



Soil Salinity and Irrigation Water Quality Status in selected areas of Awash River Basin of Ethiopia. A Review.

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ABSTRACT

This paper reviews the extent of soil salinity level and irrigation water quality in selected irrigations scheme found in awash basin. Soil salinity and alkalinity problems are commonly found in the arid and semi-arid regions of the world due to insufficient annual rainfall to leach down accumulated salts from the plants root zone. Now days, worldwide, many soils have been and are being changed into the class of problematic soils due to different natural hazards and poor agricultural practices. Salinization of land and water resources is a major landscape degradation issue worldwide, with serious salt related problems occurring in at least 75 countries. Salt affected soils have been reported to occur at most parts in the Rift Valley Zone of Ethiopia. Awash river basin is located in central Ethiopia and flows through five regional states (Oromia, Afar, Amhara, Somali, SNNP) and two administrative towns (Dire Dawa and Addis Ababa); it rises on the high plateau to the west of Addis Ababa, at an altitude of about 3000m. The pH values in most reviewed areas of upper awash ranged from normal, slightly and moderately alkaline reaction. It clearly indicate the accumulation of bicarbonate and sodium ions in the soils of the area. However it ranged from slightly, moderately and highly alkaline range in most areas of middle awash farms, and it reduced again to normal and slightly alkaline range in lower awash areas. Similar trends have been observed in regard to soil salinity and sodicity. Generally the extent and distribution of soil salinity problem is varied along the river basin. The problem is serious and abundant acre of irrigated farms are being out of production in middle awash areas as compared to upper and lower awash areas. The quality of irrigation water in these areas varied along the assessed areas. With regard to salinity, the water in upper awash area has very good quality and could not introduce problems on the quality of soils. However its quality deteriorate in middle awash areas due to blending of different water sources (lakes, hot springs, drainage water) having low quality for irrigation purpose. Therefore the factors which aggravate the expansion of soil salinity and sodicity should be properly identified to manage these inducing factors. In addition to this implementing appropriate cropping system and management practices according to soil type, level of salinity and sodicity and quality of irrigation water is important.

1. INTRODUCTION

Soil salinity and alkalinity problems are commonly found in the arid and semi-arid regions of the earth due to insufficient annual rainfall to leach accumulated salts from the root zone (US Salinity Laboratory Staff, 1954; Heluf, 1985; Kidane et al., 2006). In other words, salt affected soils often occur in areas where soluble salts and sodium (Na) accumulate in soils through physical and chemical weathering of rocks or the pedogenic process of the soil development, atmospheric precipitation and fossil salts from marine or lacustrine environments. Moreover, heavy fertilizer application and use of poor quality irrigation water and inadequate drainage have contributed to the development of salt affected soils and productivity deterioration of many soils in irrigated arid and semi-arid regions (US Salinity Laboratory Staff, 1954; Gupta and Abrol, 1990).

Now days, worldwide, many soils have been and are being changed into the class of problem soils due to different natural hazards and poor agricultural practices and among these are salt affected (saline, saline-sodic and sodic) soils, which are caused by excessive accumulation of soluble salts of varying composition, concentration and saturation of the soil exchange complex by sodium (Szabolcs, 1989) that affects the permeability of the soil for proper root growth.

Salinization of land and water resources is a major landscape degradation issue worldwide, with serious salt related problems occurring in at least 75 countries (Rhoades, 1990). Australia, followed by Asia, has the largest area under salinity and sodicity problems. In Africa also, it covers about 81 million ha of the dry land areas (Szabolcs, 1979).

