EFFECTS OF COFFEE CERTIFICATION ON SELECTED SOILPHYSICO-CHEMICAL PROPERTIES UNDER DIFFERENT PRODUCTION SYSTEMS IN SOUTHWEST ETHIOPIA

M.SC. THESIS

BY

NEGATUABERA

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M.Sc. THESIS

Submitted to the School of Graduate Studies, Jimma University, College of Agriculture and Veterinary MedicineDepartment of Natural Resource Management in Partial Fulfillment of the Requirements for the Degree of Master of Science (M.Sc.) in Watershed Management.

Major Advisor:AlemayehuRegassa (PhD)

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I have incorporated the suggestion and modifications given during the internal thesis defence and got the approval of my advisers. Hence, I hereby kindly request the Department to allow me to submit my thesis for external thesis defence.

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Name signature of student

We, the thesis advisers have verified that the student has incorporated the suggestions and modifications given during the internal thesis defence and the thesis is ready to be submitted.

Hence, we recommended the thesis to be submitted for external defence.

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Decision/suggestion of Department Graduate Council (DGC) ______________________

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Chairperson, DGC Signature Date

DEDICATION

To my father AberaKebede and mother EteneshDegufor their all-rounded and unconditional support in my life.

STATEMENT OF AUTHOR

First, I declare that this thesis is my own work and that all sources of materials used for thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for M.Sc. degree at Jimma University, College of Agriculture and Veterinary Medicine and is deposited at the University library to be made available to users under rules of the library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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BIOGRAPHICAL SKETCH

The Author, NegatuAbera, was born on 19th of July 1990 in Hossanatown of Hadiya Zone, Southern Ethiopia. He attained his junior elementary school at Hossana Junior and Secondary School from 1996 to 2003, and his secondary school at WachemoComprehensive Secondary school from 2004 to 2007 GC. He then joined MedawelabuUniversity Department of Natural Resource in 2008 GC and awarded B.Sc. degree in Natural Resource Management in 2010. After graduation, he was employed in Bureau of Revenue Authority as coordinator of Revenue Monitoring and Evaluation AnlemoDistrict of Hadiya Zone until he joined the School of Graduate Studies at Jimma University, College of Agriculture and Veterinary Medicine in September 2015 to pursue his M.Sc. degree in Natural Resource Management, specialization Watershed Management.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
ATOs	Alternative Trade Organizations
BD	Bulk Density
CEC	Cation Exchange Capacity
CSA	Central Statistics Agency
FAO	Food and Agricultural Organization
FLO	Fair-trade Labeling Organization International
FT	Fair-trade
GMOs	Genetically Modified Organisms
ICO	International Coffee Organization
ITC	International Trade Center
JUCAVM	Jimma University College of Agriculture and Veterinary Medicine
MC	Moisture content
NGOs	Non-Governmental Organizations
OC	Organic Carbon
SAS	Statistical Analysis System
SNNPR	Southern Nations Nationalities and Peoples Regional State
RA	Rainforest Alliance
SAN	Sustainable Agriculture Network
TN	Total Nitrogen
UK	United Kingdom
USA	United States of America

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ABSTRACT

Ethiopia is the origin of Arabica coffee and the 5th biggest coffee producing country in the world. Coffee is Ethiopia's most significant export crop contributing for about 24 % of the country's foreign currency income.In recent years, certification of agricultural products in Ethiopia increasingly gained attention of international certification agencies. More researchhas been conducted in relation to socio-economic impacts of certification of coffee but, researches in relation to impacts of coffee certification on soil property were not done.Therefore, this study wasconducted to analyze the effects of different coffee certification schemes on selected soil properties under different coffee production systems.To achieve the objectives: soil samples (0-30 cm depth) were randomly collected from70 plots (32 certified and 38 non-certified)including12 certified and 12 non-certified forest plots, 12 certified and 12 non-certified semi-forest plots and 8 certified and 14 non-certified garden coffeefrom three districts. The collected samples were analyzed for soil physico-chemical properties such as texture, soil moisture content(SMC), bulk density(BD), pH, electrical conductivity (EC)Cation exchange capacity (CEC), soil organic carbon (SOC), total nitrogen (TN) and available phosphorus (Av.P)following soil laboratory analytical procedure at Jimma university soil laboratory.Comparison first was made between total certified and non-certified plots. The ANOVA result revealed there was significant($P \leq 0.05$) difference between certified and noncertified coffee farms.Soils from non-certified farms had higher valuesof in clayand silt content, SMC, BD, EC, Av.P,CEC,SOCand TNas compared to certifiedones, whereassand content and pH values werenot significantly ($p > 0.05$) different. The Second comparison was among totalcertified and non-certified plots within a district. Mostsoil properties including, clay and silt content, BD, pH, SOC, TN, Av.P and CEC were higher in non-certified than didRainforestcertified farms, whereasSMC and sand content were higher in Rainforest certified farmsand no difference observed in EC. Soil properties such as sand and silt contents and TN were higher in non-certified farms than didFairtrade certified plots, whereas clay content, SMC, EC and Av.P were higher in Fairtradecertified farms and no difference observed in BD, soil pH, SOC and CEC. The soil properties such as sand and silt content. BD, TN and Av.P were higher in non-certified farms than in organic certified farms. Whereas, clay and CEC were higher in organic certified and no difference in, SMC, pH, EC, and OC.The third comparison was between certified and non-certified plots by production system within the districts. Under forest system conditionSOC, TN andAv.pwas higher in non-certified farm in all types of certification. Similarly,under semi-forest SOC, TN, Av.p and CEC were higher in non-certified plotsin all certificationand SMC,Av.p, and CEC were higher in Fairtrade certified garden stands, whereas no differences were observed for the remaining parameters in all production systems. Generally, certification has no positive contribution for the improvement ofsoil physicochemical properties in the study area. This indicates that the principles of the three certification standards have not yet applied in the ground as intended.

Keywords*:* coffee, soil physic-chemical properties, Rainforest Alliance, Fairtrade, Organic

1. INTRODUCTION

Ethiopia is believed to be center of origin and diversity for Arabica coffee and it is the 5thlargestcoffee producing and the 10th coffee exporting country in the world (ICO, 2013). Coffee is Ethiopia's most significant export crop contributing for about 24 % of the country's foreign currency income (Minten*et al*., 2014;Bäckman,2009).Ethiopia encompasses a potential opportunity to increase coffee production. It is endowed with suitable elevation, temperature, and soil fertility, indigenous quality planting materials, and sufficient rainfall in coffee growing belts of the country (Anwar,2010).

In Ethiopia coffee is not only an essential export good, but it is alsopart of the culture; where around 50 % of the produced coffee is consumed locally and there is even a cultural ceremony connected to it (Bäckman,2009).It is produced by 4 million smallholder farmers and used as income generation for about 25 percent of the population directly or indirectly (Alemseged and Getaneh, 2013). The montane rainforests in southern and southwestern Ethiopia are the only place in the world where coffee still grows wild in its natural habitat (Stellmacher*et al*., 2010).

Depending on intensity of management, level of coffee domestication, and diversity of shade trees and other plants different coffee production systems are distinguished: forest coffee, semi-forest coffee, garden coffee and plantation coffee. Forest coffee system implies tocoffee collection from natural stands of coffee in open access areas of undisturbed rainforests. Semi-forest system is a system that has limited management interventions in plots with customary individual access rights, using natural regeneration of coffee plants, complemented with planting of wild coffee seedlings collecting from the forest and nursery raised seedlings. In garden coffee system,overall species richness is lower than the semi-forest production systems (Senbeta and Denich, 2006). Plantation coffee system is asystem where coffee is grown on large commercial farms, private farms. Modern production practices such as modern input use, mulching, stumping, and pruning - are often applied in the later sytem(Taye,2012).According to Taye(2012), it is projected that forest, semi-forest, garden and plantation coffee production accounts for 10%, 35%, 50% and 5% , respectively, of the total coffee production in the country and for 10%, 35%, 35% and 20% respectivelyin southwestern Ethiopia (Wiersum*et al.*, 2008).

In the recent past, due to the interplay between increasing poverty of coffee smallholders in major producer countries and growing demands for healthier and more socially and environmentally friendly produced coffee in larger consumer countries, certification of cooperatives has gradually gained wider significance worldwide (Stellmacher and Grote, 2011).The rise of these initiatives has been fueled by the increasing globalization of production and the declining state regulation of environmental and social conditions especially in international arenas. In this regulatory wake, national and transnational non-governmental organizations are promoting a variety of new governance mechanisms using production standards, monitoring, certification, and labeling. One of the most rapid areas of growth is coffee certification. There are five relatively well-established certification and labeling systems operating in global level coffee markets (with new initiatives coming on line each year)namely Rainforest Alliance (RA), Fairtrade (FT), Organic, Common Code for the Coffee Community (4C) and Unified Communication (UC)(Laura *et al*.,2007).

All private standards are sustainability oriented, but the focus of specific standard differs from one another. For instance, Fairtrade (FT) aims to support democratically organized small scale farmers through payment of minimum price premiums for social development, improved labor rights and long-term trade relationships; and sound agricultural practices.

Now a day a number of certifications with different standard criteria work in different sector at many countries of the world.Given that each certification program has different goals, uncertainty surrounds how each contributes to ecological and economic sustainability at the farm level (Ponte, 2004). Organic certifiers such as Certimex in Mexico encourage planting diverse plant species for shade, but do not define minimum criteria, and their technical assistants reportedly advise farmers to cut or prune trees to improve yields (Bacon, 2005). Certification programs that aim to improve commodity producers' environmental, social, and economic performance face substantial challenges (Blackman and Rivera,2011). Thestandards mustbe sufficiently stringent and ensure that monitoringand enforcement are strict enough to exclude poorly performing producers(Ponte,2004). In addition, they must offerhigh enough price premiums or new customers plentiful enough to offset the costs of certification and attract considerable number of applicants. Even if these two challenges are met, however, certification schemesstill can be undermined by selection effects. Commodity producers already meeting certification standards have strong incentives to join certification programs; they need not make additional investments to qualify and can obtain premiumpricesand other benefits. But certification programs that mainly attract such producers will have a limited additional effect on producer behavior and few environmental, social, or economic benefits (Blackman and Rivera, 2011).

Organic certification focuses on organic way of production, processing and handling of the products; and Rainforest Alliance (RA) focuses on environmental protection (such as protecting biodiversity, water sources, soil fertility, wildlife. etc), basic labor and living conditions and community relations (Milder *et al*., 2014).Empirical evidences are scarce on the impact of certification on conservation in general and the findings of the few available studies are mixed. For instance, Takahashi and Todo (2013) found that RA certificated farms encourage forest conservation than non-RA certified farms in Ethiopia. In contrast, Sofie*et al* (2015) have reported no significant effect of Organic certification on biodiversity whereas that higher organic carbon in Organic certified farms than in non-certified ones in Uganda.Another study shows that farms with FT certified or without certification were not distinguishable in their biodiversity characteristics in Mexico (Philpott*et al*., 2007).

In Ethiopia, the use of socioeconomic, environmental, and/or health-concerned certification standards in agriculture is a new phenomenon compared to other countries particularly in Latin America (Stellmacher and Grote, 2011). In recent years, however, certification of agricultural products in Ethiopia increasingly gained attention of international certification agencies and standard holders, governmental and nongovernmental development agencies, and private companies supplying to specialty markets. The overwhelming majority of certification activitiesin Ethiopia focus on coffee (*coffeaarabica*)(Petit, 2007).In Ethiopia FT and Organic certification were introduced in 2005 and RA was introduced in 2007. Up to 2015, 29%, 27% and 2% of the cooperatives in Ethiopia were certified for Organic, FT and RA or Utz respectively(Mitiku*et al*., 2015; Minten*et al*., 2014).

