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Sustainable intensification of smallholder crop-livestock farming systems in northern Ghana: Optimising groundnut plant density for grain and fodder

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Abstract

The crop-livestock farming system is a common farming practice in West Africa with many technologies developed to intensify the system's productivity. However, there is limited literature on the assessment of the sustainability of integrated crop-livestock technologies at farm scale. Two on-farm trials (Agronomic trial and Livestock feeding trial) were conducted for two years (2017–2018) to identify a groundnut plant density that would be suitable, particularly for food (grain yield) and feed (fodder). Experiment I had four groundnut plant densities (22, 15, 11 and 9 (farmer practice) plants/m²) laid in RCBD with eight replications per treatment whilst the experiment II had the same four plant densities as treatments laid in RCBD with three replications per treatment. We applied the Sustainable Intensification Assessment Framework (SIAF) to compare the sustainability of the above treatments. The SIAF measures the sustainability of agricultural technologies based on five domains: productivity, economic, environment, human and social. We conducted the assessment in three steps: (I) Measured selected indicators from the five SIAF domains which were useful to answering research question, (II) Converted measured values of the indicators into scores using a scale of 0–1 and (III) Aggregated the scores under each domain and calculated sustainability index (SI) using geometric rules considering each SIAF domain as an edge of a pentagon. Specific indicators by domain measured were grain and fodder yields, weed biomass and livestock (Sheep) body weight (productivity), profitability (economic), vegetative cover, biological nitrogen fixation, leaf spot disease incidence and manure quality (environment), food security and nutrition (human) and technology rating by gender (social). The SI for 22 plants/m² increased by 82–215 % compared with that of the other treatments and was greater than one (above maximum score limit) indicating better SI relative to the other treatments. We recommend that planting groundnut at a density of 22 plants/m² will enhance the sustainability of smallholder crop-livestock farming system in northern Ghana and similar agro-ecologies through its effect on productivity, income, food security, nutrition, and gender equity.

Keywords: *Arachis hypogaea*, plant density, savannah, smallholder farmers