Study on the Changes of Soil Properties in Different Conditions

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Abstract

The present study was conducted for assessment of some properties of soil samples from farmlands during 2011 to 2015. These are used for combining rain-fed and irrigated agriculture. These farmlands are located along the Sittaung river bank in Taungoo area, Bago Region. Varieties of crops are cultivated throughout the year. Intensive cultivation is carried out in dry season (November to May) by the aid of Sittaung river water irrigation. In monsoon (late May to October) farmlands are used as rain-fed. Six representative soil samples from these farmlands were collected before irrigation and after irrigation periods. This is because irrigation may lead to negative impact on soil quality and crop productivity. However, soil analysis showed that pH of soil samples from farmlands were slightly alkaline (7.4 ± 0.2) before irrigation and slightly acidic (6.5±0.2) after irrigation periods. Texture of soils in most farmlands were found to be silt loam and loam but sandy characters were observed after irrigation periods of 2013 and 2014. Bulk density values of soil samples in both periods were below 1.6 g/mL which restricts the plant growth. Soil samples were categorized as having good porosity. Organic carbon percent of soil samples were found as 2.57 ± 0.63 % before irrigation periods and (1.69 ± 0.59) % after irrigation periods. High total nitrogen percent were noticed before irrigation periods. Available phosphorus and potassium values were found higher in before irrigation periods compare to those in after irrigation periods. Sodium adsorption ratio of soil samples were calculated and found to be 0.75±0.22 and 0.50 ± 0.05 in before irrigation and after irrigation periods respectively. These were within the permissible limit for plant cultivation. For sustaining the production and productivity of small scale farmlands in Taungoo area, farm management practices must be done.

Keywords : Sittaung river bank, soil properties, sodium adsorption ratio, irrigated farmlands

Introduction

Taungoo is district level city and located northern part of Sittaung River basin in the Bago Region. The area of this basin is about 31944.4 sq-km. This basin is situated in southeastern part of the country. Climate of Taungoo is distinctly classified into two; dry season and monsoon (Tun Ko, 2005). There is small scale farmlands located along the Sittaung River basin.

Composition and Quality of Soil

Soils are composed of solids, minerals and organic matter and pores which hold air and water. Society in general views, soils simply occur as a medium of plantation, often failing to recognize that soils regulate and partition water flow and buffer against human use and environmental changes. It supports plant growth and absorbs, buffers, and transforms chemical flows. It also retains the stones and flood water, and renews water supplies. Soil quality is the capacity of the soil to perform these beneficial functions. As soils naturally vary in their capacity to perform these functions, a soil of excellent quality for one function may

be unsuitable for another. Soil quality is, then, relative to a particular function or land use. Using the equation

$$SAR = \frac{Na^{+}meq/L}{\sqrt{\frac{(Ca^{2+}meq/L)+(Mg^{2+}meq/L)}{2}}}$$ sodium adsorption ratio can be calculated to estimate the important salts concentration for crop cultivation (Miller *et al.,* 2007).

Materials and methods

Collection of Soil Samples

Locations of soil samples from six selected irrigated farmlands are selected along the Sittaung River bank as shown in Table (1) and Figure (1). Exact coordinate of sampling locations were recorded using a Global Positioning System (GPS) device. Photographs of sampling sites of six soil samples are taken (Figure 2). Six soil samples from irrigated farmlands were collected in Zig-Zag pattern using a spade. Sampling depth was 0-20cm (Jones, 1988).

Table 1. Sampling Position of Soil Samples

No	Sampling site	Position	
		Longitude	Latitude
1	S_1Near Myogyiharbour	96°28' 1.79" E	18°55' 10.99" N
2	S_2East part of Do Thaung	96°27' 53.07" E	18°55' 20.81" N
3	S_3Middle part of Do Thaung	96°27' 44.21" E	18°55' 32.41" N
4	S_4West part of Do Thaung	96°27' 36.89" E	18°55' 42.51" N
5	S_5Edge of ThaPhanpin	96°27' 36.22" E	18°55' 0.01" N
6	S_6East part of ThaPhanpin	96°26' 2.59" E	18°55' 12.65" N

