# Predicting Soil $EC_e$ Based on Values of $EC_{1:2.5}$ as an Indicator of Soil Salinity at Magozi Irrigation Scheme, Iringa, Tanzania


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**Abstract**

*Soil salinity is one of the limitations to sustainable production of rice and other crops in many irrigation schemes in Tanzania. Soil salinity can be assessed from electrical conductivity (EC) measurements. Most soil laboratories in Tanzania appraise soil salinity from measurements of electrical conductivity of 1:2.5 soil:water suspensions ($EC_{1:2.5}$) by virtue of their simplicity. However, the influence of soil salinity on plant growth is mainly based on electrical conductivity of saturated paste extract ($EC_e$), so it is necessary to convert $EC_{1:2.5}$ to $EC_e$ in order to assess plant response to salinity. This study was conducted at Magozi Irrigation Scheme in Iringa Region, Tanzania to establish regression model for predicting $EC_e$ from $EC_{1:2.5}$ values. A total of 60 soil samples (45 samples for model training and 15 samples for model validation) were collected and analyzed for soil $EC_{1:2.5}$, $EC_e$ and soil texture. Results showed that $EC_{1:2.5}$ ranged from 0.1 to 4.2 dS $m^{-1}$ with a mean value of 0.71 dS $m^{-1}$. $EC_e$ obtained ranged from 0.3 (non-saline) to 12 dS $m^{-1}$ (very saline) with a mean of 2.4 dS $m^{-1}$ (slightly saline). In order of dominance, soil textural classes were sandy clay loam, clay, sandy clay, sandy loam and clay loam. Strong linear relationships between $EC_e$ and $EC_{1:2.5}$ were observed in the developed linear regression equations. After validation, the study selected equation $ECe = 3.4954*EC_{1:2.5}$ with $R^2$ of 0.956 for combined soil textures to be used for prediction of $EC_e$ from $EC_{1:2.5}$ at Magozi Irrigation Scheme. This model can be tested for its applicability to other similar soils in Tanzania in further studies.*



***Keywords:*** *Soil salinity, $EC_e$, $EC_{1:2.5}$, Magozi Irrigation Scheme, soil salinity prediction*


## Introduction

The 21st century is marked by various global challenges to agricultural sustainability and food production to feed the growing population (Taddese, 2001; Shahbaz and Ashraf, 2013; Godfray and Garnett, 2014). Land degradation is considered as one of the main threats to sustainable agricultural development (Taddese, 2001; Bai *et al.,* 2008). Increasing pressure on land resources due to increased human population coupled with the effects of climate change lead to different types of agricultural land degradation including soil salinization, which is the process of salt accumulation in the soil profile (Taddese, 2001; Shahbaz and Ashraf, 2013; Biswas and Biswas, 2014).

Irrigated agriculture has been viewed as one of the approaches in ensuring food security under the climate changing world (Rhoades and Chanduvi, 1999; Hanjra and Qureshi, 2010). Unfortunately, extensive areas of irrigated land have been and are increasingly becoming degraded by salinization and water logging resulting from over-irrigation and other forms of poor agricultural management (Rhoades and Chanduvi, 1999; Smedema and Shiati, 2002). Soil salinization leading to soil salinity is an important worldwide land degradation problem and poses a great threat to the development of sustainable agriculture, especially in arid and semi-arid regions (Bai *et al.,* 2008; Shrivastava and Kumar, 2015).

Soil salinity is one of the limiting factors in agricultural productivity (Sonmez *et al.,* 2008). It has been estimated that worldwide 20% of total cultivated and 33% of irrigated agricultural lands are afflicted by high soil salinity

(Shrivastava and Kumar, 2015). Therefore, soil salinity is considered as a basic factor which determines to a large extent, soil suitability for agricultural productivity (Sonmez *et al.,* 2008; Shrivastava and Kumar, 2015). Increased soluble salts in the root zone due to soil salinity reduce plant growth, crop yields and in severe cases, cause crop failure (Zhu, 2001; Datta and De Jong, 2002; Allbed and Kumar, 2013; Corwin and Yemoto, 2017). Therefore, soil salinity assessment has been viewed as an important component in agriculture management (Lesch *et al.,* 1995; Biswas and Biswas, 2014; Corwin and Yemoto, 2017). It is essential to assess soil salinity in a reliable and yet relatively easy method (Sonmez *et al.,* 2008; Matthees *et al.,* 2017).

