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SOIL FERTILITY MANAGEMENT IN SEMI-DESERT AND ARID CLIMATES: CASE STUDY-KERKEBET FARM, ERITREA

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Abstract: *Thirty-four soil samples were collected from Kerkebet farm, Eritrea, and analysed. The average soil organic matter (SOM) was 0.28%. The soil fertility can be improved through, among others, organic amendments, conservation agriculture, crop rotation, and use of adapted crop varieties. Resources in that area like Prosopis juliflora, municipal wastes and dam silt can be incorporated to the soil fertility management scheme.*

Keywords: *Soil fertility management, semi-desert, arid climates, Eritrea*

Introduction

Semi-desert and arid climates occupy a significant land area of the earth and a significant human population lives there. Agriculture in such areas is difficult due to the limited precipitation, high temperature and evapotranspiration, limited vegetation and poor soil fertility. Thus, in such resources constrained areas, smart resources

management strategies are crucial for soil fertility improvement, agricultural productivity optimisation, carbon sequestration and climate change mitigation.

In Eritrea, where more than 65% of the population makes its livelihood from subsistence rain-fed farming, semi-desert and arid climates occupy 72% of the country. The agricultural productivity is below 0.7 t ha^{-1} and as a result, food insecurity and poverty yet presents within the farming communities. The country is facing widespread land degradation [Tesfay et al., 2020]; deforestation, desertification, and temperature has increased but rainfall decreased since the 1970s [Ghebrezgabher et al., 2019]. To fight these challenges, the country plans and runs massive soil and water conservation campaigns through mass mobilization in the last two decades. Kerkebet dam, a 330 million-m^3 capacity, is a typical example in the arid northwestern part of the country from which the Kerkebet agroindustry farm is fed. The farm is in its initiation.

Soils in arid and semi-arid regions are typically characterized by low organic matter content, limited nutrient availability, and poor water-holding capacity, posing significant challenges for maintaining soil fertility [Hag Husein et al., 2021]. Thus, the study aims to assess the soil organic matter (SOM) status of Kerkebet farm and recommend potential SOM management strategies for soil fertility enhancement, productivity improvement, carbon sequestration and climate change mitigation.

Materials and Methods

The study was carried out in Kerkebet farm, Eritrea, which is located in the northwestern part of the country within the arid lowlands agroecological zone at an average altitude of 440 m above mean sea level, with 35 ^oC average monthly temperature, 147.16 mm average annual rainfall and 1853.96 mm yr^{-1} potential evapotranspiration rate. Kerkebet farm is a large-scale farm owned by the State of Eritrea. The farm is at its initial stage where, at the time of study, around 10 hectares of land was installed with irrigation facilities and cropping like cotton, onion, tomato, maize, and sorghum was running.

Soil Sampling and Analysis

Thirty-four georeferenced composite surface (0-30 cm) soil samples were collected from Kerkebet farm in Nov 2023. The soil samples were dried, grounded and sieved following standard procedures. Particle size distribution was determined using hydrometer method, texture-textural triangle, bulk density-core sampler, and SOM-Walkley-Black method.

Results and Discussions

Soil Properties

Sandy clay loams dominate the soils of the study area. The average clay, silt and sand contents, in %, were 20.59, 12.28 and 67.13, respectively (Please refer table 1). The soils have low gravel contents, with an average of 0.92%. The average bulk density was 1.40 Mg m^{-3}, which is satisfactory for sandy clay loam textured soils. SOM, in %, ranged from 0.07 to 0.72 with an average of 0.28, extremely low, which

is characteristics of severely eroded and degraded surface soils. Soils in such climates are prone to wind and water erosion, as they are bare because of low vegetation. Windstorms are also frequent in such areas. Soil erosion by wind and water, high temperature, limited vegetation, and overgrazing may contribute to low SOM content of soils [Tesfay et al., 2020: Weldewahid et al., 2023]. Thus, soil fertility improvement strategies have paramount importance for the sustainability of the farm.

Soil Fertility Management

The soils of the study area are poor in SOM. In such arid climates where SOM is a very scarce resource and the sources are very limited, identifying SOM sources, adding to soil and management is very crucial for optimised agricultural production, carbon sequestration and climate change mitigation. Potential strategies for soil fertility improvement include, among others, implementation of sustainable land management practices, for example conservation agriculture, crop rotation, use of adapted crops, and application of organic amendments [Naorem et al., 2023]. Fortunately, there are enough resources around the study area and other parts of the country that cab be tapped, but not yet utilized, for soil fertility enhancement and productivity improvement: 1) Prosopis juliflora, and 2) municipal waste.

Prosopis juliflora, an invasive tree species, is growing and invading fast, threatening biodiversity in the semi-desert and arid riverine ecosystems of Eritrea [Ogbazghi, 2016] where the study area is part of this. Thus, using it for soil fertility enhancement as a compost and biochar also serves as a controlling mechanism from further expansion of the invasive tree.

Most of Eritrean cities and towns suffer from inadequate and inefficient waste management systems. Fortunately, 80% of households are organic and safe. Thus, channeling municipal wastes to soil fertility enhancement has economic, social and environmental benefits. Amelait, Afhimbol, Fortosawa, Sawa, and other towns are growing fast because of the initiation of different farms like Kerkebet farm in the area. Thus, the municipal wastes can be converted to compost and biochar, and applied to soil. Dam silt can also be extracted regularly and applied to farms. As the River starts from the highlands and travels long to reach the Kerkebet dam, it carries a considerable amount of rich soil with it.

Table 1

Descriptive statistics of measured soil properties of Kerkebet farm, Eritrea

Soil Parameter	Minimum	Maximum	Mean	StdD	Skewness	Kurtosis
Gravel, %	0.00	10.35	0.92	1.94	3.87	17.42
Sand, %	15.00	87.50	67.13	15.46	-1.32	2.73
Clay, %	10.00	62.50	20.59	10.61	2.09	6.38
Silt, %	2.50	35.00	12.28	9.24	1.04	0.09
Bulk density, Mg m^{-3}	1.24	1.53	1.40	0.08	-0.06	-1.05
SOM, %	0.07	0.72	0.28	0.19	1.12	-0.07

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ВЛИЯНИЕ РАЗЛИЧНЫХ ФОРМ МОЧЕВИНЫ НА УРОЖАНОСТЬ ЯРОВОЙ ПШЕНИЦЫ

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Аннотация. *Представлены результаты полевого мелкоделяночного опыта по изучению эффективности различных медленно действующих форм мочевины в посевах яровой пшеницы.*

Ключевые слова: *азотные удобрения, медленно действующие удобрения, капсулированная мочевина, монокальцийфосфат, ингибитор аммонификации, ингибитор нитрификации, яровая пшеница, урожайность.*