UGANDA CHRISTIAN UNIVERSITY

MASTERS IN DATA SCIENCE AND ANALYTICS

Research Methods and Publications

By

Dr. Francis Otto

Coursework: Assignment one

Exploring the effects of excessive use of chemical fertilizers on soil health in Eastern Uganda

By

Namakula Martha B26317 J24M19/022

**Literature review**

**Introduction**

Agriculture is the core of livelihoods (IFPRI, 2009), it is a major engine of overall economic growth. With the rapid continuous growth of the human population, there is a growing demand for food and water (Abebe, 2022). To meet the increasing demand, there has been encouragement for the use of organic and inorganic fertilizers. The application of manure and chemical fertilizers can improve soil properties and various additional benefits to enhance soil health (Choudhary, 2018). Soil health is defined as the continuous capacity of the soils to function as a vital living ecosystem, sustain biological productivity, maintain the quality of air and water, and promote plant, animal, and human health (Kihara. J, 2020). However, agriculture intensification with the heavy use of chemicals has a negative impact on the soil health and environment (Gautam, 2019). For instance, farmers in Uganda use 24kgs of fertilizers per hectare every year leading to a 0.31 percent decrease in crop productivity. This results in blighting of leaves and also polluting the water below the plant with excess chemicals (Kanzomba, 2020). According to (Abebe, 2022), Uganda is one of the six African countries that use synthetic fertilizers with (1.2kg/ha). In general, the continuous use of chemical fertilizers in Uganda is increasing.

Most of the inorganic fertilizers influencing the growth and development of plants are NPK fertilizers that are rich in macronutrients nitrogen(N), phosphorus (P), and potassium (K). Moreover, fertilizers also supplement minor nutrients like calcium, sulfur, and magnesium to enhance soil fertility (Stalin Nadarajan, 2021).

The following reviews will focus on the exploration of the impacts of the long-term use of chemical fertilizers on the different soil properties.

* 1. **soil pH composition**

Inorganic fertilizers have both a short-term and long-term impact on the soil pH, this depends on the fertilizer used. For instance, Nitrogen fertilizers can induce soil acidity, based on their content of ammonium, which releases protons as it is converted to nitrate. The nitrification process releases hydrogen ions into the soil which lowers the soil pH making it more acidic (IFDC, 2023). This can lead to the death of microbes in the soil that highly contribute to the composition of the nutrients in the soil. During the acidification process, soils release base cations, such as calcium (Ca) and magnesium (Mg). Over time, and with the continued addition of Nitrogen fertilizers, the base cations can be depleted and aluminum (Al3+) is released from soil minerals, often reaching toxic levels that induce nutrient disorders in plants (Ryan, 2015).

Application of N fertilizers in excess of crop growth need leads to increased leaching of nitrate and cations (Ca, Mg) to groundwater, lakes, and rivers, which affects the quality of these water bodies negatively (Ryan, 2015).

According to (VERMA, 2005) findings, the application of Phosphorus alongside Nitrogen fertilizers led to the increase of soil pH causing alkalizing effects on the soil. However, the soil pH can be corrected over time with the assistance of rainwater leaching, microbial activities, and mineral weathering. To manage the soil pH, farmers are encouraged to often test the pH of the soils before application of fertilizers.

* 1. **soil organic carbon**

Soil organic carbon plays a crucial role in maintaining agricultural productivity by enhancing soil's physical chemical and biological properties (Choudhary, 2018). when soils are not severely degraded (or nonresponsive), they have relatively high soil organic carbon content that supports high crop yields, even in the absence of fertilizer (IFDC, 2023). When plants have access to adequate nutrients, they allocate their energies towards root growth and biomass production. The soil microbes lock carbon into the soil for long periods, which enhances soil fertility and water-retaining capacity; hence, microbes are defined as the producers of soil organic carbon (Stalin Nadarajan, 2021). Therefore, the lowest value of organic carbon in the case of control may be due to poor crop growth that resulted in poor biomass addition (VERMA, 2005).

* 1. **Microbial properties**

Soil microorganisms play an important role in soil biological processes. Microbial diversity is one of the most important microbial parameters in the soil (Choudhary, 2018). These have many essential and basic roles in soil, such as soil fertility, nutrient cycling, enhancing productivity by increasing limited nutrient availability, and degradation of inorganic as well as organic matter (Gowhar Hamid Dar, 2021). Several studies have reported that fertilizer management affects microbial diversity. Therefore, the excessive use of chemical fertilizers can alter the composition and diversity of soil microbial communities. Fertilizers continue remaining in the soil for a long duration hence changing the soil microflora and thus affecting soil health. Fertilizers with a high level of nitrogen based fertilizers especially ammonium can favor the growth of some microbes and hinder inhibiting of others. According to (Gowhar Hamid Dar, 2021), Nitrogen fertilizer, such as urea, is transformed to anhydrous ammonia and carbon dioxide when it is consumed by bacteria. Ammonia is poisonous and is responsible for destroying life in the soil, this reduces the overall microbial diversity**.** Alteration in the soil pH can cause optimal conditions for specific microbial groups leading to a shift in microbial activity and nutrient cycling processes (Abebe, 2022).

* 1. **Soil organic matter(SOM)**

The SOM impacts the physical, chemical, and biological properties of soil, and is a key indicator of soil health (Choudhary, 2018). It is a vital factor that affects soil fertility, soil properties, productivity, and the environment. Normally, SOM decreases with cultivation where no Nitrogen fertilization is practiced, but it may increase with the application of Nitrogen fertilizer it may also accelerate low soil organic matter, however, this study has not been fully demonstrated (Ryan, 2015).

**Conclusion**

Modern agriculture practices have resulted in an increased reliance on chemical fertilizers, leading to increased crop production. However, the continuous use of chemical fertilizers has reduced crop production and soil fertility in some parts of the World. Consequently, the current agricultural experiences have focused on highlighting the importance of chemical fertilizers and addressed some challenges associated with their usage while not providing simple informed practical solutions to overcome these challenges and ensure sustainable food production through effective agricultural practices, especially in Uganda. Several researchers suggest the integration of organic and inorganic fertilizers to improve crop production and crop health. However, the researchers have not come up with tools to assist farmers know the right portions of fertilizers they are supposed to use to ensure appropriate fertilizer application practices. Developing countries like Uganda should concentrate on increasing food production but also keeping the environment.

In our study, we draw from the above knowledge generated from different parts of the world to come up with learning on the impacts of excessive use of chemical fertilizers in Uganda while focusing on the Eastern region. The main objective is to ensure that farmers are provided with knowledge about the impacts of excess use of chemical fertilizers The second objective will focus on developing user friendly simple mobile tools to assist farmers make appropriate measurements for fertilizer application and accurately measure the duration of chemical fertilizer usage, understand the impacts and hence come up with informed decisions on how sustain soil productivity.

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