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Review on the Integrated Use of Organic and Inorganic Fertilizers on Production and Soil Fertility in Ethiopia

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Abstract
Depletion of soil fertility is the main problem to sustain agricultural production and productivity in many countries. Soil fertility decline is a big issue in the Agriculture of Ethiopia. Soils in Ethiopian have low levels of plant nutrients due to its removal by erosion and leaching by high rainfall. One of the major constraints for crop production in the Ethiopia is improper nutrient management. The Organic fertilizer improves physical and biological activities of soil but they have comparatively low in nutrient content, so larger quantity is required for plant growth. However, inorganic fertilizer is usually immediately and fast containing all necessary nutrients that are directly accessible for plants, but continuous use of inorganic fertilizers alone causes soil organic matter: degradation, soil acidity, and environmental pollution. So, the integrated nutrient management system is an alternative system for the sustainable and cost-effective management of soil fertility by combined apply of inorganic with organic materials resulting in rising soil fertility and productivity without affecting the environment. An experiment on organic and inorganic fertilizer application and its effect on yield of wheat and soil chemical properties of Nitisols the research finding out put at Holetta Agricultural Research Center in 2014 to 2015 these results of soil analysis after harvesting revealed that application of organic fertilizer improved soil pH, OC, total N and available P, the highest wheat grain and biomass yield (6698 kg/ha and 19417 kg/ha respectively) were obtained from the application of 50% VC and 50% N and P followed by full dose of recommended rate N and P from inorganic fertilizer resulting in 6241 kg/ha grain and 18917 kg/ha biomass yields respectively. This review indicated that different crops has showed significance response to the combined soil fertility management treatments containing both organic and inorganic forms under farmers' field condition that they could be considered as alternative options for sustainable soil and crop productivity in the soil fertility degraded of soil in Ethiopia. To maintain soil fertility, farmers have to take note of the characteristics and constraints of their soils and use sustainable management practices to conserve and improve fertility. Farmers deliberately incorporate household refuse, crop residues, animal manures, compost, biofertilizer and inorganic fertilizer into compound farm soils with the sole purpose of improving soil fertility and to enhance crop productivity. The objective of this review has assessed the effects of integrated organic and inorganic fertilizers on soil fertility and productivity. The review revealed that the appropriate application of organic with inorganic fertilizers increases productivity without negative effect on yield quality and improves soil fertility than the values obtained by organic or inorganic fertilizers separately. Therefore, farmers will be adopting this technology for increasing the crop yield and soil fertility.

Keywords: Soil fertility, Organic Fertilizer, Inorganic Fertilize, Integrated Nutrient Management
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1. INTRODUCTION

Soil fertility declining is one of the most significant constraints to increased food production in Ethiopia (Gete *et al.,* 2010). Soil fertility decline has been one of the most challenging and limiting factors for food security in the country (MoARD, 2007). The primary cause of soil fertility decline includes loss of organic matter (OM), macro and micronutrient depletion, soil acidity, topsoil erosion and deterioration of physical soil Properties (IFPRI, 2010). Anthropogenic factors such as inappropriate land use systems, mono-cropping, nutrients mining and inadequate supply of nutrients have aggravated the situation. In order to increase soil fertility in the short run, nutrients have to be added to the soil. This is often done by applying chemical fertilizers. Chemical fertilizers, however, are expensive to purchase and for most small-scale farmers this is a problem (Gete *et al.,* 2010). However, to sustain the balance of soil fertility and to ensure agricultural productivity use of organic nutrient source fertilizer and application of amenable inorganic fertilizer is quite essential.

Inorganic fertilizers are considered to be an important source of major elements in crop production. Continuous use of inorganic fertilizer resulted in a deficiency of micronutrients, imbalance in soil physicochemical properties and unsustainable crop production (Jeyathilake *et al.,* 2006). To ensure soil productivity, plants must have an adequate and balanced supply of nutrients that can be realized through integrated nutrient management where both natural and man-made sources of plant nutrients are used (Gruhn *et al.,* 2000). Combining inorganic and organic fertilizers result in greater benefits than either input alone through positive interactions on soil biological, chemical and physical properties (Bekunda *et al.,* 2010). The addition of organic amendments has been shown to maintain soil organic matter content and thereby contribute to enhanced fertilizer use efficiency (Negassa *et al.,* 2005).

Drechsel et al. (2001) reported that the application of recommended mineral fertilizers does not improve the negative nutrient balance due to the higher nutrient removal from the soils. Many types of research recommend integrated soil amendment practices because single application or practices could not reverse the existing problem (Eichler *et al.,* 2007). Integrated nutrient management practices are survival and risk avoidance strategies of farmers. It is crucial to note that greater crop productivity induced by the use of mineral fertilizers does not translate into better soil fertility in the long term when large amounts of carbon and nutrients are removed every season from the fields with the crop harvests residue (Bekunda *et al.,* 2010). Mineral fertilizers and organic amendments (crop residues, animal manure, and compost) are used to improve soil fertility and maintain agricultural fields in a productive state. Therefore, the use of integrated nutrient management is the very important and best approach to maintain and improve soil fertility (Lander *et al.,* 1998) thereby to increase crop productivity in an efficient and environmentally friendly manner without sacrificing soil productivity of future generations.

The existing cultural and social institution of communities makes labor demanding systems appropriate (Tegene, 1987). Farmers are highly linked to their innovative practices in bringing new and productive farming systems such as creating proper synergy by mixing compost and mineral fertilizer (Harris, 1998). Such as the study by Channappagoudar *et al.* (2007) and Manyong *et al.* (2001) compost and animal manure amended with mineral fertilizer gave a higher yield than mineral fertilizer or compost alone.

Soil nutrient status is widely constrained by the limited use of inorganic and organic fertilizers and by nutrient loss mainly due to erosion and leaching (Alimi, T. *et al.,* 2007). Many smallholder farmers do not have access to synthetic fertilizer because of the high price of fertilizers, lack of credit facilities, poor distribution, and other socio-economic factors. Consequently, crop yields are low, in fact decreasing in many areas, and the sustainability of the current farming system is at risk (Liu, X. *et al.,* 2007). Ethiopia is one of the 14 sub-Saharan countries with highest rates of nutrient depletion (Negassa, W *et al.,* 2006). Due to lack of adequate synthetic fertilizer input, the limited return of organic residues and manure, and high biomass removal, erosion, and leaching rates.

Long-term experimental studies show that continuous cultivation using low external inputs decreases soil fertility and crop yields in Ethiopia. A combination of mineral and organic fertilizers is necessary to sustain and improve crop production on depleted soils (Bationo *et al.,* 2006). Chemical fertilizers are also becoming very costly for farmers to apply the full recommended rates. On the other hand, sole application of organic matter is constrained by access to sufficient organic inputs, low nutrient content, high labor demand for preparation and transporting. Thus, the integration of organic and inorganic nutrient sources can improve and sustain crop yields without degrading soil fertility status; however Modern nutrient management strategy has shifted its focus toward the concept of sustainability and eco-friendliness. Therefore, the aim of this review was to assess different study on the effect of integrated use of organic and inorganic Fertilizers on improving soil fertility and increasing crop yield production in Ethiopia.