Many studies stated that coffee certification standards have impact on socioeconomic and ecological conditions. But,mostof the studies doneso far were concerned with social and economic aspects. A review byBlackman and Rivera (2011), indicated that out ofeleven studies conducted by different researchers ninefocused on the socioeconomic aspectsand only two on the environmental effects of certification and they concluded that coffee certification has significant benefit. Similarly, twenty studies conducted on social, economic and environmental impacts of coffee certification do not provide compelling evidence whether it has significant benefit or not.Even these studies have their own methodological errors and counterfactual problems.

Field research conducted in the coffee forest areas of southwestern Ethiopia in 2008 illustrate that forest coffee certification activities do not adequately promote conservation of the coffee forest ecosystem and its biodiversity. This is mainly due to the fact that certification standards are principally designed to target agricultural coffee production systems and do not adequately consider the specific ecological and socio-economic circumstances of Ethiopian forest coffee (Stellmacher*et al*.,2010).Similarly, empirical studies on the livelihood impact of coffee certification also show that different certification standards have different impacts on certified smallholders (Mitiku*et al*, 2015; Jena *et al*, 2012; Ruben and Zuniga, 2011). Nevertheless, studies are scarce in the area of the effect of private standards on conservation in general (Milder *et al*., 2014) and in Ethiopia in particular. Only two studies have in southwestern Ethiopia assessedthe impact of Rainforest Alliance certification on forest diversity (Takahashi and Todo, 2013, 2014). To the knowledge of the researcher, no study has beenconductedon the impact of coffee certification on soil physical and chemical properties in Ethiopia.

Therefore, this study was initiated to identify and there by to generate scientific information for the users on the impacts of coffee certification on soil properties in Ethiopia.

1.1. Objectives of the study

1.1.1.General objective

The overall objective of the study was to assess the effects of different coffee certification standards on selected soil properties under different coffee production systems.

1.1.2. Specific objectives

The specific objectives of the study were to assess the effects of:

- Rainforest Alliance(RA) certification on selected soil properties under forest and semi-forest coffee production systems in southwest, Ethiopia.
- Organic and Fair-trade(FT)certification on selected soil properties under forest,semi forest and garden coffee production systemsin southwest, Ethiopia.

1.2. Research questions

The following research questions were formulated to achieve the designed objectives;

1. Does Rainforest Alliance (RA) certificationhave an effect on selected soil properties under forest and semi-forestcoffee production systems in southwest Ethiopia?
2. Do Organic andFairtrade (FT)certification types have an effect on selected soil properties under forest, semi-forest and garden coffee production systemsin southwest Ethiopia?

2. LITERATURE REVIEW

2.1 Coffee production in Ethiopia

According to a legend, Ethiopia is the country where coffee was first discovered and spread tothe world. The crop plays an important role in the country's economy even today. It is heavilyexported and it is estimated that 25 % of the population depend directly or indirectly on coffeefor their livelihood(Bäckman,2009). Settled agriculture began in Ethiopia some 2000 years ago, and as long as anyone can remember Coffee Arabica has been grown in the wild forests of the south-western massive highlands in the district of Kaffa(Anwar,2010). Coffee is said to have taken the name of Kaffa, the region where it was first discovered. Export began to Yemen, and was from there introduced to Indonesia, India, The Netherlands, Colombia and Brazil. Coffee in Ethiopia is not only an important export good but it is a part of the culture; about 50 % of the produced coffee is consumed domestically and there is even a cultural ceremony connected to it (ICO,2009). Ethiopia is the world's fifth largest coffee producer and Africa's top producer, with estimated coffee production of more than 450,000 tons and marketable supply of 334,000 metric tons in farm year 2012/13. Half of the coffee produced consumed locally and the country leads the African Continent in domestic consumption. It has been used income generation for that about 20 percent of the populations, directly or indirectly, depend for a living on coffee production and trading (Alemseged and Getaneh, 2013).

Coffee is the most important crop in the national economy of Ethiopia and the leading export commodity. Ethiopia is well known not only for being the home of Arabica coffee, but also for it is very fine quality coffee acclaimed for its aroma and flavor characteristics. In 2011, Ethiopia produced around 5 percent of the world's production and 39 percent of the total production of coffee in Sub-Saharan Africa (ICO, 2012). Ethiopia encompasses a potential opportunity to increase coffee production. It is endowed with suitable elevation, temperature, and soil fertility, indigenous quality planting materials, and sufficient rainfall in coffee growing belts of the country (Anwar,2010).

Coffee production systems in Ethiopia generally categorized into four areas i.e. forest coffee, semi - forest coffee, garden coffee, and plantation coffee (Gole*et al.*,2000). Forest coffee is a wild coffee grown under the shade of natural forest trees and it does not have a defined owner. Semi-forest coffee farming is a system where farmers thin and select forest trees to let sufficient sunlight to the coffee trees and to provide adequate shade. A farmer who prunes and weeds the forest area once a year claims to be the owner of the semi-forest coffee (Senbeta and Denich,2006). Garden coffee normally found in the vicinity (near) of a farmer's residence. It normally fertilized with organic material and usually inter-cropped with other crops. The government or private investors for export purposes plant Plantation coffee. Fertilizers and herbicides usually used in the coffee plantation farming system. Ethiopia Small-scale holdings equal to or greater than 95% of total coffeeproduction(USAID, 2010).

2.2 Certification Schemes

Certification is a procedure by which a third party gives written assurance that a product,process or service is in conformity with certain standards.Certification can be seen as a form ofcommunication along the supply chain. The certificate demonstrates to the buyer that the suppliercomplies with certain standards, which might be more convincing than if the supplier itself providedthe assurance.The organization performing the certification is called a certification body or certifier (ISO,1996). The certification body might do the actual inspection, or contract the inspection out to an inspector or inspection body. The verification is done and the assurance isprovided by a party without direct interest in the economic relationship between the supplier andbuyer. An internal control is first-party verification. When a buyer verifies if the supplier adheres toa standard, it is second-party verification (FAO,2003).

Certification of products and production processes dates back to the early 1900s. Up to the late 1980s, organic certification was the single most important agricultural certification scheme. Today it certifies 15 different single products and numerous composite ones. In the 1990s, growing concerns over food safety, workers' rights, deforestation and farmers' livelihoods led to a substantial number of new certification initiatives. The RA certified its first farm (a large-scale banana plantation) in 1993. UTZ Certification started in 1998. GLOBALG.A.P. (then called EUREPGAP) started at that time as an initiative of European retailers in the horticultural sector. Towards the end of the 1990s and during the next decade, the certification movement gained momentum, with companies using it as an insurance policy that demonstrated their commitment to responsible sourcing(Kuit and Waarts,2014).

Consequently, global supply of certified sustainable coffee rose from about 1% of the total in 2001 to 9% in 2010. Estimates in that year expected the share of certified coffee to rise to 20–25% by2015.However, the 2009–10 estimatesdid not include 4C. Including 4C shows that growth of certified supply has been much stronger(Pierrot, *et al.*, 2010). In 2012 the share of certified supply reached 38% of total supply(Kuit and Waarts,2014).

Several certification programmes are active in coffee, but five dominate the market. These are 4C, UTZ Certified, RA, FT and Organic. Of these, 4C has seen the strongest growth in supply over the past years(Kuit and Waarts,2014).

2.3 Types of Certification

2.3.1 Rainforest Alliance

The Rainforest Alliance(RA) is the Secretariat for the Sustainable Action Network (SAN), a coalition ofLatin American conservation organizations dedicated to the principles of sustainableagriculture.Together, RA and SAN seek to impact tropical agriculture, producer communities, andthe ecosystems that surround them through the development of certification standards that promote the needs of producer communities in tandem with the ideals of conservation. Producer groups whomeet the SAN standards may be certified and use RA label in marketing theirproducts. Throughout its certification program, the RA seeks to “reverse the intensivemanagement systems required by industrial coffee hybrids and encourage the sustainable productionand harvesting of beans.” Its sustainable coffee program guides and rewards continual improvementson farms, and connects responsible producers and traders with conscientious buyers and bettermarkets. Farms that meet the comprehensive generic standards for coffee production established bythe Rainforest Alliance along with its partners in the Sustainable Agriculture Network receive the RA Certified seal of approval, which farmers can use to distinguish their product in theMarketplace (RA,2015).

The standards set by SAN are designed to promote tropical conservation and steer commercialagriculture practices in the tropics. RAcertified growers follow the criteria andstandards designed by SAN. RA verifies that certified products have been grown using environmentally responsible management practices, including integrated pest and diseasemanagement practices, soil and water conservation, some labour treatment practices and community relations (ECO-lebel,2015). The Rainforest Alliance Certified label standards have been tailored to crops in specific regions. There are nine main criteria areas for each crop and corresponding standards that must be met. Within pest and disease management, there is also a list of pesticides that are prohibited for use and includes the Pesticide Action Network's "dirty dozen" and the red lists of the United States Environmental Protection Agency. Within water resource standards, waterways must be protected with buffer zones and monitored for contamination. Workers must be paid minimum wage and have the right to organize(RA,2015; ECO-lebel,2015).

The RA often accredits local organizations within the Sustainable Agriculture Network to certify according to the RA Certified label program. All farm evaluations are forwarded to RA for final certification approval. In cases where there are no local certifying organizations, RA will perform the certification directly(ECO-lebel, 2015).

Since 1991, SAN has developed guidelines for the responsible management of export agriculture, certifying bananas, coffee, cocoa, citrus, and flowers and foliage according to environmental and social standards. Farms that meet the Sustainable Agriculture Network standards are "certified" and may use the RA-certified label in marketing their products(RA,2015).

In general, RA integrates biodiversity conservation, community development, workers' rights and productive agricultural practices to ensure comprehensive sustainable farm management. Certification began in 1992 by RA and a coalition of Latin American NGOs,the Sustainable Agriculture Network (SAN). First coffee farm certification was made in 1996. The RA Certified TMprogram requires that farms meet comprehensivestandards covering all aspects of production, the protection of the environment, and the rights and welfare of farm families and their local communities(kline,2009).

2.3.2 Organic Certification

Organic agriculture is a production management system that promotes and enhances biodiversity and soil activity. It is a system that relies on ecosystem management rather than external agricultural inputs. This system excludes the use of synthetic inputs, such as synthetic fertilizers and pesticides, veterinary drugs, genetically modified organisms (GMOs), preservatives, additives and irradiation. Though methods of organic farming may vary slightly, they largely follow the standards set forth in the IFOAM Basic Standards for

Organic Production and Processing (IBS). National regulations, the European Union regulation for organic farming and the Codex Alimentarius Guidelines for organic production are very similar to the IBS. Within this framework, farmers develop their own organic production system, determined by factors like climate, crop selection, local regulations, and thepreferences of the individual farmer(Ponte,2004).