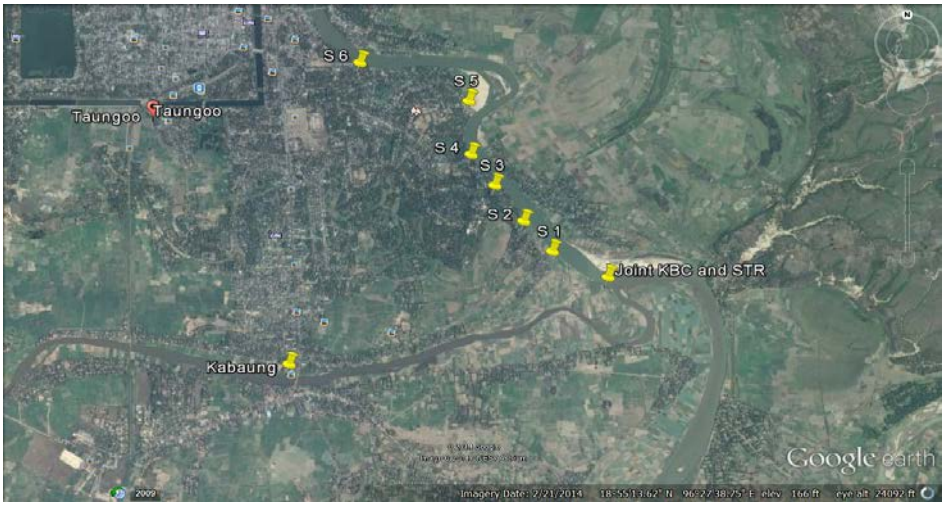
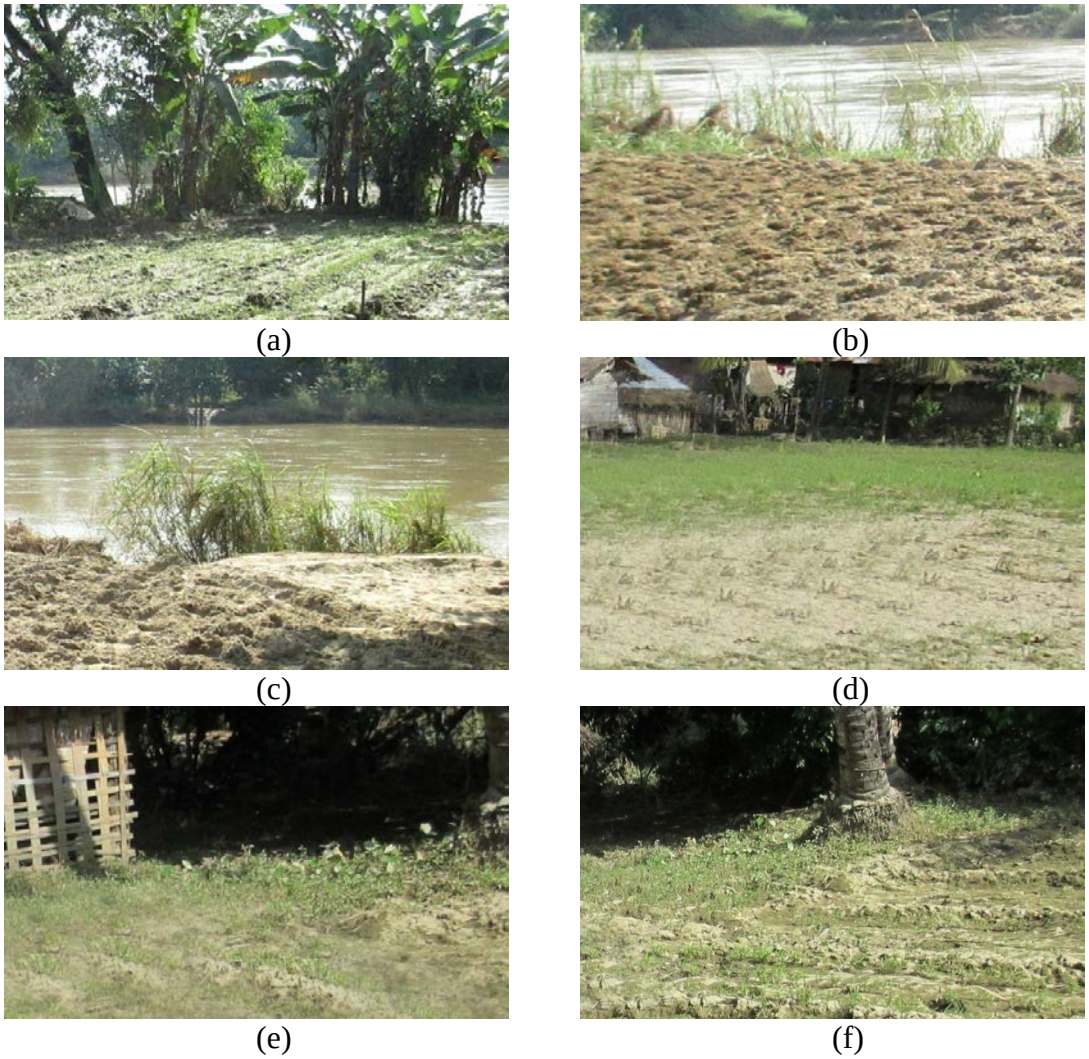


Figure 1. Google earth map of soil sampling locations



(a) (b)

(c) (d)

(e) (f)