Objective of Review

- ❖ To review the advantage and disadvantage of organic and inorganic fertilizer on productivity and soil fertility as well as on the environment.
- ❖ To review the effect of integrating organic and inorganic fertilizer on productivity and soil fertility.

2. METHODOLOGY OF REVIEW

The victory of this work, distinctive sources such as journals, Seminar, eBooks, proceedings, thesis works, and reports related to the degree of soil fertility decline in Ethiopia, its impacts on crop production and management strategies have been utilized.

3. TO REVIEW THE EFFECT OF INTEGRATED USE OF ORGANIC AND INORGANIC FERTILIZERS

3.1. Soil Fertility and Crop Productivity

Soil fertility and productivity is more than just plant nutrients and can be defined as “the physical, biological, and chemical characteristics of soil, for example, its organic matter content, acidity, texture, depth, and water retention capacity all influence fertility” (Gruhn *et al.,* 2000). It is a combination of several properties of soil (biological, chemical and physical), all of which has its own effect on nutrient dynamics and availability directly or indirectly (Woodfine, 2009). The whole world in general and developing the world in particular, need reliable information and knowledge on soil fertility and agriculture productivity which are the most challenging issue of rural livelihoods. In order to attain sustainable crop production improving crop nutrition through appropriate soil fertility management is highly essential.

Soil productivity in Africa is declining as a result of soil erosion, nutrient and organic matter (OM) depletion (Abreha, 2013). In sub-Saharan Africa, soil fertility depletion is the fundamental cause for declining per capital food production as croplands have a negative nutrient balance, with annual losses ranging from 1.5-7.1 tons ha^{-1} (t ha^{-1}) of nitrogen (N), phosphorus (P) and potassium (K) mainly due to crop harvest, leaching and low inputs applied to the soil (Adesodun, 2007 and Ahmed, 2002). Declining soil fertility is one of the most significant constraints to increased food production in Ethiopia (Gete *et al.,* 2010). In the Ethiopian cultivated fields, about 42 t $ha^{-1}$of fertile soils have been lost every year (Akamigbo and Asadu, 2001) together with essential plant nutrients mainly due to poor soil management. Soil nutrient availability changes over time. Ethiopian soils indicated that elements like K, S, Ca, Mg and micro-nutrients particularly Cu, Mn, B, Mo, and Zn are becoming depleted and deficiency symptoms are being observed on major crops in different areas of the country (Asgelil *et al.,* 2007). It is necessary to assess the capacity of a soil to supply nutrients in order to supply the remaining amounts of needed plant nutrients

3.2. Fertilizer

3.2.1. Organic fertilizer

Organic fertilizers have the following advantages to improve soil fertility: increasing organic matter in soil which improves the soil structure, creating more air space and water retention within the soil and enhances soil nitrogen content, enhanced nutrient availability, releasing nutrients at a slower and more consistent rate, improves nutrient mobilization and Protect the soil against rain and wind erosion (Akhtar, MJ., *et* al., 2009; Lal, R., 2006; Matsumoto, T. and Yamano, T., 2009; Nyalemegbe K.K *et al*., 2009; Han, S.H *et al*., 2016) Organic fertilizer enhances soil biological activity and the colonization of mycorrhiza. That enhances mutuality association between fungi and higher plants. Organic fertilizer increases root growth due to enhanced soil structure, promoting soil aggregates, enhances cation exchange capacity (Lal, R., 2006). Organic fertilizer acts as a buffering agent against undesirable soil pH fluctuations (Basel, N and Sami, M., 2014) and (Olaniyi, J.O. and Ajibola, A., 2008).

3.2.1.1. Advantages of Organic Fertilizer

Nutrient availability to plants is composed of several processes in the soil-plant system before a nutrient is absorbed or utilized by a plant. These processes include the application of nutrient to soil or nutrient existing in the soil, transport from soil to plant roots, absorption by plant roots, transport to plant tops and finally utilization by the plant in producing economic parts or organs (Fageria, 2009). Addition of OM such as crop residues, composts, and farmyard manure (FYM) to the soil is known to improve the chemical, physical and biological properties, and enhance the availability of nutrients and their uptake by crops (Okalebo *et al.,* 2007). Organic matter and soil organisms play important roles in conserving and improving soil properties that are related to soil resilience (FAO, 2005). Application of soil OM resulted with increasing of soil buffering capacity, nutrient availability and water holding capacity and supply micronutrients which may not be provided by commercial fertilizers (Mughogho, 1992). It is well known that the application of OM amendments to soil increases soil fertility (Rees and Castle, 2002). Organic matter such as compost has many essential roles to play in maintaining soil fertility, source of macro and micronutrients for plant growth and alkaline substances which counteract soil acidification (Johannes, 2000) and Montemurro *et al.* (2005) also found that P and N supplied with the application of compost or manure resulted in better grain yield.

Organic inputs, including compost, animal manure, crop residues, and green manure, are a good method of enhancing both soil physical, chemical and biological properties and crop performance (Harris, 2002). It also increases the capacity of the soil to buffer changes in pH and cation exchange capacity (CEC) and serves as a reservoir of nutrients such as N, S, P and many minor elements (Schlecht *et al.,* 2006). Soil OM encourages granulation, increases CEC and is responsible for up to 90% adsorbing power of the soils and cations such as Ca^{2+}, Mg^{2+} and K^{+} are produced during decomposition (Brady and Weil, 2005). In general, it may be concluded that OM such as application of compost increased soil pH, electrical conductivity (EC), OM, Ca^{2+}, Mg^{2+}, K^{+}, and P while C: N ratio was narrowed in acidic soil. Hence, there was a general increase in nutrient supplying capacity of soils by OM application and OM such as compost application was a good strategy for enhancing fertility status of depleted soils (Sarwar *et al.,* 2010).

However, the composition of OM is strongly dependent on the type of vegetation, kinds of soils, depth of sampling and cultural practices which is the sources of both macro and micronutrients for crop growth (Heluf, 2009). Some of the soil OM decomposes and mineralizes organic S into SO42- form which plants take up by which returning crop residue to the soil adds S to the organic pool (James *et al.,* 1982). Even compared to other sources of OM, the poultry manure is relatively a cheap source of both macronutrients (N, P, K, Ca, Mg, S) and micronutrients such as Cu, Fe, Mn and boron (B) and can increase soil C and N content, soil porosity and enhance soil microbial activity (Ghosh *et al.,* 2004). Soil OM contributes substantially to the productivity of the land as it is a source of plant nutrients and it improves the physical conditions of the soil. Low OM contents may lead to severe limitations in plant growth and to the deterioration of cropland. Almost all life in the soil is dependent on OM for nutrients and energy. The labile fraction of soil OM consists of any readily degradable materials from the plant and animal residues, and readily degradable microbial products which are an important reservoir of nutrients because the nutrients are rapidly recycled in the soil ecosystem (Foth, 1990). Organic matter is often the critical soil constituent that is needed to restore adequate conditions for root growth. Although human interventions that change the environmental conditions may have drastic effects on soil OM contents, in many soils, it is one of the major soil attributes that control the sustainability of agricultural systems. Soil OM maintenance is the key issue in low input agricultural systems.

