# Exploiting Arbuscular Mycorrhizal Fungi-Rhizobia-Legume Symbiosis to Increase Smallholder Farmers' Crop Production and Resilience Under a Changing Climate

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## Abstract

Beneficial soil microbiota, such as arbuscular mycorrhizal fungi (AMF) and rhizobia, provide essential agroecosystem services in smallholder farming systems. Such microorganisms have great potential to promote crop production and resilience under a changing climate in sub-Saharan Africa. However, their function is affected by agronomic management practices, crop genotype and soil quality, among other factors. In this work, we sought to determine the effect of soil quality and crop genotype on nodulation, percentage mycorrhizal colonization and growth of maize and cowpea crops. Soil samples were obtained from ten smallholder farms with known management history in Embu and Kitui counties of Kenya and analysed for physicochemical parameters. Greenhouse bioassays were then carried out, where the samples were put in sterilized pots in four replicates and maintained in a completely randomized design. Four cowpea and maize genotypes (locally grown landraces and recommended genotypes from *Kenya Agricultural and Livestock Research Organization*) were grown in pots for 40 days. After harvesting, nodulation in the case of cowpea, shoot dry weights and mycorrhizal root colonization were determined. Remarkably, cowpea genotypes differed significantly ($p < 0.0001$) in nodule number. The locally cultivated landrace (C2) recorded the lowest nodulation with 30.4 nodules plant$^{-1}$, compared to the open pollinated varieties (OPVs): C1, 39.15; C3, 43.70; and C4, 40.6 nodules plant$^{-1}$. Among the maize genotypes, the locally cultivated landrace (M3) recorded a significantly ($p = 0.008$) higher percentage of mycorrhizal root colonization (68.9%) compared to the OPVs: M1 58.1% and M2 65.3%, while the hybrid (M4) had the lowest root colonization of 57.8%. Soil characteristics influenced nodulation and mycorrhizal colonization, where soil P was positively correlated to cowpea nodulation. Soil organic matter, nitrogen, pH and calcium positively correlated with AMF maize root colonization. Our results demonstrate the strong effect of soil quality and crop genotype on AMF-rhizobia-legume symbiosis, which affects overall crop growth and production. These factors should therefore be critically considered during the development of efficient low-cost inocula for enhanced smallholder farmers' crop production.

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