The organic coffee market has experienced sustained growth rates in the last ten years in many high income countries. Many supermarket chains have used organic coffee as a marketing tool to attract new customers. Since organic products are sold at a premium at the retail level, it has been possible to generate higher margins for all those involved in the marketing chain. However, not all participants in the marketing chain obtain premia on an equal basis. In most European countries, organic coffee is sold mainly in natural food stores and world shops. In some countries, such as Germany, Switzerland, The Netherlands and Denmark, organic coffee is also sold in supermarkets.There seems to be no sound data on the consumption of organic coffee. Existing estimates are outdated and tend to vary enormously. Scholars and researchers agree that the market for organic coffee has grown, but most are unable to back up this assumption with empirical evidence. According to estimates of the International Trade Centre, the worldwide consumption of organic coffee in 2013 / 2014 was about 68,820 tons or 1020,000 bags(ITC,2015). Another estimate of the organic coffee sales in selected European countries for the year of 2009 shows a market of 36,400 tons(FAO, 2009).Ponte concludes that one thing that can be said with certainty is that the quality of organic coffee has improved enormously in the last few years. At the same time, according to Ponte, increased supply has led to low premia. He believes that some of the larger roasters may move into organic coffee because of this. At the same time, organic farmers may be less committed and motivated to comply with the high standards for organic coffee as price premia keep decreasing(Ponte,2004).

Organic certification program create a verified sustainable agriculture system that produces food in harmony with nature, supports biodiversity and enhances soil health.Trace back to 19th century practices formulated in England, India, and the US. First certification 1967.Developed into internationally recognized system with production throughout the world. The organic coffee sector represented nearly 3 percent of the total U.S. green coffee imports in 2007 (kline,2009).

2.3.3 Fair Trade certification

Fair trade (FT) Certification is a third-party certification process that sets standards for the way the product is produced and how much a farmer/farming cooperative earns per pound of product sold. The criteria are: fair prices for farmers and decent working and living conditions for workers, direct trade with farmers, bypassing middlemen,free association of workers and co-operatives, with structures for democratic decision-making, Access to capital, sustainable agricultural practices including restricted use of agrochemicals.Since the 1970s, the FT market has achieved widespread acceptance(FLO, 2015).

In the last three decades, it has provided considerable support to hundreds of thousands of small-scale producers in many coffee-producing countries. FT can be defined as "a trading partnership, based on dialogue, transparency and respect that seek greater equity in international trade. It contributes to sustainable development by offering better trading conditions to and securing the rights of marginalized producers and workers - especially in the South. FT organizations (backed by consumers) are engaged actively in supporting producers, awareness raising and in campaigning for changes in the rules and practice of conventional international trade"(FLO, 2015).

In the late 1980s after the collapse of the International Coffee Agreement, when coffee prices went into steep decline, a group of Alternative Trade Organizations (ATOs) and Non-governmentalOrganizations (NGOs) in the Netherlands founded the world’s first Fair-tradelabeling initiative. It was called “Max Havelaar” after the fictional Dutch character who opposed the exploitation of workers on coffee plantations in the Dutch colonies. In 1997, Max Havelaar(which by then had foundations in Switzerland, France, Belgium and Luxembourg as well as in the Netherlands) joined with the Fair-trade Foundation in the UK and Transfair (Canada, United States, Italy, Luxemburg and Germany) to formFT LabelingOrganizations International as the international umbrella organization for FT labeling. The purpose of FTlabeling is to get small producers a better price for their coffee and greater opportunities for their communities. Policies, labeling, certification and inspection have been harmonized under the FTLabelingOrganization International (FLO)(Lewine*et al.*, 2004).At present, FLO-International represents more than 20FT Labeling Initiatives. There are FT Labels widely accepted on dozens of different products, based on FLO’s standards for coffee, tea, rice, bananas, mangoes, cocoa, sugar, honey, fruit juices and footballs. FLO is constantly expanding its product standards and it was included products likefresh fruit, wines, nuts, oils and more non-food products as well(FLO,2015).

As a whole, fair-trade Support a better life for farming families in the developing world through fair prices, direct trade, community development and environmental stewardship. Began as Max Havelaar in the Netherlands in the 1970s.Now the German-based FT Labeling Organizations International (FLO) collaborates with more than twenty national branches throughout the world, including TransFair USA,which has been administering the Fair Trade Certified label since 1998(kline,2009).

2.4 Empirical studies on environmental impacts of certification

Initiatives certifying that producers of goods and services adhere to defined environmental and social-welfare production standards are increasingly popular. According to proponents, these initiatives create financial incentives for producers to improve their environmental, social, and economic performance(Blackman and Rivera, 2010). Coffee agro ecosystems are critical to the success of conservation efforts because of their ecological and economic importance. Coffee certification programs may offer one way to protect biodiversity and maintain farmer livelihoods.Farms withdifferent certifications differed for some individual vegetation variables(Philpott*et al*., 2007).

The study conducted in Sumatra, Indonesia by Philpott*et al*., (2007) examined vegetation, ant, bird diversity, coffee yield and revenues in 80 sample plots consisted 25 meter radius circleand 100 meter between plots. The method applied was diversity indices matched comparisonbetweenOrganic certified and non-certifiedrevealed that Organic farms had higher coffee densities than uncertified farms. There were significantly more tree species in the organic farms than in the uncertified farms, but numbers of ants and birds did not differ with certification. The organic farms shared a higher number of tree, ant, and bird species with forests than did Organic or uncertified farms, and a higher percentage of forest species occurred in Organic farms than in other coffee farms.

Blackman and Naranjo (2010) use detailed agricultural census and geographicinformation system data on more than 6,000 farms in central Costa Rica to test for theenvironmental impacts of organic certification. They compare rates of adoption of fourenvironmentally friendly farm management practices (soil conservation measures, shade trees, windbreaks, and organic fertilizer) and three unfriendly practices (insecticides, chemicalfertilizers, and herbicides) for certified farms and for a matched control group of non-certifiedfarms. They use propensity score matching to control for the age and education of the farmer andvarious physical characteristics of the farm, including size, coffee variety, climate, slope, aspect and distance to population centers. They found that Organic certification improves coffee growers' environmental performance. It significantly reduces chemical input use and increases theadoption of environmentally friendly management practices.

Reuda*et al.,* (2014) study at Andes, Colombia coffee farm survey have attempted to evaluate plot level diversity and vegetation cover by using pair matched case control method and additionally using remote sensing data. They revealed that the RA certified coffee farm plots have large amount of tree covers and species diversity is more than non-certified coffee farms. And concluded that the overall condition of RA certified farms were better than non-certified farms.Philpott*et al*., (2008) used a total sample of 40 coffee plots (20 FT certified and 20 non-certified) laid out in a radius of 25 meter and spacing of at least 100 meter between plots to examined vegetation structure at Chiapas,Mexico. Their results indicate no difference between certified and non-certified farms.On the hand the authors reported higher tree, ant, and bird species richness and vegetation complexity in the forest than coffee farms.

De Lima *et al*. (2009) examine the management practice and use of agrochemicals in SAN coffee certification inMinas Gerais, Brazil. In a sample of 16 farms, half of which were SAN certified, they find thatSAN certification is correlated with use of an array of environmental practices, including use of less toxic agrochemicals and solid and liquid waste management (Blackman and Rivera,2010). Hughelland Newsom (2013) examined the impacts of RA certification in two regions of Colombia in a sample of 52 certified and 52 non-certified as a control.They revealed that the biological and chemical indicators of soil quality were essentially the same between certified and noncertified farms in both regions, with the exception of arthropod richness, which was higher on certified farms.RA-certified coffee farms in Santander, Colombia, increased levels of tree cover significantly more than non-certified farms; patterns detectible from satellite at landscape scale (Rueda *et al*. 2014). The study conducted in Ethiopia, by using remote sensing data ofBeletegera forest supported by interview of local smallholders revealed that natural forests with RA-certified coffee were less likely to be deforested than forests without forest coffee or with non-certified coffee (Takahashi and Todo 2013).

Reuda and Lambin (2013) evaluated the potential of the RA certification program to fostermore resilient social-ecological systems in the face of globalization. Using the case of Santander, Colombia and a pair-basedcomparison of 86 households revealed that certified farmers had adopted significantly more environmentally friendly practices than non-certified farmers, such as tree diversity, watershed protection through fencing and reforestation, and infrastructure for water-use efficiency and wastewater management. These practices significantly increased after farmers joined the certification program. Concluded that Coffee certification in Colombia demonstrates that connections between local social-ecological systems and larger global forces can produce more sustainable livelihoods and land uses.

The study examines the role of RA coffee certification in environment in upper sekamping watershed,Sumatra ,Indonesia by applying quasi-experimental impact evaluation method by analyzing 408 farms using PSM technique the result revealed the coffeeagroforestry systems have positive and significant impacts on improving environmental benefits, but coffee certificates have non-significant impacts for environmental benefits(Arifin*et al*.,2014).Sofie*et al.*, (2015) evaluated the impacts of organic certification on conservation and soil carbon in eastern, Uganda. The study was conducted on an equal sample of 36 Organic certified and non-certified farms using diversity indices. They found no significant difference on conservation but significant difference on soil organic carbon and soil bulk density where higher value was recorded under Organic certified farms than non-certified farms for both soil properties. However, this is unrealistic for soils with higher organic matter which normally have lower bulk density.

3. MATERIALS AND METHODS

3.1 Description of the Study Area

The study was conducted in southwest Ethiopia in Shebesombo District of Jimma zone inOromia region and Decha and Gewata district of Kaffa zone, SNNP regional state.

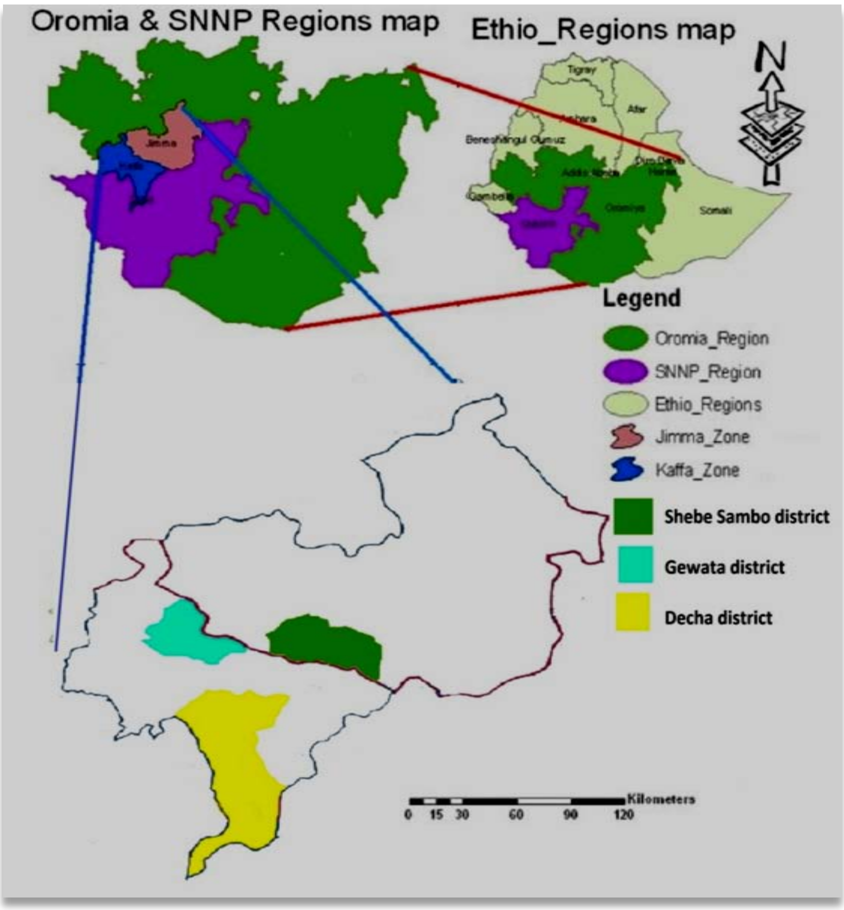

Figure 1. Map of the study area

3.1.1 Location and Population

ShebeSombo District

The study was conducted at ShebeSombo district of Jimma Zone, southwestern Ethiopia. It is locatedalong Jimma – Bonga main road at 50 km from Jimma town. Geographically, it lays between 7° 30' and 7°45’ N and 36° 15' and 36°45’E and altitude of 1900masl. CSA (2008) national census reportshows that a total population for the Woreda is 130,917of them 65,687(51%) where males and 65,687 (49%) were females. In term of area residence

122,958 (95%) people are living in the rural areas. While; 7,960 (5%) are urban dwellers. The majority of the inhabitants areMuslim; (with 76.83%), while 21.26% of the populations are practiced Ethiopian Orthodox Christianity, and 1.77% areProtestant. The area is characterized by a mid-land, mixed agriculture, moderately productive, food sufficient area. The dominant crops include teff, maize, sorghum, coffee, chat, pepper.