In Ethiopia, salt affected soils have occurred for the most part in the Rift Valley Zone (Mesfin, 1980; Heluf, 1985). Ethiopia is the first in Africa and the ninth country in the World having more than 11 million ha of salt affected soils (FAO, 1988; Szabolcs, 1989) which are mainly found in the Rift Valley, Wabi Shebele River Basin and various lowlands of the country. They occur on low-lying topography of poor permeability that has hindered the leaching of dissolved salts. As a result, vast areas of salt-affected soils occur in the Afar, Oromia and Somali lowlands, especially the Lower Wabi Shebelle River Basin. In specific terms, salt affected soils cover a good portion of the Great Rift Valley. These include the northern Rift Valley as in the Awash River Basin; the central Rift Valley such as in and around Zuwai, Shala and Abaya lakes areas; the southern Rift Valley, the Omo River Basin, Lakes Turkana and Chew Bahir areas. Moreover, some are known to occur along many river basins such as Blate in the south, Dedesa in the north-west and Setit in the north of the country. Spots of saline soils in small perennial or seasonal river valleys are common phenomenon in the drier parts of the country (EIAR, 2006; FAO, 1976, 1988; Girma and Endale, 1996; Heluf 1985 1987; Mesfin 2001; Murphy 1959 and Szabolcs, 1979). Considerable area at Metehara,

Kesem, Kebena, Melka Werer, Gewanie, Millie, Abaya and others have also become salt affected with loss of productive land because timely corrective measures were not taken (EIAR 2006; Girma and Endale 1996). A recent survey of small-scale irrigation in several regions has revealed the increased magnitude and intensity of build up from lack of soil-water-crop management (Heluf 1985; and 1987).

In general, 2,280 ha of land at Melka Sedi, 500 ha Metehara, 300 ha Assayita, 220 ha Kebena or Yalo, 145 ha Kesem, 100 ha Gewane, 56 ha Werer State Farm, 80 ha Shoa, Kefa Dura, 20 ha Millie and some areas at Tangay Kuma State Farm have been proved as salt affected soils (Fentaw, 2007). According to the same author, it is expected that salt affected soils in these areas will dramatically increase if the current irrigation practice is allowed to continue. Based on EIAR, 2006 report Large areas of the Awash River Basin especially the middle and lower parts of the basin are saline or sodic or in saline or sodic phase and thus potentially exposed to salinization and sodicity. Therefore, the developments of saline soils are a dynamic phenomenon that needs to be monitored regularly in order to secure up-to-date knowledge of their nature, extent of magnitude and spatial distribution in irrigated areas.

General objective:

- to review soil salinity and irrigation water quality status in selected areas of awash river basin of Ethiopia

Specific objectives:

- to review soil salinity status in selected areas of the awash river basin
- to review irrigation water quality status in selected areas of the awash river basin

2. Description of Awash Basin

Awash river basin is located in central Ethiopia and flows through five regional states (Oromia, Afar, Amhara, Somali, SNNP) and two administrative councils (Dire Dawa and Addis Ababa); it rises on the high plateau to the west of Addis Ababa, at an altitude of about 3000m. Awash basin is located in the Rift Valley which drains a catchment area of 110,000 km² and has a total length of approximately 1250 km. the basin has an annual flow of 4.6 billion m³ (3.75% of Ethiopia's total freshwater flow). The mean annual rain fall varies from approximately 1600mm (highlands North East of Addis) to 160mm (Northern part of the basin). The overall population amounts approximately 10,500,000 (Ronald and Henk, 2013).

The Awash River basin is the most developed river basin in Ethiopia so far. Water allocation and scarcity is a critical issue, as a result of enormous industrial and agricultural activities in the catchment

area. Moreover the Awash River is also the most utilized and polluted river in the country. Protection of water resources, using the full potential of the water system and an integrated approach of water management, is very weak. Population growth is high and food insecure situations and malnutrition exist, together with pollution of crops on surface water irrigated lands. The two biggest cities of Ethiopia are situated in the Upper Awash river basin. Rapid industrialization in combination with untreated discharges together with problems like agricultural pollution, erosion, weak sanitation control lead to a high pressure on water quality. No structural monitoring is done. Solid and liquid waste is not collected and treated properly, causing ground water and surface water pollution (Ronald and Henk, 2013).

