

3 NUTRIENT OPTIMIZATION

A successful Nutrient Management Plan accomplishes two objectives:

- determines how to provide nutrients at the appropriate rate, timing, and with the appropriate method to produce an economically optimal crop in terms of both yield and quality
- minimizes the risk of causing pollution by loss of nutrients via runoff, leaching, emissions to the air or other mechanisms

This chapter defines the Agronomic Balance and Crop Removal Balance concepts. These concepts, when applied together, help determine appropriate nutrient application rates to help meet the above two objectives.

The three nutrients that are central to the Nutrient Management Planning process are nitrogen, phosphorus, and potassium.

DEFINITIONS

For the purposes of this planning process, the following definitions are used:

Crop Nutrient Uptake: the amount of a nutrient that is predicted to be taken up by a crop (assuming all other related requirements are met) in a one year period.

Crop Nutrient Recommendation: the amount of plant available nutrient recommended for a crop on an annual basis to produce an economically optimal and environmentally sustainable yield.

Crop nutrient recommendations are generally determined by subtracting the amount of a nutrient estimated to be available in the soil from the predicted crop nutrient uptake. The calculation includes an estimate of the amount of soil organic nitrogen that will be released into plant-available forms over the course of the growing season (e.g. by mineralization).

Crop nutrient recommendations for phosphorus and potassium depend on soil test results and the crop. For field vegetables and berries, crop phosphorus and potassium recommendations come from the most current BC-based soil test interpretation guidelines. For forage crops, crop phosphorus and potassium requirements in this planning process are similar to but not identical to these guidelines.



Interpretations for Soil Test Phosphorus and Potassium: Guidelines for Southern British Columbia

Agronomic Balance: the crop nutrient recommendation minus the amount of the available nutrient from all nutrient sources (manure and commercial fertilizer) in the year of nutrient application.

Negative agronomic balances indicate situations where the planned application rates would likely provide more available nitrogen, phosphorus or potassium than the crop requires in the year of application. The current nutrient management planning process provides annual agronomic balances. A longer-term agronomic balance would require a modified definition.

Crop Removal: the amount of a nutrient removed from the crop at harvest.

Crop removal depends on the yield of a crop as well as the amount of a nutrient per unit weight of the harvested portion of the crop. Crop removal estimates do not depend on soil test results (although in reality, crops can take up nutrients in 'luxury' amounts in some cases of high nutrient levels).

Crop Nutrient Factor: the amount of a nutrient per unit weight in the harvested portion of a crop.

In the current nutrient management planning process, crop nutrient factors are used to estimate crop removal for all crops except berry crops (for which crop removal occurs but is not being estimated at this time).

Crop Removal Balance: the crop removal of a nutrient minus the total amount of that nutrient from all nutrient sources that are added to the soil, over a certain time period. For the current planning process, the time period is one year. A longer-term crop removal balance would require a modified definition.

This crop removal balance concept assumes that all of the nitrogen, phosphorus and potassium that is added to the soil eventually becomes potentially available to plants. Negative crop removal balances indicate situations where inputs of a nutrient exceed the outputs, and the difference is the amount that is left to accumulate in the soil or be lost to the environment.

BALANCING NUTRIENTS: THE PRIORITY NUTRIENT

This section outlines a general process for determining appropriate nutrient balances for each field (or part of a field) of a farm, using the terms defined in the above section.

The Priority Nutrient

Selecting appropriate application rates begins with identifying the priority nutrient for each section of the farm for which a soil test is taken. The Planning Advisor should give priority to a specific nutrient to target for optimization in the Nutrient Management Plan. Both crop production and environmental factors need to be considered in this decision. In some cases, a farmer may choose to optimize for one nutrient on one field and another nutrient on other fields.

The concept of priority nutrients becomes practically important when animal manures are used. The ratio of nitrogen to phosphorus to potassium present in manures is seldom balanced with the ratio required by most crops, especially

when potential loss and availability factors are considered, so it is difficult to balance all nutrients with crop requirements using only manures. In most cases where potassium or phosphorus are selected as the priority nutrient, the farmer will be challenged to supply enough nitrogen for crop growth. Nitrogen deficits may be best managed by conserving nitrogen in manure and using supplemental nitrogen fertilizer.

The following criteria are suggested to assist the Planning Advisor and farmer in selecting the priority nutrient:

1. **Dairy or beef operations:** manage manure application based on **potassium** if soil potassium is over 300 ppm (Kelowna soil test method, 0-15 cm sampling depth). If under 300 ppm go to (3).
2. **Non-cattle operations:** manage manure application based on **potassium** if soil potassium is over 400 ppm (Kelowna soil test method, 0-15 cm sampling depth). If under 400 ppm go to (3).
3. Manage manure application based on **phosphorus** if field runoff or erosion might enter a phosphorus sensitive environment. Generally phosphorus sensitive environments are located where runoff water enters lakes in the interior of BC. If suitable buffers are utilized and no runoff reaches the watercourse or if not in a phosphorus sensitive environment go to (4).
4. Manage manure application based on **nitrogen**.

Agronomic and Crop Removal Balances

For raspberries and blueberries, the nutrient management planning process currently provides only agronomic balances.

For forage and field vegetable crops, agronomic balances are considered first and then crop removal balances in the following manner:

1. If the priority nutrient is potassium or phosphorus and the agronomic balance for the priority nutrient is negative, evaluate the crop removal balance for the priority nutrient. If the crop removal balance is negative, then aim to decrease the nutrient application rates to reach a crop removal balance of zero for the priority nutrient.

These situations indicate high soil potassium or phosphorus levels, and the Planning Advisor should provide advice to reduce build up of potassium or phosphorus in soils of highest risk.

2. Planning Advisors should aim to keep all nutrient application rates at or below the the agronomic rate for nitrogen, such that agronomic nitrogen balances are not negative.

