Introduction

In Kenya crop production is spreading rapidly to marginal areas formerly considered unfarmable due to steep slopes and frequent droughts. There is also a shift in crop production in favor of annual crops. These developments are causing deterioration of the already fragile environment.

The shifting cultivation systems in the tropics avoided the damage of the fragile soils (Lai 1976) but is not presently applicable because of scarce land resources. Conventional tillage has accelerated erosion, destruction of soil physical properties (Lai 1976) which has led to reduced productivity of the soils and frequent crop failures.

Minimum tillage eliminates excessive tillage and is reported to increase organic matter percentage (Thomas et al 1984), to conserve moisture, reduce soil erosion, and reduce labor requirements as well as to allow more land to be utilized for food production. This on-farm experiment on maize + bean cropping system was carried out in three agroecological zones (AEZ) of upper midlands (UM2, UM3, UM4) (Jaetzold, 1983) of Kiambu and Embu districts of Kenya. Five treatments: 1) conventional tillage 2) pre-emergence alachlor 3) post-emergence bentazon 4) farmers' method and 5) zero tillage (no till) were tested in a randomized complete block design and evaluated on seed germination, crop performance, crop yields, soil characteristics and farmer assessment.

RESULTS

Germination:

Germination of both maize and beans was satisfactory in all treatments in various AEZs. Germination was faster and more uniform in zero tillage probably due to moisture conserved by mulch.

Crop development:

Post-emergence bentazon suppressed growth of maize and beans with more phytotoxicity observed in UM4 (hot dry areas). Maize plants under zero tillage in UM2 (cool wet areas) were smaller and nitrogen deficient. These plants caught up with those of other treatments and attained dark green color at tasselling. Maize in UM3 and UM4 developed normally with zero tillage treatment resulting in healthier looking crops than in other treatments. Zero tillage maize in heavy clay soils performed poorly compared with conventional and the farmers' method.
Plant height
Bean plant height was not affected by tillage methods. Zero tillage in UM2 resulted in short nitrogen deficient plants till tasselling after which the plants attained the height and green color of the crops under other treatments. In UM3 and UM4, maize under zero tillage was taller than in other treatments while post emergence treatment had shortest plants.

Pods per plant: Zero tillage resulted in more pods per plant in all AEZs with the greatest increase in UM4.

Crops yields:
Beans: Beans under zero tillage resulted in higher yields in all AEZs with percentage increase over conventional tillage increasing with increasing moisture deficits. UM2 at 29% while UM4 58%. Pre-emergence alachlor had higher yields than conventional and farmers' method.

Maize: Zero tillage in UM2 resulted in reduction (9%) of yield compared with conventional tillage. This reduction could be due to reduction in vigor in zero tilled plots. However, maize in UM4 zero tillage out-yielded other treatments with a yield advantage of 12% over conventional tillage.

Soil properties:
Infiltration rates: In general infiltration rate was higher in UM2 than in UM4. UM2 receives higher rainfall. The higher infiltration rates helps in water percolation thus reducing erosion by runoff, while increasing the loss of nutrients especially nitrates through leaching. Nitrate leaching may be the cause of poor maize crop performance at development in UM2.

Soil moisture conservation: Though soil moisture was not quantified the crop under zero tillage in UM4 began showing signs of moisture stress long after other treatments were severely affected. The crop in zero tillage passed short dry spells without wilting.

Soil erosion: Soil loss by water erosion was not quantified but farmers observed that all plots that received primary and secondary tillage had observable soil loss during or after a heavy downpour. Zero tillage plots had no observable soil loss.

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