	25	16	29	15	2.70	1.43
	29.2%	20.8%	13.3%	24.2%	12.5%		
The farmers are providing training on agricultural techniques of coffee production	32	19	16	45	8	2.82	1.36
	26.7%	15.8%	13.3%	37.5%	6.7%		

The study examining the effects of agricultural intensification on forest coffee production that indicated on table 4 in the study area provided valuable insights. When asked about the use of seeds for forest coffee production, 14.2% of farmers strongly agreed, 10.0% agreed, 9.2% were neutral, 50.0% disagreed, and 16.7% strongly disagreed, resulting in a mean score of 3.45 and a standard deviation of 1.28.

Regarding the use of fertilizers to increase coffee yield, 33.3% of farmers strongly agreed, 12.5% agreed, 8.3% were neutral, 31.7% disagreed, and 14.2% strongly disagreed, with a mean of 2.81 and a standard deviation of 1.52. The use of pesticides to protect coffee production had 30.8% of farmers strongly agreeing, 12.5% agreeing, 10.8% neutral, 31.7% disagreeing, and 14.2% strongly disagreeing, resulting in a mean of 2.86 and a standard deviation of 1.50.

Technologically advanced skills during harvesting were strongly agreed upon by 15.0% of farmers, with 35.8% agreeing, 22.5% neutral, 22.5% disagreeing, and 4.2% strongly disagreeing, yielding a mean of 2.65 and a standard deviation of 1.11. The use of irrigation and modern harvesting methods to increase coffee production was strongly agreed upon by 22.5%, with 18.3% agreeing, 17.5% neutral, 32.5% disagreeing, and 9.2% strongly disagreeing, resulting in a mean of 2.88 and a standard deviation of 1.33.

Changes in vegetation to reduce the number of crop species and varieties were strongly agreed upon by 29.2% of farmers, with 20.8% agreeing, 13.3% neutral, 24.2% disagreeing, and 12.5% strongly disagreeing, producing a mean of 2.70 and a standard deviation of 1.43. Lastly, the provision of training on agricultural techniques for coffee production was strongly agreed upon by 26.7%, with 15.8% agreeing, 13.3% neutral, 37.5% disagreeing, and 6.7% strongly disagreeing, resulting in a mean of 2.82 and a standard deviation of 1.36.

Overall, the findings indicate a range of perceptions regarding the intensification of agricultural practices and their impacts on forest coffee production, highlighting areas of both support and concern among the farmers.

Table 5. The effects of extensification agriculture on forest coffee production

The effects of extensification agriculture on forest coffee production	strongly agree	Agree	neutral	Disagree	strongly disagree	Mean	SD
The farmers use less fertilizer inputs in coffee production	42	15	6	40	17	2.79	1.55
	35.0%	12.5%	5.0%	33.3%	14.2%		
The farmers frequently use less machinery while harvesting forest coffee	34	43	15	23	5	2.35	1.20
	28.3%	35.8%	12.5%	19.2%	4.2%		
The farmers have vulnerable to use very less and cost-effective pesticides	32	50	16	19	3	2.26	1.10
	26.7%	41.7%	13.3%	15.8%	2.5%		
The farmers use more land to	42	40	14	15	9	2.24	1.26

harvesting forest coffee production	35.0%	33.3%	11.7%	12.5%	7.5%		
The farmers are reducing the capital employ for coffee production	18	50	19	24	9	2.63	1.18
	15.0%	41.7%	15.8%	20.0%	7.5%		
The farmers use less labor while harvesting coffee	17	12	11	60	20	3.45	1.28
	14.2%	10.0%	9.2%	50.0%	16.7%		
The farmers are well informed how to use technology advanced inputs	37	36	15	30	2	2.37	1.21
	30.8%	30.0%	12.5%	25.0%	1.7%		

As table 5 depicted that the study on the effects of extensification agriculture on forest coffee production in in the study area, provided several key insights. When asked about the use of less fertilizer inputs in coffee production, 35.0% of farmers strongly agreed, and 12.5% agreed, 5.0% were neutral, 33.3% disagreed, and 14.2% strongly disagreed, resulting in a mean score of 2.79 and a standard deviation of 1.55.

