Supplemental Material:

Long-Term Cropping Effects on Partitioning of Water Flow and Nitrate Loss between Surface Runoff and Tile Drainage

Supplemental Fig. S1: a) Cumulative tile flow volume, b) flow weighted mean (FWM) tile nitrate concentration, c) cumulative tile nitrate loss from not-fertilized (-NF) treatments over a 5-yr period (May 2008 to April 2013) on a clay loam soil. Treatments include: Monoculture Corn (MC), Continuous bluegrass Sod (CS), Rotation Corn (RC), Rotation Oat (RO), Rotation Alfalfa 1st year (RA1), and Rotation Alfalfa 2nd year (RA2). Top horizontal dashed line b) - Canadian drinking water limit for human health (10 mg NO$_3^-$-N L$^{-1}$); bottom horizontal dashed line - Canadian long-term nitrate limit for freshwater aquatic life (4.7 mg NO$_3^-$-N L$^{-1}$)
Supplemental Fig. S2: a) Cumulative surface flow volume, b) flow weighted mean (FWM) surface runoff nitrate concentration, c) cumulative surface runoff nitrate loss from not-fertilized (-NF) treatments over a 5-yr period (May 2008 to April 2013) on a clay loam soil. Treatments include: Monoculture Corn (MC), Continuous bluegrass Sod (CS), Rotation Corn (RC), Rotation Oat (RO), Rotation Alfalfa 1st year (RA1), and Rotation Alfalfa 2nd year (RA2). Top horizontal dashed line b) - Canadian drinking water limit for human health (10 mg NO₃⁻-N L⁻¹); bottom horizontal dashed line - Canadian long-term nitrate limit for freshwater aquatic life (4.7 mg NO₃⁻-N L⁻¹)
Precipitation:

Yearly precipitation varied between study years with the 2008/2009 (956 mm), 2010/2011 (946 mm) and 2013/2014 (849 mm) being the same or slightly greater (±8%) than the 54-yr average (846 mm). In 2009/2010 rainfall (589 mm) was 30% lower than average, with every month with exception of June, August and October having below average precipitation. Further, the average rainfall in the pre-cropping period (January to April 2010) was 44% lower than the long-term average for this period. The 2011 growing season received 774 mm or 65% more rain than the historical average (468 mm), with May, September and November receiving more than double the respective monthly total precipitation (Table 1). Averaged over the 5 years, 26% (±5%) of precipitation occurred during pre-cropping, 56% (± 9%) during the growing season and 18% (±5%) during post-cropping, following closely to the 54-yr average.
Supplemental Table S1 - Monthly precipitation totals during the study period (May 1, 2008 to April 30, 2013), the 54-year average (1959-2013) and the annual precipitation within the growing season, post-cropping and pre-cropping periods at Woodslee, Ontario

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Supplemental Table S2. Wilcoxon signed-rank test results for tile drainage: paired by average daily flow (n = 1825); paired by collection event (n = 62) for average flow weighted mean (FWM) nitrate concentration; and paired by collection event (n = 62) for average nitrate loss. Paired comparisons include annually fertilized (F) versus not fertilized (NF) for the same crop, for rotation corn versus monoculture corn, and for 1st year alfalfa versus 2nd year alfalfa. Rotation corn (RC), rotation oat (RO), rotation alfalfa 1st year (RA1), rotation alfalfa 2nd year (RA2), continuous bluegrass sod (CS), monoculture corn (MC).

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*Significance (P) level: * P < 0.05, ** P < 0.001, *** P < 0.0001
Supplemental Table S3. Wilcoxon signed-rank test results for surface runoff: paired by average daily flow (n = 1825); paired by collection event (n = 62) for average flow weighted mean (FWM) nitrate concentration; and paired by collection event (n = 62) for average nitrate loss. Paired comparisons include annually fertilized (F) versus not fertilized (NF) for the same crop, for rotation corn versus monoculture corn, and for 1st year alfalfa versus 2nd year alfalfa. Rotation corn (RC), rotation oat (RO), rotation alfalfa 1st year (RA1), rotation alfalfa 2nd year (RA2), continuous bluegrass sod (CS), monoculture corn (MC).

<table>
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<tr>
<th>Comparisons</th>
<th>Daily Average Flow (Ld⁻¹)</th>
<th>SD</th>
<th>Percent Change (%)</th>
<th>Average FWM (mg N L⁻¹)</th>
<th>SD</th>
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<th>Average Nitrate Loss (kg N ha⁻¹)</th>
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*Significance (P) level: * P < 0.05, ** P < 0.001, *** P < 0.0001
Supplemental Table S4. Harmonic mean saturated hydraulic conductivity, $K_H$ (cm s$^{-1}$), for the top 40 cm of the cropping and fertilization treatments (Eq. 1). The $K_H$ values were derived from saturated hydraulic conductivity, $K_S$ (cm s$^{-1}$), data in Reynolds et al. (2014b). The component $K_S$ data are 4-year averages (2004-2007) in order to adequately represent all four phases of the corn-oat-alfalfa-alfalfa rotations.

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<th>Cropping Treatment</th>
<th>Annually Fertilized</th>
<th>Not Fertilized</th>
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<td>$3.73 \times 10^{-2}$</td>
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<td>Corn-Oat-Alfalfa-Alfalfa Rotation (RC-RO-RA1-RA2)</td>
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