Figure 2. Soil sampling sites from cultivated fields: (a) Near Myogyi harbour (S_1); (b) East part of Do Thaung village (S_2); (c) Middle part of Do Thaung (S_3); (d) West part of Do Thaung(S4); (e) Edge of Tha Phanpin (S_5); and (f) East part of Tha Phanpin (S_6)

Preparations of Soil Samples

Each of the soil sample was spread out on aluminum tray and removed unnecessary things like stones, pieces of root and leave. The collected soil samples were thoroughly mixed on clean piece of thick paper and the bulk sample size was reduced by quartering technique so that about 500g of composite samples were retained individually. Each of the samples was kept in polyethene bag with suitable description and identification marks. Samples were mixed during drying process to expose fresh surfaces. After air-drying, soil samples were crushed gently in mortar and pestle, and sieved through a 2 mm sieve (Tandon, 1999).

Determinations of Soil Properties

pH by pH meter, texture by pipette method, bulk density by core method, porosity by pycnometer, organic carbon by Walkly Black method and nitrogen by Kjeldahl method and phosphorus by bismuth-phosphomolybdate complex method were used. Sodium and potassium concentration was determined by flame photometer. Calcium and magnesium contents were determined by atomic absorption spectrophotometer (Nathan *et al.,* 1998). Data analysis was performed using Statistical Package for Social Science (SPSS). Various soil properties (mean ± SD) were evaluated and analyzed to explain the variations between two periods. Correlation analysis among variables was performed using Pearson correlation coefficient (r) to measure the strength of relationship between some variables.

Results and Discussion

Mean pH value of soil was 7.4 ± 0.2; moderate alkaline nature of soil was found in the most sampling sites in before irrigation, and after irrigation period, nearly neutral mean value of soil (6.5±0.2) was due to irrigation of that area (Figure 3). During the study periods, texture of soil samples from sampling sites was found silt loam and loam (Table 2). However, in after irrigation periods, some sampling sites were getting sandy character at the end of irrigation with river water. This may be due to the fact that irrigation river water contains sand particles in some sources during pumping the water out. Figure (4) shows the mean values of bulk density in both periods. It was found that the mean bulk density value (1.25±0.12)g/mL were higher in after irrigation periods than (0.91±0.15)g/mL of before irrigation ($P< 0.01$). In general, bulk densities greater than 1.6 g/mL tends to restrict root growth (McKenzie *et al.,* 2004). In Figure 5, mean porosity percent (55.90±4.40)% of soil samples in before irrigation periods were higher than (43.68±3.53)% of after irrigation period($P<0.05$). These were within the 40-45% moderate porosity and 45- 50 % good porosity (Beerneart, 1994). Mean values of organic carbon percent were (2.57±0.63%) and (1.69±0.59 %) were found in before irrigation periods and after irrigation periods respectively (Figure 6). According to Landon (1991) the categories for the organic carbon contents of soils are: low (<4%), medium (4%-10%) and high (>10%). Thus organic carbon contents of the soil in the farmlands in both periods are low. In before irrigation periods, total nitrogen percent were higher than those after irrigation of periods (Figure7). Significant differences were observed between two seasons ($P<0.05$). In after irrigation period or dry season (November to May) which is longer period than monsoon (June to October). During monsoon, farmers in those areas practice low crop cultivation frequency compared to crop cultivation in dry seasons. A negative and significant ($r = - 0.568$) relationship between total nitrogen percent and bulk density was observed. Phosphorus contents of soil samples were found the mean values of 17.66±2.47 ppm in the before irrigation periods and 15.34±2.13 ppm in after irrigation periods during study period (Figure 8). Orthophosphates originate

largely from primary and secondary minerals and from organic sources. Havlin *et al.*,(1999) rated Olsen phosphorus as P < 3 ppm as very low, 4-7 ppm as low, 8-11 ppm as medium and >12 ppm as high. Thus available phosphorus in soil samples in the study area in both seasons are categorized as high. In this study, a weak negative correlation (r = - 0.368) was observed between available phosphorus and bulk density. Mean values of the available potassium contents were (51.64±3.26) ppm and (44.25±4.23) ppm in before irrigation and after irrigation periods respectively (Figure 9). These are valid for medium available potassium > 30 ppm (Beerneart, 1994). In this study, negative and significant relationship (r = - 0.608) between available potassium and bulk density was observed. The sodium adsorption ratio (SAR) of soil; the mean values of before irrigation period and after irrigation periods were 0.75±0.22 and 0.50±0.05 respectively(Table 3). All sodium adsorption ratios of the soil samples were within permissible limit of 0 – 3 (Beerneart, 1994). Thus, soils in the farmlands did not pose problem on plants cultivation. In this study, sodium adsorption ratios were weakly correlated with bulk density (r = - 0.185).