Regarding the frequent use of less machinery while harvesting forest coffee, 28.3% of farmers strongly agreed, 35.8% agreed, 12.5% were neutral, 19.2% disagreed, and 4.2% strongly disagreed, with a mean of 2.35 and a standard deviation of 1.20. Farmers' vulnerability to using very few and cost-effective pesticides was strongly agreed upon by 26.7% of respondents, with 41.7% agreeing, 13.3% neutral, 15.8% disagreeing, and 2.5% strongly disagreeing, resulting in a mean of 2.26 and a standard deviation of 1.10.

The use of more land for harvesting forest coffee production had 35.0% of farmers strongly agreeing, 33.3% agreeing, 11.7% neutral, 12.5% disagreeing, and 7.5% strongly disagreeing, producing a mean of 2.24 and a standard deviation of 1.26. The reduction in capital employed for coffee production was strongly agreed upon by 15.0% of respondents, with 41.7% agreeing, 15.8% neutral, 20.0% disagreeing, and 7.5% strongly disagreeing, resulting in a mean of 2.63 and a standard deviation of 1.18.

When it comes to using less labor while harvesting coffee, 14.2% of farmers strongly agreed, 10.0% agreed, 9.2% were neutral, 50.0% disagreed, and 16.7% strongly disagreed, with a mean of 3.45 and a standard deviation of 1.28. Lastly, the farmers' knowledge of using technologically advanced inputs was strongly agreed upon by 30.8% of respondents, with 30.0% agreeing, 12.5% neutral, 25.0% disagreeing, and 1.7% strongly disagreeing, resulting in a mean of 2.37 and a standard deviation of 1.21.

Overall, these findings indicate mixed perceptions regarding extensification practices in forest coffee production, with significant variations in the level of agreement among farmers on different aspects of extensification.

Table 6. The Practices of Forest Coffee Production

The Practices of Forest Coffee Production	strongly agree	agree	neutral	Disagree	strongly disagree	Mean	SD
The forest coffee sustains the livelihoods of farmers	28	32	11	40	9	2.61	1.36
	23.3%	26.7%	9.2%	33.3%	7.5%		
The forest coffee has harvesting with traditional agriculture inputs	23	30	6	49	12	2.59	1.45
	19.2%	25.0%	5.0%	40.8%	10.0%		
The forest coffee protects the bio diverse habitants	18	49	13	29	11	2.49	1.50
	15.0%	40.8%	10.8%	24.2%	9.2%		
The farmers yield high quality coffee comes from forests	23	32	10	45	10	2.53	1.44
	19.2%	26.7%	8.3%	37.5%	8.3%		
There are strong and sustainable incentives for communities to protect forest coffee	23	30	6	49	12	2.35	1.10
	19.2%	25.0%	5.0%	40.8%	10.0%		
The forest coffee production is degraded due to lack of fertilizers	18	49	13	29	11	2.57	1.22
	15.0%	40.8%	10.8%	24.2%	9.2%		
The forest coffee production is susceptible for damages due cutting of tress and woods	22	31	13	27	27	2.65	1.35
	18.3%	25.8%	10.8%	22.5%	22.5%		
The forest coffee production is not protected through pesticides	18	67	14	16	5	2.77	1.30
	15.0%	55.8%	11.7%	13.3%	4.2%		
There is soil degradation and grazing of forest coffee land due to livestock's	24	39	4	43	10	3.20	1.28
	20.0%	32.5%	3.3%	35.8%	8.3%		
The forest coffee production is vulnerable for damage and exhaustion due to use of land for extra purposes	23	30	10	51	6	2.65	1.38
	19.2%	25.0%	8.3%	42.5%	5.0%		

The study on the practices of forest coffee production on table 6 in the study area revealed various insights from the participants. The sustainability of forest coffee for farmers' livelihoods saw 23.3% strongly agreeing, 26.7% agreeing, 9.2% neutral, 33.3% disagreeing, and 7.5% strongly disagreeing, with a mean score of 2.61 and a standard deviation of 1.36.

