Journal Brief

INTEGRATED SOIL FERTILITY MANAGEMENT PROSPECTS FOR SOIL PRODUCTIVITY AND FOOD SECURITY IN MACHAKOS COUNTY

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ABSTRACT

Integrated soil fertility management is the most cost-effective and time-efficient method of restoring soil fertility and increasing per capita yields on Sub-Saharan African smallholder farms. However, low acceptance has resulted from a lack of knowledge about the prospects of these strategies prior to promoting them. In 2016, the Mwania watershed in Machakos, eastern Kenya, was surveyed to fill this void. About 174 household heads were chosen using the "farmer-led adoption approach and a pretested structured questionnaire to obtain primary data on their household gender, education level, food security, cultivated land size, soil fertility practices, and constraints to determine the potential use of integrated soil fertility management practises at the watershed level. Data were analysed using the Statistical Package for Social Sciences Version 22 computer program for descriptive attributes. Relationships between dependent and independent variables were determined using the tobit regression model. According to the findings, 85% of households are headed by men, with over 82% being post-primary graduates, who are the main decision makers. The majority (83%) cultivate 2 ha and 57% acknowledged food insecurity, with 89.1%, 73.1%, and 45.1% blaming it on climate variability, limited soil moisture, and a lack of input access, respectively. Low fertility scored 40% at medium level with labour at 40% in low cluster constraints, could be because of high unemployment rates. Animal manure and chemical fertiliser use were reported at 95.5% and 76.6%, respectively, although they were using them separately, probably due to high cost, increased labour requirements, and accessibility problems resulting in continuous low yields. Therefore, huge prospects of integrated soil fertility management practices' use exist in the Kenyan semi-arid, especially when promoted at community level.

Keywords: Adoption,potential, integrated soil fertility management requirements, tobit model, community level.

INTRODUCTION

Globally, agricultural growth in 21st century is constrained with new and complex challenges emerging from global warming and climate variability (Unganai and Murwira, 2010; Kwena *et al*., 2018). The situation is worse in semi-arid areas such as lower eastern Kenya, where annual rainfall is between 500 and 800 mm, with a coefficient of variation of 45% (Jaetzold *et al.*, 2006), and the agricultural growing season lasts between 60 and 120 days. Temperatures range from 20 to 35°C, while daily pan evaporation rates range from 4 to 9 mm. These areas have annual moisture deficits of more than 50% and are the most vulnerable to land degradation (Itabari *et al.*, 2011; Karuma *et al.*, 2014; Kathuli and Itabari, 2015; Jaetzold *et al.*, 2006). Cereals and legume yields seldom exceeds one tonne and 0.5 t/ha, respectively against more than 1.9 t and 0.5 t/ha obtained from surrounding Kenya Agricultural and Livestock Research Organization (KALRO) stations (Kwena *et al*., 2017). According to Kenya National Bureau of Statistics (KNBS) (2019), Kenya's population residing in the country's eastern dry regions was 8%. It is crucial to note that the population of these regions is steadily increasing, with the majority migrating from overpopulated highlands to arid regions, thereby aggravating widespread poverty, a recurrent need for emergency food supply and an increasing dependence on food imports. Kenya imports on average 7.5 million bags of maize yearly (Faostat., 2021), to meet domestic demand, and expected climate change would exacerbate the problem (Unganai and Murwira, 2010). This ever-increasing demand for food, despite limited land resources, necessitates the development of new, more

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environmentally friendly food production methods, and one such approach is Integrated Soil Fertility Management (ISFM)