Decha District

Decha is one of the woredas in the Kaffa zone of the Southern Nations, Nationalities, and Peoples' Region of Ethiopia. Geographically, it is found center 7° 30' and 6°50' N and 36° 10' and 36° 35'E Altitude of 1600. The name Decha comes from one of the provinces in the former Kingdom of Kaffa, which had approximately the same boundaries. Part of the Keffa Zone, Decha is bordered in the south by the Omo River which separates it from the DebubOmo Zone, in the west by the Bench Maji Zone, in the northwest by Chena, in the north by Ginbo, on the northeast by Menjiwo, and on the southeast by the Denchya River which separates it from the Konta special woreda. The town ofDecha is Chiri. The southern tip of Decha is included in the territory of the Omo National Park.

Based on the 2007 Census conducted by the CSA, this woreda has a total population of 128,887, of whom 64,438 are men and 64,449 women; 5,460 or 4.24% of its population are urban dwellers. The majority of the inhabitants practiced Ethiopian Orthodox Christianity, with 63.9% of the population reporting that belief, 15.75% were Protestants, 14.3% practiced traditional beliefs, 3.51% embraced Catholicism, and 2.18% were Muslim.

Gawata District

Gewata is one of the wored as in the Southern Nations, Nationalities, and Peoples' Region of Ethiopia. Part of the Keffa Zone, Gewata is bordered on the south by Chena, on the west by Gesha, on the northwest by Sayilem, on the northeast by the Oromia Region, and on the southeast by Ginbo. Gewata was formed from parts of Ginbo and Geshaworedas. Geographically, it is found between 7° 30' and 7°15' N, 35° 10'E and 35° 45'E and Altitude of 1800.

Based on the 2007 Census conducted by the CSA, this woreda has a total population of 72,473, of whom 35,764 are men and 36,709 women; 1,440 or 1.99% of its population are urban dwellers. The majority of the inhabitants practiced Ethiopian Orthodox Christianity, with 52.85% of the population reporting that belief, 28.93% were Protestants, and 17.49% were Muslim.

3.1.2 Climate

Kafa zone receives a heavy rainfall around 1,700 mm distributed throughout the year; the mean temperature is 19.4°C (Bekele, 2003) (Fig. 2). And Jimma zone receives annual precipitation of 1,500 mm and an annual average air temperature of approximately 20 (Fig. 3).

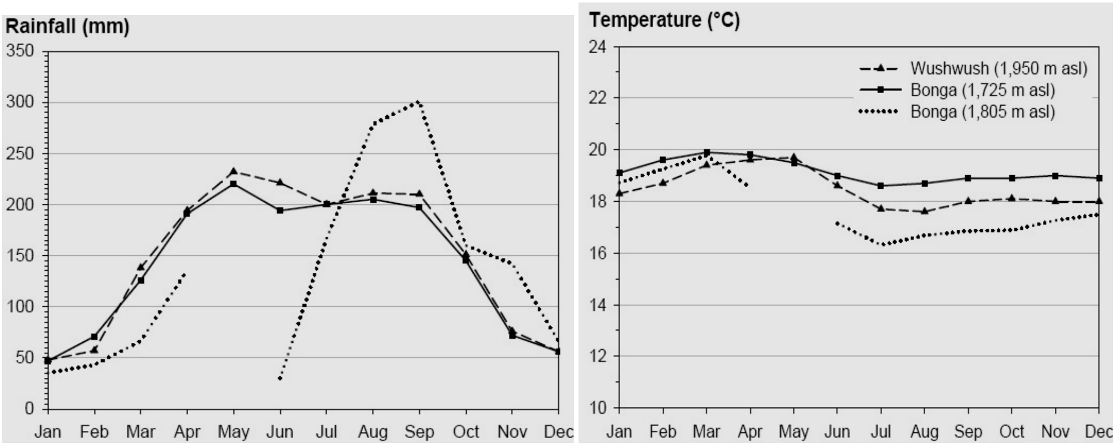

Figure 2. Fig. 2: Average annual temperatures(°C) and average total rainfall (mm) in wushwush and Bonga(Source: Schmitt, 2006)

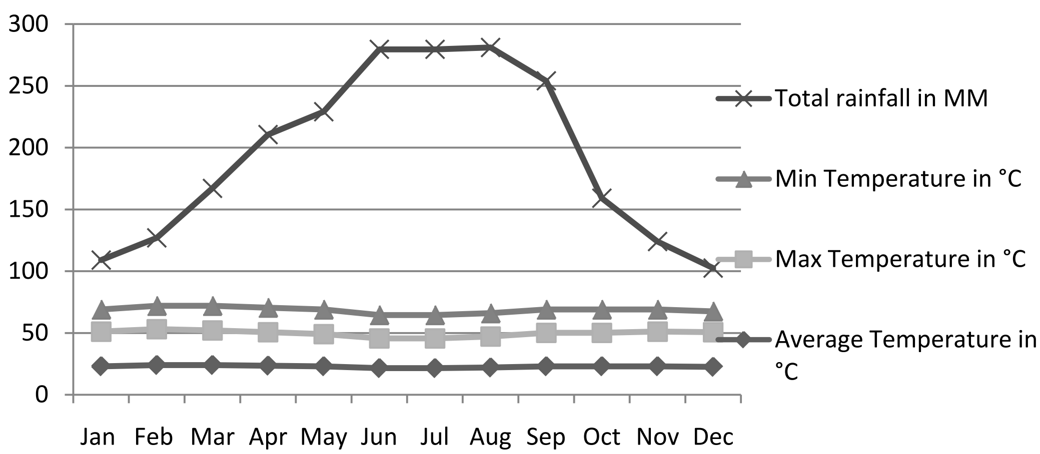

Figure 3.Average annual temperatures(°C) and average total rainfall (mm) in Jimma(Source: world climates, 2016).

3.1.3 Topography and soil

Kafa zone is highly slopping form ranging from 10 % to over 60% and altitude range from 500 to 3350 m.a.s.l.The soil of the area mostly is red or brownish ferisols derived from volcanic parent material, and nitosols, acrisols, vertisols, and cambisols group of soils are found in the area also (Gole, 2003b). And Shebe district topography is complex and consists of undulating hills that range from 1,200 to 2,900 m in height, with steep mountainous terrain in certain locations, the soils of the study area are largely volcanic origin and relatively fertile and dominated by nitosols soil type (Takahashi and Keijiro, 2016).

3.1.4 Forest Resources

The moist Afromontane forests in the Kafa Zone represent more than 45% of all forest found in SNNPRS (NABU, 2011) is characterized by highly biodiversity with around 309 vascular plant species including 16 endemics, one hundred bird species and at least 48 mammalian species (Schmitt, 2006). The forest contributes to climate protection as significant carbon storage and provides wild coffee, a variety of commercially valuable spices and honey from wild bees (NABU,2015).

The total area of the Shabesombodistrict is 755.43 Km^2 and 65% of it is covered by agricultural land, while, forest, grassland and woodland cover 25, 7.3 and 2.7 percent respectively. The forest area can be divided into two types: the coffee forest area, and the highland forest area without coffee. In both types of forest, the residents are mostly farmers, producing vegetables, honey, milk and cereals such as maize, wheat, barley and teff (Todo and Takahashi, 2013).

3.2 Method of Data Collection

In this research both primary and secondary source of data were collected and used. The primary data were obtained from soil sample analysis. The secondary information was obtained from such data sources as published journals, reports, official records and project reports.

3.2.1 Study site selection

Three districts namely Shebe, Decha and Gowata where Rainforest Alliance (RA), Organic and Fairtrade (FT)coffee certification respectively implemented on three coffee production systems (forest, semi-forest and garden) were purposively selected. In each district and coffee production systems soil samples were collected from both certified and non-certified plots.Fourplots wererandomlysampled from each production system and certification types.Therefore, for each coffee production system, there were 24 plots (4 x 2 (certification type) x 3 (districts)), except for the garden coffee production system where

Rainforest Alliance coffee certification standard has not been implemented and thus 22 plots were sampled. Therefore, a total of 70 plots were used to collect soil samples (Table 1).

Table 1. Study sites, plot number by site and certifications

Management systems	Plots by Sites and Certification						Total by production system
	Shebe		Decha		Gowata		
	RA	Non-cert	Organic	Non-cert	FT	Non-cert	
Forest	4	4	4	4	4	4	24
Semi-forest	4	4	4	4	4	4	24
Garden	0	6	4	4	4	4	22
Total by certification	8	14	12	12	12	12	**70**
Year of certification introduced in the area	2007 GC		2005 GC		2005 GC		

3.2.2 Soil sampling

Composite soil samples were collected from a depth of 0-30 cm using auger. The size of each plot used for soil sampling was 20x20 meters for forest and semi forest and 10x10 meters for garden coffee production system. In each district the certified and non-certified study sites with relatively similar topography and climate were carefully identified in order to match with the bio-physical characteristics of the area.. The collected soil samples were handled in plastic bags to determine soil physical and chemical properties. Whereas, undisturbed soil sample was collected using coresamplingmethod (FAO, 2007) to determine soil bulk density. In total 70 composite soil samples were collected using simple random sampling using auger (Margesin and Schinner, 2005) from each certified and matched non-certified plots under forest, semi-forest and garden coffee production systems. The collected soil samples wereanalyzed in the Laboratory of soil science, Jimma University using standard laboratory analytical techniques. Soil samples were air-dried, ground, mixed well and passed through a 2-mm sieve for selected soil physical and chemical properties analysis.

