2016 Post-Harvest Nitrate Study: Hullcar Valley Questions and Answers

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A technical report was posted, titled "Tracking Post-Harvest Soil Nitrate in Agricultural Fields in the Hullcar Valley: 2016 Post-Harvest Nitrate Study." The following questions and answers are intended to increase understanding of the study's results and limitations.

Acronyms

- N, nitrogen
- NO_3, nitrate-nitrogen
- ppm, parts per million
- PHNT, post-harvest nitrate test

Questions

1. What are the key findings and scope of the study?

Ministry of Agriculture conducted a ”Post-Harvest Soil Nitrate” study of farms located over the Hullcar Aquifer (Township of Spallumcheen, BC) in the fall of 2016

- 40 agricultural fields over or near the ‘Hullcar Aquifer 103’ were included in the study and 800 individual sample cores were collected
- Information from a study like this serves as a report card to farmers on how well they are managing nitrogen for crop production and gives some indication of potential risk of nitrates leaching into groundwater
- Results from the study showed that soil nitrates over the Hullcar Aquifer in the fall of 2016 were in a similar range to soils in other studies in the Okanagan and Fraser Valley
- Post-harvest nitrate test (PHNT) values were medium or low in 55% of the fields sampled, high in 38% of the fields, and very high in 8% of the fields sampled
- Results were variable from farm to farm, and between types of crops. Annual crops like corn had higher soil nitrate levels. This is consistent with other studies
- Fields rated as “high to very high” have the greatest opportunity for improvement with adoption of improved on-farm nutrient management practices. Improved practices are expected to improve groundwater quality over time

A subcomponent of the study was a “Benchmark” study conducted between the fall of 2016 and mid-April 2017 in the area over the Hullcar Aquifer

- At each of 4 Benchmark sites, nitrate concentrations were measured in each of 3 soil layers (0-30, 30-60, and 60-90 cm depths) on 4 dates between October 2016 and April 2017
- The Benchmark sites were representative of soil properties with moderate to high leaching potential
- The results indicate the extent to which nitrate leaching through the top 90 cm of soil *actually* occurred or did not occur during the 2016/17 non-growing season
- At the soil nitrate levels observed during the October 2016 sampling date, nitrate did not leach below the 60 cm layer at any of the 4 sites, despite the wetter-than-average conditions during the study period that would have favoured more leaching compared to other years
- The results do not support the use of the post-harvest nitrate test (PHNT) as a measure of environmental risk or nitrate leaching in the Hullcar Valley of the North Okanagan
- Because leaching to groundwater occurs over a period of years, the information collected in this study cannot be directly linked to current groundwater nitrate levels, nor does it indicate the presence or movement of nitrate below the 90 cm depth of soil

2. Where does soil nitrate come from?

- Ultimately, soil nitrate comes from any nitrogen source added to the soil (like manure, composts, fertilizer or nitrate-rich irrigation water) or from the soil itself
- Soil nitrate may form as a result of microbial activity
    - moist soils and warm temperatures increase this activity
    - tillage (e.g., ploughing) increases this activity

Soil microbes convert	**Organic N →**	**Ammonium N →** NH_4**-N**	**Nitrate N** NO_3**-N**
Contained in raw manure	Yes	Yes	No
Contained in soil	Yes	Yes	Yes
Taken up by plants	No	Yes	Yes
Moves with soil water*	No	No	Yes

* Because nitrate does not attach to clay particles like ammonium does, nitrate leaches more readily in most soils. Once leached out of the root zone, nitrate will continue moving to ground water and surface water.

3. Under what conditions does nitrate leaching occur?

- There must be nitrate in the soil, and
- There must downward movement of water through the soil
- Manure that is applied to soil does not immediately contribute nitrate to the soil (see Question 2)
- Water that is applied to a soil does not necessarily move below the root zone. The soil acts like a sponge that can absorb water.