Table 2. Texture of Soil Samples from Farmlands along Sittaung River Bank in Before irrigation and After irrigation Periods

Sample	Texture							
	Before irrigation 2011	After irrigation 2012	Before irrigation 2012	After irrigation 2013	Before irrigation 2013	After irrigation 2014	Before irrigation 2014	After irrigation 2015
S_1	Silt loam	Silt loam	Silt loam	Loamy sand	Silt loam	Loamy sand	Silt loam	Silt loam
S_2	Silt loam	Silt loam	Silt loam	Loamy sand	Silt loam	Loamy sand	Loam	Loam
S_3	Silt loam	Silt loam	Silt loam	Loamy sand	Silt loam	Loamy sand	Silt loam	Loam
S_4	Silt loam	Silt loam	Loam	Silt loam	Silt loam	Loam	Silt loam	Loam
S_5	Silt loam	Loam	Silt loam	Loam	Silt loam	Loam	Silt loam	Loam
S_6	Loam	Silt loam	Silt loam	Silt loam	Loam	Loam	Silt loam	Loam

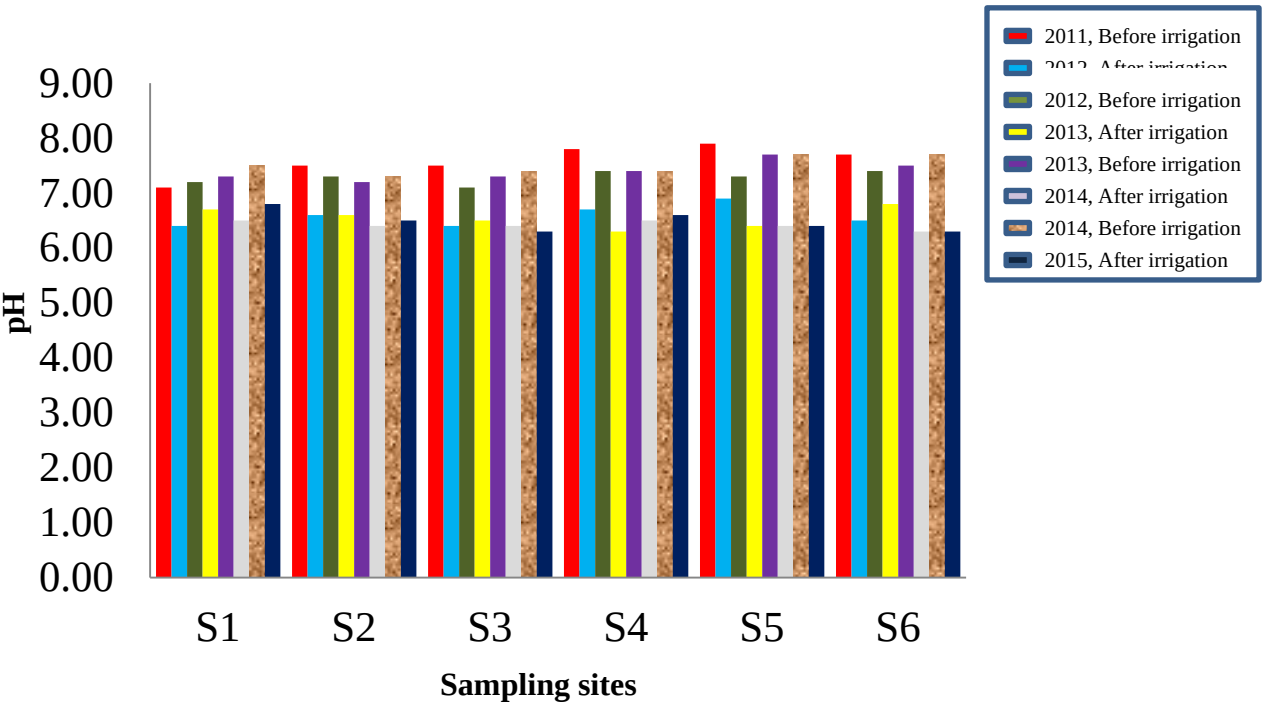


Figure 3. pH values of soil samples from farmlands along Sittaung river bank in before irrigation and after irrigation periods.