3.2.3 Laboratory Analysis

3.2.3.1 physical properties

Soil physical properties such as texture, bulk density and moisture content were analyzed following standard procedure provided by (Sahlemedin and Taye, 2000). The particle size distribution wasdetermined by the hydrometer method (Houba*et al.,* 1989). Hydrogen peroxide (H_2O_2) was used to destroy soil organic matter and sodium hexaetaphosphate $(NaPO_3)_6$ as well as sodium carbonate (Na_2CO_3) wereused as soil dispersing agent and also one drops of amyl alcohol was used for foam reduction. Bulk density of undisturbed soil sample were determined by core method (FAO, 2007) using core sampler and determining the mass of solids and the water content of the core, by weighing the wet core, drying it to constant weight in an oven at 105°C for 24 hours and calculated as:

$$BD = \frac{\mathrm{Mcs} - \mathrm{Mc}}{\mathrm{Vc}}$$

Where,

BD = Bulk density in gcm^{-3}

Mcs = the mass of each core with its dry soil in g

Mc = the mass of each empty core in g and

Vc = Volume of core in cm^3

Soil moisture content was determined by gravimetric method. The collected core samples were arrived to JUCAVM soil laboratory 3hrs after collection.

$$\textit{Percent of moisture}\ (\text{wt }\%) = \frac{A-B}{B-C} x100$$

Whereas;

A=weight of wet soil in gram + tin weight,

B=weight of oven dry soil in gram + tin weight and

C=weight of the empty tin

3.2.3.2 Chemical Properties

Soil pH was measured potentiometrically in water at the ratio of 1:2.5 using a combined glass electrode pH meter.Air dried soil of 10 g was taken in a beaker and to this 25 ml of water was added. The mixture was stirred for 30 min. The pH meter was calibrated using standard buffer solution of pH 4.0, 7.0 and 10.0. Then electrode of the pH meter was inserted in to the supernatant solution and the pH reading was taken.(Chopra and Kanwar, 1976). Electrical conductivity was measured by conductivity meter using 1:2.5 soils: water ratios.Air dried soil of 10 g was taken in a beaker and to this 50 ml of water was added.The mixture was stirred with automatic stirrer for 30 minutes. The soil was allowed to settle down and the EC value was measured inserting electrical conductivity meter in to the supernatant solutionas described by Sahlemedhin and Taye, (2000).

To determine organic carbon, the Walkley and Black (1934) method was employed in which the carbon wasoxidized under standard conditions with potassium dichromate in sulfuric acid solution.1 g finely ground soil sample was passed through 0.5 mm sieve without loss was taken into 500 ml conical flask, to which 10 ml of 1 N potassium dichromate and 20 ml concentration H_2SO_4 were added with measuring cylinder. The contents were shaken for a minute and allowed to stand for 30 min. Then 200 ml distilled water, 10 ml orthophosphoric acid and 1 ml diphenylamine indicator were added. The solution was titrated against 0.5 N ferrous ammonium sulfate till the colour flashes from blue-violet to green. The blank titration was carried at the beginning without soil.The results were calculated by the following formulas:

Organic carbon % = N x((V1– V2)/S) x 0.39 x mcf

Where: N = Normality of ferrous ammonium sulfate (FAS)

V1 = Volume of 0.5 N FAS required to neutralize 10 ml of 1 N K2Cr2O7 i.e. blank reading (ml).

V2 = Volume of 0.5 N FAS needed for titration of soil sample (ml)

S = Weight of air-dry sample (g) 0.39 = 0.003 x 100% x 1.31 (0.003 is the milliequivalent weight of carbon in g).

The total nitrogen contents in soils were determined using the Kjeldahl procedure by oxidizing the organic matter with sulfuric acid and converting the nitrogen into NH_4^+ as ammonium sulfate. 1 g soil sample (< 0.5 mm sieve) and transfer into a digestion tube and organic matter was oxidized by treating soil with concentrated sulfuric acid, nitrogen in the organic nitrogenous compounds being converted into ammonium sulfate during the oxidation. The acid traps NH_4^+ ions in the soil, which were liberated by distilling with NaOH. The liberated NH_4^+ was absorbed in boric acid and back titrated with standard H_2SO_4.

Potassium sulfate was added to raise the boiling point of the mixture during digestion and copper sulfate and selenium powder mixture was added as a catalyst. The procedure determines all soil nitrogen (including adsorbed NH_4^+) except that in nitrate form(Reeuwijk, 2002).

Determination of available phosphorous wascarried out by the Bray 2 methods byusing 2.0g air-dry soil < 2 mm in a 50 ml bottle by extracting ammonium fluoride (0.03 M NH_4F) and hydrochloric acid (0.1 M HCl) solution (Bray and Kurtz,1945) and Frank *et al*. (1998).In this procedure, the soil samples were extracted with excess of NH_4OAc solution. Soil cation exchange capacity (CEC) was measured after leaching the ammonium acetate extracted (ammonium ion standard) soil samples with 10% sodium chloride solution. The amount of ammonium ion in the percolate was determined by the Kjeldahlprocedure and reported as CEC. The cation exchange capacity of the clay fraction was estimated by dividing the CEC of the soil by the percentage of the clay and then multiplied by hundred and expressed as cmol (+) kg^{-1} clay.

3.3 Data Analysis

Data were collected from certified and non-certified fields; normality was first tested using the Shapiro-wilk test. The Analysis of Variance (ANOVA) was performed to test the differencesbased on nested design.The difference was determined following the General Linear Model (GLM) procedure at $P \leq 0.05$ level using SAS 9.3,whileTukey wasemployed to identify differences between certified and non-certified plots under the different production systems.

4. RESULT AND DISCUSSION

In the study areas, RA, Organic and FT certification standards were applied on different coffee plots under different production systemsat smallholder coffee producers' level.In this research, the effects of these three certifications under three coffee production systemson selected soil physical properties (such as texture, bulk density and moisture content) and chemical properties (such as soil reaction, Electric Conductivity, Organic Carbon, Total Nitrogen, Available Phosphorus, CationExchange Capacity) were assessed. The production system were forest, semi-forest and garden coffee and the random factors which are the characteristics within individual plots, such as vegetation coverthatranges from2 to7 tree per plot for garden and9 to 87 tree per plot for forest and semi-forest were recorded. Besides, altitude ranges from 1528 to 2157masland the site have relatively similar slope.Then the data were collected in certified fields and matched non-certified fields.The detail results are presented in the following sub-topics.

4.1 SoilPhysical Properties

Soil particle size distribution: The Soil particle size distribution result showedthatthe clay and silt content were significantly ($P\leq0.05$) differentfor certified and non-certified farms. While, there was no significant difference in sand content among certified and non-certified plots (Table 1).Also certified and non-certified production systems within the respective districts showed that the clay and sand fraction of the soils were revealed statistically significantly($P\leq0.05$) different.The result of coffee production system between certified and non-certified within the particular districts were statistically significantly ($P\leq0.05$) different for particle size distribution. Statistical analysis also showed the random factor which is thecharacteristics within individual plot wasnot significantlydifferent (Table 2).

Based on the types of certification schemes,sand fractions of the soil were significantly ($P\leq0.05$)different inRA and Organic certified as compared with non-certified plots. The higher mean (49%) values were observed in RA certified plots and lower mean (39%) valueswere for non-certified ones. In Decha districtwhere Organiccertification was applied, the higher mean (44%) values observed in non-certified farms and lower means(37%) value observed in Organic certified farms.There was no significant difference observed between FT certified and non-certified plots for sand fraction. The analysis also showed the clay fractionsof non-certified plotswere significantly ($P\leq0.05$)

differentfromRA, FT andOrganic certified plots. . The higher mean(27%) value was observed fornon-certified farms and the lower (23%) observed forRA certified plots.The clay fraction in FT certified farm was higher (25%)than didnon-certified farm was lower (21%) value. On organic certified farm clay fraction was higher (34%) and non-certified was lower (23%) value.

Based on the percentage of clay, silt and sand content, soil textural classes of RA certified farmsunder forest and semi-forest conditions were loam and sandy loam respectively and under non-certified production in forest, semi-forest and garden,it wasloamand both clay loam respectively (Table 2).Clay and sand fraction of the soils were not significantly *($P>0.05$*) different forcertified and non-certifiedforest, semi forest and garden production systemsWhile there was significant ($P\leq0.05$) difference in silt content among production system(Table 2).

Mean values of : silt at RA certified under forest and semi-forest coffee production systems were 33% and,31%,respectively and under non-certified forest,semi-forest and garden production systems the values were 39.5%, 30% and 32%, respectively (Table, 1). ComparedtoRA certified forest coffee production, higher silt proportion was observed inthe non-certified forest coffee productions (Table 2).However, there was no difference observed under semi-forest and garden between RA certified and non-certified. The higher silt proportion at non-certified forest might be attributed to dense covers which suppress soil erosion. Similarly,Deekor*et al*., (2012) reported that silt content were higher in dense vegetation cover that helps by retarding soil erosion.

Textural classes forFT certified plotsunder forest, semi-forest and garden systems were clay loam andboth loam respectively and the same rating was observed for non-certified farms in the respective production systems (Table 2). Clay and silt fraction of the soils were not significantly *($P>0.05$*) affected by FT certification in forest, semi forest and garden production systems.But, there was significant($P\leq0.05$) difference in sand content among certified and non-certified plots ofproduction systems.Mean values of sand inFT certified forest, semi forest and garden coffee s were40%,46% and 46% respectively, whereasthe corresponding values undernon-certifiedcondition were 37, 53.5 and45.25% respectively. The higher value was observed fornon-certified as compared to certified semi-forest. There was no difference between both certified and non-certified plots in forest andgarden stands.

Sand, silt and clay fraction of the soils were not significantly *($P>0.05$)* different by Organiccertified and non-certified forest, semi forest and garden production system.

In the production system under the three certifications the area which hadhigher sand content might be an indication of removal of clay fraction due to soil erosion and also higher amount of sand might indicate the existence of soil erosion. Similarly,Gachene and Kimaru (2003) reported that clay particles are much smaller than sand particles, and once detached by erosion they are easily transported. This might indicate that higher soil erosion in non-certifiedsemi-forest as compared toFT certified semi-forest coffee plots.Higher sand content is probably caused by increasing run off and soil erosion, whereas relatively higher clay content might be due to less erosion. Similarly, Abinet,(2011) has reported that the higher clay content means that there is relatively low soil erosion in the site, while the lower clay means there is relatively higher soil erosion (particularly sheet erosion), which may reflect the differences in their vegetation cover.

Bulk density (**BD g/cm^3**):Comparison of the results between certified and non-certified plots is given in Table 2. The analysis of variance revealed that BD showed statistically significant($P\leq0.05$) difference between certified and non-certified coffee plots. The higher value (0.99) was observed for non-certified plots compared to (0.94) certified coffee stands. Certified and non-certified plotswithin the respective districts were significantly($P\leq0.05$) different. Coffee production systems also showed significant difference between certified and non-certified plots within aparticular district. But, the random factor which is the characteristicswithin individual plots was not significantlydifferent (Table 2).

Based on the types of certification scheme significant ($P\leq0.05$) difference wasobserved forBD in RA and Organic certified farms compared to the non-certified ones. Whereas there was no significant difference between plots in FT certified area.Mean values of soil bulk density of RA certified and non-certified plots were 0.89 and 0.96, respectively,.While mean values forOrganic certified and non-certified were 0.89 and 0.95 respectively.Contrary to this finding, Sofie*et al., (*2015) reported thatsoil BD was higher in Organic certifiedthan non-certified coffee farms.

Mean values of soil bulk density inRA certified production system under forest and semi forest condition were 0.87and0.92 g/cm^{3}respectively, and the non-certified farms under forest, semi forest and garden systems were0.83, 0.97and 1.07 g/cm^3 respectively, (Table 2).Statistical analysis revealed that soil bulk density was significantly ($P \leq 0.05$) affected bycoffee production system where, the highest value (1.07 g/ cm^3) was observed innon-certifiedgarden and no difference was observed between RA certified and non-certified forest and semi-forest coffee production systems (Table 2).

Similarly, for FT certified area the result revealed that soil bulk density was significantly ($P \leq 0.05$) affected with coffee production practices where, the higher value(1.16 g/ cm^3) was observed fornon-certified semi-forest than for FT certifiedsemi-forest,and there was no significant difference between certified and non-certified forest and garden coffee plots.Mean values of the soil bulk density forOrganic certified forest, semi-forest and garden plots were 0.87, 0.90 and 0.90 g/cm^3 , respectively, and the corsponding values fornon-certifiedwere0.96, 0.87 and 1.02 g/cm^3 respectively (Table 2). There were no significant difference between Organic certified and non-certified plots under all production systems.