2.1. Soils and Irrigation Water in upper Awash

2.1.1 Soil reaction

Soil pH is an important soil indicator since it has an influence on availability of soil nutrients, solubility of toxic nutrient elements in the soil, physical breakdown of root cells, and CEC in soils whose colloids (clay/humus) are pH-dependent and biological activity. Generally the pH of arid and semi-arid areas is alkaline. According to Kasahun et al. (2016) the pH of the Soil irrigated using ground water are higher than that of irrigated with Awash and Modjo River. It is above 8 for the land irrigated with ground water in both districts. While he found that, soil pH ranges from 6-7.5 for the land irrigated with river in both districts. However the pH of the soil irrigated using Awash River in Bora district is in the neutral range (6.9-7.3). This result clearly showed that there is higher ionic concentration in soil solution of irrigated using ground water than in river based irrigated land. Kiflu et al. (2013) also reported that the soil reaction in zeway area is slightly alkaline for the surface (7.90) and pH increased down the profile to alkaline, where the value in subsurface horizons reached up to 9.57. Another author Ruffeis et al. (nd) reported that the pH of soil of wonji area ranges from 7.4 to 8.4 indicating moderately alkaline soils.

2.1.2. Soil salinity and sodicity

The soil electrical conductivity as an indicator of soil salinity problem varied in different locations though the basin. According to Kasahun et al. (2016) the EC values are highly varied among irrigated lands irrigated using ground water in both Bora and Lume districts and it is not vary for the irrigated land using river water across different soil depth intervals. In addition, EC value showed a decreasing trend with the soil depth at all sampling sites. This is mainly due to the fact that salinity accumulated on the plough layer due to low leaching of saline soil to the sub surface and sodic soil characteristics that can reduces soil water infiltration.

Soil salinity in general and EC values in particular increase with the soil depth. Its value is ranging from 2.1 to 4.1 ds/m and 0.26 to 0.41 ds/m at the land irrigated with the ground water and river, respectively. Therefore, EC values at the land irrigated using ground water is in the range of moderately saline that have still a potential to restrict plant growth and crop yield. Both ESP and SAR values are above the normal range of soil quality for irrigation. ESP of soil at irrigated land using ground water ranges from 31-52% indicating that soil sodicity is extremely high.

Another author (Kefyalew et al. (2011) indicates that the surface and sub-surface soils of the Meki-Ogolcha area which were irrigated from water sources of Lake Zeway and ground water were found to be saline sodic and sodic soils. Soils of irrigated lands in Meki Zuwai areas revealed sodic in the subsurface horizons (Mesfin, 2001). Similarly the ESP of the soil profile opened at the Ethio-Flora farm increased from 9.03 at the surface 0-28 cm to 19.56 at the depth of 166-200 cm (Mesfin, 2001). The ESP in the Zeway State Farm increased consistently with depth and varies from 6.1 at the surface 0-28 cm to 92.82 at the depth of 144-200 cm. In the farmers' field, ESP increased from 3.13 at the surface layer to 55.22 at 27- 85 cm. However, the soils were free from excessive concentrations of soluble salts indicating existence of potentially sodic soils. According to Kefyalew and Kibebew (2016) the saturated soil hydraulic conductivity of the surface layer of the profile of Meki Ogolcha land irrigated from Meki River was grouped into moderate permeability class while layers 2 and 3 of the same profile fall in to the slow permeability class and the author suggested that the problem is arise from the effect of soil salinity and sodicity level on it.. The EC ranged from 4.38 dS m⁻¹ in the surface horizon to 11.58 dS m⁻¹ in lower horizon which indicates that the soils of area are affected by salinity.

Ruffeis et al. (nd) reported that electrical conductivity of Wonji sugar area ranges from 151 to 475 μ S/cm and can be rated as salt free. The pH of all soil samples ranges from 7.4 to 8.4 indicating moderately alkaline soils. The same author also reported that the ESP of the soils lies below 6% (0.99 to 5.88%) which is definitely below the threshold of 15% and therefore the soils can be rated as non-sodic. Another author (Girma and Awulachew, 2007) stated that in wonji irrigation area, there is a problem of a shallow groundwater table due to improper irrigation practices in some parts of the estate which might create salinity problems.

According to Megersa et al. (2009), Metehara Sugar Estate is experiencing effects of a rising GW table and salinity in some fields, and as a result, the yield of certain fields is decreasing and a significant area of cultivated lands is being abandoned. The same author developed the spatial map of the soil salinity based on Sodium Absorption Ratio (SAR) using ordinary kriging method and the author concluded that the cause of soil salinity in the area is highly saline Lake Beseka water

introduction to the plantation. They also revealed that the Abadir extension & section north are subjected to rising salinity (SAR) value as compared to the other sections of the plantation. The author described the soil salinity level increased almost as a function of the increase in water table depth. Most of the of plantation sections (Abadir extension, Abadir A, River land, Awash, Chore, East and North) have soil salinity problem ranging from moderate to severe condition. The increment of soil salinization in the subsoil (40 to 100 cm) is due to the capillary rise (secondary salinization) from the saline groundwater (Megersa *et al.*, 2009).

