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Optimising harvesting frequency of *Moringa stenopetala* for biomass yield, nutritional quality and food security in Ethiopia

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Abstract

Moringa stenopetala is a high-value multipurpose tree with exceptional potential to strengthen multifunctional agroecosystems in arid and semi-arid Africa by simultaneously addressing malnutrition, supporting livestock productivity, and enhancing climate resilience. Yet evidence-based harvesting protocols that balance biomass productivity with nutritional quality and long-term plant vigour remain lacking. This study determined the optimal harvesting frequency for *M. stenopetala* across early developmental stages in Bena-Tsema District, South Omo Zone, southern Ethiopia – one of Ethiopia’s most food-insecure dryland regions. Five harvesting intervals (15, 30, 45, 60, and 75 days) were evaluated in a factorial Randomised Complete Block Design (RCBD) with three replications. Key indicators included growth parameters (plant height, root collar diameter, branch number, and recovery rate); biomass yield (g/plant, kg/ha, and kg/ha/year); proximate composition (protein, ash, crude fiber, fat, carbohydrate, and energy); and fat-soluble vitamins (A, D, E, and K). Harvesting frequency significantly affected all measured parameters ($p < 0.05$). The 30-day interval maximised fresh biomass yield (3,566 g/plant), achieving the best balance between productivity and plant recovery – making it the recommended protocol for smallholder farmers prioritising leaf output. Longer intervals (60–75 days) supported superior vegetative growth (tree height up to 2.33 m, branch number up to 18) but yielded fewer harvests annually. Crucially, protein content (24–27 %) and fat-soluble vitamins remained high and largely stable across all intervals, confirming that nutritional quality is robust to harvesting management. These results establish that *M. stenopetala* can serve as a reliable, year-round source of human nutrition and livestock feed under optimised management, even in nutrient-poor dryland soils. By providing scientifically grounded harvesting guidelines, this study supports the integration of *M. stenopetala* into climate-resilient agro-ecosystems – contributing to food security, dietary diversity, and sustainable land use across the semi-arid Horn of Africa.

Keywords: Harvesting frequency, *Moringa stenopetala*, nutritional quality, proximate composition, vitamin content