Soil salinity is generally measured by electrical conductivity (EC) (US Salinity Laboratory Staff, 1954; Sonmez *et al.,* 2008; Landon, 2014; Corwin and Yemoto, 2017). A soil is considered saline if the EC of a saturation extract exceeds 4 dS $m^{-1}$ at 25°C (Sonmez *et al.,* 2008; Kargas *et al.,* 2018). Soil salinity or EC may be measured on the bulk soil ($EC_a$), in the saturation paste extract ($EC_e$), in soil: water ratio suspensions of 1:1 to 1:5 such as 1:1, 1:2, 1:2.5 and 1:5 or directly on soil water extracted from the soil in the field ($EC_w$) (US Salinity Laboratory Staff, 1954; Sonmez *et al.,* 2008; Corwin and Yemoto, 2017; Kargas *et al.,* 2018).

Since 1954 to date, the $EC_e$ has been considered as the best indicator of crop response to salinity compared with EC from other soil to water ratio suspension methods (US Salinity Laboratory Staff, 1954; Rhoades *et al.,* 1989; He *et al.,* 2013; Matthees *et al.,* 2017; Kargas *et al.,* 2018). Soil salinity assessment is therefore, based on measurements of the electrical conductivity of the saturated paste extract ($EC_e$), which has been established as the standard method (US Salinity Laboratory Staff, 1954; He *et al.,* 2013; Matthees *et al.,* 2017; Kargas *et al.,* 2018). This approach is however expensive, cumbersome and tedious as it requires more time and skill associated with the manual preparation of the soil paste (He *et al.,* 2013; Kargas *et al.,* 2018) than soil to water ratio methods.

Instead of measuring soil $EC_e$, a number of researches from various soil laboratories in the world have found it easier to measure the EC of soil: water ratios such as 1:1, 1:2, 1:2.5 and 1:5 which are more easily attainable (Sonmez *et al.,* 2008; He *et al.,* 2013; Landon, 2014; Kargas *et al.,* 2018) as they are easier to prepare, save time and less costly (He *et al.,* 2013). Therefore, it is likely that many laboratories, particularly commercial ones, will continue to appraise soil salinity from EC of soil to water suspensions like 1:2.5 measurements because of their convenience and speed (He *et al.,* 2013; Matthees *et al.,* 2017; Kargas *et al.,* 2018). It has however been noted that the soil over water mass ratios are very poorly correlated with the actual soil moisture conditions (Sonmez *et al.,* 2008; Kargas *et al.,* 2018). Therefore, in order to assess plant response to salinity, it is necessary to convert EC from soil to water suspensions values to $EC_e$ (Sonmez *et al.,* 2008; He *et al.,* 2013; Matthees *et al.,* 2017). Conversion factors obtained from model equations are used to estimate $EC_e$ from EC values of soil to water suspensions (Khorsandi and Yazdi, 2011; He *et al.,* 2013).

Various studies have shown that highly significant linear correlation exists between EC values measured in saturated paste extracts and EC values from different soil to water ratios (Sonmez *et al.,* 2008). The study by Sonmez *et al.,* (2008) concluded that EC values from extracts of 1:1, 1:2.5 or 1:5 soil to water ratios can be used to estimate saturated paste electrical conductivity ($EC_e$). Recent study for Greece soils by Kargas *et al.,* (2018) reported that the methods providing $EC_{1:1}$ and $EC_{1:5}$ values are linearly correlated to the $EC_e$ methodology with a high correlation coefficient ($R^2 > 0.93$).