2.1.3. Irrigation water quality

According to Ruffeis *et al.* (nd) the pH of Wonji/Shoa irrigation system are in the normal/neutral range (pH = 6.5 to 8.5) for all water samples. Similarly the drainage water shows a lower pH of 6.3 which indicates slightly acidic water. The author also concluded that the pH in all the water samples taken does not seem to be influenced by irrigation. Similar results are given by Girma (2005) who indicated the measured pH values of both irrigation water and Factory used water samples varied from 7.4 to 8.1 (from near neutrality to medium basic in reaction) while the pH values of drainage water samples varied from 7.0 to 7.8 (normal range) and all groundwater samples varied in pH values from 7.1 to 8.3. Girma (2005) also reported that the irrigation water (i.e. Awash River water) and factory used water were free of potential hazards of salinity, sodicity and specific ion toxicities. Moreover, drainage water was nearly of similar quality. The same author also reported that total salt content of groundwater for some sugarcane fields was relatively high (i.e., EC values exceeded 700 $\mu\text{S}/\text{cm}$); a critical limit above which osmotic effects are known to occur. SAR values were low in all groundwater samples. The potentially toxic ions Na^+ , Cl^- and Boron were also found at low concentrations. In general the irrigation water used in Wonji/Shoa Sugar Plantation is of high quality (Ruffeis, *et al.*, (nd)), but Hardly any adverse impacts on the soil quality resulting from irrigation activities are to be expected on this scheme. The same author reported that SAR/adj RNA to EC ratio indicates that a slight to moderate reduction in the infiltration rate might occur. The EC value of Awash River, the irrigation water source of Wonji/Shoa, is 293 $\mu\text{S}/\text{cm}$. The drainage water and the reservoir water shows EC values increased values compared to the irrigation water, 357 and 388 $\mu\text{S}/\text{cm}$ respectively. With regard to salinity the water is still of very good quality and should not pose any problems on soils in case it is reused for irrigation.

According to Megersa *et al.* (2009), the EC_w is none severe (Awash River, Irrigation Canals, Factory waste and Reservoirs), moderately severe (Ground water) and highly severe (Beseka Lake). All the values ranges from low to high severity. The SAR value also ranges low (Awash River, Irrigation Canals and Reservoirs and Drainage water to highly toxic (Factory waste, Ground water and Beseka Lake).

2.2. Soils and Irrigation Water in middle Awash

2.2.1. Soil reaction

The soil pH in Kesem area as reported by Zeleke *et al.* (2014) is in alkaline reaction which ranges from 7.7 to 10.3. According to Frew *et al.* (2015) soil pH found to be varied between 6.9 to 8.9 for Melka Sedi and 7.06 to 9.1 for Melka Werer farm areas. The author concluded that the pH values appeared to be low in saline soils, where calcium and magnesium were dominant and on the other hand the pH is high in sodic and saline sodic soils where sodium seems dominant. The pH of the amibara area is in general greater than 7, indicating alkalinity reaction. Since the pH value or the soil reaction is influenced by the presence and concentration of cations, its ranges varies in salt affected soils. Ashenafi *et al.* (2016) also reported that in amibara. Invariably, according to (Dhan and Yihenew (2016) the pH value of the Allaideghe plains found in amibara district was generally high and ranging from 7.7 to 8.2 and with minimum variation.

