

Farmers in the central highlands of Kenya do face problems of low crop yields due to soil fertility decline. This is as a result of continuous cropping, nutrient losses through crop harvests, soil erosion and leaching coupled with inability to replenish the soil through use of external inputs. The situation is aggravated by poor adoption, among farmers, of improved soil fertility management options. This study investigated feasibility of using integrated soil fertility replenishment technologies (SFRT) involving organics in combination with inorganic fertilizer to improve soil fertility and consequently crop yields in Chuka, Meru south district. The organic materials evaluated comprised of two leguminous trees (*Calliandra calothyrsus* and *Leucaena trichandra*), two herbaceous legumes (*Mucuna pruriens* and *Crotalaria ochroleuca*), *Tithonia diversifolia*, a locally available tree shrub, and cattle manure. Effect of these organic materials (sole or combined with inorganic fertilizer) on maize yields and soil properties (pH, macronutrients, inorganic nitrogen) was assessed under both on-station and on-farm experiments. Farmer adoption surveys were carried out to assess adoption process that included technology preferences and farmers' experiences, as well as household and farm characteristics determining decision to adopt or not to adopt SFRT. All biophysical data were subjected to ANOVA and means separated using LSD at  $\alpha = 0.05$ . Social data were subjected to descriptive statistics and summarised using means, frequencies and percentages. Factors influencing adoption were subjected to multivariate regression analysis. The on-station experiment showed that treatments that had sole application of the organic materials at 60 kg N ha<sup>-1</sup>, and organic materials (30 kg N ha<sup>-1</sup>) plus inorganic fertilizer (30 kg N ha<sup>-1</sup>) gave similar yields ( $p > 0.05$ ). However, these treatments recorded higher maize yields than that from sole inorganic fertilizer treatment. They maintained maize yields at 4 to 6 t ha<sup>-1</sup> and should therefore be recommended for use by farmers, who currently get 0.5 to 1.5 t ha<sup>-1</sup> from their conventional farming systems. Herbaceous legumes gave the lowest yields among the organic resources, but performed better than the control treatment. At the onfarm trials, maize yields from researcher designed and farmer-managed trials were less variable than those from farmer designed and managed trials, which was attributed to differences in management practices among farmers. The organic materials had a positive contribution to soil pH, K, C and N while cattle manure showed superiority in terms of its contribution to soil properties. The amount of soil inorganic N within the plow layer and N-uptake by maize monitored during 2002 LR and 2004 LR seasons showed variation among the treatments, sampling periods, and between the seasons. There were high amounts of soil inorganic N at 0-15 cm soil depth at the beginning of the season, followed by a decline from around 4 to 8 weeks after planting. This trend was attributed to rapid mineralization of the incorporated organic materials and "Birch effect" that was followed by leaching, due to intense rainfall, coupled with uptake of N by the maize crop. Treatments that had tithonia, calliandra and leucaena applied had the highest soil inorganic N in most sampling periods and also the highest cumulative N uptake by maize. It was evident that the effect of external inputs on N uptake was dependent on climatic conditions (especially rainfall) prevailing throughout the growing period. Poor rains during 2004 LR resulted in accumulation of soil inorganic N and restricted N uptake by the maize crop. There was high residual inorganic N at 100-150 cm soil depth that was probably due to greater N mineralization compared to plant uptake in the top-soil immediately after the onset of the rainy season and subsequent nitrate leaching. This inorganic N observed in the 100-150 cm depth is below the rooting zone of most maize plants and may not be available to the maize crop. The study established that first farmer preferences were SFRT involving manure and tithonia combined with fertilizer followed by fertilizer alone and was attributed to easy accessibility and probably low opportunity cost of practicing these technologies. Technologies

that combined organic and inorganic fertilizer were more popular among farmers and farmers used them on significantly ( $p \leq 0.05$ ) larger plots than with application of either sole organics or inorganic fertilizer. Farmers developed innovations that involved mixing of organic materials, which gave high yields possibly due to increased nutrients supply and other benefits associated with organic materials. The main benefits reported were increased crop yields and fodder (calliandra and leucaena) and this could have been a driving force to the adoption of the technologies. The major constraints were high labour demand and inadequate biomass and farmer tried to cope by preparing land early; applying materials without chopping and planting trees near the crop fields. Five factors were identified to significantly ( $p \leq 0.1$ ) influence adoption. Age of household head and number of mature cattle negatively influenced adoption.

Farm management category, ability to hire labour and number of months in a year households bought food for the family positively influenced adoption. The odds in favour of adoption increase by a factor of 0.9 for households hiring labour, while households buying food for more than three months in a year have an adoption probability of 25%. The implication of these results is that adoption of improved SFRT could be enhanced through targeting of young families where both spouses work on farm fulltime, food insecure households and farmers who lack access to other sources of soil improvement such as those without enough cattle to produce manure. This study has filled an important gap by providing a recommendation on some appropriate technologies for replenishing soil fertility by smallholder farmers in Meru South District. The role of cattle manure in increasing soil fertility parameters was well demonstrated and due to its easy accessibility in the region, it is likely to remain one of the key resources for managing soil fertility. [t is therefore recommended that factors that seem to limit its performance especially on farms such as low quality be addressed. The study also showed how farmers test and manage new soil fertility management innovations to meet their livelihood objectives, and identified factors crucial for enhancing adoption of integrated SFRT. The government therefore needs to strengthen, expand and support long-term soil initiatives that aim at enhancing adoption of these technologies. Policies and institutional support should be focussed on enhancing willingness and ability of farm households to adopt the technologies while taking into consideration key factors that were identified to influence adoption in this study. Further research is recommended on the following areas: residual effects on soil of low and high quality organic resources, partitioning of N upon decomposition of these resources, tradeoffs of biomass banks on farms and their economic viability, diffusion and potential of up-scaling of integrated soil fertility management technologies in the area.