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Research Application Summary

Improving soil nutrients and water management to increase crop yield for enhanced livelihoods of small scale farmers in semi-arid eastern Kenya

Mochoge, B.E.[1] & Danga, B.O.[1]
[1]Department of Agricultural Resource Management, Kenyatta University,
P. O. Box 43844 – 00100, Nairobi, Kenya
Corresponding author: bmochoge@hotmail.com

Abstract

Food insecurity in Kenya is on the increase unless appropriate measures are taken. This is because nearly 80% of the land is arid to semi-arid and therefore not favorable for crop production using the current methods of production. The issue is limited nutrient use efficiency and low moisture storage in soils to warrant plant growth. This calls urgently for appropriate technologies to be put in place in order to increase moisture storage in soils and increase nutrient use efficiency to spur food production in semi-arid fragile ecosystems. A study to respond to low moisture content in soils and inefficient use of nutrients is being initiated at Gachoka, semi-arid Eastern Kenya. The study will evaluate moisture storage in soil due to run-off rain water captured in the trapezoidal bunds and how this will impact the availability and uptake of nutrients. Use of manure to increase water retention in soils and to provide mineral N through mineralization, and application of N and P fertilizers to supplement the soil available nutrients for sustainable soil fertility management will be part of the treatments. Plots within the bunds measuring 4.5 m x 4.5 m will be used for treatments and maize and cowpea will be the test crops. Available soil moisture content will be measured using neutron water meter and tensiometers while available plant nutrients (NH_4,NO_3 and P) in soil and nutrients contents in plants will be analyzed. Treatments will be factorial and randomized in a complete block design. The data will be subjected to analysis of variance and regression. Nutrient use efficiency and gross returns will be calculated. Expected outputs will include increased knowledge on trapezoidal bunds on water storage by researchers and farmers, higher crop yields, general increase of soil productivity and its sustainable management, and training of two MSc students.

Key words: Kenya, nutrient use efficiency, run-off collection, simulation models, soil moisture storage, Trapezoidal bund

Résumé

L'insécurité alimentaire au Kenya est en croissance à moins qu'on prenne des mesures appropriées. La raison simple est que presque 80% de terre est d'aride à semi-aride et donc non favorable pour la production végétale en utilisant les méthodes courantes de production. Le probleme est l'efficacité limitée dans l'utilisation des nutriments du sol et la faible accumulation de l'humidité dans les sols pour garantir la croissance des plantes. Ceci exige urgemment des technologies appropriées à mettre sur place afin d'augmenter le stockage d'humidité dans les sols et augmenter l'efficacité d'utilisation des nutriments afin de stimuler la production de nourriture dans les écosystèmes semi-arides fragiles. Une étude pour répondre à la faible teneur en humidité dans les sols et à l'utilisation inefficace des nutriments est lancée à Gachoka, dans le Kenya semi-aride oriental. L'étude évaluera le stockage d'humidité dans le sol dû à l'eau de pluie de ruissellement captée dans les digues trapézoïdales et comment effectuer la disponibilité et la prise des nutriments. L'utilisation de l'engrais pour augmenter la conservation de l'eau dans les sols et pour fournir l'azote N minéral par la minéralisation, et l'application des engrais d'azote N et de phosphore P pour suppler les nutriments disponibles du sol pour une gestion durable de fertilité du sol feront partie des traitements. Des parcelles de terrain dans les digues mesurant 4.5 m x 4.5 m seront employées pour des traitements . Le maïs et le dolique de Chine seront les cultures d'essai. Le contenu d'humidité disponible dans le sol sera mesuré à l'aide de l'appareil de mesure à neutron et des tensiomëtres tandis que les nutriments de plante disponibles (NH_4, NO_3 et P) dans le sol et le contenu d'éléments nutritifs dans les plantes seront analysés. Les traitements seront factoriels et randomisés dans une conception de bloc complète. Les données seront soumises à l'analyse de la variance et de la régression. L'efficacité d'utilisation des nutriments et les rendements bruts seront calculés. Les resultants attendus incluront la connaissance accrue sur les digues trapézoïdales sur le stockage de l'eau par des chercheurs et des fermiers, des rendements de récolte plus élevés, augmentation générale de la productivité de sol et de sa gestion durable, et formation de deux étudiants de maîtrise.