2.2.2. Soil Salinity and sodicity

Soil salinity as a threat for crop production is occurring in most areas of middle awash areas. According to Zeleke *et al.* (2014) salt content of Kesem Sugar Project fields is considered at higher quantities to affect plant growth. In most filed areas, electrical conductivity of saturation extract (EC_e) ranged from 8.96 to 66.69 dS/m, which are strongly saline. Among soluble cations, soluble sodium is the dominant one followed by potassium and calcium ions. In addition to electrical conductivity, the same author also reported that the values of exchangeable sodium percentage (ESP) was above the critical level (ESP>15). These soils are characterized by saline sodic soils which have the problems of both salinity and sodicity, and thus the area possess the appearances and properties of both saline and sodic soils independently. Melkamu Alemayeh (2016) reported that the soils of the kesem area has high EC_e and value indicates high occurrence of sodicity as they ranged between 0.9 to 8.0 dS m⁻¹ and 9.9 to 42.7%, respectively. Results indicate that the ESP of most of the locations covering large surveyed exceeds 15% indicating occurrence of high sodicity.

According to Frew *et al.* (2015) Soils of the Amibara area exhibited high range of variation in EC_e values. EC_e value varied from 0.33 dS/m to 82.1 dS/m and 0.4 dS/m to 37.5 dS/m, respectively for soil samples taken from Melka Sedi and Melka Werer farms. Generally out of 249 soil samples taken from amibara area, 48 % of the soil samples were mapped as non-saline soils with EC_e values less than 2 dS/m. 18 % of the soil ranges for slightly saline soils with EC_e values between 2 dS/m to 4 dS/m and the rest 34 % of the soil ranges between moderately saline to severe salinity with EC_e values greater than 4 dS/m. However, based on the soil sample taken from depth of 0-30 cm, out of 249 soil

samples, about 78, 21 and 1% of the soil is mapped as non-sodic, very slightly sodic and slightly sodic to very strongly sodic, respectively. In general according to this author about 65.60, 34.34 and 0.06% of Amibara irrigated area are classified as non-saline, saline and saline sodic soil classes. Based on field assessment done by Kidane *et al.* (2006) on 4,000 ha of irrigated lands at Melkasedi indicated the occurrence of about 40, 16.98 and 0.02% of saline, saline – sodic, and sodic soils, respectively. Ashenafi *et al.* (2016) reported that the electrical conductivity in the amibara irrigation project ranges from 0.41 to 93.94 dS m⁻¹ in both Fluvisols and Vertisols soil classes and the author reported that Significant parts of Fluvisols of the Amibara irrigation area is characterized as non-saline non-sodic, saline, sodic and saline sodic soils. Finally the author concluded that around 27.51% in Fluvisols and 8.76% Vertisols of AIP area are saline soils. About 6.36% in Fluvisols of the area is mapped as saline-sodic soils. The same author also reported that approximately, 0.33% of Fluvisols in AIP area are sodic soils among the two types of soils, significant area of farms under the light textured Fluvisols were affected by salinity and sodicity problem; whereas in Vertisols, the extent of area affected by salinity is less severe. Another author (Girma and Awulachew, 2007) stated that in Amibara irrigated area, Salinity and Sodicity/alkalinity are the major problems that resulted in the valley due to irrigation practices in the enterprise. The same author reported that in some places high salinity and sodicity/alkalinity levels coupled with poor drainage of the soils are at present resulting in quite a large area of productive lands being abandoned from cultivation. Over 2,000 ha of the Melka Sedi state farm that was cultivated for bananas and other areas that were cultivated for cotton have gone out of cultivation due to these problems. According to Gedion (2009) report about 77, 19.9, 3 and 0.1% of amibara irrigation scheme are classified as non-saline none sodic, saline, saline sodic and sodic soil classes, respectively.

2.2.3. Irrigation water quality

According to Zeleke *et al.* (2014) water samples taken from the surface of some fields and main irrigation canals at Kesem area, high in pH (> 8) was recorded and the author suggested that the cause of high pH value is the dominance of bicarbonate ions. Salt concentration (EC values) in all water samples is also very high compared to the critical value and they suggested that the salt (EC) effect of groundwater on crop water availability would be severe. Among the cations, all water samples are dominated by sodium followed by calcium and magnesium whereas, among the anions, bicarbonate and chloride ions are dominant. The same author reported that SAR values of the water samples were 8.5, 12, and 48.4 and when such values are interpreted together with salt concentration (EC

values), the effect of sodium, present in the groundwater, on soil infiltration would be moderate to minimal range. From toxicity point of view, concentration of sodium in all groundwater samples is too high to affect plant growth. Toxicity level of chloride ion in all groundwater samples is also very high. In general, it can be said that all water samples are poor in quality with respect to salinity and sodicity effects. The possible source of groundwater which is currently inundating some fields at Kesem is water flowing internally from the upland area (possibly from Mount-Fentale), dissolving saline rocks and seeping to low lying areas of Kesem.

