



Removal of Phosphorus by Field Crops

The New York Phosphorus Index (P Index) was developed to rank individual fields for relative risk of P runoff losses. One key premise of the P Index is that as soil test P increases, environmental losses may increase too. To prevent or reduce the rate of soil test P increase, the P Index requires producers to limit P application to estimated crop removal (in P_2O_5 equivalent) when risk is rated "High", and no P in any form may be applied if the P Index is "Very High". Phosphorus removal is a function of the harvested portion of a crop and the P content of the harvest. In this fact sheet we show how to estimate manure/fertilizer application limits if the P Index is high, based on projected P removal by the crop.

Yield

Yields may vary depending on soils, drainage, management, weather, etc. For corn, soil and drainage-specific yield potentials are available from "Nitrogen Guidelines for Field Crops in New York State" downloadable from http://nmsp.css.cornell.edu/nutrient_guidelines/. Yield potentials are given in bu/acre assuming 85% dry matter (DM). If silage corn is planted, divide yield potential in bu/acre by 5.9 to get estimated silage yield at 35% DM (Box 1).

Box 2: Converting from bu/acre to tons/acre for corn.

The yield potential of a Palmyra soil is 140 bu/acre (85% DM). I am harvesting the corn for silage. What is the yield potential in tons/acre of corn silage?

$$140 / 5.9 = 23.7 \text{ tons/acre (35\%DM)}$$

For alfalfa, yield potentials can be found in "Potassium Guidelines for Field Crops in New York State" also downloadable from http://nmsp.css.cornell.edu/nutrient_guidelines/. Alternatively, records from actual field harvest averages can be used. Yields need to be converted to a total amount of dry matter (DM in lbs/acre) as P content of the harvested crop is given as a % of DM (Table 1). To convert from "as-is" yield in tons/acre to total amount of DM in lbs/acre, multiply the "as-is" yield in tons/acre by the % DM and 2000 (Box 2).

Box 2: Calculating dry matter (DM) yield of corn silage.

A field yielded 24 tons/acre corn silage (35% DM). How much is that in lbs DM/acre?

Step 1: Convert tons/acre at 35% DM to 100% DM:

$$23.7 * 0.35 = 8.3 \text{ tons/acre}$$

Step 2: Convert tons/acre to lbs/acre

$$8.3 * 2000 = 16600 \text{ lbs DM/acre}$$

Percentage Phosphorus in Harvest

Table 1 shows average P content (% P_2O_5 equivalent on DM basis) of field crops commonly grown in New York State.

Table 1: Percentage DM and P_2O_5 equivalent of common field crops. To convert from P_2O_5 to P, multiply by 0.44.

Field Crop	% P_2O_5 of DM*
Alfalfa	0.76
Alfalfa-grass mix	0.53
Alfalfa-trefoil-grass	0.53
Birdsfoot trefoil	0.53
Birdsfoot trefoil-grass	0.53
Birdsfoot trefoil-clover	0.53
Clover	0.78
Clover-grass	0.55
Clover-seed production	0.78
Grasses	0.64
Grass-intensive management	0.78
Barley-spring	0.66
Barley-spring with legume	0.66
Barley-winter	0.66
Barley-winter with legume	0.66
Barley straw	0.55
Buckwheat	0.82
Corn-grain	0.71
Corn-silage	0.62
Oats	0.71
Oatlage	0.74
Oats-seeded with legume	0.69
Oats straw	0.51
Rye-seed production	0.82
Ryelage	0.87
Sorghum-forage	0.50
Sorghum-sudangrass	1.15
Sudangrass	1.15
Soybeans	1.49
Sunflower	2.34
Triticale/peas	0.69
Wheat	0.66
Wheatlage	0.69
Wheat straw	0.32

*To convert from P_2O_5 to P, multiply by 0.44.

Common Dry Matter Contents

If specific DM levels of the crop are not known, use 92% DM for straw, 90% for hay, 35% for haylage and silage corn, and 85% for grain.

