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Practices to reduce nitrate leaching and increase nitrogen use efficiency in irrigated agriculture

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Despite the large body of research in irrigated agriculture, it is still not clear which practices most effectively reduce nitrate leaching (NL) while maintaining crop yield. A meta-analysis (MA) of published experimental results from agricultural irrigated systems was conducted to identify those agricultural practices that have proven effective at reducing NL and to quantify the scale of reduction that can be achieved. Forty-four scientific articles were identified which investigated four main strategies (water and fertilizer management, use of cover crops and fertilizer technology) creating a database with 279 observations on NL and 166 on crop yield. Management practices that adjust water application to crop needs reduced NL by a mean of 80% without a reduction in crop yield. Improved fertilizer management reduced NL by 40%, and the best relationship between yield and NL was obtained when applying the recommended N fertilizer rate. Applications above the recommended rate increased leaching without enhancing yield. Replacing a fallow with a non-legume cover crop (CC) reduced NL by 50% while using a legume CC did not have any effect on NL. Legume CC increased yield and N use efficiency while yields following non-legume CC were not different from the fallow. Improved fertilizer technology also decreased NL but was the least effective of the selected strategies. The risk of nitrate leaching from irrigated systems is high, but optimum management practices may mitigate this risk and maintain crop yields while enhancing environmental sustainability.