Harvesting forest coffee with traditional agricultural inputs was strongly agreed upon by 19.2%, with 25.0% agreeing, 5.0% neutral, 40.8% disagreeing, and 10.0% strongly disagreeing, resulting in a mean of 2.59 and a standard deviation of 1.45. Regarding the protection of biodiverse habitats by forest coffee, 15.0% strongly agreed, 40.8% agreed, 10.8% were neutral, 24.2% disagreed, and 9.2% strongly disagreed, producing a mean of 2.49 and a standard deviation of 1.50.

The perception that high-quality coffee yields come from forests was strongly agreed upon by 19.2% of farmers, with 26.7% agreeing, 8.3% neutral, 37.5% disagreeing, and 8.3% strongly disagreeing, resulting in a mean of 2.53 and a standard deviation of 1.44. The presence of strong and sustainable incentives for communities to protect forest coffee was strongly agreed upon by 19.2%, with 25.0% agreeing, 5.0% neutral, 40.8% disagreeing, and 10.0% strongly disagreeing, yielding a mean of 2.35 and a standard deviation of 1.10.

The degradation of forest coffee production due to a lack of fertilizers had 15.0% strongly agreeing, 40.8% agreeing, 10.8% neutral, 24.2% disagreeing, and 9.2% strongly disagreeing, with a mean of 2.57 and a standard deviation of 1.22. Susceptibility to damage from tree and wood cutting was strongly agreed upon by 18.3%, with 25.8% agreeing, 10.8% neutral, 22.5% disagreeing, and 22.5% strongly disagreeing, resulting in a mean of 2.65 and a standard deviation of 1.35.

The lack of protection through pesticides was strongly agreed upon by 15.0% of farmers, with 55.8% agreeing, 11.7% neutral, 13.3% disagreeing, and 4.2% strongly disagreeing, resulting in a mean of 2.77 and a standard deviation of 1.30. Soil degradation and grazing due to livestock were strongly agreed upon by 20.0%, with 32.5% agreeing, 3.3% neutral, 35.8% disagreeing, and 8.3% strongly disagreeing, producing a mean of 3.20 and a standard deviation of 1.28.

Lastly, the vulnerability of forest coffee production to damage and exhaustion due to land use for extra purposes was strongly agreed upon by 19.2%, with 25.0% agreeing, 8.3% neutral, 42.5% disagreeing, and 5.0% strongly disagreeing, resulting in a mean of 2.65 and a standard deviation of 1.38. These findings highlight the varied challenges and perceptions among farmers regarding the practices and sustainability of forest coffee production.

4.2 Linear Regression Analysis

Assumption Tests

Before applying the multiple linear regression analysis to investigate the effects of land use change on forest coffee production in Gomma woreda, Jimma zone, Oromia Regional State, South West Ethiopia some tests were conducted to ensure the appropriateness of data analysis as follows:

Normality Test

The researcher used the histogram method to test the normality of the data. The histogram is bell-shaped which leads to infer that the residuals (disturbance or errors) are normally distributed. The residuals should be normally distributed about the predicted dependent variable score. As shown on Figure 1 below, the dependent variable is normally distributed for each value of the independent variables.