Phosphorus Crop Removal

To determine P_2O_5 removal, multiply the total yield by % DM and the percentage P_2O_5 in the DM. An example is given in Box 3.

Box 3: Estimating P_2O_5 removal for corn silage.

The yield potential of a Palmyra soil is 23.7 tons/acre (35% DM). What is the estimated P_2O_5 removal?

Step 1: Convert tons/acre at 35% DM to 100% DM:

$$23.7 * 0.35 = 8.3 \text{ tons/acre}$$

Step 2: Convert tons/acre to lbs/acre:

$$8.3 * 2000 = 16600 \text{ lbs DM/acre}$$

Step 3: Multiply DM yield by % P_2O_5 :

$$16600 * 0.62/100 = 103 \text{ lbs } P_2O_5/\text{acre}$$

$$(\text{or } 103/23.7 = 4.35 \text{ lbs } P_2O_5/\text{ton of silage})$$

To estimate crop removal for grain crops, bu/acre yields need to be converted to lbs/acre using test weights (lbs/bu). For example, a bushel of shelled corn (85% DM) has a test weight of 56 lbs/bu. Common test weights are listed in Table 2 and an example of a corn grain calculation is given in Box 4.

Table 2: Standard test weight and dry matter of corn grain and small grains.

Field Crop	% DM	Test weight (lbs/bu)
Barley	85	48
Corn – Shelled	85	56
Corn- Ear	85	68
Oats	86	32
Rye	86	56
Soybeans	87	60
Wheat	87	60

Box 4: Estimating P_2O_5 removal for grain corn.

The yield potential of a Palmyra soil is 140 bu/acre (85% DM). What is the estimated P_2O_5 removal?

Step 1: Convert bu/acre to lbs/acre (100% DM):

$$140 * 56 * 0.85 = 6664 \text{ lbs DM/acre}$$

Step 2: Multiply DM yield by % P_2O_5 :

$$6664 * 0.71/100 = 47 \text{ lbs } P_2O_5/\text{acre}$$

$$(\text{or } 47/140 = 0.34 \text{ lbs } P_2O_5/\text{bu of grain})$$

Manure Application to Crop Removal

Once P_2O_5 crop removal is estimated, the associated maximum manure and fertilizer application rate can be determined. The planner and producer must decide how to apportion P_2O_5 between manure and fertilizer if

both are used. Once the P_2O_5 fertilizer rate (if any) has been determined, this amount should be deducted from the total amount of P_2O_5 that can be applied with manure (Box 5).

Box 5: Calculating manure application limit.

Crop removal is 103 lbs P_2O_5 /acre. Starter contains 15 lbs P_2O_5 /acre. What is the approximate manure target assuming N is not an issue and manure contains 4 lbs P_2O_5 per ton or 16.7 lbs per 1000 gallons?

Step 1: Calculate P_2O_5 that can be applied with manure:

$$103 - 15 = 88 \text{ lbs } P_2O_5/\text{acre}$$

Step 2: Convert to amount of manure:

$$88 / 4 = 22 \text{ tons/acre}$$

$$88 / 16.7 = 5000 \text{ gallons/acre}$$

Practical Implications

For fields rated "High" by the P Index, there is no agronomic reason to increase soil test P levels any further and P applications (manure and/or fertilizer) are limited to estimated removal of P. Exact removal rates are difficult to predict in advance as yields and P contents vary from field to field and year to year but this fact sheet shows how to approximate P removal for P Index purpose. Comprehensive Nutrient Management Plan (CNMP) planner must be sure to calculate estimated P removal for fields with a "High" P Index score to help producers stay in compliance with their CNMP.

Disclaimer:

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

Additional Resources:

- o New York Phosphorus Runoff Index webpage: <http://nmsp.css.cornell.edu/publications/pindex.asp>.

For more information



Cornell University
Cooperative Extension

Nutrient Management Spear Program
<http://nmsp.css.cornell.edu>

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