Human and livestock interference might be the main reason for the observed relatively high bulk density innon-certified garden plots than RA certified, andnon-certified semi-forest plots than FT certified plots..Humaninterferences have high impact on compaction of soil particularly under high grazing intensity (Fatunbi and Dube, 2008). Whereas, the protection of human interferences, livestock grazing and organic matter addition from forest and semi forest could be the cause for low soil bulk density under forest and semi-forest for both certified and non–certified coffee plots. Similarly, Tadele*et al*.,(2013) havereported that in the area with high vegetation cover have low soil bulk density because of biomass return and OM existence.

Table 2. Mean (±SEM) effect of coffee certification on soil particle sizes, bulk density and moisture content

Factors			N	Sand (%	Silt (%)	Clay (%)	Textural class	BD (g/cm^3)	SMC (%)
Comparison between total certified and non-certified									
Certification	C		32	42 ±7.36^a	29.4 ±5.96^b	27.87 ±7.9^a	Clay loam	0.94±0.09^b	34.94 ±4.31^a
	NC		38	42±5.88^a	32.97±4.79^a	24.47±7.26^b	Clay loam	0.99±0.1^a	29.83±8.32^b
CV				12.82	15.74	24.38		5.28	3.72
P value				0.7406	0.0037	0.0402		<.0001	<.0001
Comparison between total certified and non-certified with in Districts									
District(Certification)	SH	C	8	49±6.41^a	28.0±6.32^a	23±4.14^c	loam	0.89±0.03^c	40.67±1.23^a
		NC	14	39±3.76^c	33.71±5.41^a	27.3±5.18^b	Clay loam	0.96±0.10^b	29.67±6.46^c
	GE	C	12	44.16±5.35^b	30.83±5.14^a	25.0±7.05^{bc}	Clay loam	1.01±0.08^a	32.8±2.95^{abc}
		NC	12	45.25±11.3^b	32.91±5.6^a	21.83±10.0^d	loam	1.07±0.09^a	23.03±8.71^c
	DE	C	12	37±5.59^c	29.0±6.6^a	34±6.92^a	Clay loam	0.89±0.07^c	33.27±3.3^a
		NC	12	44±4.7^b	32.16±3.1^{a}2	23.83±5.21^c	loam	0.95±0.08^b	36.82±1.96^a
CV				12.82	15.74	24.38		5.28	3.72
P value				<.0001	0.6144	0.0011		<.0001	<.0001
Comparison between certified and non-certified by production system within Districts									
Rainforest Alliance Certification(Shebe District)									
SHEBE	C (RA)	F	4	45 ±4.32^a	33.0±3.65^b	22.0±5.41^a	loam	0.87±0.02^c	39.97±6.58^{ab}
		SF	4	53±5.88^a	31.0±1.62^b	16.0±1.5^a	Sandy loam	0.92±0.03^{bc}	41.37±8.52^a
		G		-	-	-		-	-
	NC	F	4	37.5±3.41^a	39.0±2.83^a	23.5±5.0^a	Clay loam	0.83±0.03^c	36.15±1.56^{bc}
		SF	4	40±2.58^a	30.0±5.03^b	30.0±5.41^a	Clay loam	0.97±0.09^{ab}	33.2±8.13^c
		G	6	38.5±3.41^a	32.0±5.77^b	29.5±2.51^a	loam	1.04±0.01^a	21.0±2.15^d
CV				9.69	11.06	19.36		5.19	5.21
P value				0.0895	0.0014	0.3169		0.0002	0.0001

Factors N				Sand (%	Silt (%)	Clay (%)	Textural class	BD (g/cm^{3})	SMC (%)
				Fairtrade Certification (Gewata District)					
GEWATA	C (FT)	F	4	40 ±2.58^{c}	28.0±6.0^{a}	32.0±8.16^{a}	Clay loam	0.98±0.03^{b}	36.37±3.32^{a}
		SF	4	46.5±6.81^{b}	31.5±5.97^{a}	22.0±3.26^{a}	loam	0.94±0.04^{b}	32.14±5.44^{b}
		G	4	46±4.16^{b}	33±2.82^{a}	21±2.58^{a}	loam	1.12±0.02^{a}	29.9±5.51^{c}
	NC	F	4	37±1.03^{c}	34.0±4.76^{a}	29.0±1.18^{a}	Clay loam	0.97±0.04^{b}	34.6±5.03^{a}
		SF	4	53.5±8.69^{a}	29.5±5.97^{a}	17.0±9.59^{a}	loam	1.16±0.02^{a}	15.34±4.21^{e}
		G	4	45.25±1.02^{b}	35.25±5.7^{a}	19.5±5.5^{a}	loam	1.09±0.64^{a}	19.17±2.36^{d}
CV				15.25	14.83	30.64		2.87	2.15
P value				0.0413	0.2904	0.0629		0.0001	0.0001
				Organic certification(Decha District)					
DECHA	C(ORG)	F	4	35.5 ±5.0^{a}	29.0±2.83^{a}	35.5±5.26^{a}	Clay loam	0.87±0.09^{a}	34.75±5.59^{ab}
		SF	4	34±4.76^{a}	28.5±1.21^{a}	37.5±7.55^{a}	Clay loam	0.90±0.07^{a}	29.18±6.29^{b}
		G	4	41.5±5.0^{a}	29.5±2.51^{a}	29±6.22^{a}	Clay loam	0.90±0.08^{a}	35.9±5.03^{ab}
	NC	F	4	43.5±5.74^{a}	31.5±3.0^{a}	25.0±8.72^{a}	Clay loam	0.96±0.03^{a}	34.57±7.15^{ab}
		SF	4	47±3.65^{a}	31.0±3.65^{a}	22.0±2.31^{a}	Clay loam	0.87±0.06^{a}	38.45±9.78^{a}
		G	4	41.5±3.78^{a}	34.0±2.58^{a}	24.5±3.41^{a}	Clayloam	1.02±0.07^{a}	37.45±2.59^{a}
CV				12.59	20.28	23.06		7.38	2.63
P value				0.1922	0.9607	0.4432		0.0923	0.0001
				ANOVA					
Cert				0.7406	0.0037	0.0402		<.0001	<.0001
Cert (Dist)				<.0001	0.6144	0.0011		<.0001	<.0001
Pro(Dist*Cert)				0.0066	0.0690	0.0561		<.0001	<.0001
plot(Dist* Cert*Pro)				0.1801	0.3191	0.5897		0.1861	0.0214

Means within column followed by the same letter are not significantly different at P≤ 0.05 according to Tukey HSD (Honestly significance difference)) (Cert= certification, Dist=district, pro=production system)=Fixed factors, plot(Dist* Cert*Pro)=*Random factor, CV= Coefficient of variance, BD = bulk density, and SMC = Soil moisture content,RA =rain forest alliance,ORG= organic FT= fair-trade C= certified, NC=Non-certified*

Soil Moisture content (%SMC): The analysis of variance revealed that soil MC showed statistically significant (*P≤0.05*) difference between certified and non-certified coffee productionsystems. The higher mean value (34.94)was observed forthe certified plots. Certified and non-certified plotswithin the respective districts were significantly (*P≤0.05*) different for soil MC, which also showed significant difference due to coffee production systems.Statistical analysis also showed therandom factor which is the characteristics within individual plots was significantly (*P≤0.05*) different. Based on the types of certification schemes the soil MCshowedsignificant (*P≤0.05*) difference between RA and FT certified areas and non-certified ones,whereasthere was no significant difference among plots in Organic certified area. Mean values of the soil MC of RA certified and non-certified plots were 40.67 and 29.67%,respectively, and the higher value was for RA certified. Mean values of the soil MC of FT certified and non-certified were 32 and 23%, respectively, and the higher mean value was for non-certifiedplots (Table 2).

Mean values of the soil moisture content for RA coffee certification in forestand semi forest were 39.97 and 41.37%, respectively and the mean values for non-certified coffee production inforest, semi forest and garden were 36.15, 33.19 and 21.0% respectively(Table 2). Higher value of SMC was observed incertified semi-forest than non-certified plots and there was no difference between certified and non-certified plots in the forest system.Mean values of soil moisture content for FT certified and non-certified coffee plotsunder forest, semi forest and garden were 36.37, 32.14 and 29.9% and 34.6, 15.34 and 19.17 % respectively (Table 2).Higher SMC was observed for FT certified semi-forest and garden than for non-certified plots.

As compared to thenon-certified plots, theRA certifiedsemi-forest stands showed higher SMC and no difference was observed between the plots in the forest system. In the FT, higher value was observed in both certified semi-forest and garden than non-certified plots and there was no differencebetween the plots in the forests.Higher moisture percentage in semi forestis probably attributed to reduced evaporation rate due to increase surface cover with vegetation.The presence of vegetation that is used for different purposes may affect soil physical properties, such as water retention capacity and aggregate stability, leading to enhanced crop water availability (Brady and Weil, 2002).Masebo*et al*. (2014) reported that addition of organic matter through litter fall from tree and shrubs had improved soil physical conditions, which in turn had increased the water holding capacity and thus the soil moisture content.

4.2 Soil chemical properties

Soil reaction (pH-H_2O 1:2.5):Analysis of variance revealed that PH showed statistically significant ($p>0.05$) difference between certified and non-certified coffee plots. Also certified and non-certified plotswithin the respective districts were significantly ($P\leq0.05$) different. The result of coffee production system between certified and non-certified plots within the particular districts were statistically ($P\leq0.05$) different. Statistical analysis also showed the random factors which is the characteristicswithin individual plots were not significant ($p>0.05$) (Table 3). Based on the types of certification schemes, significant ($P\leq0.05$) difference was observed for pH betweenRAcertified and non-certified plots. Whereas, there was no significant difference between plots in FT and Organiccertified areas. Mean values of the soil pH of RA certified and non-certified plots were 5.67 and 6.0,respectively and the higher value was observed in non- certified plots.

No significant difference was observed between RA certified and non-certified plots in all the production systems. Soil pH of the non-certified plots was not significantly ($P>0.05$) different compared with FT certified ones within the same production system. Mean values of soil pH of FT certified plots under forest semi forest and garden conditions were 4.92, 5.8 and 5.95 respectively, and the corresponding values fornon-certified ones were 4.93, 5.22 and 6.10, respectively, (Table 3). This is probably due to the presence of relatively higher human interference and management practices in garden than forest and semi forest of both certified and non-certified.

According to Mohammed (2003) the soil PH affected by steepness of topography, excess rainfall and inorganic fertilizer application are responsible for reduction of pH in the soil.Non-significant difference in soil pH was observedin all types of productionsystem between Organiccertified and non-certifiedplots. Based on the classification by Pandey(2000) soil pH in three coffee production systems ofbothcertified and non-certified plots rangefrommoderately to slightly acidic.The presence of higher pH in vegetation cover might be attributed to the ameliorating effect of the high content of OM that form Al and Fe-OM complexes and release of hydroxyl ions as well as deposition of basic cations (Habtamu*et al*, 2014).