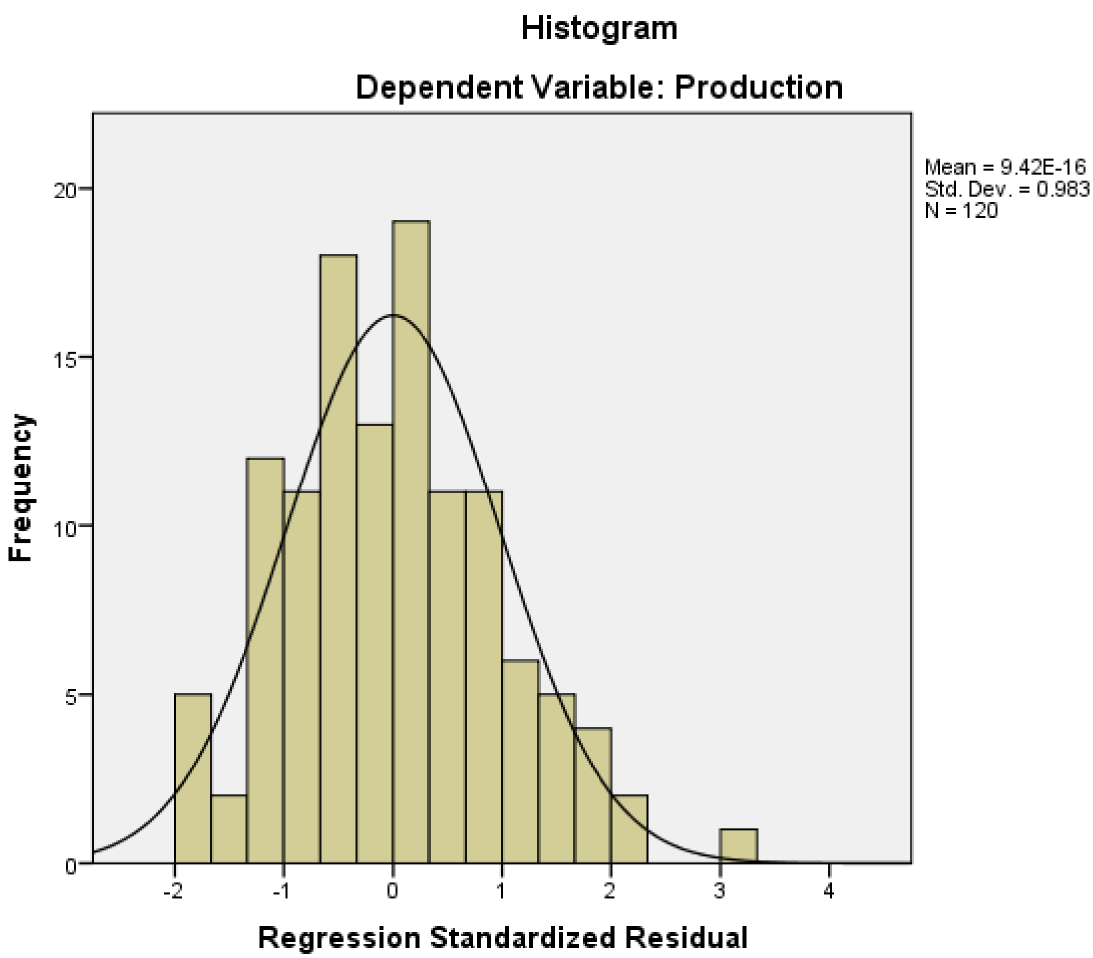


Figure 1: The regression model assumption of normality in the study

Linearity Test

Linearity refers to the degree to which the change in the dependent variable is related to the change in the independent variables. To determine whether the relationship between the independent variables Extensification, afforestation, deforestation, intensification and dependent variable Production is linear; plots of the regression residuals through SPSS software had been used. In case of linearity, the residuals should have a straight-line relationship with predicted dependent variable scores.

As shown on Figure 2 below, the change in the dependent variable is more of related to the change in the Independent Variables. Therefore, there is no linearity problem on the data for this study and residual follow at straight line.

