

Book of Abstracts

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EVALUATING ENVIRONMENTAL PERFORMANCE OF APPLE PRODUCTION SYSTEMS IN JAPAN: PATHWAYS TOWARD SUSTAINABLE AGRICULTURE

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This study assessed the environmental performance of apple production in Japan's Aomori and Iwate prefectures using Life Cycle Assessment to identify environmental hotspots and inform sustainable strategies. The study examined three orchard systems: traditional and tall-spindle in Aomori and open-center in Iwate, using a cradle-to-farm gate boundary with 1 kg of apples as functional units. Inventory data were gathered directly from Aomori and Iwate research institutes through field visits. Background data were sourced from Ecoinvent, and WFLCB. LCA, uncertainty and sensitivity analysis were performed using SimaPro 9.6.0, employing the ReCiPe 2016 Midpoint (H) methodology. The finding indicated that traditional system emits 0.230 kg CO₂ eq kg⁻¹, with fertilizers (53%) and pesticides (70%) as major contributors. The tall-spindle system shows lower global warming potential (0.189 kg CO₂ eq kg⁻¹) but higher machinery and gasoline use. The open-center system relies more on diesel (52%) and pesticides (77–82%), resulting in the highest impacts on terrestrial Eco toxicity and fossil resource scarcity. Across all systems, chemical fertilizers dominate global warming and terrestrial Eco toxicity in traditional and tall-spindle systems, while pesticides significantly affect freshwater Eco toxicity and human toxicity. The open-center system's impacts are driven by machinery and diesel use. Based on results, mitigation strategies should focus on precision agriculture to optimize chemical use, improve machinery efficiency, and adopt renewable energy. These findings show how regional farming practices influence environmental impacts and highlight the need for tailored mitigation strategies. Future research should adopt multicriteria LCA, integrating economic, land use (LANCA), and efficiency (DEA) metrics to assess apple production systems' sustainability.

Keywords: Life cycle assessment, apple production, Orchard training systems, environmental impact, sustainability agriculture