Most of the studies conducted in other countries were mainly based on relating $EC_e$ with $EC_{1:1}$, $EC_{1:2}$ and $EC_{1:5}$ with very few on $EC_{1:2}$ (Sonmez *et al.,* 2008; Corwin and Yemoto, 2017). All equations have shown regional variability (Sonmez *et al.,* 2008; Corwin and Yemoto, 2017) suggesting that there is a need for regional specific equations. Soil testing laboratories in Tanzania run many thousands of samples each year for EC by using an easier method of $EC_{1:2.5}$. A specific benefit for measuring electrical conductivity using extracts of 1:2.5 soil to water ratio is that the measurements can be conducted for samples prepared for pH measurements and thus saving both time and resources for laboratory works (Sonmez *et al.,* 2008). However, there are no conversion factors developed for converting soil $EC_{1:2.5}$ to $EC_e$ for Tanzanian soils. Furthermore, the soil EC interpretation guidelines used are based on $EC_e$ (US Salinity Laboratory Staff, 1954; Sonmez *et al.,* 2008; Corwin and Yemoto, 2017). Literature has documented that the $EC_e$ values are usually higher than the EC values determined by soil to water suspension methods like 1:2.5 (Sonmez *et al.,* 2008; Corwin and Yemoto, 2017). This means that the current approach of using $EC_e$ based interpretation guidelines to interpret $EC_{1:2.5}$ values may lead to unrealistic soil salinity assessment in the country.

Studies have shown that rice (*Oryza sativa* L.) crop production in Tanzania is threatened by salt affected soils among other factors (Kashenge-Killenga, 2010). Irrigated rice is one of the major sources of rice production in Tanzania as one of the efforts to ensure food security and incomes of farmers under the climate changing world (Kashenge-Killenga, 2010; Mtengeti *et al.,* 2015; Rugumamu, 2014). Magozi Irrigation Scheme is one of the rice producing schemes in Iringa region (Mdemu *et al.,* 2017) facing the problem of soil salinity. Assessment and monitoring of soil salinity in this scheme and other areas is important and require relevant salinity measurements (He *et al.,* 2013; Corwin and Yemoto, 2017; Matthees *et al.,* 2017). Although measurements of electrical conductivity (EC) in 1:2.5 soil to water suspension is possible, no linear model has been established to convert $EC_{1:2.5}$ to $EC_e$ for accurate salinity assessments. This study developed a linear model that can be used to predict $EC_e$ from $EC_{1:2.5}$ in this scheme with a potential application in other soils of Tanzania.

## Materials and Methods

### Description of the Study Area

The research was conducted at Magozi Irrigation Scheme which has an area of 1300 ha. The scheme is located at Ilolompya Ward, in Iringa Rural District of Iringa Region, which is composed of three villages namely Magozi, Ilolompya and Mkombilenga. Irrigation water at Magozi comes from the Little Ruaha River. The scheme is located at about 60 km North West of Iringa town and lies from 7°28'45.74"-7°25'14.08"S to 35°27'37.91"-35°28'45.92"E. The average altitude is 700 m above mean sea level and the climate is semi arid tropical with unimodal rainy season between November and May.

### Pre-field work

A reconnaissance soil survey was conducted to recognize and establish soil variation in terms of surface salinity features, soil texture and topography at Magozi Irrigation Scheme. The 500m x 500m sampling grid was prepared in QGIS (QGIS 2.6.1-Brighton) using the scheme boundary shape file and the sampling point UTM coordinates were captured by coordinate capturing tool in QGIS and later on transferred into the GPS device (GARMIN GPSmap 62) for navigation during soil sampling.