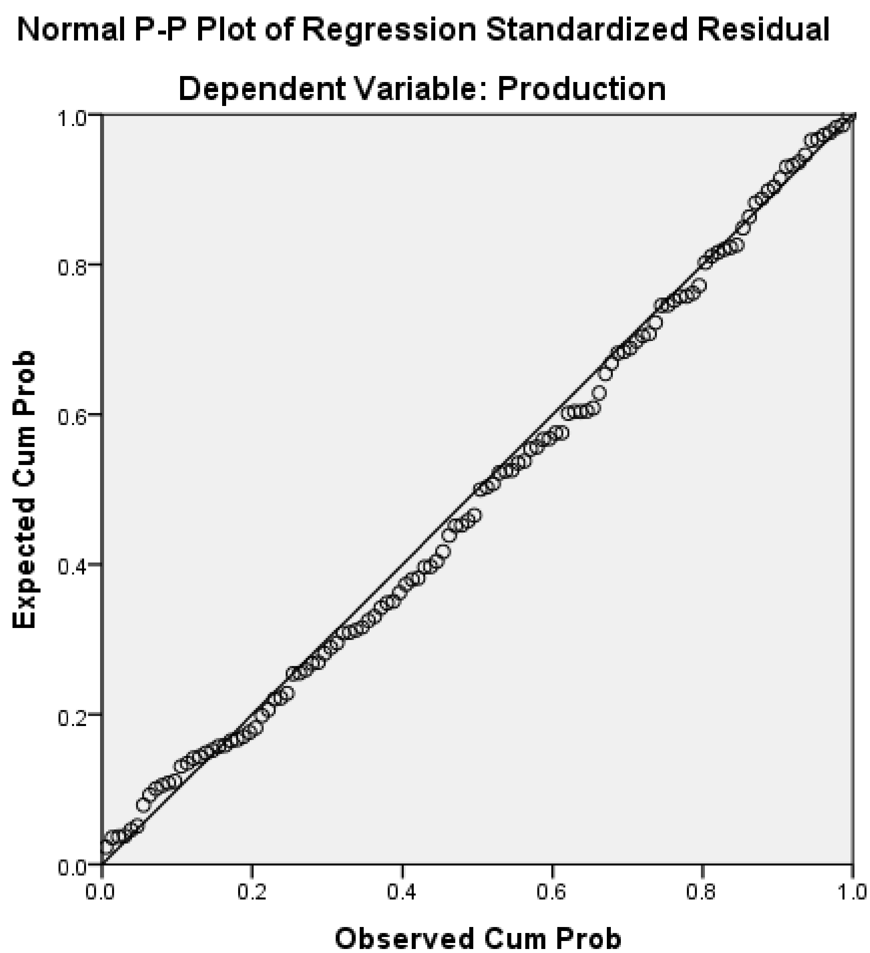


Figure 2: The regression model assumption of linearity in the study

Multicollinearity Tests

The regression analysis presented in Table 7 includes multicollinearity statistics that are crucial for understanding the relationships between predictors influencing forest coffee production. Each predictor's tolerance and variance inflation factor (VIF) values provide insights into the extent of multicollinearity among the independent variables.

Table 7: Co linearity Statistics

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.309	.253		5.167	.000		
	Deforestation	-.236	.077	-.274	-3.064	.003	.768	1.302
	afforestation	.162	.073	.197	2.225	.028	.784	1.276
	Intensification	.369	.079	.429	4.688	.000	.729	1.371
	Extensification	.151	.076	.167	1.987	.049	.862	1.160

a. Dependent Variable: forest coffee Production

In table 4.7 tolerance values measure the proportion of variance in one predictor that is not explained by the other predictors in the model. In this analysis, all predictors—deforestation, afforestation, intensification, and extensification—exhibit tolerances ranging from 0.729 to 0.862. These values suggest that each predictor shares less than 30% (or 27.9% to 13.8%) of its variance with the other predictors, indicating moderate to high tolerance levels and implying minimal multicollinearity concerns.

Variance inflation factor (VIF) values complement tolerance by quantifying how much the variance of a regression coefficient is inflated due to multicollinearity with other predictors. The VIF values in Table 7 range from 1.160 to 1.371 for deforestation, afforestation, intensification, and extensification, respectively. VIF values below 5 generally indicate acceptable levels of multicollinearity, with values below 10 considered tolerable in most analyses. Therefore, the

VIFs observed in this model further confirm that multicollinearity is not a significant issue among the predictors.