3.2.1.2 Organic matter

Soil organic matter contains approximately 58% organic carbon. Organic matter content in soil has a major influence on the physical and chemical properties of soils. Soil humus is the organic fraction of soil derived from the decayed tissue of plants and animals, and from animal excreta (Teklu, 2005). As it breaks down, it releases nutrients in a form which can be taken up by plants and crops, so it increases the availability of nutrients that affect yield. Organic matter also helps to bind soil particles together that improve the physical properties of the soil making it easier for roots penetration. Tillage becomes easier and the soil becomes well-drained. The binding effect also reduces wind and water erosion and also improves the water holding capacity of the soil (Gurung *et al*, 1997). The major organic fertilizers used for soil fertility amendment include manure, compost, crop residues, and house waste.

3.2.1.2 Manure

Since time immemorial animal manure is the prime source of the soil fertility management to improve the way for many farmers of Ethiopia. Traditionally, it is used as fertilizer to ameliorate soil fertility depletion in many parts of Africa in general and Ethiopia in particular. For example, the study conducted by Elias (2002) reported that 87 percent of Kindo Koisha (Southern Ethiopia) farmers apply animal manure. This is because applying animal manure has a residual effect in the soil (Elias, 2002). The effect varies based on the amounts applied. However, it is dependent on the availability of livestock and family labor for transporting into their fields (Elias, 2002). But today it is also extensively used as a source of household energy (Assefa, 2005).

Organic manures are all forms of organic soil amendments that originate from both livestock waste and crop residues, with the nutrients in them being mineralized by soil microbes and slowly making them available to plants over a long period of time (Lampkin, 2000). The application of organic manure can contribute to agricultural sustainability (Wells *et al.,* 2000) as a continuous and adequate use of manure with proper management has been shown to have many advantages, which include providing a whole array of nutrients to soils, increasing soil organic matter (Verma *et al.,* 2005), improving water holding capacity and other physical properties of soil like bulk density, penetration resistance and soil aggregation (Wells *et al.,* 2000).

3.2.1.3. Compost

Compost is the final product obtained from the decomposition of the organic matter, wastes from preparing food and gardening, sweeping up leaves, collecting manure, straw and grass clippings, etc. It enhances soil fertility, soil structure, and water storage capacity for two or more years, unlike chemical fertilizer (Fentaw, 2010) the presence of organic matter in the soil is fundamental in maintaining soil fertility and decreasing nutrient losses. Thus, compost is a good organic fertilizer because it contains nutrients as well as organic matter. Organic matter plays a number of important roles in soils, both in their physical structure and as a medium for biological activity. In addition, organic matter makes its greatest contribution to soil productivity. It provides nutrients to the soil, improves its water holding capacity, and helps the soil to maintain good tilt and thereby better aeration for germinating seeds and plant root development (Edwards and Hailu, 2011).

3.2.1.4. Crop residue

Crop residues include the above-ground biomass of plants remaining in the field grains, tubers, and other products have been collected. The crop residues are incorporated into the left as mulch (Elias, 2002). It is a way of directly recycling nutrients into the soil taken by the plants from the soil earlier. It is used for soil protection and soil fertility improvement (Smith and Elliott, 1990). Normally in Ethiopia, crop residues are removed for animal feed (Edwards and Hailu, 2006; Elias, 2002). About 42 percent of farmers in Kindo Koisha apply crop residues for improving their soil fertility While others immediately plow fields to protect roaming of animals due to the free range grazing practices (Elias, 2002) Crop residues protect soil from the direct impacts of rain, wind, and sunlight leading to improved soil structure, reduced soil temperature and evaporation, increased infiltration, and reduced runoff and erosion While some studies suggest that plant roots contribute more carbon to soil than surface residues (Whitbread et.al,2003), crop residue contributes to soil organic matter and nutrient increases, water retention, and microbial and macro invertebrate activity. This effect typically leads to improved plant growth and increased soil productivity and crop yield (NRCS, 2006).

3.2.1.5. Household Waste and Farmyards

Organic wastes from the house commonly are added to soils as sources of plant nutrients and to improve the physical properties of the soil. The common house waste added to the soil is ash (Barbaric, 2006).

3.2.1.6. Disadvantages of Organic Fertilizer

Potentially pathogenic improperly-processed organic fertilizers may contain pathogens that are harmful to humans or plants because organic fertilizers are derived from a substance like animal feces or plant/animal matter contaminated with pathogens (Chen, J.H., 2008 and GTZ, 2009). Limited Nutrient Availability: they are relatively low in nutrient content, so larger volume is needed to supply enough nutrients for plant growth. Hence, large-scale agriculture without use inorganic fertilizers it is difficult (Vanlauwe, B*., et al,* 2010). Accurate application is tie due to the composition of organic fertilizers highly variable, so that the accurate application of nutrients to match plant production is difficult.

3.3. Inorganic Fertilizer

The addition of chemical fertilizers might be essential because chemical fertilizers can re-establish the soil fertility very quickly and the nutrients are obtainable to the plants as soon as the fertilizers are dissolved in the soil (Matsumoto, T. and Yamano, T., 2009). Inorganic fertilizer increases root residues that mean indirectly increases organic matter (Scholl, L. and Nieuwenhuis, R., 2004). Due to this recently farmers put an emphasis on chemical fertilizer application in order to increase productivity (Basel, N and Sami, M., 2014). Using inorganic Fertilizer is very important to increase crop production and soil fertility improvement.

3.3.1 Advantages of Inorganic Fertilizer

Inorganic fertilizers are good for the rapid growth of plants because the nutrients are already water soluble. Therefore, the effect is usually immediately and fast, contains all necessary nutrients that are ready to use. Inorganic fertilizers are quite high in nutrient content and only relatively small amounts are required for productivity. The correct amount of applications of inorganic fertilizer can increase soil organic matter through higher levels of root mass and crop residues (Chen, J.H., 2008, Han, S.H *et al.,* 2016, GTZ, 2009 and Scholl, L. and Nieuwenhuis, R., 2004).

3.3.2 Disadvantages of Inorganic Fertilizer

Over-application can result in negative effects such as leaching, pollution of water, acidification and reduces the availability of the trace element or alkalization of the soil. Chemical fertilizer enhances the decomposition of soil organic matter, which leads to degradation of soil structure and decrease in soil aggregation results in nutrients are easily lost from soils through fixation, leaching, gas emission and can lead to diminishing fertilizer efficiency (Alimi, T.,2007, Chen, J.H., 2008, GTZ,(2009), Savci, S. (2012) and Adediran, J.A., *et al.,* 2004). Over treatments of chemical fertilizers can destroy decomposers and other soil organisms, reduce the colonization of plant roots with mycorrhiza and inhibit symbiotic N-fixation by rhizobia due to high N-fertilization (Chen, J.H., 2008, Abedi, T., *et al*., 2010, GTZ,(2009)and Gruhn, P., *et al*., 2000) and also hazardous to the soil environment. This showed that over treatments Chemical fertilizer causes problems not only to the soil health but also to the human health and physical environment.

