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Livestock Corralling, Plant Density and N Fertiliser Effects on Soil, Weed, Maize Yield and Income

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Abstract

Small scale crop-livestock farming systems dominate in West Africa. Farmers adopt different practices such as keeping animals overnight on fallow lands to deposit manure and urine (corralling), different cropping densities and apply organic and inorganic fertilisers to maximise crop yields and improve soil fertility. However, quantitative data on the interactions of these practices on crop yields, soil properties and vegetation resources is limited. A two-year study was conducted in Sudan savannah ecology of Ghana to test the hypothesis that stocking density of sheep and goat (SDSG) corralling, maize plant density (MPD) and N fertiliser rate (NFR) may increase soil quality, weed diversity, yield and net income. A split-split plot design with eight household farms as replicates was used to study the effect of three SDSG (0, 70 and 140 heads ha⁻¹, main-plot), three MPD (66 667, 100 000 and 133 333 plants ha⁻¹, sub-plot) and three NFR (0-40-40, 60-40-40 and 90-40-40 NPK kg ha⁻¹, sub-sub plot). The animals were corralled from 19:00 to 06:00 hours GMT the following day with no feed and water for a period of 178 nights. The animals grazed communal pastures and crop residues during the day before corralling them at night. Increasing the SDSG corralling from 0 to 140 heads ha⁻¹ increased ($P < 0.01$) soil chemical and biological properties. The SDSG affected weed species diversity with high ($p < 0.01$) number of broadleaves, grasses, and sedges on plots where sheep and goat were corralled. The SDSG \times MPD and SDSG \times NFR interactions had significant on grain yield and net income. The interaction effect increased grain yield by 92% and net income by eighteen-fold. The results suggest that maize-livestock farmers without access to mineral fertiliser could corral sheep and goats at 70 or 140 heads ha⁻¹ with maize plant density at 100 000 plants ha⁻¹ for improved grain yield and net income. Those with access to mineral fertiliser could corral sheep and goats either at 70 heads ha⁻¹ with mineral fertiliser at 90 kg N ha⁻¹ or 140 heads ha⁻¹ with mineral fertiliser at 60 kg N ha⁻¹ to increase grain yield and net income on Ferric lixisol soils of Sudan savanna zone of Ghana and similar ecologies.

Keywords: Fertility, interaction effect, profitability, savannah, stocking rate