Title
Considering Crop Rotation in Nutrient Balancing

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Article
A recent news article (*Ontario Watershed study shows over application of phosphorus*) reported on research that indicates phosphorus is over applied by 40% for corn and wheat. If 50 lbs of phosphorus is applied to each of corn and wheat, then 40% would represent 40 lbs P_2O_5 or about a 1 ppm soil test increase in soil test phosphorus levels. The research quoted in the article, gives no indication of soil fertility levels or crop rotation, both of which are essential to nutrient balancing.

Nutrient balancing compares how much nutrients were applied to a crop rotation to how much is removed over the crop rotation. In order to balance nutrients, soil fertility levels, yield goals and crop needs are required information to determine proper application rates. Corn and wheat have greater response to applied nutrients (especially seed-placed phosphorus), and applying to crop needs allows producers to follow the principles of right rate, right time and right place.

In Ontario a general guideline is that it takes approximately 35 lbs of P2O5 to increase soil test levels by 1 ppm and it takes about 20 lbs of K2O to increase potassium levels by 1 ppm. There are variations based on soil characteristics, however these amounts give producers an indication of how closely they are increasing or decreasing soil fertility in their fields.

Nutrient management planning, crop needs/recommendation are always the first priority, especially on soils with low fertility levels. For livestock farms where with adequate soil fertility levels and where nutrient recommendations are low, manure application rates are set to match the nutrients removed by a crop. Manure is most often applied to meet the nutrient needs of a corn crop, followed by wheat and forage crops. Manure and fertilizer application does not often occur on a soybean crop since soybeans do not make efficient use of the manure nitrogen (the root nodules supply the plant's nitrogen needs), however the soybean crop does remove significant nutrients from the field. Manure nutrient management plans generally have manure and/or commercial fertilizer applied 1 or 2 times in the rotation to meet the crop needs for a full rotation of crops. Therefore if 40% more phosphorus is applied to 1 crop in the rotation, it may be providing nutrients for the crop year where no nutrients are applied. From an environmental perspective this means manure and fertilizer are applied less frequently and from an economic perspective it allows a grower to follow 4R principals that maximize economic nutrient efficiency.

Table 1 shows the crop needs and crop nutrient removal for a corn-soybean-wheat rotation with average yield goals. In one scenario, the soil fertility levels are low, where nutrient needs are higher than crop removal, while in the second scenario the soil fertility levels are adequate and fertilizer needs are lower – often met with a commercial fertilizer starter.

Typical Example of Nutrient Balancing for a 3-crop rotation

Nutrient Balancing with **Low Soil Fertility** Levels (P=6 ppm and K = 35 ppm)						
	Nutrients Recommended			**Nutrients Removed**		
	N	**P_2O_5**	**K_2O**	**N**	**P_2O_5**	**K_2O**
Corn (175)	161	80	125	145	73	51
Soybeans (45)	0	45	80	175*	38	63
Wheat (90)	100	45	27	177	63	147
Rotation Total	**261**	**170**	**232**	(500-175) **320**	**175**	**260**

Nutrient Balancing with **Adequate Soil Fertility** Levels (P=30 ppm and K = 120 ppm)						
	Nutrients Recommended			**Nutrients Removed**		
	N	**P_2O_5**	**K_2O**	**N**	**P_2O_5**	**K_2O**
Corn (175)	161	18	27	145	73	51
Soybeans (45)	0	0	27	175*	38	63
Wheat (90)	100	18	18	177	63	147
Rotation Total	**261**	**36**	**72**	(500-175) **320**	**175**	**260**
Approximate Change in Soil Fertility levels (over rotation if no fertilizer was applied)				---	5 ppm	13 ppm

Over the rotation the nutrients recommended will help ensure maximum economic yields, while the nutrients removed give an indication of how quickly fertility levels will decrease. While soil testing gives an indication of nutrients available for a crop, and are a small part of a "soil bank" of nutrients which are impacted by many physical and biological factors, responsible crop production should not mine the nutrients from the soil. Healthy soils with good infiltration capacity, good aggregate stability and diverse microbial populations will be the best defense for minimizing environmental impact from nutrient loss.

Human nutrition is important to overall health and the Canada Food Guide gives suggested best practices. Similarly, food production requires good crop nutrition. Nutrient Management planning tools help Ontario producers to manage and apply nutrients based on soil fertility levels, crop rotation and crop needs accounting for field conditions that could impact environment. NMAN software allow producers to see what impact decisions such as timing of application or application rate could impact nutrient availability.