Electrical conductivity:Analysis of variance revealed that EC showed statistically significant (*P≤0.05*) difference between certified and non-certified coffee plots. The higher value was observed under certified condition. Certified and non-certified production within the respective districtshad alsosignificantly (*P≤0.05*) different values. The result of coffee production system between certified and non-certified within the particular districts were significantly(*P≤0.05*) different. Statistical analysis also showed the random factors which are the characteristics within individual plots were not significant (Table 3). Based on the types of certification, the soil EC values were significantly (*P≤0.05*) different for FT certified and non- certified areas. Whereas, there was no significant difference between plots in RA and Organic certified area. Mean values of the soil EC of FT certified and non-certified plots were 0.11 and 0.08 ds/m respectively.

There was no significant difference in EC between RA certified and non-certified plots in all types of production (Table 3).However, there was significant (*P≤0.05*) difference in EC between FT certified and non-certified plots under the same production system (Table 2).Mean values of EC for FT certified coffee production system under forest, semi forest and garden condition were 0.12, 0.11 and 0.11 dS/m respectively and for the corresponding non-certified plots were 0.10, 0.9and 0.07dS/m respectively (Table 2). Higher EC value was observed forFT certified garden than the non-certified one. There was significant (*P≤0.05*) difference in EC between Organiccertified and non-certified plots under the differentproduction systems (Table 3).Mean values of EC forOrganic certified coffee production system under forest; semi forest and garden condition were 0.09, 0.12 and 0.10 dS/m respectively and 0.10, 0.11 and 0.09 dS/mfor the respectivenon-certifiedplots (Table 3). No difference was observed under the same production between certified and non-certified.

Organic carbon (**OC %**): analysis of variance revealed that OC showed statistically significant (*P≤0.05*) difference between certified and non-certified plots. The higher value was observed under non-certified production. Also certified and non-certified production within the respective districts were significantly (*P≤0.05*) different for OC. The result of coffee production system between certified and non-certified within the particular certification and districts were statistically (*P≤0.05*) different. Statistical analysis also showed the random factor,which are characteristics within individual plots were not significantly different (Table 3). Based on the types of certification schemes the soil OC were significant ($P \leq 0.05$) difference was observed for soil OC betweenRA certified and non- certified areas, whereas there was no significant difference in FT and Organic certified area. The result showed that no difference was observed between Organic certified and non-certified farms, but, as reported by Sofie*et al.*, (2015) the soil OC was higher in Organic certified than non-certified. Mean values of soil OC forRA certified and non-certified plots were 2.11 and 3.46,(Table 3)..

There was significant ($P \leq 0.05$) difference in OC between RA certifiedand non-certified production systems (Table 3). Mean values of soil organic carbon for the RA certifiedcoffee plotsunder forestand semi forest conditions were 3.02 and 2.39% respectively and 3.50, 2.81 and 4.29% for the non-certified forest, semi forest and gardensystems respectively(Table 3).Ingeneral,the highest mean (3.50) value was observed fornon-certifiedand the lowest (2.39%) was observed forcertified forest coffee production system.There was significant ($P \leq 0.05$) difference in OC between FT certified and non-certifiedplots (Table 3). Mean values of soil OC for the FT certified coffee production under forest, semi forest and garden condition were 1.87, 2.56 and 2.85%, respectively, and the corresponding values for non-certified oneswere 2.64, 3.27 and 2.60% respectively (Table 3). Whereas the highest mean (2.64 and 3.27%) valueswere observed for non-certified forest and semi foreststandscompared to FT certified ones. No difference was observed between FT certified and non-certified garden stands. There was significant ($P \leq 0.05$) difference in OC between Organiccertified and non-certified types of production (Table 3).Mean values of soil organic carbon for the Organic certified coffee production under forest, semi forest and garden conditionswere 1.96, 2.03 and 2.34% respectively and the corresponding values for non-certified plotswere 3.48, 3.04 and 2.10%, respectively (Table 3). Whereby the highest mean (2.64 and 3.27%) values were observed fornon-certified forest and semi forest stands inOrganic certification scheme. No difference was observed between Organic certified garden and non-certified garden stands.

The higher value in the forest and semi forest non-certified farms than RA,FT and Organic certified plotsmight be due to high biomass return,due to soil management practices and the presence of good vegetation covers, which reduce erosion through various mechanisms, such as addition of organic matter and surface litter, and thus improve soil coherence andanchore through root system, and physical blockage, and thus reduction of kinetic energy of surface run off (Skarpe,1991).The greater organic carbon content of the soil under garden coffee production might be due to the added organic matter input to the soil through human interference,maintenance of the available organic matter and plant nutrients, improvement of the physical structure of the soil and thus, reduction run off. Similarly, (Abiy, 2008) reported that less biomass return causes the reductionof soil OM, TN and Av.p in low vegetative land compared with high vegetative covered site in which litter found on the soil surface consists of dead plant remains, which protect the soil surface from raindrop impact and surface runoff. FAO (2005) has reported that the most significant chemical and physical changes in soil parameters as a result of vegetation occur at or near the surface and are related to the supply of organic matter from litter and human supply.

Table 3. Mean (±SEM) effect of Coffee certification on selected soil chemical properties

Factors			N	pH H_2O (1:2.5)	EC (dS/m)	OC (%)	TN (%)	Av.P (ppm)	CEC (cmol (+) kg^{-1} clay)
				Comparison between total certified and non-certified					
CERT	C		32	5.81±0.46 [a]	0.11±0.01[a]	2.3±80.40 [b]	0.20±0.03 [b]	10.58±1.16 [b]	21.64±2.88 [b]
	NC		38	5.88±0.55 [a]	0.10±0.01 [b]	3.07±0.65 [a]	0.26±0.05 [a]	11.64±2.48 [a]	22.85±3.5 [a]
CV				5.66	9.32	12.33	12.73	7.03	8.62
P value				0.2976	0.0003	<.0001	<.0001	<.0001	0.0136
				Comparison between total certified and non-certified with in Districts					
DIST	SH	C	8	5.67±0.4[b]	0.10±0.01[ab]	2.11±0.18[c]	0.23±0.03[b]	9.55±0.72[c]	18.83±2.90[b]
		NC	14	6.0±0.41 [a]	0.10±0.01[ab]	3.46±0.74[a]	0.30±0.06[a]	12.97±2.4[a]	25.57±3.61[a]
	GE	C	12	5.55±0.49[b]	0.11±0.01[a]	2.43±0.44[bc]	0.20±0.03[b]	10.57±1.0[b]	20.88±1.35[b]
		NC	12	5.41±0.57[b]	0.08±0.01[b]	2.82±0.35[b]	0.24±0.02[b]	9.54±0.53[b]	20.69±2.24[b]
	DE	C	12	6.15±0.21[a]	0.10±0.01[ab]	2.70±0.33[b]	0.18±0.02[b]	11.27±1.09[b]	24.28±1.50[b]
		NC	12	6.22±0.32[a]	0.10±0.01[b]	2.87±0.61[b]	0.24±0.05[a]	12.18±2.49[a]	21.83±2.26[b]
CV				5.66	9.32	12.33	12.73	7.03	8.62
P value				<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
				Comparison between certified and non-certified by production system within Districts					
				Rainforest Alliance Certification (Shebe District)					
SHEBE	C(RA)	F	4	5.79±0.55 [a]	0.09±0.02 [a]	3.02±1.35[bc]	0.26±0.00[bc]	9.08±1.61[b]	21.42±0.83[ab]
		SF	4	5.56 ±0.22 [a]	0.11±0.04 [a]	2.39±0.55 [c]	0.20±0.02[c]	9.08±1.61[b]	16.25±1.1[b]
		G		-		-	-		
	NC	F	4	6.05±0.92 [a]	0.11±0.04 [a]	3.5±2.91[ab]	0.30±0.25[b]	15.33±6.79[a]	23.83±0.69[a]
		SF	4	6.18 ±0.23 [a]	0.10±0.02 [a]	2.81±0.62 [c]	0.24±0.05[bc]	14.08±4.69[a]	24.71±0.76[a]
		G	6	6.12±0.35 [a]	0.11±0.01 [a]	4.29±0.75[a]	0.37±0.07[a]	9.64±1.23[b]	27.31±5.16[a]
CV				7.9	9.92	17.42	17.73	9.05	13.9
P value				0.64	0.1493	0.0307	0.0395	0.0001	0.0484

Factors			N	pH H_2O (1:2.5)	EC (dS/m)	OC (%)	TN (%)	Av.P (ppm)	CEC (cmol (+) kg^{-1} clay)
					FairtradeCerification (Gewata District)				
GEWATA	C(FT)	F	4	4.92±0.18^{b}	0.12±0.04^{a}	1.87±0.55^{c}	0.16±0.05^{c}	10.53±1.91^{ab}	22.46±5.34^{a}
		SF	4	5.8 ±0.19^{a}	0.11±0.02^{ab}	2.56±1.36^{b}	0.22±0.12^{b}	9.75±3.23^{b}	19.84±4.18^{ab}
		G	4	5.95±0.56^{a}	0.11±0.03^{ab}	2.85±1.57^{b}	0.24±0.13^{b}	11.43±5.20^{a}	20.34±5.22^{ab}
	NC	F	4	4.93±0.49^{b}	0.10±0.01^{b}	2.64±1.67^{b}	0.23±0.14^{b}	9.74±2.13^{bc}	23.59±1.15^{a}
		SF	4	5.22 ±0.46^{b}	0.09±0.32^{bc}	3.27±0.67^{a}	0.28±0.05^{a}	8.96±1.50^{c}	19.79±4.79^{ab}
		G	4	6.10±0.35^{a}	0.07±0.00^{c}	2.60±0.92^{b}	0.22±0.08^{b}	9.92±1.8^{bc}	18.71±2.48^{b}
				4.29	9.23	6.81	6.02	5.39	2.83
				0.0001	0.0167	0.0001	0.0001	0.005	0.0001
					Organic certification(Decha District)				
DECHA	C(ORG)	F	4	6.14±0.24^{a}	0.09±0.02^{b}	1.96±0.40^{d}	0.17±0.03^{d}	11.66±3.52^{b}	24.5±3.81^{a}
		SF	4	6.31 ±0.15^{a}	0.12±0.01^{a}	2.03±0.72^{d}	0.18±0.05^{cd}	12.16±1.13^{b}	25.75±4.71^{a}
		G	4	6.01 ±0.46^{a}	0.10 ±0.02^{b}	2.34±0.49^{c}	0.20±0.04^{c}	10.0±1.54^{c}	22.5±2.53^{a}
	NC	F	4	6.25±0.69^{a}	0.10±0.03^{b}	3.48±0.52^{a}	0.30±0.04^{a}	15.19±1.37^{a}	24.5±2.79^{a}
		SF	4	6.40 ±0.37^{a}	0.11±0.03^{ab}	3.04±0.76^{b}	0.26±0.06^{b}	9.62±2.0^{c}	21..5±2.88^{a}
		G	4	6.0±0.39^{a}	0.09±0.02^{b}	2.10±0.47^{d}	0.18±0.04^{cd}	11.75±7.98^{b}	19.5±0.3^{a}
CV				3.81	8.73	3.31	6.52	5.55	13.06
P value				0.1236	0.0087	0.0001	0.0001	0.0001	0.45
					ANOVA				
Cert				0.2976	0.0003	<.0001	<.0001	<.0001	0.0136
Cert (Dist)				<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Pro(Dist*Cert)				<.0001	0.0006	<.0001	<.0001	<.0001	<.0001
plot(Dist* Cert *Pro)				0.8752	0.7464	0.9399	0.9433	0.4855	0.9695

Means within column followed by the same letter are not significantly different at P ≤ 0.05 according to Tukey HSD (Honestly significance difference) (Cert= certification, Dist=district, pro=production system)=Fixed factors, plot(Dist* Cert*Pro)*=Random factor, CV= Coefficient of variance, EC=electric conductivity, OC =organic carbon, TN=total nitrogen, Av.P= available phosphorus, RA =rain forest alliance, ORG= organic FT= fair-trade C= certified, NC=Non-certified*

Total nitrogen (TN %):Analysis of variance revealed that TN showed statistically significant (*P≤0.05*) difference between certified and non-certified plots. The higher mean value (0.26%)was observed under non-certified production. Certified and non-certified plotswithin the respective districts were significantly (*P≤0.05*) different for TN.The result of coffee production system between certified and non-certified within the particular certification and districts were statistically (*P≤0.05*) different. Statistical analysis also showed the random factor which is the characteristics within individual plots was not significantlydifferent (Table 3). Based on the types of certification schemes the Soil TN of certified plots were significantly (*P≤0.05*) different from the non-certified ones in RA, FT and Organic certification schemes. Mean values of soil TN of RA certified and non-certified plots were 0.23 and 0.30% respectively.Mean values of soil TN of FT certified and non-certified plots were 0.20 and 0.24%, respectively. Mean values of the soil TN of Organic certified and non-certified plots were 0.18 and 0.24%, respectively.