3.4. The Effect of Integrated Organic and Inorganic Fertilizer on Productivity and Soil Fertility

3.4.1. Integrated Organic and Inorganic Nutrient Management

The use of locally available, nutrient-rich organic sources is an effective means for improving soil fertility and increasing crop yield in view of the escalating cost of inorganic fertilizers and low fertilizer use efficiency of crops (Wassie Haile, 2012). Some of the studies conducted to explore alternate organic nutrient sources and partly substitute inorganic fertilizers by biomass transfer, farmyard manure (FYM), compost and green manure.

3.4.2. Effect of Integrated Organic Fertilizer and Inorganic Fertilizer on Soil Fertility.

Evidence showed that application of FYM alone or in combination with inorganic fertilizers enhances proper nutrition and maintenance of soil fertility (Teklu Erkosa and Hailemariam Teklewold; 2009 and Balesh Tulema, 2005). A study by (Brar, B.S., *et al*., 2015) showed that integrated use of inorganic fertilizer along with organic fertilizer (100% NPK + FYM) improved soil physical conditions such as CEC and pH resulted in higher maize and wheat yields.

According to (Han, S.H *et al*., 2016) the NPK fertilizer treatment leads to soil acidification, whereas organic manure + NPK treatments significantly increased soil pH. Similar type finding was reported by (Walia, M.K., and Dhaliwal, S.S., 2010) that the incorporated nutrient management system results in rising organic carbon content, available nitrogen, phosphorus, and potassium increasing from 0.390% to 0.543%, 171.7 to 219.3 $kg \cdot ha^{-1}$ and 20.5 to 43.3 $kg \cdot ha^{-1}$ respectively. Several studies revealed that the integrated use of inorganic fertilizer with an organic fertilizer like manure significantly ($P < 0.05$) increases soil organic C content, total N, and the available soil nutrients (Ali, M.E. et al., 2009; Zhao, Z., *et al.,* 2014 and Redda, A. and Kebede, F., 2017) improves the overall soil properties (Mahmood, F., *et al.,* 2017). For sustainable productivity, mixed use of chemical with organic fertilizer has proved to be highly beneficial in terms of balanced nutrient supply (Chen, J.H., (2008), and Ayeni, L.S. and Adetunji, M.T., 2010) significantly higher than yields from sole organic fertilizer application (Efthimiadou, A., *et al*.,2010). Also, the use of organic fertilizers together with appropriate chemical fertilizers had a higher positive effect on microbial biomass and hence soil health (Elkholy, M.M., *et al*., 2010 and Abedi, T., *et al*., 2010).

Compost contains significant amounts of valuable plant nutrients including N, P, K, Ca, Mg and S as well as a variety of essential trace elements (Madeleine *et al.,* 2005). Thus, compost can be defined as an organic multi-nutrient fertilizer (Amlinger *et al.,* 2007). Its nutrient content, as well as other important chemical properties like

C/N ratio, pH and electrical conductivity (EC), depends on the used organic feed stocks and compost processing conditions. By an appropriate mixture of these organic input materials, hummus and nutrient-rich compost substrates can be produced which serves as a substitute for commercial mineral fertilizers in agriculture (Amlinger *et al.,* 2007). However, their diverse beneficial properties for amelioration outreach their nutrient content.

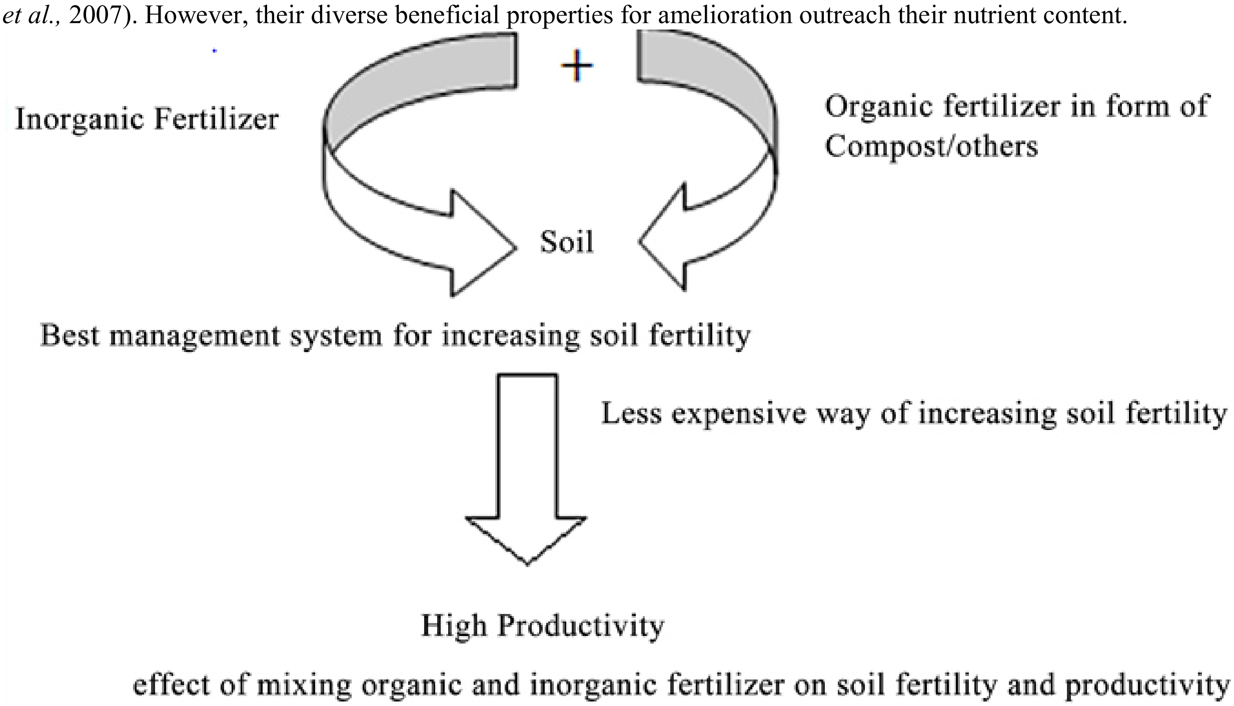

Figure1. Effect of mixing organic and inorganic fertilizer on soil fertility and productivity

Table1: Selected physicochemical properties of the experimental soils before planting maize at Antra Catchment, Northwestern Ethiopia

Parameters	Mean value
Bulk density (g cm $^{-3}$)	1.2
Particle density (g cm $^{-3}$)	2.4
Total porosity (%)	47.8
pH(H_2O)	4.53
OC (%)	1.6
Total N (%	0.15
Available P (ppm)	4.8
Available S (ppm)	2.9
CEC (cmole+ kg^{-1})	32.6
Exchangeable Ca (cmole+ kg^{-1})	9.9
Exchangeable Mg (cmole+ kg^{-1})	2.1
Exchangeable K (cmole+ kg^{-1})	0.6
Exchangeable Na (cmole+ kg^{-1})	0.2
PBS (%)	41.6