In summary, the multicollinearity statistics presented in Table 7 indicate that the regression model's predictors—deforestation, afforestation, intensification, and extensification—are relatively independent of each other in explaining variations in forest coffee production. These findings enhance the reliability of the regression results, suggesting that each predictor makes a unique and statistically significant contribution to the model without being excessively influenced by multicollinearity.

Table 8. Model Summary

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.806[a]	.649	.640	.42819
a. Predictors: (Constant), Extensification, afforestation, deforestation, intensification				
b. Dependent Variable: Forest coffee Production				

The model summary of table 4.8 for the study investigating the impact of Extensification, Afforestation, Deforestation, and Intensification on forest coffee production in Gomma Woreda, Jimma Zone, Oromia Regional State, South West Ethiopia, indicates a robust relationship. The coefficient of determination (R-squared) of 0.649 suggests that approximately 64.9% of the variance in forest coffee production can be explained by the four predictors included in the model. This indicates a moderately strong relationship between the independent variables (extensification, afforestation, deforestation, intensification) and the dependent variable (forest coffee Production).

The adjusted R-squared of 0.640, which considers the number of predictors in the model, reinforces this relationship, suggesting that these variables collectively contribute significantly to predicting coffee production levels. The standard error of the estimate, measured at 0.42819, reflects the accuracy of the model in predicting actual coffee production values based on the included predictors. Overall, these findings underscore the model's reliability in assessing the influence of agricultural practices on forest coffee production in the study area.

4.3 Discussion of ANOVA Result

Table 9 ANOVA Result of variables

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	52.855	4	4.871	12.096	.000[b]
	Residual	28.602	115	.403		
	Total	81.456	119			
a. Dependent Variable: Forest coffee Production						
b. Predictors: (Constant), Extensification, afforestation, deforestation, intensification						

The analysis of variance (ANOVA) of table 4.9 results for the regression model examining the effects of extensification, afforestation, deforestation, and intensification on forest coffee production in Gomma Woreda, Jimma Zone, Oromia Regional State South West Ethiopia, yielded significant findings.

The total sum of squares was 81.456, with 52.855 attributed to regression across the four predictors. This resulted in a highly significant F-statistic of 12.096 ($p < .000$), indicating that the regression model as a whole significantly explains the variability in forest coffee production. The residual sum of squares was 28.602, suggesting that there is some unexplained variability remaining in the model after accounting for the predictors. These results underscore the importance of extensification, afforestation, deforestation, and intensification as significant predictors influencing forest coffee production in the region, providing valuable insights into agricultural practices and their impact on forest coffee yields.

Table 10 Correlation coefficient of between the variables

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.309	.253		5.167	.000
	deforestation	-.236	.077	-.274	-3.064	.003
	afforestation	.162	.073	.197	2.225	.028
	intensification	.369	.079	.429	4.688	.000
	Extensification	.151	.076	.167	1.987	.049
a. Dependent Variable: Forest coffee Production						

The coefficients table 4.10 presents the results of the regression analysis examining the relationship between forest coffee production and the predictors: deforestation, afforestation, intensification and extensification in Gomma Woreda, Jimma Zone, Oromia Regional State South West Ethiopia. The constant term in the model is 1.309, indicating that when all predictors are zero, the estimated production of coffee is 1.309 units.

Among the predictors, deforestation shows a negative unstandardized coefficient of -0.236, with a standardized coefficient (Beta) of -0.274. This suggests that for each unit increase in deforestation, coffee production is expected to decrease by 0.236 units, and this relationship is statistically significant (t = -3.064, p = 0.003).

Conversely, afforestation has a positive unstandardized coefficient of 0.162 and a Beta of 0.197, indicating that an increase in afforestation by one unit is associated with a 0.162-unit increase in coffee production, which is also statistically significant (t = 2.225, p = 0.028).