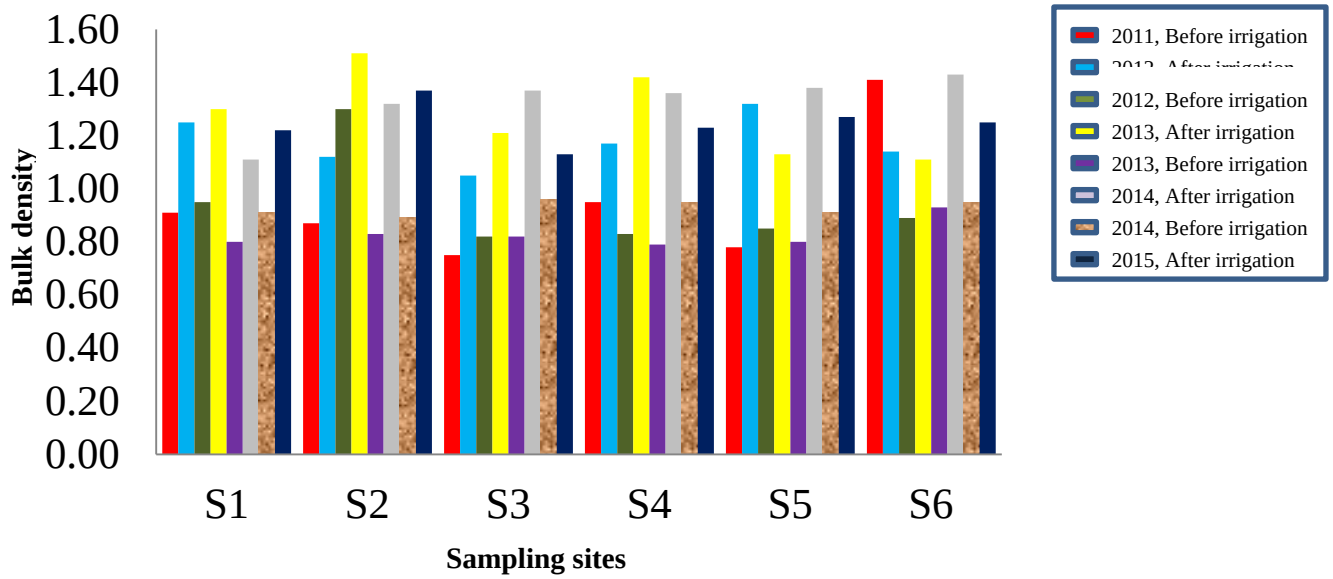


Figure 4.Bulk density values of soil samples from farmlands along Sittaung river bank in before irrigation and after irrigation periods.

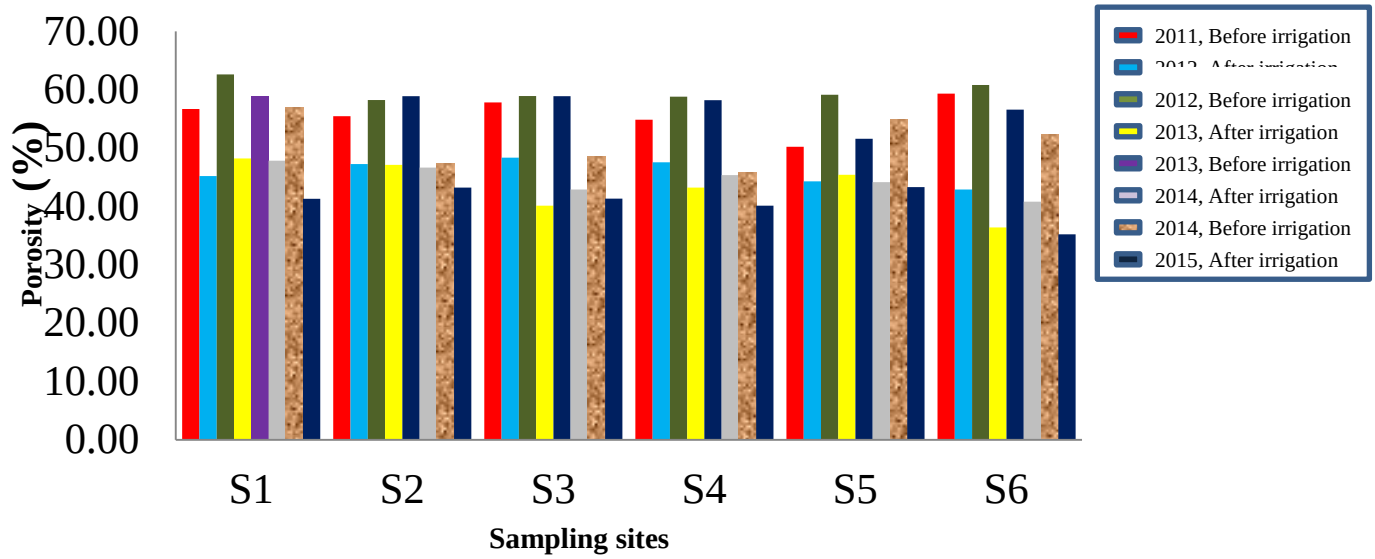


Figure 5. Porosity percent of soil samples from farmlands along Sittaungriver bank in before irrigation and after irrigation periods.