Source; Habtamu (2015); Effects of Organic and Inorganic Fertilizers on Selected Soil Properties after Harvesting Maize at Antra Catchment, Northwestern Ethiopia

Habtamu (2015) was conducted an experiment on the effects of integrated application of compost and inorganic fertilizers on soil physical properties after harvesting maize the initial and post-harvest soil is different by the effects of integrated application of organic and inorganic fertilizers on bulk density shows from (Table 1 and 2). The Bulk density decreased after two years maize harvesting (Habtamu, 2015). This decrease in bulk density two years after harvesting maize might be due to the increase in OM by the effects of high doses of compost application which improved soil aggregates by increasing pore spaces and structures. These results are in consistent with that of Tilander and Bonzi (1997), Sylvia *et al.* (1999) and Weber *et al.* (2007) who corroborated those organic inputs contributed to improve soil structure/aggregation and decreased soil bulk density, and thus increased the percentage of pore spaces and as a consequence, soil water infiltration and water holding capacity.

The effects of integrated application of compost and inorganic fertilizers on soil physical properties two years after harvesting maize (Table 2). The total porosity in the soil was increased with the application of organic and inorganic fertilizers two years after harvesting maize (Table 2). The total porosity and bulk density in this study which might be due to the fact that as OM increases, soil aggregation and pore spaces increases while bulk density and compaction/sealing decreases by increasing the total porosity of the soil. These results were supported again by Sylvia *et al*. (1999) who elucidated that OM contributes for improving soil structure or aggregation, water infiltration and water holding capacity.

Table 2: Effects of integrated application of organic and inorganic fertilizers on selected soil physical properties two years after harvesting maize at Antra Catchment, Northwestern Ethiopia

Parameters							
N and S (kg ha^{-1})		**Bulk density (g kg^{-1})**			**Total porosity (%)**		
		Compost (ton ha^{-1})					
N	**S**	**0**	**5**	**10**	**0**	**5**	**10**
	0	**1.27**	**1.24**	**0.91**	**39.9**	**49.4**	**61.8**
0	**15**	**1.15**	**1.05**	**1.01**	**53.1**	**58.0**	**57.9**
	30	**1.11**	**1.09**	**0.88**	**56.5**	**55.5**	**63.0**
	0	**1.22**	**1.07**	**0.98**	**46.1**	**55.2**	**61.6**
60	**15**	**1.16**	**0.99**	**1.0**	**50.6**	**61.2**	**59.7**
	30	**1.18**	**1.1**	**1.02**	**46.2**	**55.1**	**58.0**
	0	**1.14**	**1.05**	**0.89**	**52.3**	**55.9**	**62.1**
120	**15**	**1.19**	**0.99**	**0.91**	**47.3**	**59.3**	**61.9**
	30	**1.25**	**1.25**	**0.93**	**50.0**	**49.6**	**62.0**

Source; Habtamu (2015)

Table 3: Selected soil chemical properties after maize harvest in response to the integrated application of organic and inorganic fertilizers

N and S		**Parameters**																	
		pH-H2O			**Total N (%)**			**Av. P (ppm)**			**OC (%)**			**Av. S (ppm)**			**CEC (cmol+kg^{-1}**		
(kg ha^{-1})		**Compost (ton ha^{-1})**																	
N	**S**	**0**	**5**	**10**	**0**	**5**	**10**	**0**	**5**	**10**	**0**	**5**	**10**	**0**	**5**	**10**	**0**	**5**	**10**
0	0	4.51	4.46	4.57	0.12	0.13	0.14	5.23	5.26	5.79	0.10	1.80	1.83	2.91	3.73	3.67	31.4	29.6	29.6
	15	4.51	4.45	4.47	0.12	0.14	0.15	5.35	5.70	5.96	1.69	2.23	1.82	3.59	3.76	3.82	29.9	29.3	29.5
	30	4.5	4.46	4.4	0.13	0.14	0.14	5.31	5.44	6.05	1.86	1.84	1.95	3.73	3.76	3.91	31.9	30.8	31.9
	0	4.51	4.43	4.39	0.13	0.14	0.15	5.35	6.07	5.79	1.82	1.92	1.89	3.26	3.76	3.79	23.5	30.5	29.8
60	15	4.47	4.42	4.42	0.13	0.14	0.15	5.45	5.7	5.88	1.84	1.89	1.86	3.56	3.85	3.79	31.9	33.1	28.3
	30	4.38	4.43	4.45	0.13	0.13	0.13	5.42	5.70	5.44	1.84	1.87	2.53	3.62	3.82	3.88	29.9	31.9	33.6
	0	4.37	4.42	4.43	0.13	0.14	0.18	5.42	5.61	6.23	1.80	1.76	1.94	3.53	3.76	3.82	30.8	31.1	29.3
120	15	4.42	4.43	4.48	0.14	0.15	0.16	5.26	5.96	5.96	1.89	1.92	2.07	3.65	3.82	3.9	31.7	30.5	24.4
	30	4.44	4.4	4.46	0.13	0.14	0.14	5.35	5.88	6.14	1.91	1.84	1.88	3.70	3.91	4.03	31.1	29.7	31.6

Source; Habtamu (2015); Effects of Organic and Inorganic Fertilizers on Selected Soil Properties after Harvesting Maize at Antra Catchment, Northwestern Ethiopia

According to Habtamu (2015) stated the effects of integrated application of compost and inorganic fertilizers on soil chemical properties after two years maize harvesting this experiment indicated that pH was affected by integrated application of organic and inorganic fertilizers which was increased with the application of high doses of compost compared to the initial soil. The highest pH (4.57) was observed in plots treated with 10 t compost ha^{-1} and nil rates of chemical fertilizers that gave a slight increase (0.9%) from the initial soil. There is positive correlation between pH and OM two years after harvesting maize (Table 3). The compost has liberated alkaline substances and cations such as Ca^{2+}, Mg^{2+}, K^{+} which increase CEC and Organic carbon in the soil was increased after two-year harvesting maize with the application of organic and inorganic fertilizers. These results are consistent with that of Lie *et al.* (2010) and Xueli *et al.* (2012) who reported that the application of OM in combination with inorganic fertilizers exerted greater influence and linearly increased soil OC levels.

In general, integrated application of organic and inorganic fertilizers improved soil physicochemical properties. Locally available OM such as compost is a rigorous source of plant nutrients which were approved by this experiment and par with different authors. Wakene *et al.* (2007) elucidated that integrated nutrient management is an option to alleviate soil fertility problems as it utilizes available organic and inorganic nutrients for sustainable agricultural production and productivity. Aspasia *et al.,* (2010) also revealed that combined use of NPK and FYM increased soil OC, total N, P and exchangeable K by 47, 31, 13 and 73%, respectively compared to the sole application of NPK fertilizers. According to the reports of Vanlauwe *et al.* (2001) and Tayebeh, *et al.* (2010), when one applies compost along with chemical fertilizers, compost prevents nutrient losses and consequently, integrated use of inorganic fertilizers and compost improved the efficiency of chemical fertilizers and crop productivity as well as sustain soil health and fertility. Similarly, Tchale and Sauer (2007) indicated that the productivity of poor smallholder farmers in Sub-Saharan Africa can greatly be improved by the combined uses of organic and inorganic based sources of fertilizers.