**Plate 1: A section of Magozi Irrigation Scheme showing white patches on the surface, which are signs of salinity**

### Field soil sampling

The pre field work established soil sampling points based on systematic 500m x 500m grids. However, additional points were included to take care of the observed soil variations in the area during soil sampling. Therefore, a total of sixty (60) surface composite soil samples at a depth of 0-30 cm were collected from Magozi Irrigation Scheme and sent to the Soil Science Laboratory at Sokoine University of Agriculture for analysis of soil $EC_{1:2.5}$, $EC_e$ and soil texture. Soil texture was included as an important parameter which affects soil electrical conductivity (US Salinity Laboratory Staff, 1954; Sonmez *et al.,* 2008).

**Soil sample selection for studying $EC_e$ prediction from $EC_{1:2.5}$**

Out of 60 soil samples, 45 soil samples (75%) with combined soil textures were used as model training data set while 15 soil samples (25%) were used as model validation data set. The selection considered the location of sample point in the irrigation scheme area as well as the soil textural classes' variation in order to reduce sampling biasness. Fig. 1 is the map of Magozi Irrigation Scheme showing soil sampling points distribution for this study.

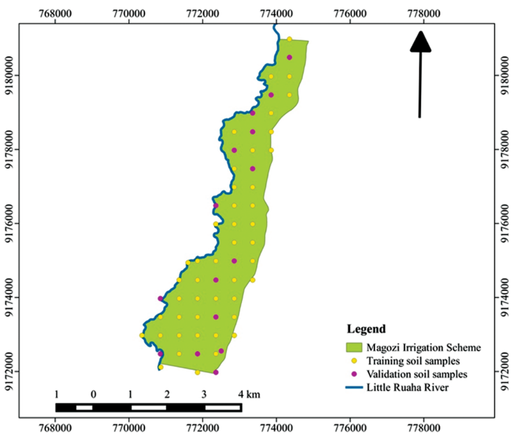


**Figure 1: Distribution of soil sampling points at Magozi Irrigation Scheme**

**Laboratory analysis for soil $EC_{1:2.5}$, $EC_e$ and soil texture**

Soil samples were air-dried, ground and passed through a 2-mm sieve for laboratory determination of soil $EC_{1:2.5}$, $EC_e$, particle size analysis (soil texture) at Soil Science Laboratory of the Sokoine University of Agriculture. Particle size analysis was determined by hydrometer method after dispersion with 5% sodium hexametaphosphate (Moberg, 2001) whereby the soil textural classes were determined using USDA textural triangle (Soil Survey Staff, 2014). Soil electrical conductivity ($EC_{1:2.5}$) in dS $m^{-1}$ were measured potentiometrically in water at a ratio of 1:2.5 soil: water (Okalebo *et al.,* 2002). Soil $EC_e$ was determined by saturated paste extract method using standard method (Rhoades, 1996).

Linear relationship between electrical conductivity of the saturated paste extract ($EC_e$) and of the 1:2.5 soil to water suspension ($EC_{1:2.5}$)

**Statistical Analysis**

Linear regression analysis to relate $EC_e$ and $EC_{1:2.5}$ for the training data set and the data set for each soil textural class were conducted using GenStat Software and Microsoft Excel 2013 Analysis ToolPak (Wim *et al.,* 2007). All statistical tests were performed at $p \leq 0.05$ significance level. The linear models were assessed by using coefficient of determination ($R^2$) according to Wim *et al.* (2007).

**Model selection and validation**

Several models were developed in this study but the best linear regression model was selected based on the large number of soil samples used to develop it, availability of validation data set for testing it as well as good coefficient of determination ($R^2 > 0.8$) (Matthees *et al.,* 2017). Higher $R^2$ values represent smaller differences between the observed data and the fitted values. Further selection criteria for the final model was done by testing the prediction accuracy for the equation with intercept and without intercept when subjected to the validation data set (Matthees *et al.,* 2017; Kargas *et al.,* 2018). To further compare the prediction accuracy between model with intercept and without intercept, a scatter plot was established to relate linear relationship between measured $EC_e$ and predicted $EC_e$ by assessing $R^2$ and prediction error represented by root mean square error (RMSE) (Sonmez *et al.,* 2008; Kargas *et al.,* 2018). Therefore a model which predicted ECe from $EC_{1:2.5}$ with smaller mean difference between measured and predicted $EC_e$, higher $R^2$ and smaller RMSE values as compared to other models was selected for use in this study (Sonmez *et al.,* 2008; Matthees *et al.,* 2017).

