Crop rotation: An effective system to improve crop production efficiency and minimize C footprints

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Abstract

Crop rotation has long been recognized as a beneficial management practice that increases crop productivity, break disease and insect cycles, and reduces the seed bank of stubborn weeds. However, its ecological services and environment benefits have not been systematically measured and analyzed. In this presentation, I will use two case studies to demonstrate the dual benefits of crop rotation for crop productivity and environmental carbon (C) footprint in the Eastern Canadian Mixedwood Plains Ecozone. Case 1 is an on-going study testing a maize-dominated cereal and legume crop rotation since 1992. It consists of three cropping systems: maize-soybean (MS), maize-forage legume (MF), and continuous maize monoculture (MM). Maize plots were fertilized with varying levels of nitrogen fertilizer and dairy manure during the maize phase of crop rotation. Case 2 was a four-year, four-crop, canola-dominated phase rotation and conducted over two cycles (2011-2018) at three sites in eastern Canada. In each rotation type, both crops appeared each year. For example, MS and SM, soybean-canola (SC) and CS, etc. occurred simultaneously at each site each year to account for the annual environmental influence on crop rotation effects, thereby total greenhouse gas (GHG) emissions and C footprint could be estimated annually. The following main points can be drawn from these projects: 1. The continuous maize monoculture produced the lowest grain

yield, while maize in rotation with forage-legume yielded the highest; 2. Repeated manure application could provide up to 100% of the N required for the maximum maize yield; 3. N replacement values (NRV) ranged from 40 to 120 kg ha-1 for maize-soybean, and from 130 to 180 kg ha-1 for maize-forage legume rotation systems; 4. The magnitude of C footprint reduction varied with N fertilizer application rates, and maize treated with 100 kg N ha-1 in MS rotation produced the greatest economic yield with relatively low GHG emissions and C footprint; 5. Diversified cropping systems increased crop yields by an average of 32% and reduced the C footprint by 33%; and 6. Planting soybeans as a previous crop to canola is a promising strategy to increase canola crop productivity and N uptake, thereby reducing the carbon footprint of canola production. Our findings suggest that increased maize yields and reduced C footprints can be achieved through appropriate N application and crop rotation with forage legumes or soybeans, and that planting canola after soybeans or wheat following canola is a viable and sustainable strategy in eastern Canada.

Keywords: Cropping system, Carbon footprint, Sustainable production, Greenhouse gas emission intensity, Nutrient use efficiency

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