Intensification shows a positive unstandardized coefficient of 0.369 and a Beta of 0.429, indicating a strong positive relationship with forest coffee production.

Specifically, for each unit increase in intensification practices that forest coffee production is expected to increase by 0.369 units, with a high level of statistical significance ($t = 4.688$, $p < 0.001$).

Finally, extensification exhibits a positive unstandardized coefficient of 0.151 and a Beta of 0.167. This suggests that an increase in extensification practices by one unit is associated with a 0.151-unit increase in coffee production, reaching statistical significance ($t = 1.987$, $p = 0.049$).

Overall, these results provide insights into how different agricultural practices impact on forest coffee production in the study area, highlighting the importance of afforestation, intensification, and to a lesser extent, extensification, while cautioning about the detrimental effects of deforestation on forest coffee production yields.

CHAPTER FIVE

5. Conclusion and Recommendations

5.1 Conclusions

Based on the result of data obtained and major finding of the study, the following conclusions were drawn:

In conclusion, the study underscores the complex interplay between land use changes, agricultural practices, and the sustainability of forest coffee production in Gomma Woreda, Jimma Zone, Ethiopia. The findings highlight both the challenges and opportunities facing farmers and ecosystems in this region.

It is evident that unsustainable land use practices, including deforestation and agricultural intensification, pose significant threats to forest coffee cultivation by degrading soils, diminishing biodiversity, and increasing vulnerability to climate impacts. However, there is optimism regarding the potential benefits of sustainable practices such as afforestation and organic farming, which are perceived as crucial for maintaining productivity and ecosystem health.

Moving forward, fostering sustainable agricultural practices, promoting community engagement, and advocating for supportive policies emerge as critical strategies. These efforts should prioritize biodiversity conservation, soil health improvement, and resilience-building against climate variability.

Moreover, capacity building through education and training will empower farmers to adopt practices that enhance both their livelihoods and the ecological integrity of forest coffee landscapes. By integrating these recommendations into policy frameworks and on-the-ground initiatives, stakeholders can collectively work towards securing a sustainable future for forest coffee production in Gomma Woreda and similar regions. This approach not only addresses current challenges but also aims to safeguard the invaluable environmental and economic benefits provided by forest coffee ecosystems for generations to come.

5.2 Recommendations:

Having the major findings and conclusion of the study, the researcher forwarded the following recommendations:

- It is advisable to encourage farmers and stakeholders to adopt conservation practices that protect forest coffee ecosystems, such as sustainable land use planning and the conservation of bio diverse habitats.
- It is recommended that to provide training programs aimed at enhancing farmers' knowledge of sustainable agricultural practices, including agroforestry techniques that integrate forest coffee production with forest conservation.
- It is better to give advocate for policies that support sustainable land management and regulate practices that threaten forest coffee production, such as deforestation and unsustainable agricultural intensification.
- It is recommended that to foster community participation in forest coffee management through cooperative initiatives and incentives that promote sustainable production methods.
- It is recommended that invest in research to develop innovative solutions for enhancing forest coffee resilience to environmental changes and improving productivity while preserving biodiversity.
- It is better to establish monitoring frameworks to assess the impact of agricultural practices on forest coffee production continually. This will help adapt strategies based on empirical data and feedback from stakeholders.
- It is recommended that implementing these given recommendations, stakeholders can work towards sustainable forest coffee production that benefits both local livelihoods and ecosystem health in the study area.

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APPENDIX I

ADDIS ABABA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE

DEPARTMENT OF ZOOLOGICAL SCIENCE

Questionnaire to be filledd by the households

Dear Respondents!