ISFM is a systematic, conscious, participatory, and broad knowledge intensive holistic approach to soil fertility research. To maximise production potential, the approach advocates for careful management of soil fertility aspects. It entails the development of nutrient management technologies to ensure an adequate supply of organic and inorganic inputs (Vanlauwe and Zingore, 2011; Mugwe *et al*., 2019). These technologies are widely used elsewhere to quickly and cheaply reverse declining soil fertility and obtain desired crop yield (Saginga and Woomer, 2009). But their professional use hasn't been well transferred to Kenyan semi-arid fields, and some of these technologies are too expensive and time-consuming for poor small-scale farmers to fully implement and reap the optimum benefits ISFM envisaged (Mugwe *et al*., 2009; Saginga and Woomer, 2009; Mutuku *et al*, 2017). These factors not only influence ISFM adoption, but also largely contributing to distorted agronomic knowledge at scale (Mugwe *et al.*, 2009; Mutuku *et al.*, 2017). Farmers, for example, are quick to adopt new crop varieties while consistently ignoring recommendations for improved soil and water management practises, resulting in marginal yield increases from improved germplasm rather than the full benefits envisaged in the ISFM framework. The majority of farmers, for example, do not use right inorganic fertiliser type, rates and timing (Ariga, *et al.*, 2008; Itabari *et al.*, 2013; Kwena *et al*., 2017). Therefore, ISFM concept necessitates a minimum level of education from participating farmers in order to grasp principles drawn from a variety of disciplines, particularly fertiliser use, which remains an entry point (Vanlauwe and Zingore, 2011; Mutuku *et al.*, 2017). However, the use of animal manure alone is limited in terms of collection, processing and application, necessitating huge family labor force which sometimes is not readily available (Itabari *et al*., 2013; Mutuku *et al*, 2017).

Instead of the silver bullet collections that have been used in the past, ISFM is a compass that shows land managers the best sustainable system of restoring soil fertility for improved rural livelihoods (Sanginga and Woomer, 2009). It becomes reasonable before scaling up a basket of ISFM recommendations that education level, labour demand, and cultivated land size must be well articulated (Mugwe *et al*., 2019; Mutuku *et al*., 2017). As a result, the study sought to ascertain the likelihood of employing the ISFM strategy to reverse declining soil fertility and boost crop yields. This study is significant for both farmers and researchers because it intents to identifies workable ISFM options and research that can be scaled up quickly and cheaply rather than traditional blanket ISFM recommendations, which most farmers avoid.

MATERIALS AND METHODS

Description of the Study area

The Mwania watershed covers 899.9 ha and is located at 10 33º to 10 34º E and 370 5º to 370 29º S in semiarid Machakos County, Kenya, . The study was superimposed on the ongoing project, "Integrated Management of Water for Productivity and Livelihood Security in Eastern and Central Africa under Variable and Changing Climatic Conditions." It operated in lower eastern Kenya's Machakos county in LM_4 (lower mid-land marginal cotton zone) and LM_5 (lower mid-land livestock millet zone).

The watershed is located in agro-ecological zone (AEZ) IV, defined as semiarid areas with limited potential for rain-fed agriculture (Jaetzold *et al.* 2006). The watershed receives 711 mm of annual rainfall, averaging between 250 and 400 mm per season, with a significant inter-seasonal coefficient variation (%) of 48 to 50 (Jaetzold *et al.* 2006). Farmers in the study area believe that short rains are more reliable for crop production than long rains, possibly due to their more even distribution (Okwach and Simiyu, 1999). Given that the majority of rivers in the study area are seasonal, they cannot provide adequate water when it is most needed. Groundwater resources are also scarce, and the water produced in many areas is saline (Jaetzold *et al*., 2006). The seasonal high and low temperatures are 25°C and 13.1°C, respectively, with July and September being the coldest and hottest months. Evapotranspiration rates are generally high, reaching 8.2 mm/day in February and September (Jaetzold *et al*., 2006), with February and September being the hottest months of the year (Jaetzold *et al*., 2006). As a result, the study site accurately represents the prevailing semiarid climatic conditions in Machakos County.

The Mwania watershed has prominent biophysical characteristics such as undulating topography with high slope variations ranging from 2-20% (Jaetzold *et al.*,