**Results**

**Status of soil $EC^{1:2.5}$, $EC_e$ and soil texture in the studied soils**

The results for the selected 60 soil samples summarized in Table 1, showed that the soil electrical conductivity measured in 1:2.5 soil to water suspension ($EC_{1:2.5}$) ranged from 0.11 to 4.2 dS $m^{-1}$ with the mean of 0.71 dS $m^{-1}$. The soil electrical conductivity ($EC_e$) determined by saturated paste extract method ranged from 0.3 dS $m^{-1}$ (non-saline) to 12 dS $m^{-1}$ (very saline) with a mean of 2.4 dS $m^{-1}$ (slightly saline) (Rhoades, 1996; Bannari *et al.,* 2008). The studied soils showed variation in soil texture where the soil textural classes percentage composition per total soil samples were 42, 28, 10, 10 and 10% for sandy clay loam, clay, sandy clay, sandy loam and clay loam respectively.

**Table 1: Descriptive statistics for selected physicochemical properties of the studied soils (n = 60)**

| Parameter | Minimum | Maximum | Mean | Standard deviation |
|---|---|---|---|---|
| **Electrical conductivity (EC)** | | | | |
| Soil $EC_{1:2.5}$ (dS $m^{-1}$) | 0.11 | 4.2 | 0.71 | 1.33 |
| Soil $EC_e$ (dS $m^{-1}$) | 0.3 | 12 | 2.4 | 4.7 |
| ***Particle size distribution*** | | | | |
| % Clay | 13.56 | 59.56 | 33.68 | 10.79 |
| % Silt | 4.28 | 33.92 | 17.27 | 7.35 |
| % Sand | 15.52 | 78.52 | 49.05 | 15.5 |
| **Soil textural classes** | **Number of samples (n=60)** | | **% Textural class** | |
| Sandy clay loam | 25 | | 42 | |
| Clay | 17 | | 28 | |
| Sandy clay | 6 | | 10 | |
| Sandy loam | 6 | | 10 | |
| Clay loam | 6 | | 10 | |

**Relationship between electrical conductivity of the saturated paste extract ($EC_e$) and $EC_{1:2.5}$**

**Linear regression equations relating $EC_e$ and $EC_{1:2.5}$**

Table 2 summarizes the mathematical equations indicating the linear relationships obtained between $EC_e$ and $EC_{1:2.5}$ after linear regression analysis for the training data set with combined soil textural classes and the equations for individual soil textural classes.

The linear regression model estimates (m) ranged from 1.9719 in clay soils to 5.0143 in sandy loam soils and ranging from 2.2413 in clay soils to 4.9260 sandy loam soils for equations with intercept and without intercept, respectively. This indicates that clay textured soils showed smaller difference between $EC_e$ and $EC_{1:2.5}$ as compared to other coarse textured soils. Sandy loam textured soils indicated higher difference between $EC_e$ and $EC_{1:2.5}$ by having the largest estimate which is in line with other literatures (Bannari *et al.,* 2008; Sonmez *et al.,* 2008). The $R^2$ ranged from 0.9226 for clay soils to 0.9932 for clay loam soils and 0.891for clay soils to 0.991 for sandy loam soils for equations with intercept and without intercept respectively.

