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Nutrient Removal as a Soil Fertility Planning Tool

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HIGH YIELDING AND PROFITABLE crop production comes from fields that have an adequate supply of plant nutrients. These nutrients are provided by soil reserves or applied fertilizer and organic amendments.

Sustaining high yields and quality in crops requires that farmers use soil testing to assess their soil nutrient reserves and amend the soil with nutrient sources so that an adequate and available supply of nutrients will be there for the crop grown. This means that at optimum soil fertility levels nutrients removed should be replaced using a balance of inputs and outputs. To make this balance work, you need to understand the removal of nutrients by the crops you grow.

There are two important expressions of plant nutrient demand. The first is nutrient uptake and refers to the total amount of nutrient taken up by the crop. It is the quantity that plants require to grow to maturity.

The second, and more critical expression of nutrient demand relative to fertility planning, is nutrient removal. This is the quantity of nutrients contained in the grain, forage, and straw that are removed from the field. Nutrient removal rates can be determined by submitting your grain or forage sample to a lab for nutrient analysis, and then calculating the actual removal using yield data. Alternatively, average nutrient contents in the harvested portion of crops can be used to estimate the removal amounts.

Table 1. Nutrient uptake by the growing crop and removal in the harvested portion of selected crops.

Crop	Unit	Uptake (removal) N	Uptake (removal) P_2O_5	Uptake (removal) K_2O
Cereals				
Barley	lb/bu	1.53 (1.10)	0.61 (0.40)	1.46 (0.35)
Oats	lb/bu	1.38 (0.80)	0.40 (0.25)	1.60 (0.20)
Corn	lb/bu	1.18 (0.75)	0.63 (0.44)	1.41 (0.29)
Wheat				
10% protein[1]	lb/bu	1.55 (1.10)	0.67 (0.50)	1.47 (0.35)
12% protein	lb/bu	1.83 (1.30)	0.67 (0.50)	1.47 (0.35)
14% protein	lb/bu	2.12 (1.50)	0.67 (0.50)	1.47 (0.35)
Oilseeds				
Canola	lb/bu	3.12 (1.88)	1.30 (0.91)	2.05 (0.46)
Flax	lb/bu	2.58 (2.00)	1.42 (1.10)	2.00 (0.65)
Sunflower	lb/cwt	3.90 (2.80)	1.43 (1.10)	2.03 (0.60)
Soybean[2]	lb/bu	5.80 (4.00)	1.00 (0.80)	4.40 (1.40)
Pulses				
Field peas[2]	lb/bu	3.36 (2.40)	1.45 (1.20)	3.00 (0.71)
Lentils[2]	lb/bu	3.01 (2.00)	0.90 (0.62)	2.57 (1.10)
Root Crops				
Potatoes	lb/cwt	0.63 (0.35)	0.27 (0.15)	0.77 (0.56)
Sugar beets	lb/ton	9.57 (4.00)	2.49 (1.50)	17.82 (6.60)
Forages[3]				
Alfalfa[2]	lb/ton	56	15	60
Bromegrass	lb/ton	36	13	59
Fescue	lb/ton	38	18	52
Timothy	lb/ton	38	14	62
Barley silage	lb/ton	40	13	29
Corn silage				
(67% water)	lb/ton	8.30	3.60	8.30

[1] At same moisture content as grain yield measured.
[2] Legume crops obtain most of their N from atmospheric N fixation.
[3] Forage yield on a dry matter basis.

Table 1 shows the amount of nitrogen (N), phosphorus (P), and potassium (K) taken up by the growing crop, and removed in the harvested portion (removal shown in brackets). If the crop residues are all returned to the soil, the removal amount is that which must be replaced to maintain a long-term *status quo*. Both P and K are presented as oxide equivalents (P_2O_5 and K_2O, respectively) to facilitate comparisons between crop removal and the form represented in common fertilizers.

The values in **Table 1** are not recommended rates of nutrient application per unit of production, but merely quantities of nutrients removed in harvested product. It may be possible to farm some highly fertile soils for years (even decades) before their ability to adequately supply certain nutrients is diminished. Other soils may be depleted in just a few years.

Soil fertility levels should never be allowed to drop to the point that yields are threatened. In general, soils with more clay and organic matter are better buffered. That is, it takes longer to deplete these soils of their available nutrients. And, logically, fields intensively managed for higher yields are more rapidly depleted.

Generalizing nutrient removal across crops is a dangerous habit to get into, and could cost you yield and profits. High protein crops, such as peas, soybeans and canola, have high levels of N removal. While the peas and soybeans are capable of fixing N through their association with *Rhizobia*, canola relies on soil residual nutrients and fertilizer additions. The same applies for high protein wheat, where the levels required to capture protein premiums require substantially more N.

Phosphorus and K uptake and removal also vary considerably between crops. Oilseed and grain legume crops have a high P demand relative to cereals. Soybeans have a particularly large appetite for K. Given that most of the K taken up by annual crops remains in the straw, the K removal by forages can result in a rapid drawdown on soils with a poor K supply rate.

Farmers in some regions find it difficult to apply all of the nutrients required with particular crops, especially when all the fertilizer is applied at seeding. This problem is common where all the P a crop receives is applied as a starter at seeding, and the crop tolerance to seed row applied fertilizer is low. To account for this some producers will estimate the P removal for their rotation cycle. They then apply more either as part of their pre-plant fertilizer operations, or increasing the amount applied in years when the crop being grown has a higher level of tolerance to seed placed fertilizer.

Soil fertility planning based on soil testing to estimate residual nutrient levels, along with crop removal estimates, will not only move us closer to maintaining long-term soil fertility, but also help us achieve maximum production potential. ■

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