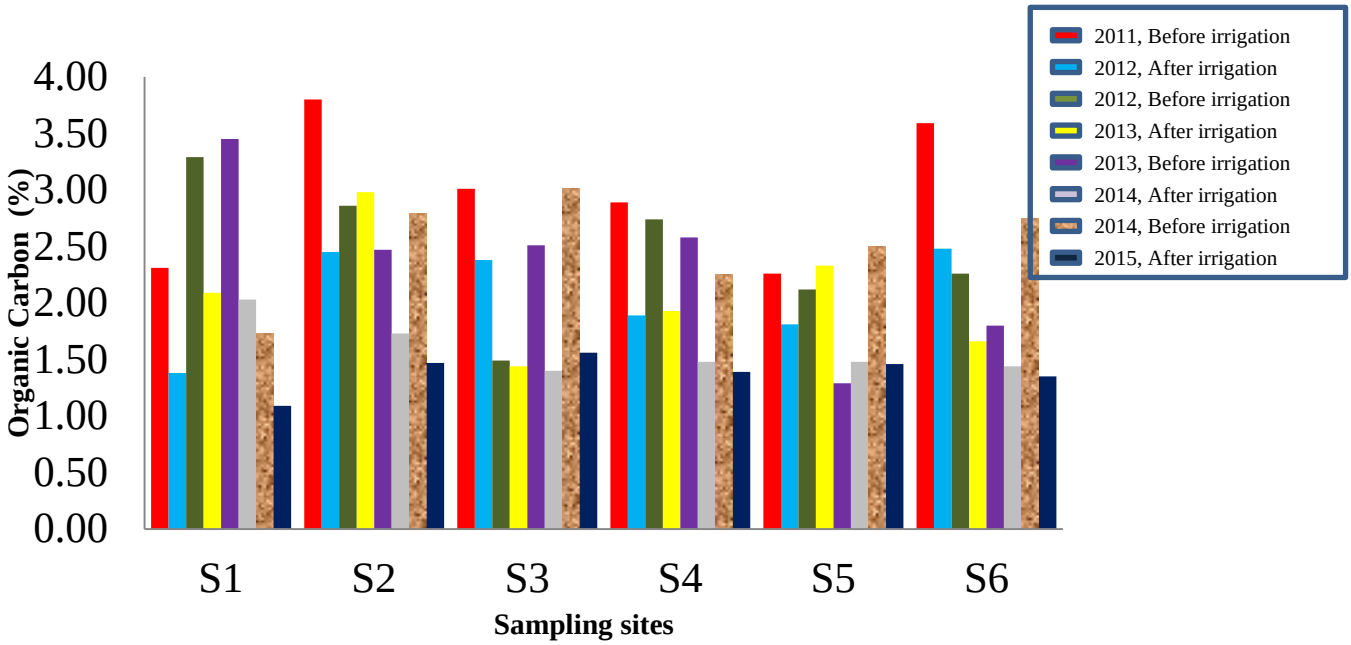


Figure 6. Organic carbon percent of soil samples from farmlands along Sittaungriver bank in before irrigation and after irrigation periods.