4. Why do a Post-Harvest Nitrate Study?

- The study was done to describe fields in the study region according to their levels of post-harvest soil nitrate in 2016
- This information helped producers prioritize the areas or fields that deserved the most consideration for improved nitrogen management practices in 2017
- Reducing the amount of nitrate left unused by the crop (i.e. post-harvest soil nitrate) is in many cases a "win-win strategy" for the environment and for the farmer; it means less nitrate has the potential to be leached and it helps reduce costs of crop nitrogen fertilization over time
- The study results do not show the amount of nitrate that will reach the aquifer from any field. Nitrate pollution of groundwater from agricultural lands often comes from diffuse or nonpoint sources over large areas of land, not a single point

5. What does a PHNT soil test show and not show?

- A PHNT soil test result **shows**: a snap shot in time of the amount of nitrate not used by the most recently harvested crop; whether nitrogen management can be more efficient; and the amount of nitrate that *can* be lost (e.g. leached) before the next growing season
- PHNT soil test results **do not show**: the amount of nitrate that will be available to the next crop; or the amount of nitrate that *will* be lost (e.g. leached) before the next growing season in dry, cold climates such as in the Okanagan

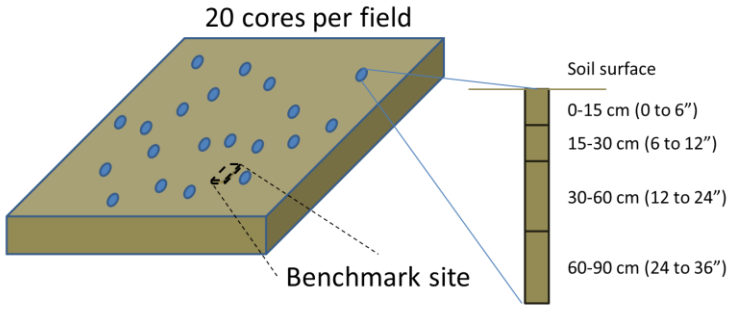
6. What do PHNT values mean with respect to impact on the aquifer?

- In areas that have a dry, cold climate such as the Hullcar Valley, no direct relationship has been identified between the PHNT value and nitrate leaching or the nitrate concentration in the aquifer
- The Post-Harvest Nitrate Study does NOT measure the risk of nitrate leaching into the aquifer
- Results of the Post-Harvest Nitrate Study are being used by the Province in combination with other research to investigate nitrate impacts on the aquifer

7. How were soil samples taken?

Post-Harvest Soil Testing

- Each soil test result was measured from a composite soil sample
- Each composite sample included sampling at 20 locations (cores) chosen randomly
- 800 individual sample cores were collected and each core sample was 90 cm long. Each core sample was then split apart by depth and then a composite sample for each depth
- Areas that were not typical were avoided (e.g., areas close to roads; dead furrows; a small wet spot in an otherwise dry field) to obtain soil samples that were representative of the field



Post-Harvest Soil Testing

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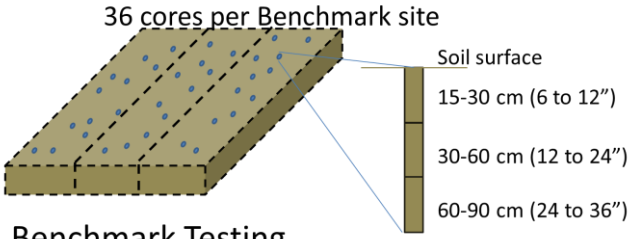
Benchmark Testing

- A Benchmark site was set up in a small section of each of four of the 40 fields
- Each soil test result was measured from three composite soil samples; each composite sample including sampling at 12 locations (cores) chosen randomly, for a total of 36 sampling locations per site
- As with the Post-Harvest Soil Testing method, each 90-cm core was split apart by depth and a composite sample for each depth was created
- As with the Post-Harvest Soil Testing method, areas that were not typical were avoided



Benchmark Testing

8. How deep should soil samples be taken to measure PHNT?

- The PHNT must consider sampling depth and the timing of sampling relative to leaching events
- It was determined that samples at a 90 cm depth were appropriate given the weather conditions in the sample area and the timing of sampling
- For monitoring the effectiveness of nutrient management plans, sampling to a 60 cm depth is generally recommended in the Okanagan Valley of B.C. for the PHNT
- On sites with a hardpan layer, bedrock, or large stones or boulders at a depth of less than 60 cm, sampling to a 60 cm or 90 cm depth is not practical or not possible

9. What were the rating criteria in this study and why were they used?

- The rating system for the Post-Harvest Nitrate Study was:

Rating	2016 Post-Harvest Nitrate Study **0-90 cm** soil depth (kg NO_3-N/ha)
Low	0 – 49
Medium	50 – 99
High	100 – 200
Very High	> 200

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- A 90 cm depth was used after considering the likely effects of leaching events and the time of year
- The objective of the PHNT soil test is to describe the amount of soil nitrate unused by the most recently harvested crop regardless of where it is in the soil profile. The Ministry is confident that sampling at 90 cm of depth captures the amount of nitrate not used by the crop in 2016
- The rating classes were developed to provide guidelines to improve management for a given field on which the same crop will be grown the next year
- High or very high PHNT values indicate that nitrogen application rates could be reduced without risk to crop quality or yield, assuming near-optimum yields

10. Why are PHNT amounts expected to be greater under annual crops (e.g. silage corn) than perennial forage crops (e.g. grass or alfalfa)?

