Tropentag, September 10-12, 2025, hybrid conference

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Arrangement, timing, and synergy: rethinking maize-soybean intercropping for productivity gains in southern Africa

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Abstract

Intercropping improves resource-use efficiency and crop synergy. In Southern Africa, adding soybean to maize systems can increase total yield and protein output per area. This study assessed maize-soybean intercropping under different spatial (sole maize/soybean, within-row, 1–1, 2–2, 4–4 strips) and temporal (early, medium, late) arrangements at Chitedze (Malawi), Villa Ulongue (Mozambique), and Msekera (Zambia) using a split-plot randomised complete block design (2023–2024) replicated four times. Key parameters included soil moisture (%), chlorophyll, grain yield (kg/ha), harvest index (HI) (%) and land equivalent ratio (LER).

Soil moisture measured during flowering (maize) and podding (soybean) showed early and medium plantings at Chitedze having higher moisture (5.7 %) than late (4.2 %). At Msekera, 2–2 and 4–4 strips retained more moisture (44 % and 32 %) than sole cropping (25.5 %). Chlorophyll content was consistently higher in strip systems across sites: maize recorded 50–75 and soybean 35–50, versus 30–45 and 20–35 SPAD units in sole and within-row systems.

Intercrops had higher LER than sole crops, except for late planting at Chitedze and 2–2 strips across windows at Villa Ulongue (LER < 1). At Chitedze, LER ranged from 1–1.7 (early), 1.1–1.2 (medium), and 0.5–0.7 (late). Villa Ulongue showed 1.2–2.3, 1.1–2.7, and 1.0–2.7; Msekera had 1.1–1.4, 1.0–1.2, and 1.2–2.3 for early, medium, and late windows.

Soybean yields varied by site. At Chitedze, early and medium sole crops yielded 1300 and 1100 kg/ha; early 2–2 matched medium sole. At Villa Ulongue, 4–4 strips yielded 1800–1900 kg/ha, exceeding 1–1 and within-row (500–600 kg/ha). At Msekera, sole cropping yielded highest; 4–4 gave 900 and 1200 kg/ha for early and medium, others <500 kg/ha.

Maize yields peaked in 4–4 strips at Villa Ulongue (6000, 5800, 4300 kg/ha for early, medium, late). Others yielded <1 t/ha. At Chitedze: 1700, 1000, and 500 kg/ha. At Msekera: 3000–3100 kg/ha (early/medium), 2000 kg/ha (late). HI trends: Chitedze (55 % early/medium vs. 32 % late); Msekera (35.3 % vs. 30.5 %).

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Overall, early and medium planting with 2–2 and 4–4 strips improved yields and LER compared with sole cropping, offering productive, protein-rich systems for smallholders.

Keywords: Chlorophyll content, grain yield, harvest index, intercropping, land equivalent ratio, maize, planting windows, soil moisture, soybean