The main objective of this study will to be investigate *the effects of land use change on forest coffee production* in Gomma woreda, Jimma zone, Oromia Regional State, South West Ethiopia. This study is ultimately focused for academic purpose so that your response will be keep secretly. Therefore, you are kindly request to fill the following questions accordingly. The questions are inquired you about the effects of land use change on forest coffee production, factors of land use change, how farmers practices land use change, strategies adapted by farmers and the effects of land use change on coffee production in the study area

I. Background of the Respondents

1. Gender: Male□ Female □

2. Age: 26-30 □ 31-35 □ 36-40 □ 41-50 □ 51 and above □

3. Educational status: Literate □ Illiterate □ primary school □ High school □ Certificate □ Diploma □ degree and above □

5. Year of experience: 5 ≥ years □ 6-10 years □ 11-15 years □ 16-20 years □ above 20 □

II. Instruction: The following tables are design in line with the objectives of the study (the effects of deforestation, how afforestation affects forest coffee production, how the intensification of agriculture, how extensification of agriculture the effects on coffee production in the study area.

Therefore, you are allowed to put your tick mark on the scale written from (1-5) under each table

Key: 5: Strongly disagree, 4: disagree, 3: neutral, 2: agree, 1: strongly

II. The effects of deforestation on forest coffee production

No	The practices of deforestation	5	4	3	2	1
1	The producers use the digging a little deeper of land decrease forest coffee production					
2	The farmers use cleaning the land for farming or livestock damage the forest coffee production					
3	The Farmers use slash and burn agricultural products directly influencing coffee production					
4	The producers deliberately using cutting, cleaning and removal of rainforest for pasture purposes reduce composition of coffee forest					
5	The farmers use cleaning forests for personal needs like fuel, hunting and agriculture					
6	The farmers are shifting agriculture, livestock production and fuel					
7	There is the practicing logging, natural disasters, urbanization and mining purposes					

III. The effects of afforestation on forest coffee production

No	The practice of afforestation	5	4	3	2	1
1	The farmers use planting new trees where no forest stands					
2	The farmers use planning trees where the forest is depleted					
3	The farmers use to restoration and regeneration of forest					
4	The farmers afforested trees by choices of species to be planted					
5	Farmers use planning of trees to encapsulated the planting of right trees at right places					
6	The farmers use afforestation aiming to transform landscape that has been occupied.					
7	The farmers use it to rebuild the damaged and depleted forests.					

IV. The effects of Intensifications of agriculture on forest coffee production

No	The intensification of agriculture	5	4	3	2	1
1	The farmers are use seeds for forest coffee production					
2	The farmers are exposed to use fertilizers to increase level of yield of coffee production					
3	The farmers use pesticides to protects the coffee production					
4	The farmers use technologically advanced skill during harvesting coffee					
5	The farmers use irrigation and modern harvesting methods to increase the coffee production.					
6	The farmers' deliberately use changes in vegetation in reducing numbers of crops species and varieties.					
7	The farmers are providing training on agricultural techniques of coffee production					

v. The effects of extensification agriculture on forest coffee production

No	Extensification of agriculture	5	4	3	2	1
1	The farmers use less fertilizer inputs in coffee production					
2	The farmers frequently use less machinery while harvesting forest coffee					
3	The farmers have vulnerable to use very less and cost-effective pesticides					
4	The farmers use more land to harvesting forest coffee production					
5	The farmers are reducing the capital employ for coffee production					
6	The farmers use less labor while harvesting coffee					
7	The farmers are well informed how to use technology advanced inputs					

VI. The Practices of Forest Coffee Production

No	Forest Coffee Production	5	4	3	2	1
1	The forest coffee sustains the livelihoods of farmers					
2	The forest coffee has harvesting with traditional agriculture inputs					
3	The forest coffee protects the bio diverse habitants					
4	The farmers yield high quality coffee comes from forests					
5	There are strong and sustainable incentives for communities to protect forest coffee.					
6	The forest coffee production is degraded due to lack of fertilizers					
7	The forest coffee production is susceptible for damages due cutting of tress and woods.					
8	The forest coffee production is not protected through pesticides					
9	There is soil degradation and grazing of forest coffee land due to livestock’s					
10	The forest coffee production is vulnerable for damage and exhaustion due to use of land for extra purposes					