Poor nutrient-use efficiency in agricultural soils remains a major environmental and human health concern. Best Management Practices (BMPs) such as zero-tillage, cover crop use and crop rotation can enhance nutrient-use efficiency, but their long-term ecological effects are not well understood. This study assessed the effects of 30 year-old tillage, crop rotation, and cover crops on populations of ammonia oxidizing bacteria (AOB), ammonia oxidizing archaea (AOA), and arbuscular mycorrhizal fungi (AMF).

The objectives of this study were to:
1) Quantify ammonia monooxygenase (amoA) gene copy numbers in different crop rotation and tillage treatments.
2) Determine tillage effects across soil depths on total/active microbial populations and soil properties in a continuous monoculture and a BMP system employing a four year crop rotation with a red clover cover crop.
3) Relate microbial population trends and corn yields.

### Experimental Design

1) Samples were collected (Fig. 2) on May 3rd 2010 (after tillage, planting and fertilization events) and on June 30th 2010 (after tillage, planting and fertilization events). Surface samples were collected in all study treatments.

In CC and RC treatments, samples at 0-15cm and 15-30cm were also collected (Fig. 3).

2) Soils were analyzed for bulk density, % moisture content, and water stable aggregates in the 1-2mm size fraction.

3) Molecular analysis (August 2010-Present)  
   1) DNA/RNA extraction using MoBio Powersoil RNA Extraction kit and accessory DNA elution kit.
   2) Reverse-Transcription of RNA to DNA.
   3) Quantitative Polymerase Chain Reaction (qPCR) to quantify amoA gene copy numbers and AOA genes.
   4) Permits low detection of AOB, AOA, and AMF to quantify microbial community diversity.

### Methodology

1) DNA revealed gene copy numbers were affected by depth of sampling in the CC and RC plots (Fig. 6, p<0.05). Red clover cover crop incorporation enhanced WSA in both tilled and no-till soils by 3.6% and 8.0% respectively as compared to an identical crop rotation with no red clover (RC vs. CSW).

2) Bulk density increased with depth in till plots and was higher in no-till plots (Fig. 4). Moisture increased with depth (Fig. 5, p<0.05) and was higher in no-till plots. CCNT at 15-30cm had the highest soil moisture at 22.7%.

### Summary

1) Lowest corn yields were found in NT plots and corresponded with soils exhibiting the greatest water stable aggregation and soil moisture.

2) amoA copy number was dependent on soil depth and sample time. Interestingly, long-term crop rotation and tillage did not significantly alter the quantity of amoA genes in soil.

### Future work

1) Relate microbial population data with corn yields and total microbial biomass carbon and nitrogen.

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