Feed the Future Innovation Lab for Food Security Policy

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Changing the fertilizer conversation in Nigeria: The Need for Site Specific Soil-Crop Fertilizer Use

Blessing Agada

Key Findings

- Landscape positions dictates fertilizer need. Distinct features in terms of slope, water holding capacity and inherent soil fertility determine the amount and type of fertilizer to be used (ICRISAT, 2017). This needs to be understood and appreciated by farmers, extension agents and those involved in the design and implementation of farmer productivity programs, particularly those involving fertilizer.
- Soil rooting depth is critical. Having 10 -20 cm topsoil loss could decrease yield of corn even with added inorganic fertilizer. Complete total crop failure could occur (see figure 1) where, with increasing depth of soil loss, yields declined drastically even with added fertilizer at recommended rate for the area. Limitations within a soil profile will reduce its effective rooting depth affecting anchorage, growth and development. (Agada 2018 unpublished Ph.D. Dissertation).
- Rainfall characteristics such as high rainfall amounts, intensity and drop size will lead to loss of soil nutrients (weather added as organic or inorganic amendments) and loss of soil particles (Obi and Salako 1995; Agada et al, 2016) furthering the vicious cycle of erosion. Thus with varied environmental conditions across the country, real-time nutrient management strategies are necessary (Theriault et al, 2018).
- There is an urgent need to educate farmers on fertilizer management practice. This involves information on fertilizer placement and timing, soil depth, soil types, slope positions and other agronomic/ management practices. With increased variation in climate, changing, or modifying hitherto farmer knowledge of certain agronomic practices in order to improve agricultural productivity is key (Delgado et al, 2011).

Introduction

Africa is the only continent believed not to have benefitted from the green revolution (Mbabazi et al, 2015). Several factors have been outlined as the reasons for this failure including varying soil types. Even the Malawian heralded Green revolution in Africa has not been without its downsides. Recent findings provide shocking discoveries of high use of synthetic/inorganic fertilizer at great financial cost to farmers and government. Such use has occurred alongside rising soil infertility due to low soil organic matter (SOM) levels that no longer supports maize growth or its responsiveness to fertilizer (Snapp, 2014).

Low soil fertility, is increasingly being recognized as a major biophysical cause for declining food security among small holder households in Sub Saharan Africa (SSA) where soil nutrient resource(s) are continually being depleted with shorter fallow periods and continuous use (Stoorvogel and Smaling, 1990). Soil nutrient resources are continually being depleted because of nutrient mining with no adequate replenishment. This downward spiral has largely led to a decline in crop yields, food insecurity and environmental degradation (Oldeman, 1994; den Biggerlaar, et al, 2004)

Erosion inevitably reduces soil productivity. The extent of the reduction depends on soil profile characteristics, the crop grown, soil management and the microclimate (Lal, 1983). Soil erosion is particularly problematic in the tropics due to high rainfall intensities and generally less fertile soils (Lal, 1998). The highly weathered soils of the topics (Oxisols and Ultisols) are generally less fertile and thus require soil management to be productive.

Following the Abuja declaration in 2006 (where heads of Government in Africa pledged to increase fertilizer usage from the near 8-10 kg/ha to up to 50 kg/ha by 2015), there has been a renewed outcry for an increase in the use of inorganic fertilizers across many countries in Africa. (https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/african-fertilizer-financing-mechanism/abuja-declaration/).

However, this increase of fertilizer usage may not guarantee the desired increase in yield. Various researchers have shown that though fertilizer usage in Nigeria has

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increased compared to earlier reports (Sheahan and Barret, 2014) the yield responses to inorganic fertilizer is still low for many cereals including maize (Liverpool-Tasie et al, 2017; Liverpool-Tasie, 2016). This finding of low yield response to inorganic fertilizer is quite consistent across the continent (Pan and Christiansen, 2012; Mather et al. 2016).

Nitrogen is overwhelmingly the most important nutrient needed to increase yield. However, its availability depends on an understanding of its dynamics, soil organic matter formations and crop use efficiency. Although nitrogen (N) is very important amongst the other 16 essential elements and abundant in the atmosphere, it is highly mobile and limiting especially in the tropics.

Mineralization of N is rapid with high temperatures as well as high losses due to leaching and erosion from high intensity rains of the tropics (Agbede, 1986).