Mots clés: Utilisation effective des nutriments au Kenya, Eaux de ruisselement, model de simulation, stockage de l'humidite du sol, bande trapezoidale

Background

Agriculture is a vital development vehicle for achieving the Millenium Development Goal (MDG) on halving the share of

people suffering from extreme poverty and hunger by 2015. This is a big challenge for Kenya and other developing countries whose economic growth depend on agriculture and about 80% of their rural population derive their livelihood from.

Food production in Kenya has been declining for the last three decades (FAO, 2002). Limited good agricultural land (12%), declining soil fertility, impact of climate change and rapid population estimated at 2.8% per annum have been cited as some of the main contributing factors (Mochoge and Mwonga, 1988; FAO,1990). The pressure on good arable land due to high population growth rates, has forced farming to expand to marginal arid and semi-arid lands, which are fragile ecosystems easily prone to quick degradation. In this region, efforts to achieve food security, reduce poverty and improve people's livelihoods are hampered by adverse effects of biophysical factors such as low and erratic rainfall, low soil fertility, and low use of manure and mineral fertilizers (Giller *et al.*, 1997). To improve food production in dry-lands and to reduce poverty, new strategies that enhance soil and water management have been developed. This include conservation tillage, rain water harvesting(RWH) and production of high value market crops (Ngigi 2001; Ekaya, 2007).

The long term effects accrued to improved fertility interventions within RWH structures such as cereal – legume intercrop and combined use of manure and mineral fertilizers have not been well documented. There is need therefore for better understanding on the dynamic soil processes that take place to enable optimize their use and lead to better prediction of crop yields.

Literature Summary

Research to improve food production in dry-lands and to reduce poverty has concentrated on new strategies to enhance soil and water management (Prinz, 1994; Ngigi 2001; Ekaya 2007). In semi-arid Israel, lgbadun *et al.* (2008) demonstrated under irrigated maize that extending moisture availability in the maize root zone, at critical growth storages by just one week can improve maize yield by up to 20%. Increased soil moisture also enhances nutrients use efficiency.

The use of manure improves water holding capacity of soils and the physical sustainability of the soil (Lal *et al.*, 1977; Lampkin, 1992; Mochoge *et al.*, 1997). In some fertilizer trials that have been carried out in Kenya increased yields have been reported and range between 40-80% (Mochoge *et al.*, 1997).

Study Description

Field experiments will be conducted at Gachoka, Mbeere District of the semi-arid eastern Kenya. The site represents low midlands, agro-ecological zone (LM3). The study will investigate the effects of water storage, use of manure (5 and 10 tons/ha) and NP fertilizer (50 and 75 kg/ha) on the dynamic changes in soil physical properties, nutrient use efficiency and microbial regime changes in soil. N dynamic changes will be studied in Mineralization experiments where soil samples will be incubated in the laboratory. Mineral fertilizers and manure will be applied only to maize while cowpeas will benefit from that applied to maize. Measurements of available soil moisture will be done by neutron water meter and tensiometers placed at different depths in the field. Rainfall will also be recorded during the two seasons of the experiment. The treatments will be arranged in a randomized complete block design (RCBD) and replicated three times within the trapezoidal bunds where run-off water will be captured. Plots measuring 6.0 x 6.0 m will be used. Grain yield data will be determined at 12.5% moisture content. Price values of maize and cowpea will be calculated using the market prices of that period; treatment differences will be examined using Turkey – Krammer significant difference (HSD) test, Regression and correlation analyses between treatment means will be done.

Research Application

The research is expected to evaluate the efficiency of trapezoidal bunds in water collection and storage in soil for crop production, and use of manure and mineral fertilizers for crop performance and sustainable soil fertility. The research is also expected to train two MSc students.

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