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Why Measuring Field-level Food Losses Matters: Evidence of Bias and Improved Estimation Methods in Fruit Production

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Abstract

Food losses at the primary production stage remain one of the least accurately quantified components of the agri-food chain, largely due to methodological limitations in field measurement. Robust and comparable data are essential for designing effective reduction strategies, yet current approaches often rely on simplified sampling or subjective assessments. This study analyses methodological challenges involved in estimating pre-harvest and harvest losses through an empirical application in persimmon orchards in Valencia (Spain). Fieldwork was conducted during two consecutive seasons (2019–2020), covering multiple commercial plots managed by producer cooperatives. Two measurement approaches were implemented and compared: (i) a conventional random sampling method based on a limited number of trees per plot, and (ii) an alternative protocol combining full-plot visual characterisation of loss levels (low, medium, high) with stratified sampling and weight extrapolation. Additionally, prior qualitative assessments from technical staff were recorded to contrast perceived and measured losses. Results reveal systematic discrepancies between methods and perceptions. Differences in estimated losses between measurement approaches were frequently substantial, with deviations often being considerable depending on plot heterogeneity. Perception-based classifications by field technicians showed limited alignment with measured values, while random sampling tended to underrepresent areas with higher accumulation of fruit losses. These findings highlight the influence of selection bias, observer bias and spatial variability within plots. The alternative stratified approach demonstrated a greater capacity to capture intra-plot heterogeneity, leading to more consistent and realistic estimations of losses, while requiring a very similar level of resources to those invested in random sampling. By integrating full-field assessment with targeted measurements, this method reduces bias associated with purely random or perception-based approaches, while remaining operationally feasible in commercial settings. The study underscores that inaccurate measurement of field-level losses may significantly distort the understanding of the magnitude of food losses and undermine the effectiveness of reduction policies. Establishing more robust and standardised measurement protocols is therefore a prerequisite for improving data quality and supporting decision-making in primary production systems. These results contribute to the ongoing discussion on how to enhance the reliability of food loss quantification at source and provide practical insights applicable to other perennial cropping systems.

Keywords: Harvest losses, Stratified sampling, Measurement protocols, Observer bias, Perennial cropping systems