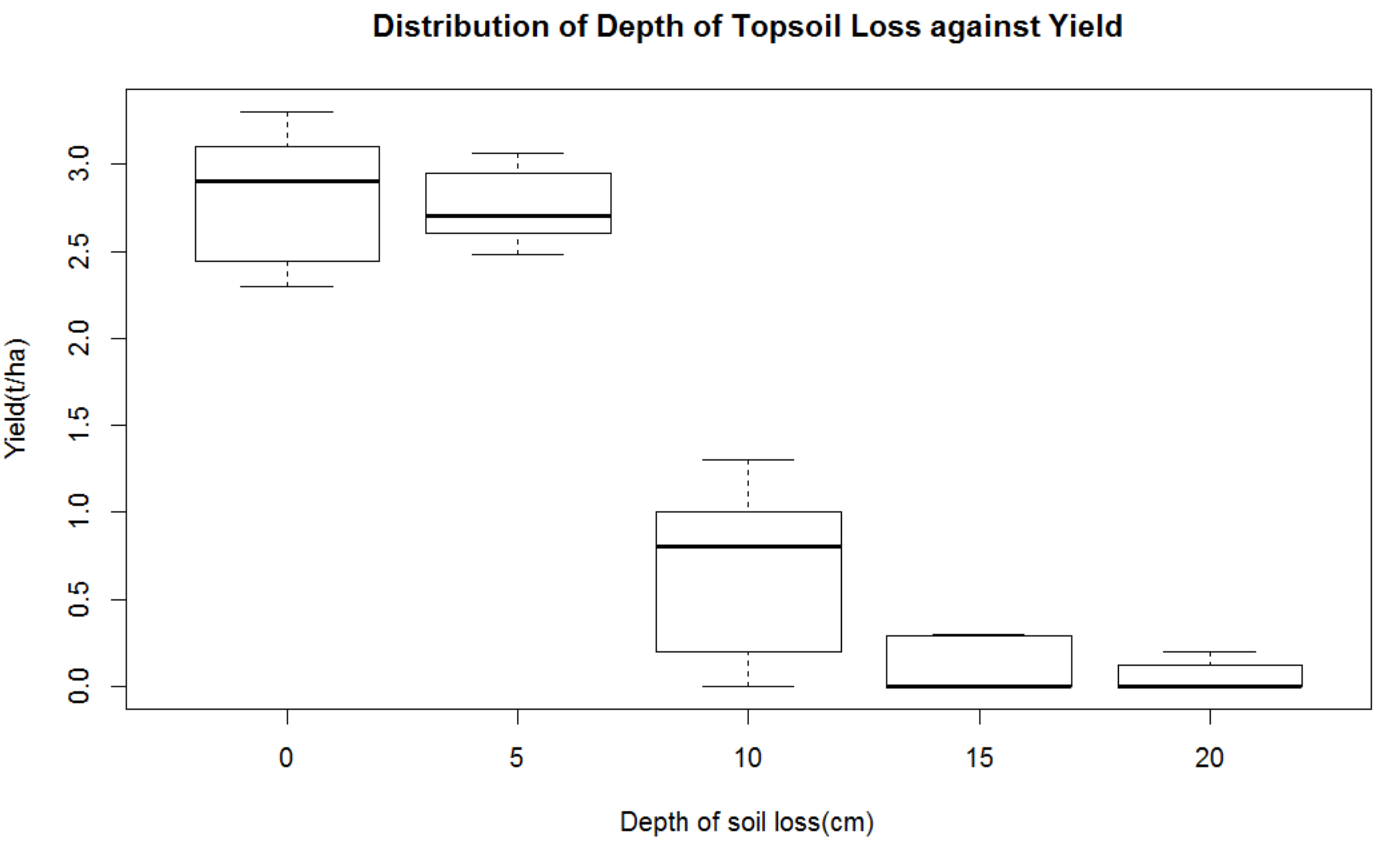

Figure 1: Shows yield losses in relation to incremental depths of topsoil loss (simulated erosion). Top soil loss at 15cm and at increasing depths resulted in complete total crop failure. Implying that as erosion occurs on a field due to high intensity rainfall, conventional tillage methods, kinds of soil management, soil properties which influences productivity are affected as the effective rooting depth (soil bulk) is truncated. This finding brings to the fore issues of soil types, limitations within a soil profile as well as varying rainfall characteristics as obtained in the tropics (Lal and Moldenhauer ,1987; Obalum et al, 2012).

The current approach in Nigeria and most African countries is to provide blanket recommendations of inorganic fertilizer application rates that do not take into account land scape positions, rainfall characteristics, soil types and soil characteristics.

Thus, this method of application is based on soil chemical fertility with still poor yields. Soil is a dynamic entity. Increasing yields requires a holistic approach to managing and manipulating the physical chemical and biological fertility of soils. There is therefore a need, for "**site specific**" nutrient management. Such management practice needs to be tailored to specific soil type, soil rooting depth, inherent soil productivity, slope, crop yields potentials and environmental conditions as these varies across agro climatic zones and farmer fields. It is only when these factors are properly managed, that Nutrient limitations can be easily addressed for increased crop yields.

Preliminary results from on-farm trials with maize in Indonesia, the Philippines, and Vietnam clearly indicate significant opportunities to increase yield and profitability, if crop and nutrient management are fine-tuned to site-specific conditions (Witt et al, 2006) Farmers however, will need to adjust both the timing and amount of fertilizer nutrients (N, P, and K), to allow for better match of crop demand for nutrients.

Site specific management optimizes how the soil supplies nutrient over time and space and matches it to crop requirements so that crop productivity is increased and the efficiency of fertilizer use improved, ultimately reducing cost. It uses the 4R's principle of *Right source*/product, *Right rate, Right placement, Right Timing* to fertilizer application.

As the call for fertilizer use increase is made across the continent (often via expensive government and development programs), particular attention needs to be made to site specific management. This is necessary to ensure that such efforts translate to increase productivity and greater returns on investment as well as reduce Nitrogen losses through volatilization, leaching and runoff ensuring a safer environment.

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About the Author

Agada is a PhD candidate from Federal University of Agriculture Makurdi. Her dissertation deals with the impact of soil characteristics on the usefulness of fertilizer treatment. This policy brief was written by Mrs. Agada at Michigan State University as part of her activities as a Project Scholar of the Feed the Future Nigeria Agricultural Policy Project. The analysis was done using R software and the policy brief was done under the supervision of Dr. Saweda O. Liverpool-Tasie of MSU

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