Girma (2006) reported that in most water samples collected from middle awash samples, total dissolved solids (TDS) ranged from 100.0 to 40737 mg/l. the author suggested that the excess value of TDS was mainly due to high concentration of soluble carbonates, bicarbonates chlorides, sulfates, phosphates, nitrates, iron, manganese and other minerals in the analyzer water sample. The author also reported occurrence of high conductivity values in deep wells which varies from 2.36 to 2.44 dS/m. According Girma (2006) to High pHw value was recorded in wells, which was attributed to the content of bicarbonate and carbonate sources from underground calcite mineral weathering. The same author also reported that the pH in different water sampling sites of Awash River also varied from 8.4 to 8.58, which was expected to be close to, the normal pHw range that is from 6.5 to 8.4 for some agricultural crops. However high concentration of soluble sodium was recorded in deep wells and drainage waters. Moreover, soluble Na varied from 71.8 to 500 mg/l and from 75.33 to 1150 mg/l in deep wells and drainage waters respectively. Soluble sodium above 120 mg/l in irrigation water can cause toxicity to many plants (Girma, 2006).

2.3. Soils and Irrigation Water in lower Awash

2.3.1. Soil reaction

According to Mohamed and Tessema (2013) the pH in soils of fursa irrigated area is ranged from moderately alkaline to strongly alkaline reaction. Generally high pH values were recorded at subsurface as compared to surface soil layer. Similarly another author mulat *et al.* (2018), stated that the pH of surface soil of Tendaho sugarcane production farm varied from 7.8 to 8.6, which can be described as moderately alkaline and strongly alkaline.

2.3.2. Soil salinity and sodicity

According to Mulat *et al.* (2018) in most of the profiles opened in tendaho sugar plantation farm, electrical conductivity (EC) of the soils was higher than 4 dS/m, indicating that there would be actual salinity hazard in the soils of the area and high EC values were recorded

at middle layer of the profile, due to leaching of salt from surface to subsurface layer. The same author also reported that the level of exchangeable sodium percentage of the profile opened at the most low-lying portion of the farm varied from 4.93 at the surface to 28.96 at sub surface depth of 30 to 80 cm, and the soils represented by this profile were characterized by sodicity hazards. Another author Sileshi et.al. (2016) stated that, about 80% of Dubti/Tendaho state farm is dominated by salt affected soils (27.14% saline, 29.22% saline-sodic and 23.36% sodic soils). The same author also indicated that the predicted map obtained by using Kriging, about 82% of Dubti/Tendaho state farm is dominated by salt affected soils (29.0% saline, 30.63% saline sodic and 22.54% sodic soils). Finally the author reported that more than half of Dubti/Tendaho state farm was occupied by shallow (< 2 m) ground water with poor quality due to high level of salinity in it. Generally, he stated that the expansion rate of salt affected soils has been increasing with time and space. Finally the author concluded that if the present irrigation practice is continuing, it is expected that most of the cultivated lands will become sterile within a short period of time and he recommend that regular monitoring of the farm area in order to secure up-to-date knowledge of their extent to improve management practices and take appropriate actions. According to Mohamed and Tessema, (2013) the electrical conductivity as a measure of soil salinity in fursa small scale irrigation system found between 0.083 and 7.75 dS/m, which is generally non-saline to moderately saline. The exchangeable sodium percentage is generally classified as medium (0.8 to 2.1%) and commonly increases with depth, except in the mapping unit three which is extremely a high value (40.1%), which indicates that the soils are potentially sodic.

2.3.3. Irrigation water quality

Mohamed and Tessema (2013) revealed that the pH of the Fursa River water is slightly alkaline (7.36) or nearly neutral. They also found that the electrical conductivity (ECw) of the irrigation water is classified as medium range. Moreover, the total dissolved solids is lies from slight to medium range.