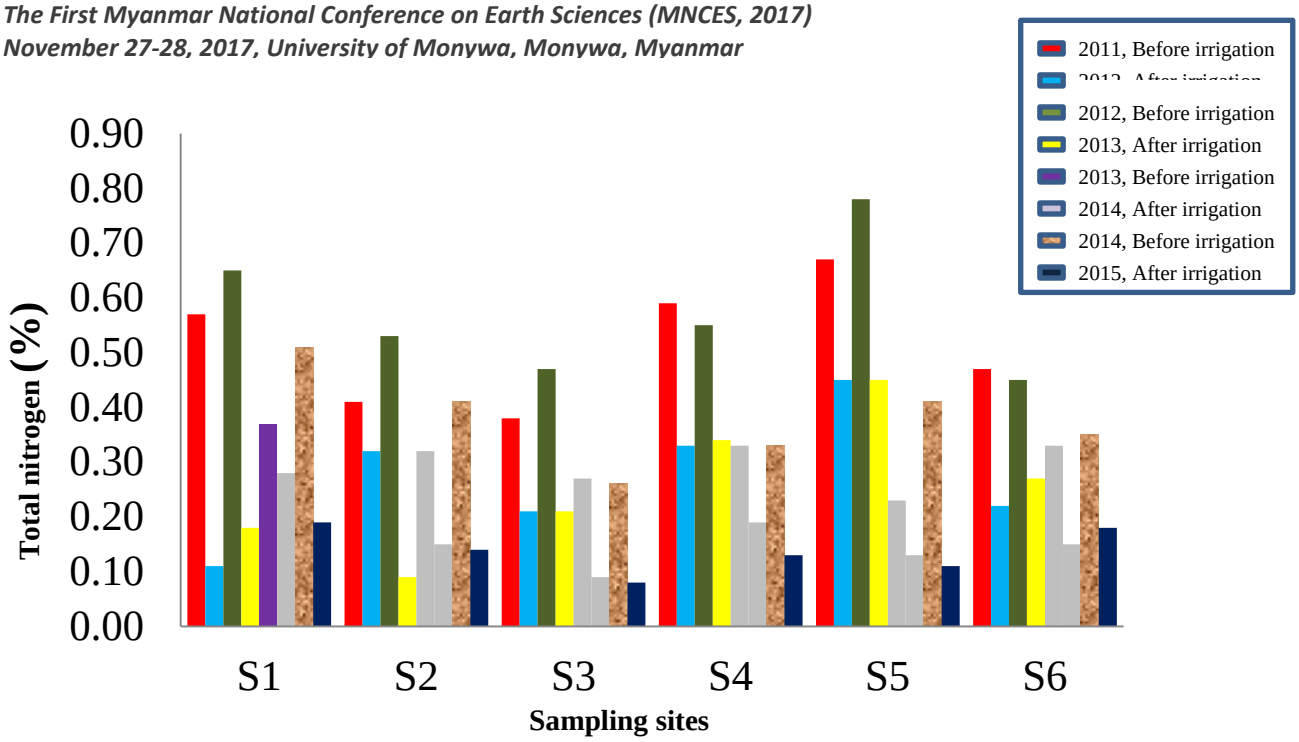
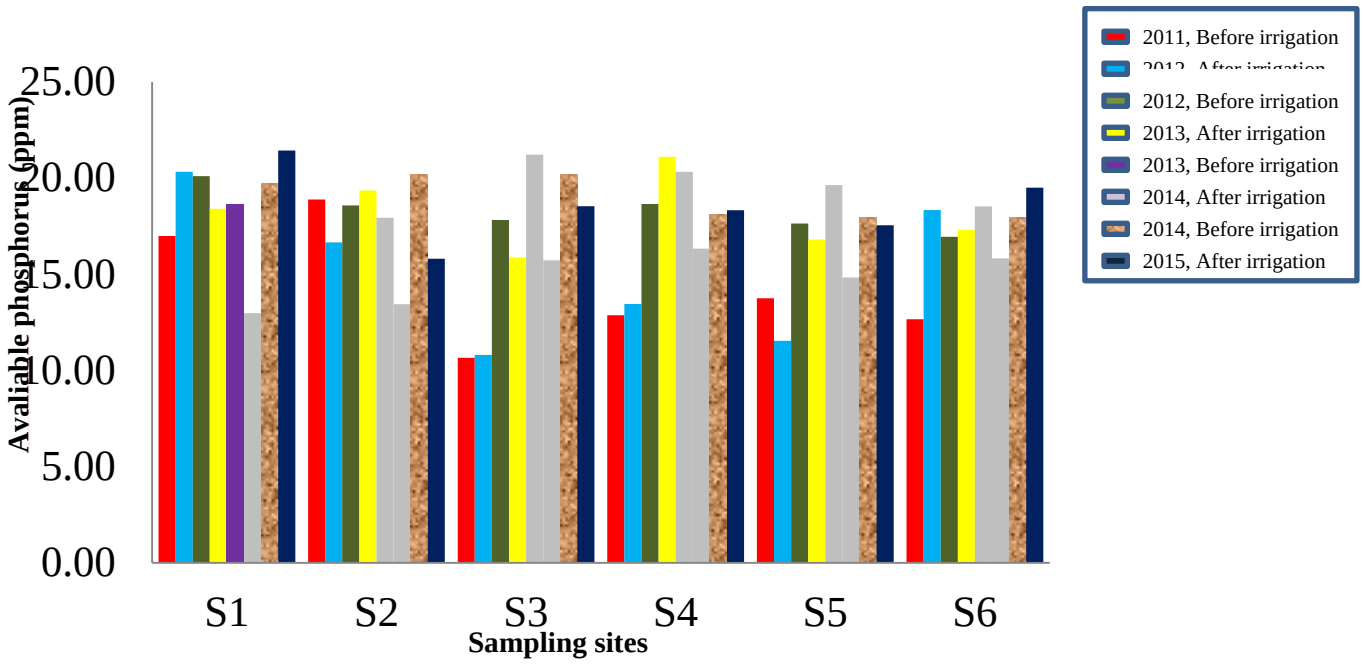


Figure 7. Total nitrogen percent of soil samples from farmlands along Sittaungriver bank in before irrigation and after irrigation periods.



Sittaungriver bank in before irrigation and after irrigation periods.