**Model selection and validation**

The linear model for combined soil textures was selected for use in this study because it was developed using relatively adequate samples and it had validation data set of combined texture soil samples. But the small soil sample sizes for individual textures could not provide adequate samples to form training and validation data sets for each soil textural class and for estimates comparison purposes. The models to be selected in this category of combined soil textures were either $EC_e = 3.5381EC_{1:2.5} - 0.1337$ with $R^2$ of 0.9565 and or $EC_e = 3.4954EC_{1:2.5}$ with $R^2 = 0.956$ for equation with intercept and without intercept respectively. Moreover, the linear model for combined soil textures without

**Table 2: Linear regression models relating $EC_e$ and $EC_{1:2.5}$**

| Soil sample type | Number of samples | Linear model with intercept | | Linear model without intercept | |
|---|---|---|---|---|---|
| | | Equation | $R^2$ | Equation | $R^2$ |
| Combined soil textures (Model training data) | 45 | $EC_e = 3.5381EC_{1:2.5}$ - 0.1337 | $R^2 = 0.9565$ | $EC_e = 3.4954EC_{1:2.5}$ | $R^2 = 0.956$ |
| Sandy clay loam | 25 | $EC_e = 3.5326EC_{1:1.25}$ + 0.2106 | $R^2 = 0.9835$ | $EC_e = 3.5811EC_{1:2.5}$ | $R^2 = 0.9828$ |
| Clay | 17 | $EC_e = 1.9719EC_{1:2.5}$ + 0.3779 | $R^2 = 0.9226$ | $EC_e = 2.2413EC_{1:2.5}$ | $R^2 = 0.8910$ |
| Sandy clay | 6 | $EC_e = 3.403EC_{1:2.5}$ - 0.1125 | $R^2 = 0.9841$ | $EC_e = 3.2919EC_{1:2.5}$ | $R^2 = 0.9827$ |
| Sandy loam | 6 | $EC_e = 5.0143EC_{1:2.5}$- 0.1091 | $R^2 = 0.9915$ | $EC_e = 4.926EC_{1:2.5}$ | $R^2 = 0.9910$ |
| Clay loam | 6 | $EC_e = 2.2794EC_{1:2.5}$ + 0.3171 | $R^2 = 0.9932$ | $EC_e = 2.8622EC_{1:2.5}$ | $R^2 = 0.9070$ |

intercept was preferred for use in this study to predict $EC_e$ from $EC_{1:2.5}$ because the $EC_{1:2.5}$ cannot be absolute zero for the studied soils (Bannari *et al.,* 2008).

**ECe prediction results on validation data set**

The models $EC_e = 3.5381EC_{1:2.5} - 0.1337$ and $EC_e = 3.4954EC_{1:2.5}$ were compared on their ability to predict $EC_e$ from $EC_{1:2.5}$ by using validation data set (n=15). A summary of predicted $EC_e$ from measured values for both equations is presented in Table 3.

**Table 3: $EC_e$ prediction results for linear models with intercept and without intercept on the validation data set**

| Statistic | Measured $EC_e$ (dS $m^{-1}$) | Predicted $EC_e$ (dS $m^{-1}$) | |
|---|---|---|---|
| | | $EC_e$=3.5381$EC_{1:2.5}$ - 0.1337 | $EC_e$=3.4954$EC_{1:2.5}$ |
| Minimum | 0.65 | 0.33 | 0.45 |
| Maximum | 12.03 | 14.66 | 14.61 |
| Mean | 2.70 | 2.58 | 2.68 |
| Standard deviation | 3.15 | 3.64 | 3.60 |

Further comparison in $EC_e$ prediction accuracy between $EC_e = 3.5381EC_{1:2.5} - 0.1337$ (with intercept) and $EC_e = 3.4954EC_{1:2.5}$ (without intercept) models was performed by linear regression analysis to relate linear relationships between measured ECe and predicted $EC_e$ from both models. The $R^2$ and RMSE (prediction error) observed for the measured $EC_e$ versus predicted $EC_e$ from $EC_e = 3.5381EC^{1:2.5} - 0.1337$ (with intercept) scatter plot were 0.937 and 0.946 (dS $m^{-1}$) respectively. The $R^2$ and RMSE observed for the measured $EC_e$ versus predicted $EC_e$ from $EC_e$= 3.4954$EC_{1:2.5}$ (without intercept) scatter plot were 0.937 and 0.933 (dS $m^{-1}$) respectively.

