Persistent Nitrate Leaching in California's Central Valley: Assessing Conservation Practice Effectiveness

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Keywords: Groundwater Quality, Vadose Zone Monitoring, Nitrate Pollution, Agriculture

Abstract: Groundwater quality in California's Central Valley is critically threatened by nitrate contamination from agricultural activities. While conservation practices have been deployed, their ability to effectively mitigate nitrate leaching remains unclear. This study investigated nitrate dynamics on a row crop rotation system farm (RCRSF) and an almond orchard (AO) using a tiered approach: advanced vadose zone monitoring, groundwater sampling, and field-scale mass balance analysis. The RCRSF utilized subsurface drip irrigation, irrigation water nitrate crediting, and fertigation, while the AO employed surface drip and high-frequency, low-concentration fertigation. Despite these efforts, both sites showed nitrate levels in pore water and groundwater exceeding the EPA's 10 mg/L NO_3-N drinking water standard. Field-scale mass balance calculations indicated residual nitrate remaining in the soil profile, which winter rainfall, as evidenced by vadose zone monitoring, mobilized towards groundwater. This study underscores the necessity for research focused on improving nitrogen use efficiency and minimizing residual soil nitrate. Additionally, further investigation into the drivers of nitrate mobilization in deeper soil layers is warranted to inform effective groundwater protection measures.

Funding Acknowledgement: This work is supported by USDA NRCS grant number NR233A750023C051 and USDA NIFA Award # 2021-68012-35914.