Significant (*P≤0.05*) difference was observed between RA certified and non-certified plots for TNin the three production practices (Table 3).Mean values of soil TN of RA certified coffee plots under forest and semi-forest condition were 0.26 and 0.20% respectively. For the non-certified coffee production in forest, semi forest and garden systems, the values were 0.30, 0.24 and 0.37% respectively (Table 3).Where the higher meanvalues were observed under non-certified forestand semi-forest than certified coffee production.Significant (*P≤0.05*) difference was also observed between FT certified and non-certified plots in the three production practices (Table 3).Mean values of soil TN of FT certified coffee production practice inforest; semi forest and garden were 0.16, 0.22 and 0.24% respectively and the corresponding valuesfor the non-certified coffee plots were 0.23, 0.28 and 0.23% respectively (Table 3).Highervalue(0.28%) was recorded for the non-certifiedforestthan FT certified forest but, there was no difference between certified and non-certified semi-forest andgarden stands. The highest value observed under non-certified forest might be due to nitrogen fixing of different tree species and relatively high OM content.

Significant (*P≤0.05*) difference was observed betweenOrganic certified and non-certified farms in the three production practices (Table 3). Mean values of soil TN of Organic certified coffee plots inforest; semi forest and garden production systems were 0.17, 0.18 and 0.20% respectively. For the non-certified coffee plots in forest, semi forest and garden were 0.30, 0.26 and 0.18% respectively (Table 3).The highest values were recorded on the non-certified forest and semi forest than Organic certified,though, there was no difference between certified and non-certified garden. This might be due to the existence of nitrogen fixing plant species and high OM content in the non-certified site.This result was in agreement with that of Abiy (2008) who reported thatdifference in SOM content causes the significant difference in total nitrogen between different land management and utility practices due to intensities of soil erosion. Similarly, Degefu*et al.* (2011) have reported that nitrogen fixation level increases and is particularly promoted for soil fertility replenishment through management practices.

Available phosphorus (**Av.P ppm**): analysis of variance revealed that there was significant ($P \leq 0.05$) difference between certified and non-certified plots for. The higher mean value (11.64 ppm) was observed under non-certified farms. Also certified and non-certified production within the respective districts were significantly ($P \leq 0.05$) different. The result of coffee production system between certified and non-certified within the particular certification and districts were significantly ($P \leq 0.05$) different. Statistical analysis also showed the random factor which is the characteristics within individual plots was not significantlydifferent(Table 3). Based on the types of certification schemes the soil Av.Pwere significantly ($P \leq 0.05$) different in RA, FT and Organic certified areas with that of non- certified. Mean values of the soil Av.P of RA certified and non-certified were 9.55 and 12.97 respectively and the higher value was observed in non- certified. Mean values of the soil Av.P of FT certified and non-certified were 10.57 and 9.54 respectively and the higher value was observed in certified. Mean values of the soil Av.P of Organic certified and non-certified were 11.27 and 12.18 respectively (Table 3).

The available phosphorus showed significant ($P \leq 0.05$) difference between RA certified and non-certified farms for all the production system (Tables 3). Mean values of available phosphorus for the RA certified coffee standsunder forestandsemi forest conditionswere 9.08 and 10.03 ppm respectively and for the non-certified plots in forest,semi forest and garden stands, the mean values were 15.33, 14.08 and 9.64 ppm respectively (Table 3). Accordingly, the highest value were observed for non-certified than RA certifiedforest and semi-forest coffee stands. The available phosphorus concentration was significantly ($P \leq 0.05$) different forFT certified and non-certified farms regardless of production systems (Tables 3).Mean values of available phosphorus for the FTcertified coffee plotsunder forest, semi forest and garden production systems were 10.53, 9.75 and 11.43 ppm respectively and for the non-certified in which production under forest semi forest and garden were 9.74, 8.96 and 9.92 ppm respectively (Table 3). Accordingly, the highest values observed under the three types of FT certified production than non-certified.The available phosphorus was significantly ($P \leq 0.05$) different between Organic certified and non-certified farms by production system (Tables 3). Mean values of available phosphorus for the Organic certified coffee production under forest, semi forest and garden were 11.66, 12.16 and 10.0 ppm respectively and for the non-certified plotsthe corresponding values were 15.19, 9.62 and 11.75 ppm respectively (Table 3). Accordingly, the highest values observed under Organic certified semi-forest thannon-certified semi-forest and also the highest value observed under non-certified forest and garden coffee production than Organiccertified. The concentration of relatively higher phosphorus under non-certified forest coffee site might be due to the presence of high organic matter accumulation under higher vegetation cover.

In all types of certification and non-certified farms the concentration of relatively higher phosphorus under forest and semi-forest coffee site might be due to the presence of high organic matter accumulation under higher vegetation cover.This is in harmony with the findings of Bot and Bentites (2005), who reported land covered with vegetation increased the accumulation of soil organic matter, and the presence of this organic matter affected both the chemical and physical properties of the soil and overall health. Furthermore, the increase in vegetation cover could decrease sediment-associated nutrient losses by reducing the erosive impact of raindrops and soil erosion velocity(Mekuria*et al.,* 2009). Similarly, Tadesse*et al*. (2002) observed available soil phosphorus concentration in the surface soils that were significantly higher under the trees than the open fields.

Cation Exchange Capacity (**CEC cmol/kg**): analysis of variance revealed that CEC showed statistically significant ($P \leq 0.05$) difference between certified and non-certified coffee plotswith higher mean value (22.85) for non-certified stands. Certified and non-certified farms within the respective districtsalso showed significant ($P \leq 0.05$) difference. The result of coffee production system between certified and non-certified within the particular certification and districts were statistically significantly ($P \leq 0.05$) different. Statistical analysis also showed the random factors that are characteristics within individual plots were not significantly different (Table 3). Based on the types of certification schemes the soil CEC were significant (*P≤0.05*) difference observed in RA and Organic certified areas with that of non- certified. Whereas there was no significant (p>0.05) difference in FT certified area. Mean values of the soil CEC of RA certified and non-certified were 18.83 and 25.57 respectively and the higher value was observed in non-certified. Mean values of the soil CEC of Organic certified and non-certified were 24.28 and 21.83 respectively and the higher value was observed in certified.

CEC was significantly (*P≤0.05*) different between RA certified and non-certified farms by production system (Tables 3). Mean values of the Cation Exchange Capacity for RA certified coffee plotsunder forest and semi forest condition were 21.42 and 16.25 cmol/Kg respectively and the respective values for the non-certified forest, semi forest and garden stands were 23.84, 24.71 and 27.31cmol/kg respectively(Table3).Accordingly, the highest value was observed under non-certified semi-forest than RA certified semi-forest coffee production, whereas, no difference observed between RA certified and non-certified forest. CEC was significantly (*P≤0.05*) different between FT certified and non-certified farms by production system (Tables 3). Mean values of the Cation Exchange Capacity for FT certified coffee production under forest, semi forest and garden were 22.46,19.84 and 20.34cmol/kg respectively and for the non-certified production under forest, semi forest and garden were 23.59, 19.79 and 18.71cmol/kg respectively (Table3).Accordingly, the highest values observed under certified garden than non-certified garden and no difference observedunder forest and semi-forest between FT certified and non-certifiedcoffee production. CEC was not significantly (*P>0.05*) different between Organic certified and non-certified farms by production system (Tables 3).

In both certification types RA and FT there were differences observed between certified and non-certified production. The higher value under non-certified semi-forest in theshebesombo district the area in which RA certification was applied might be due to the fact that, accumulation of relatively high organic matter, clay contents and, has greater capacity to hold cations there by resulting in greater potential fertility in the soil. Therefore, soil CEC is expected to increase through improvement of the soil organic matter content. In line with this Kibret (2008) has reported that soil CEC is associated with clay and organic matter colloidsand especially organic matter renders soils to have a better CEC. Thus, slight difference in soil organic matter can make a big difference inCEC.

Similarly,Abiy (2008) also reported a higher mean value of CEC in vegetation planted site than less vegetative.

5. CONCLUSIONANDRECOMMENDATION

In the study area, RA, FT and Organic certification were not contributing for the improvement of soil physico-chemical properties as compared with the non-certified farms. Most of soil properties such as, clay, silt, soil bulk density, soil pH, OM, OC, TN, Av.P, CEC and were higher in non-certified farms than RA certified. The reason might be due to biomass return from vegetation. Whereas, soil moisture and sand contents were higher in RA certified farms as compared with non-certified farm and no difference observed for EC. This might be due to the less biomass return in the RA certified because the major part of above ground biomass was removed by livestock grazing which in turn negatively affect the soil physicochemical properties. Besides, the trampling and compaction effect on the soil due to human interference, free livestock grazing, soil erosion problem has a role to play in physicochemical soil characteristics.

Most of soil properties such as sand, silt and TN were higher in non-certified farms than FT certified. Whereas, clay, soil moisture content, EC and Av.P, were higher in FT certified farms as compared with non-certified farm and no difference in soil bulk density, soil pH, OM, OC and CEC. Therefore, the farms were not distinguishable in their soil characteristics and there was no a big difference between certified and non-certified plots. This might be shows the certification management problems when certifying and follow up to check either the principles are applied or not.

Most of soil properties such as sand, silt soil bulk density TN and Av.P were higher in non-certified farms than Organic certified plots. Whereas, clay and CEC were higher in Organic certified as compared with non-certified farms and, no difference was observed for soil moisture content, soil pH, EC, OM, and OC. Therefore, the farms were not distinguishable in their soil characteristics as the difference between certified and non-certified plots was not that big.

Based on these findings, the following suggestions were given;

- ✓ All the certifications types did not show positive impact for the improvement of soil physicochemical properties improvement in the study area. Therefore, more focusing on timely monitoring and evaluation either the farmers applied the principles of standards as intended or not is better option for environmental and soil physicochemical property improvement.

- ✓ To overcome the constraints of practicing standards related toenvironmentalconservation certification providing organizations strengthen learning opportunities through facilitating farmers training center and their operation in the study areas of the administration;create and strengthen the extension contact between farmers and development agents.

- ✓ Further research is needed on the way of certification application, other environmental parameters, biodiversity improvement, soil micronutrient improvement, and soil health improvements in order to clearly understand effects of the certification practices on soil and environment.

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7. APPENDIX