Irrigation water containing large amounts of sodium is of special concern due to sodium effects on the soil and poses a sodium hazard usually expressed in terms of sodium adsorption ratio (SAR). Mohamed and Tessema (2013) found that the SAR of the water which is used as source of irrigation for fursa irrigation system is 10.0, while the adjusted SAR approaches 20.40. However, SAR value of water greater than nine (>9) was severely restricted to use for irrigation due to risk of sodium hazard (Wesstcott and Ayers, 1985). This implies early warning for potential hazard of sodic soil in the area (Mohamed and Tessema, 2013).

According to (Sileshi, 2016), the irrigation water quality of Awash river at Dubti/Tendaho area was found to be highly problematic in summer and autumn;

whereas it became moderate and safe in winter and spring seasons. The same author also reported that the mean pH of awash irrigation water varied from 7.78 to 8.72 in which the lowest and highest values were recorded during spring and autumn, respectively. The author also identify that the pH of the water sample around Dubti/Tendaho state farm was higher than the normal range (> 8.4) in autumn season. The reason might be the addition of waste effluents having high alkaline contents from upper stream of River Awash basin through erosion in summer and the residual impacts of those waste materials in autumn when the dilution effect is less prominent.

Furthermore, the EC of River Awash water near Dubti/Tendaho state farm sites fall under doubtful class (750 - 2250 μScm^{-1}) in autumn and summer while good (250 - 750 μScm^{-1}) in Winter and Spring seasons. The author reported that the seasonal variation might be due to high evaporation in summer and autumn.

According to Sileshi, (2016), the irrigation water quality in relation to SAR value near Dubti/Tendaho state farm was excellent (< 10 SAR) in all the seasons except summer which was in the range of good (10- 18 SAR). The author also reported that based on a more strict evaluation of irrigation water quality in terms of SAR value suggested by SAI (2010), the Awash River water being used around Dubti/Tendaho falls in the range of severe (> 5 SAR) in Autumn and Summer, and significant (2–4 SAR) in Winter and Spring seasons, respectively

Similar results were also reported by Mulat et.al. (2018). The same author found that the amount of sodium in irrigation water is of special concern due to sodium effects on the soil and poses a sodium hazard usually expressed in terms of SAR.

3. CONCLUSION AND RECOMMENDATIONS

Soil salinity and alkalinity problems are commonly found in the arid and semi-arid regions of the world due to insufficient annual rainfall to leach accumulated salts from the plants root zone. This review tries to include most of the irrigation projects found in Awash River basin, rift valley of Ethiopia. From this review it can be concluded that in most of irrigation projects and farms there is a trend of increasing of soil salinity which will negatively affect the soil physical properties which results in reduction of productive lands. Specifically in Bora and Lume district there is the existence of potential sodicity problem in the soil. Around meki and zeway area there is problem of salinity due saline sodic and sodic soils and which increase in the subsurface horizons. In wonji area the soil moderately alkaline reaction and the quality of irrigation water is in the normal/neutral range. The substantial parts of Amibara farm areas are affected by salinity problem. High proportion of the irrigated land has been abandoned or soon will be abandoned mainly because of secondary salinization resulted from shallow saline groundwater

table. The most area of Kesem irrigation area is highly affected by salinity and sodicity problems which are mostly associated with saline groundwater, which can alter soil physical and chemical properties and hence hinder sugarcane growth. The soil salinity and sodicity level of the fursa area is classified as non-saline and non-sodic for mapping unit one, non-saline and non-sodic for the surface layer of mapping unit two and three, while it is saline for the sub- surface layer of site three. The SAR and EC_w of the water is medium quality. In methara sugar plantation there is problem of soil salinity ranging from moderate to severe condition. The EC_w and SAR values are ranges from none severe to moderately severe and from low to highly toxic, respectively. Similarly the problem of soil salinity and sodicity is becoming a serious environmental stress in dubti and tendaho sugar plantations. Generally all zones of awash basin (upper, middle and lower) are

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- Based on the above conclusion the following recommendation could be drawn;
- The factors which aggravate the expansion of soil salinity and sodicity should be properly identified to manage these inducing factors.
 - Implementing appropriate cropping system and management practices according to soil type, level of salinity and sodicity and quality of irrigation water.
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