The beneficial effects of combined use of organic and inorganic nutrients on soil fertility and crop yields have been repeatedly shown in field trials (Roland, *et al.,* 1997). Highly productive soils with supplemental fertilizer, lime, manure and proper choice of disease free, high yielding varieties are apt to have higher OM contents than comparable less productive soils due to the amounts of root and top residues to be returned to soils. Combination of OM and mineral fertilizers provides ideal environmental conditions for crops as OM improves soil properties while mineral fertilizers supply plant nutrients which are limited (FAO, 2000; Vanlauwe *et al.,* 2006). Ayeni and Adetunji (2010) also reported that integrated application of poultry manure and NPK fertilizers was more effective in increasing nutrient availability and crop yield than the sole application of any of fertilizer materials. Furthermore, Teklu et al. (2004) indicated that integrated use of FYM and inorganic fertilizers greatly improved soil quality, leading to sustainability.

Organic matter such as compost application is also affordable and less risky soil nutrient management practices which sustains cropping system through better nutrient recycling, improved soil structure and water holding capacity (Makind, 2007; Adejumo *et al.,* 2010). Tiwari *et al.* (2002) also elucidated that application of OM in fertilization schedule improved OC status and available N, P, K and S in soils which sustain its health. Similarly, significant improvements were observed in soil total N, OC, available P and CEC by using organic amendments (World Bank, 1995). Ezekiel (2010) also reported that OM increases available moisture content of soils, moderates soil acidification, improves soil bulk density, increase buffering capacity against drastic change in pH, completion $A1^{3+}$ and thereby reducing its toxicity, improves soil aeration and beneficial microbial activities as well as CEC of the soil. Zhihui *et al.* (2007) also indicated that compared to the control, long-term application of high amount of FYM increased OC, total N and S contents by 63, 50 and 37%, respectively. Furthermore, low soil OM content has been implicated for poor soil structure, low N availability, poor soil aeration and high soil compaction (María *et al.,* 2014).

Nitrogen and phosphorous are the most limiting nutrients for wheat production that affect the rapid plant growth and improves grain yield. Under most field conditions, the amounts of soluble and readily mineralized soil N are insufficient to meet the crop requirement. Therefore, to obtain better growth of high yielding crops, N as chemical fertilizer, manure, crop residue, or other source, must be added. Asnakew Woldeab *et al.* (1991) also reported that increased usage of N fertilizer is considered as one of the primaries means of increasing wheat grain yield in Ethiopia. the effects of farmyard manure, compost, vermicompost, and N and P fertilizers and their combinations on the yield of wheat and soil chemical properties.

Table 4: The effect of organic and inorganic fertilizer application on soil chemical properties analyzed for samples after harvest of the crops 2014 and 2015.

Treatments	pH (H2O)	N (%)	P(PPM)	OC (%)
Recom.N and p	4.14	0.17	10.17	1.18
Conventional compost	5.0	0.25	14.69	1.61
Farmyard manur (FYM)	5.06	0.27	16.26	1.75
Vermicompost VC	5.03	0.24	17.1	1.67
50% VC + 50 % FYM	4.89	0.22	13.75	1.46
50%VC + 50% FYM	4.8	0.22	14.15	1.58
33% VC + 33% CC + 33% FYM	4.85	0.25	17.37	1.69
50% VC + 50% NP	4.8	0.22	15.38	1.63
50% CC + 50% NP	4.7	0.20	13.43	1.55
50% FYM + 50% NP	4.8	0.23	15.03	1.61

Source (Girma and Gebreyes 2018)

Girma and Gebreyes (2018) Conducted an experiment on organic and inorganic fertilizer application and its effect on yield of wheat and soil chemical properties of Nitisols the research finding out put at Holetta Agricultural Research Center in 2014 to 2015 these results of soil analysis after harvesting revealed that application of organic fertilizer improved soil pH, OC, total N and available P in (Table.4). Therefore, from the results of this finding it can be concluded, combined or multiple use of chemical fertilizer and locally available organic fertilizer application is the best approach for achieving higher soil fertility and the way of recycling soil nutrients.

3.4.3. Experimental Results on the Effect of Integrated Organic Fertilizer and Inorganic Fertilizer on Crop Productivity

3.4.3.1 Maize

Mahmood, F., *et al.* (2017) reported that mixed use of organic with inorganic fertilizers significantly ($p < 0.05$) increased maize yield than individual use of organic or inorganic fertilizer (Ayeni, L.S. and Adetunji, M.T., 2010). The other the integrated use of poultry manure along with NPK fertilizer were more successful in rising nutrient availability and maize yield than the sole application of any of the fertilizer materials on sandy soil, loam texture with a high proportion of coarse sand (84%). Similarly, Brar, B.S., *et al*., (2015) reported that integrated use of inorganic fertilizer along with organic fertilizer (100% NPK + FYM) was improved soil physical conditions and increased in soil organic carbon might have resulted in higher maize yields. The finding of several researchers showed that integrated use of chemical and organic fertilizer has proved to significantly increase maize productivity (Efthimiadou, A., *et al*., 2010; Gemechu, B., *et* al., 2017 and Wapa, J.M., *et al*., 2014).

Table 5: Effect of enriched FYM and inorganic fertilizers on grain yield Agronomic result data of hybrid maize (BH-140) at Chiro, Western Hararghe, Ethiopia from 2008 to 2010

Treatment	Mean grain yield of maize (kg/ha)
Control (0 FYM and 0 N and P)	1647.5
10 t/ha FYM+0 N and P	6652.5
8 t/ha FYM and 25 kg/ha N + 20 kg/ha P	5857
6 t/ha FYM and 50 kg/ha N + 40 kg/ha P	5170.5
4 t/ha FYM and 75 kg/ha N + 60 kg/ha P	8158.5
2 t/ha FYM and 100 kg/ha N + 80 kg/ha P	6668.5
100 kg/ha N + 100 kg/ha P	6997

Source (Zelalem, 2014.)

Zelalem., (2014) conducted an experiment on Effect on grain yield from the application of FYM and inorganic fertilizers at Chiro, eastern Ethiopia in this finding the highest yield was 8158.5kg/ha and the lowest yield was 1647.5 kg/ha recorded at treatments Control (0 FYM and 0 N and P) and 4 t/ha FYM and 75 kg/ha N + 60 kg/ha P respectively. Thus, it is recommended that, application of 4 t/ha FYM incorporated with 75 kg of N and 60 kg of P at Chiro can significantly increase hybrid maize (BH-140) yield and its harvest index and sustain its productivity over years. However, profitability of this technology needs to be tested at different locations and in different seasons in the eastern part of Ethiopia. Application of farmyard manure (FYM) alone or in combination with inorganic fertilizers helps in proper nutrition and maintenance of soil fertility in maize fields when applied at proper doses replenishing the most deficient macro and micro nutrients which in turn help in getting the highest grain yield and harvest index in hybrid maize varieties.