Figure 8. Available phosphorus contents of soil samples from farmlands along

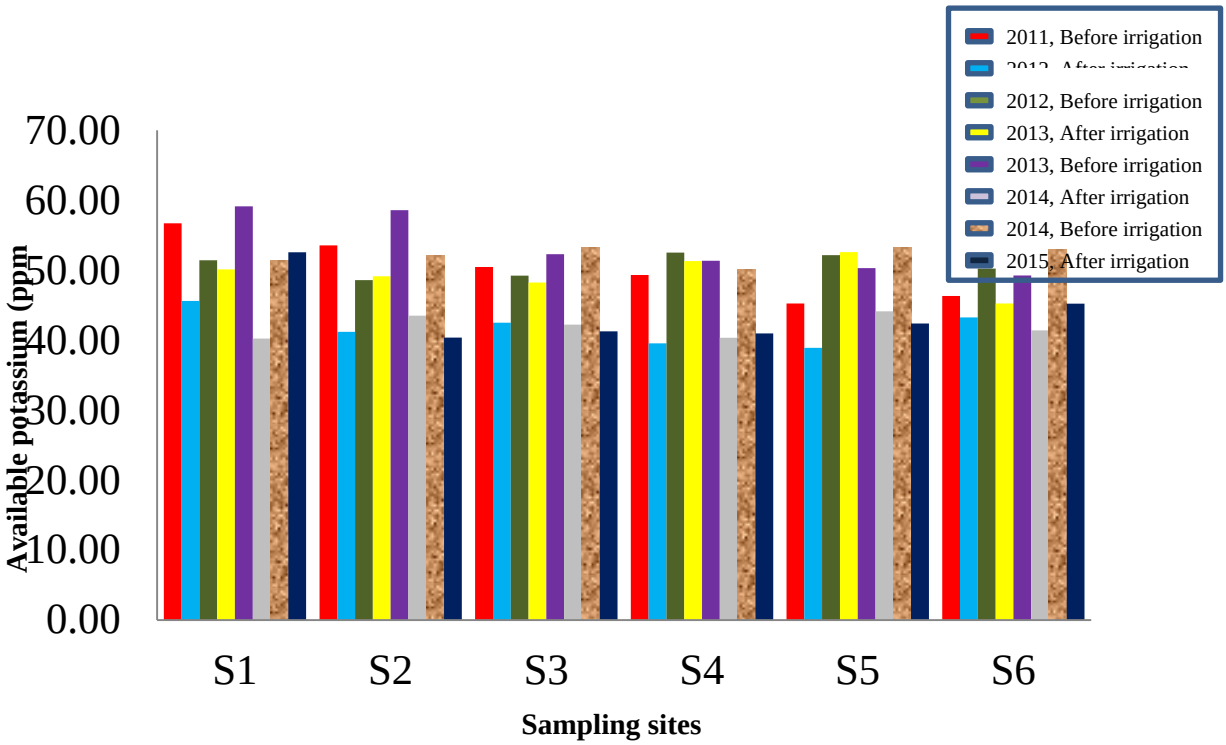


Figure 9. Available potassium contents of soil from farmlands along Sittaungriver bank in before irrigation and after irrigation periods.

Table 3. Sodium Adsorption Ratio of Soil Samples from Farmlands along Sittaung River Bank in Before irrigation and After irrigation Periods

Sample	Sodium adsorption ratio (SAR)							
	Before irrigation 2011	After irrigation 2012	Before irrigation 2012	After irrigation 2013	Before irrigation 2013	After irrigation 2014	Before irrigation 2014	After irrigation 2015
S_1	0.47	0.43	0.50	0.12	1.08	0.55	0.83	0.53
S_2	0.50	0.38	0.60	0.21	0.80	0.68	1.32	0.52
S_3	0.49	0.51	0.44	0.17	0.79	0.79	0.67	0.59
S_4	0.68	0.59	0.37	0.10	0.68	0.60	1.06	0.54
S_5	0.74	0.65	0.68	0.18	0.72	0.81	0.80	0.58
S_6	0.94	0.65	0.72	0.23	0.75	0.59	1.27	1.08
(Mean ±SD)		Before irrigation (0.75± 0.22)			After irrigation (0.50± 0.05)			

Conclusion

Investigations on the suitability of irrigated soil properties were conducted in six small scale farmlands along the Sittaung River bank in before irrigation periods (November) and after irrigation periods (May) during 2011 to 2015. From the analysis of soil samples

from the irrigated farmlands along Sittaung River bank, it was found that soil pH in farmlands were acceptable for cultivation. Silt loam character was found in most farmlands from 2011 to 2015 but sandy character was noted in some soils in after irrigation periods of 2013 and 2014.Low bulk density and high porosity indicated that the soils have good physical condition for plant growth. However, low organic carbon percent was found in soils. High total nitrogen percents were found in before irrigation periods and low to medium contents in after irrigation periods indicating the relatively low nitrogen utilization. High available phosphorus and medium available potassium contents for plant cultivation were observed. Thus, nitrogen fertilizer should be applied for cultivation in farmlands during irrigation periods. Furthermore, sodium adsorption ratios were within the permissible limit of 0 to 3 in both periods indicating that the soils in the farmlands were found to have no adverse effect on horticulture crop production.The lands used for small scale irrigations are also utilized for rain fed agriculture during monsoon. Low cultivation frequency favours the fertility status. Irrigating with river water affect the little decrease in soil composition, macro and micro nutrients in soils. The generating scientific information had paramount importance for sustaining the production and productivity of small scale irrigation in Taungoo area.

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