- Greater PHNT amounts are expected under annual crops than the perennial forage crops, because of the perennial forage crops' greater ability to take up soil nitrate before harvest
- Nitrogen uptake in a silage corn field may stop 4 weeks or more before harvest. After nitrogen uptake into the corn stops, soil temperatures and moisture conditions that favour microbial activity will result in additional nitrate being released into the soil prior to harvest
- In contrast, perennial forage crops continue to take up nitrate prior to harvest as the microbes release it into the soil at the end of the growing season

11. Why is there soil nitrate left at the time of harvest if nitrogen was applied at an agronomic rate?

- Applying nitrogen at an agronomic rate (i.e., an agronomic nitrogen balance of zero) does not mean that there will be no soil nitrate in the root zone at the time of harvest
- The amount of soil nitrate at any given time depends on the producer's nitrogen management practices as well as environmental factors (e.g., soil temperature and moisture)
- The amount of post-harvest soil nitrate that can expected in an economically viable cropping system, with the implementation of beneficial management practices, varies with the crop type

12. What were the limitations of the study?

- Conclusions about the depth of nitrate leaching over the non-growing season cannot be generalized to sites with soil nitrate levels that were higher than those observed among the Benchmark sites
  - A 2017/18 Post-Harvest Nitrate Study is underway to address limitations of the 2016/17 work.
  - In 2017/18, Benchmark sites are being monitored to include those sites expected to have very high soil nitrate levels in October 2017 based on the 2016 PHNT results
- The last Benchmark samples were taken in mid-April, there is potential that leaching could have occurred after mid-April in 2017
  - In 2017/18, the Benchmark sampling will continue into May 2018
- One composite PHNT soil sample was taken for each of the fields, regardless of field size or variability
  - 8 large fields from fall 2016 PHNT sampling were each split into two composite PHNT soil samples for fall 2017 PHNT sampling.

13. What can farmers do to improve nitrogen management?

- Farmers can use the PHNT to improve nitrogen management by comparing year-to-year values for the same crop grown on the same field

Rating	Post-harvest nitrate test (kg N/ha)	Management suggestion if growing the same crop next year in the same field
Low	0 – 49	Continue with N management program
Medium	50 – 99	Consider changes to N management
High	100 – 200	Reduce N without risk to crop quality or yield
Very High	> 200	Reduce N without risk to crop quality or yield

- The Ministry of Agriculture provides support to producers to improve their nutrient management practices though:
    - Educational and Extension support:
        - The Ministry provides producers with access to tools, knowledge, and expertise to support responsible on farm nutrient management.
        - The Environmental Farm Plan Program provides a voluntary, no-cost, confidential on-farm risk assessment process to educate producers on better understanding their environmental risks as well as support to identify beneficial management practices to support improvements related to nutrient management.
    - Cost-Share Funding to support implementation of nutrient management related beneficial management practices:
        - The Beneficial Management Practices (BMP) Program provides cost-share funding to support producers in implementing beneficial management practices. This funding supports both planning as well as cost-share funding for nutrient management related equipment and innovative technology.
        - Examples of nutrient related cost-share funding, provided through the BMP Program:
            - Nutrient Management Planning
            - Manure Treatment Systems
            - Manure Application Equipment
            - Composting of agricultural waste
            - Nutrient recovery from waste water

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- Beneficial practices farmers can adopt include:
    - Update nutrient management plans, including manure nutrient analyses, to determine the amount of nitrogen available to the crop
    - Ensure manure application equipment is properly calibrated in order to more precisely know how much manure is being applied
    - Use 'test strips' with different application rates on different parts of the field, and then monitor crop yield, quality and PHNT to determine whether application rates can be reduced without compromising yield or quality
    - Irrigate efficiently to avoid leaching nitrate
    - Practice the '4R' principles of nutrient stewardship
        - Right Source, Right Rate, Right Time, Right Place

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