3.4.3.2. Rice

Moe, K., *et al*., (2017) Carried out an experiment on the “Combined Effect of Organic Manures and Inorganic Fertilizers on the Growth and Yield of Hybrid Rice”. The result showed that the integrated application of organic manures with inorganic fertilizers was effective in enhancing the growth and yield of hybrid rice. These outcomes have the great potential for reducing the use of chemical fertilizers without decreasing the yield of hybrid rice (Redda, A. and Kebede, F., 2017) Conducted research on the “Effects of Integrated use of Organic and Inorganic Fertilizers on Soil Properties Performance, using Rice (Oryza sativa L.)”. The results showed that the integrated use of organic manure with inorganic fertilizers not only increased the rice yield but also improved the fertility status of the soil than inorganic fertilizers alone. Experimental studies on rice by (Alim, M.A., 2012) Showed that for improvement rice productivity, mixed use of synthetic N with organic N sources is needed to be practiced. Similarly, many authors have suggested that rice productivity was significantly raised by the combined application of organic with inorganic fertilizes (Ali, M.E. et al., 2009, Nyalemegbe, K.K *et al.,* 2009 and Gangmei, T.P. and George, P.J.2017)

3.4.3.3 Wheat

Chekolle, A.W., (2017) Conducted research on the “Evaluation of Synergistic Effect Organic and Inorganic Fertilizing System on Grain Yield of Bread Wheat (Triticum aestivum L.) At Southern Tigray, Northern Ethiopia”. The outcome showed that the incorporated use of farmyard manure with N and P fertilizers are efficient than the use of either N/P or farmyard manure alone. A similar result was reported by Agegnehu, G., et al., (2014) that the incorporated application of organic with inorganic fertilizers enhanced the yield of wheat as well as soil fertility. Abbas, G., *et al*., (2012) Reported that application of NPK with poultry manure significantly increased wheat productivity. Several investigators have concluded that combined use inorganic fertilizer with organic materials perform better in terms of improving productivity and yields of wheat (Akhtar, MJ *et al.,* 2009; Brar, B.S., *et al*., 2015 and Khan, S. and Khalil, S.K., 2014).

Applications of all inorganic fertilizers with or without FYM influenced wheat yield at Hagerselam, Southern Ethiopia. Combined application of 20 tons FYM ha^{-1} with 46 kg N and 40 kg P ha^{-1} gave the highest grain yield of wheat (Wassie Haile et al., 2010). Even if the amounts are huge, Wassie Haile et al. (2010) recommended the application of 23 kg N and 20 kg P ha^{-1} with 20 tons FYM ha^{-1} or 46 kg N and 40 kg P ha^{-1} with 10 tons FYM ha^{-1} for farmers around Hagerselam, southern Ethiopia. On the other hand, application of 6 tons FYM ha-1 and 30 kg N ha-1 gave the highest wheat grain yield in central highlands of Ethiopia but a comparable result was obtained due to 3 tons FYM ha^{-1} and 30 kg N ha^{-1}. The economic analysis revealed that 6.85 tons FYM ha^{-1} and 44 kg N ha^{-1} for the wheat crop was the economic optimum rates (Teklu Erkosa and Hailemariam Teklewold, 2009).

Another experiment conducted on red soils at Holeta indicated that the effect of the combined application of inorganic N and P fertilizers and FYM highly significantly increased wheat grain yield (Getachew *et al.,* 2014). The application of 60/20 kg N/P ha^{-1} and 30/10 kg N/P ha^{-1} with 50 % manure and compost as N equivalence increased mean grain yield of wheat by 151 and 129 %, respectively compared to the control, and by 85 and 68 %, respectively compared to application of 23/10 kg N/P ha^{-1}. In their recent work, Abdi Ahmed et al. (2016) found that despite the highest grain yield achieved with 92 kg N ha^{-1} + 160 kg P2O5 ha^{-1} + 20 tons FYM ha^{-1}, application of 92 kg N ha^{-1} + 160 kg P2O5 ha^{-1} + 0 FYM ha^{-1} was more economical in Jijiga plain, eastern Ethiopia. Nigus *et* *al.* (2014) also reported applying 6 tons compost ha^{-1} with 34.5/10 kg N/P ha^{-1} (50 % of the recommended NP) gave a wheat yield increase of 521 %, and followed by 8 tons compost ha^{-1} (442%) and 8 tons compost ha^{-1} (361 %) applied with 34.5/10 kg N/P ha^{-1} over the control, no compost & N-P fertilization (Table 6). The residual effect from the 1-year application of compost and inorganic fertilizers also gave yield benefits ranging from 7 to 271 %. This indicates that farmers who cannot afford to apply compost every year could improve productivity by as much as 271 % by applying compost every other year (Nigus *et al.,* 2014). Another trial conducted at Adet Research Center revealed that wheat after green manure incorporation resulted in significantly higher grain yields. Two-Year mean grain yield showed that incorporation of lupine as green manure increased grain yield of wheat more than green manure vetch (Yeshanew and Asgelil, 1999). Mean grain yields of all treatments were significantly higher in the first year than in the second year. A significantly higher yield obtained from lupine-manure plots than vetch-manure and the control plots which gave 1.8- and 1.4-tons ha^{-1} respectively (Yeshanew and Asgelil, 1999).

Table 6: The use of compost and inorganic fertilizer on bread wheat Agronomic result data in the Gumara Maksegnit watershed, North Gondar

Compost* (t ha^{-1})	**N-P fertilizer (kg ha^{-1})**	**Grain yield (kg ha^{-1})**
0	**0**	**604**
0	**17.3-5**	**1233**
0	**34.5-10**	**1538**
4	**0**	**1514**
4	**17.3-5**	**2381**
4	**34.5-10**	**2787**
6	**0**	**2057**
6	**17.3-5**	**2576**
6	**34.5-10**	**3752**
8	**0**	**2727**
8	**17.3-5**	**2707**
8	**34.5-10**	**3279**

Source: Nigus *et al.,* 2014

The application of 4, 6 and 8 t compost ha^{-1} imply addition of 0.19, 0.29, and 0.38 kg available P ha^{-1}; 40, 60, and 80 kg exchangeable Ca ha^{-1}; 7, 10.5, and 14 kg exchangeable Mg ha^{-1}; 1.9, 2.8, and 3.7 kg exchangeable K ha^{-1}; and 0.8, 1.1, and 1.5 kg exchangeable Na ha^{-1}.

