Bioenergy crop *Miscanthus x giganteus* acts as an ecosystem engineer to increase bacterial diversity and soil organic matter on marginal land

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Bioproduct crop cultivation on the world's vast amount of marginal land could foster agroecosystems that not only provide renewable sources of energy and materials but also help to rehabilitate damaged lands and mitigate climate change. However, we lack fundamental knowledge of the microbially-mediated processes that govern biomass crop productivity on and rehabilitation of marginal lands. For example, plant-microbe interactions occurring at the root-soil interface undoubtedly influence plant productivity and soil nutrient cycles, but the underlying mechanisms of these dynamics remain obscure. *Miscanthus x giganteus* (*Miscanthus*) stands out for its propensity to produce large amounts of biomass and accumulate soil carbon even on marginal lands, and emerging evidence suggests the clear role of plant-microbe interactions in facilitating these favorable traits. However, we lack a data-driven, mechanistic understanding of how *Miscanthus* alters soil microbial community structure and function leading to soil organic matter accumulation and high plant yields. This is especially true when considering variation in land management strategies (e.g., fertilization strategy) and disturbance intensity. To fill this knowledge gap, we established *Miscanthus* stands on marginal land in West Virginia, USA across a spectrum of disturbance intensities and fertilization regimes. We measured plant performance, soil properties, and microbial dynamics over the first three years of *Miscanthus* establishment. We determined that plant performance (e.g., aboveground biomass yield) and microbial carbon use efficiency (CUE) increased over time during establishment under all disturbance intensities but remained lower overall at the most intensely disturbed site. Across all sites, bacterial diversity and microbial carbon use efficiency increased over time and were positively correlated with soil organic matter. We also observed increases in the relative abundance of key plant growth promoting microbes (e.g., mycorrhizal fungi and bacterial N-fixers). There was no effect of nutrient addition on plant yield, soil carbon concentrations, or microbial carbon cycling. All told, our results suggest that *Miscanthus* consistently increases microbial diversity and carbon use efficiency, facilitating soil organic matter accumulation across sites despite varying land use histories and soil properties. In this way, *Miscanthus* acts as an ecosystem engineer, improving soil biological and chemical properties such that highly disturbed soils come to resemble less disturbed systems over time.