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## Maximizing carbon sequestration through integration of pigeon pea in smallholder systems across South Asia and Africa

SHEM KUYAH<sup>1</sup>, JULES BAYALA<sup>2</sup>, KANGBENI DIMOBE<sup>3,2</sup>, KARL HUGHES<sup>2</sup>, MATTIAS JONSSON<sup>4</sup>,  
TARIRAI MUONI<sup>4</sup>, SHALANDER KUMAR<sup>5</sup>, A. SIGRUN DAHLIN<sup>4</sup>, WELDESEMAYAT SILESHI<sup>6</sup>, INGRID  
ÖBORN<sup>4</sup>

<sup>1</sup>*Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya*

<sup>2</sup>*The Center for International Forestry Research and World Agroforestry, Burkina Faso*

<sup>3</sup>*University of Dedougou, Burkina Faso*

<sup>4</sup>*Swedish University of Agricultural Sciences (SLU), Sweden*

<sup>5</sup>*International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India*

<sup>6</sup>*Addis Ababa University, Ethiopia*

### Abstract

Sustainable intensification is one of the options recommended for increasing carbon sequestration for the dual purpose of improving crop productivity and mitigating climate change. Yet many questions remain, such as which species give the greatest soil and aboveground carbon benefits. The CGIAR Research Program on Grain Legumes and Dryland Cereals has identified pigeon pea (*Cajanus cajan* L.) as one of the priority crops capable of transforming underperforming agriculture to become resilient, productive and profitable. Despite the large body of literature on pigeon pea, its contribution to carbon sequestration in agroforestry has not yet been explored. We scanned publications to determine the role of pigeon pea in carbon sequestration in Africa and South Asia. Carbon in post-harvest (aboveground) residues from pigeon pea was  $2.21 \pm 0.38 \text{ Mg ha}^{-1}$  in Africa and  $2.75 \pm 0.34 \text{ Mg ha}^{-1}$  in South Asia. Using average root-to-shoot ratio for pigeon pea (0.21), and assuming 47% carbon fraction in dry matter and 65% carbon in rhizodeposition, total carbon potentially available for addition to the soil ranged from  $1.21 \pm 0.44 \text{ Mg ha}^{-1}$  when residues are removed to  $2.98 \pm 0.51 \text{ Mg ha}^{-1}$  when residues are retained in Africa, and from  $1.50 \pm 0.54 \text{ Mg ha}^{-1}$  when residues are removed to  $3.70 \pm 0.46 \text{ Mg ha}^{-1}$  when residues are retained in South Asia. Absolute soil organic carbon concentration (SOC) on farms with pigeon pea was  $1.68 \pm 0.19 \%$ . The effect of pigeon pea on SOC was positive and significant (lnRR: 0.299, 95% CI= [0.02, 0.84]). On average, SOC in farming systems with pigeon pea was 35% higher at the end of experiment relative to values at the start of experiment. High biomass production and SOC increase under pigeon pea shows its potential to build resilience when integrated into current smallholder farms. We discuss the challenges and opportunities for integrating perennial grain legumes in tree-based cropping systems, including recommendation for future research priorities.

**Keywords:** Aboveground carbon, dryland cereals, rhizodeposition, soil organic carbon, sustainable intensification