Table 7: Effects of integrated nutrient application on wheat yield Agronomic result data

Year	GY(kg/ha)	BY(kg/ha)
2014	5177.3	14651.5
2015	5749	17174.2
Treatments		
Recom.N and p	6241	18917
Conventional compost	5790	14500
Farmyard manur (FYM)	4635	13667
Vermicompost VC	5144	15333
50% VC + 50 % FYM	5213	15583
50%VC + 50% FYM	5189.3	15125
33% VC + 33% CC + 33% FYM	5923	17000
50% VC + 50% NP	6698	19417
50% CC + 50% NP	5940.7	17000
50% FYM + 50% NP	6148.3	16583

Source (Girma and Gebreyes, 2018)

According to reporting Girma and Gebreyes, 2018 on conducted an experiment on Organic and inorganic fertilizer application and its effect on yield of wheat and soil chemical properties of Nitisols research finding out put at Agricultural Research Center 2014 to 2015 the highest wheat grain and biomass yield (6698 kg/ha and 19417 kg/ha respectively) were obtained from the application of 50% VC and 50% N and P followed by full dose of recommended rate N and P from inorganic fertilizer resulting in 6241 kg/ha grain and 18917 kg/ha biomass yields respectively. Therefore, the results of this study have clearly indicated that it is possible to fairly increase wheat yield through combined or multiple nutrient application approach, rather than applying nutrient from one source. In line with the current result, research findings of Tekalign Mamo *et al.* (2001) and Getachew *et al.* (2012) indicated that wheat has showed significance response to the combined soil fertility management treatments containing both organic and inorganic forms under farmers‟ field condition that they could be considered as alternative options for sustainable soil and crop productivity in the degraded highlands of Ethiopia. Moreover, the crop has responded differently to application of N and P on different soil types.

3.4.3.4. Tomato
A study by Isitekhale, H.H., *et al*. (2013) showed that the use of mixed NPK fertilizer along with poultry manure was more effective for tomato cultivation. Similarly, by Charles, O., Haruna, I. and Raphael, O., 2012) reported that the mixed use of organic with inorganic fertilizers significantly ($p \leq 0.05$) increased the total number of collected tomato and weight of harvest. According Islam, M.A*., et al.* (2017) mixed fertilizer (organic+ inorganic) created the highest amount of flower clusters (31.2), fruit clusters (24.9), fruit yield (15.3 t/ha) and plant height (71.6 cm) than to the no fertilizer application. The result showed that the effect of mixed fertilizers on tomato yield was significantly ($p < 0.01$) higher yields than the control (no fertilizer application). Khan, A., *et al*. (2017) Conducted an experiment on the "Effect of compost and inorganic fertilizers on yield and quality of tomato" the result showed the yield and quality parameters of tomato fruit increased significantly ($P \leq 0.05$) by a mixed-use of compost with inorganic fertilizers. Also, the study by Ogundare, S.K., *et al*. (2015) showed that the use of inorganic and organic fertilizer had better results on tomato productivity.

3.4.3.5. Teff
The Effects of integrated nutrient application on teff yield and yield components tef through integrated nutrient application approach, rather than applying nutrient from one source the current result, research findings of Tekalign *et al. (*2001), Ayalew (2011) and Getachew et al. (2012) indicated that teff has showed significance response to the integrated soil fertility management treatments containing both organic and inorganic forms under farmers" field condition that they could be considered as alternative options for sustainable soil and crop productivity in the degraded highlands of Ethiopia.

4. SUMMARY AND CONCLUSION
Soil erosion, continuous cultivation, and low nutrient application are the major cause of the decline in soil fertility in Ethiopia. In some cases, the loss of organic matter together with the loss of topsoil aggravates the problem of soil water retention resulting in moisture stress rather than nutrient deficiency. Due to the high cost of fertilizer, most of the farmers in the country use less amount with the blanket recommendation, this becomes complex for management due to intricate combinations of agro-climate, the soil, topography and the socio-economic condition of various locations. Therefore, the blanket recommendation and other fertilizer and pesticide application alone in Ethiopia are not a sufficient solution to the existing problem in the face of the farmer and in the face of reality. The solution should be the one which considers the complex interactions of agro-climate, soil and the topographic environmental condition of the locality. Integrated soil fertility management is the best option to solve the existed soil nutrient problem. It is important to analyze the complex interactions and effects of the agro-climate, soil, and the environment with the various agronomic practices.

Integrated soil fertility management plays a critical role in both short-term nutrient availability and longer-term maintenance of soil organic matter and sustainability of crop productivity and integrated use of inorganic fertilizers and organic fertilizer improved the efficiency of chemical fertilizers and crop productivity as well as sustain soil health and fertility. The results showed that the integrated application of organic and inorganic fertilizers improve the productivity of crops as well as the fertility status of the soil. However, ISFM is the notably preferred option in replenishing soil fertility and enhancing productivity, it is not yet widely taken up by farmers.

Generally, it is understood that the positive impacts of organic sources application on crop yield and soil properties can be realized after long term applications. In addition to improving the long-term productivity of the soil, this soil fertility management approach has resulted in a large cost saving of mineral fertilizers. Using organic fertilizers in combination with inorganic fertilizers has also shortened days to maturity, which is a good strategy to enable the plant to escape terminal moisture stress in rain-fed crop production. Thus, considering the poor soil fertility management by resource-poor smallholder farmers and the high cost of mineral fertilizers, combined use of organic and mineral fertilizers at justifiable rates is central to enhance the productive capacity of the soil and to improve crop yield and productivity.

In various cases, the loss of organic matter results in reducing physical, biological and functional properties of soil. Organic fertilizers have more benefits in the long run compared to inorganic fertilizers. Organic fertilizer improves the physical, biological, and chemical properties of soil but the nutrients may not be as readily available to the plants. Inorganic fertilizer is usually immediately and fast containing all necessary nutrients that are ready for plants. The excess use of inorganic fertilizers in agriculture can lead to soil deterioration, soil acidification, and environmental pollution. The integrated soil fertility management system is an alternative approach for the sustainable and cost-effective management of soil fertility and is characterized by reduced input of inorganic fertilizers and combined use of inorganic fertilizers with organic materials. The Combined applications of organic and inorganic fertilizers improve soil fertility, productivity and reduce the impact of inorganic fertilizer on the environment. So, it is an alternative way for sustainable soil fertility and crop productivity in Ethiopia. As research finding effect of integrated use of organic and inorganic fertilizers improve soil fertility, increasing crop yield of maize, wheat, teff, rice, and tomato and also increasing the biomass of yield.

This review indicated that different crops has showed significance response to the combined soil fertility management treatments containing both organic and inorganic forms under farmers' field condition that they could be considered as alternative options for sustainable soil and crop productivity in the soil fertility degraded of soil in Ethiopia. To maintain soil fertility, farmers have to take note of the characteristics and constraints of their soils and use sustainable management practices to conserve and improve fertility. Farmers deliberately incorporate household refuse, crop residues, animal manures, compost, biofertilizer and inorganic fertilizer into compound farm soils with the sole purpose of improving soil fertility and to enhance crop productivity. The objective of this review has assessed the effects of integrated organic and inorganic fertilizers on soil fertility and productivity. Therefore, farmers will be adopting this technology for increasing the crop yield and soil fertility.

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