Quantifying yield and water quality benefits of cover cropping at a landscape scale using satellite imagery

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INTRODUCTION

• Excess nutrients from intensive agricultural practices have led to serious environmental issues such as harmful algal blooms in the Great Lakes and around the world [1] (Fig 1).
• These agricultural practices also have led to loss in soil organic carbon and soil health degradation.
• Cover cropping is one of the conservation practices that help mitigate water quality and soil health problems due to intensive agricultural practices. [2] (Fig 2).
• Several cover crop field trails evaluating the role of cover crops on yield and soil health exist but only few studies have investigated the effect of cover crops at a landscape scale.

OBJECTIVES

To assess the effect of cover cropping on crop yield and water quality at a landscape scale

Study Area

• Maumee Watershed (Fig 3)
• 80% of the watershed is in corn and soybean production
• Agricultural production contributes to ~85% of the phosphorus load to the Maumee River which drains in the Lake Erie
• Only a small percentage of farmers in the watershed are adopting conservation practices including cover crops

RESULTS

• On average, there were slight to negative advantages of cover crops on corn and soybean yields (Fig 7).
• The yield differences between field with and without cover crops however were not significant for soybean.
• These findings were found to be consistent with prior studies focused on field trials [4][5].

METHODS

Data

• Cover crop data from 2008 to 2019 from our previous work focused on mapping cover crop practices using satellite imagery
• Landsat-MODIS fused satellite images at 30 m spatial resolution [3]
• PRISM Daily Spatial weather data at 4 km spatial resolution
• USDA annual CropLand Data Layer at 30 m spatial resolution
• County scale annual yield data from NASS were integrated with satellite imagery to develop high-resolution corn and soybean yield estimates
• In-situ water quality data at Maumee River from Heidelberg University’s National Center for Water Quality Research

Figure 4: Data used in the study

Figure 5: Step by step framework of the study

• Extracted corn and soybean areas using spatial and temporal cover crop maps
• Evaluated summer crop yield and nutrient load/concentration with the cover crop area in the corresponding winter season.

Figure 3: Maumee River watershed (17326 sq km)

Figure 6: Cover crop areas in the Maumee River Watershed

Figure 7: Yield difference between fields with and without cover crops

Table 1: Correlation between cover crop area and nutrient load in Maumee River during 2009-2020.

<table>
<thead>
<tr>
<th>Concentration/Load</th>
<th>Correlation (R) with Cover Crop Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP</td>
<td>0.45</td>
</tr>
<tr>
<td>N (Nitrate)</td>
<td>-0.72</td>
</tr>
<tr>
<td>SRP</td>
<td>-0.28</td>
</tr>
<tr>
<td>Nitrate</td>
<td>0.25</td>
</tr>
<tr>
<td>SRP</td>
<td>-0.44</td>
</tr>
</tbody>
</table>

CONCLUSIONS

• No significant to slightly negative change in yield on cover cropped fields.
• Cover cropping correlated with reduction of nitrate and SRP concentration and load showing implication of the practice in improving water quality.

FUTURE WORKS

• We will focus on assessing cover crop biomass and nutrient uptake efficiency using different remote sensing technologies (from Drones to satellite).

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