**Discussion**

Significant differences between soil $EC_{1:2.5}$ and soil $EC_e$ values at P<0.05 were observed (Sonmez *et al.,* 2008). The soil electrical conductivity ($EC_e$) of the saturated paste extract ranged from non-saline (0.3 dS $m^{-1}$) to very saline (12 dS $m^{-1}$) with a mean being slightly saline (2.4 dS $m^{-1}$) (Rhoades, 1996; Bannari *et al.,* 2008). The 12 dS $m^{-1}$ $EC_e$ which is rated as very saline (Rhoades, 1996) is an alarming result which indicates that some areas of Magozi Irrigation Scheme are at higher risk of developing more salinity. This might negatively affect rice production in this area.

Good correlations ($R^2$>0.8) were observed in all linear regression models for combined soil textures and in individual soil textural classes. Generally the linear regression models slope estimates for $EC_{1:2.5}$ and coefficient of determination ($R^2$) varied with soils textural class. This variation may be due to the effects of soil texture in soil electrical conductivity as well as differences in number of samples for individual textural classes. The study conducted by Sonmez *et al.* (2008) at Akdeniz University in Turkey obtained a linear regression model $EC_e = 3.91EC_{1:2.5} + 0.27$ with $R^2$ of 0.99 for combined soil textures. The observed differences in slope and intercept from those obtained in this study may be due to the soil variability between the two countries.

While the mean value from the measured $EC_e$ of validation data was 2.7 (dS $m^{-1}$), the $EC_e = 3.5381EC_{1:2.5} - 0.1337$ model predicted mean $EC_e$ of 2.58 (dS $m^{-1}$) while $EC_e = 3.4954EC_{1:2.5}$ model predicted a mean of 2.68 dS $m^{-1}$. This indicated that the model without intercept ($EC_e = 3.4954EC_{1:2.5}$) predicted mean $EC_e$ more closely to the measured mean $EC_e$ as compared to the model with intercept. All models showed the same $R^2$ while the prediction error (RMSE) was smaller for $EC_e$=3.4954$EC_{1:2.5}$ prediction results than $EC_e$=3.5381$EC_{1:2.5}$-0.1337. According to these results, the linear model without intercept ($EC_e$=3.4954*$EC_{1:2.5}$) was selected as the best model to predict $EC_e$ from $EC_{1:2.5}$ in Magozi Irrigation Scheme due to its higher prediction accuracy as compared to $EC_e = 3.5381EC_{1:2.5} - 0.1337$.

## Conclusions and Recommendations

This study showed that $EC_e$ can be predicted from $EC_{1:2.5}$ for the soils of Magozi Irrigation Scheme. The linear regression model $EC_e = 3.4954*EC_{1:2.5}$ for combined soil textures showed high $EC_e$ prediction precision when tested with the validation data set, indicating that, this model can be used to predict $EC_e$ for the soils of Magozi Irrigation Scheme. This model can also be tested for potential application in Tanzanian soils especially in cases where there is limitation of sample size. However, the other developed linear models according to textural classes in this study can be tested in further similar researches by using adequate validation soil samples of individual textural classes so as to test for their capability in predicting soil $EC_e$ for particular soil textural classes.

Similar studies are recommended to be done in other soils of Tanzania in order to establish more regional specific linear models to be used for prediction of $EC_e$ from the commonly measured $EC_{1:2.5}$. The soil laboratories in Tanzania can use such models to save time and labour resources for determination of $EC_e$. This will also facilitate more relevant and precise soil salinity assessments in the country by providing $EC_e$ values that are used to assess plant response to salinity as opposed to the current reliance on $EC_{1:2.5}$ values for soil salinity assessment in Tanzania.

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