BC FoodWeb

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RESEARCH SUMMARY

Balancing nitrogen and phosphorus on vegetable farms in southwest BC

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Production Type
- Field vegetables

Practice Benefit(s)
- Improved nutrient management

Research Location
- Southwest BC (lower Fraser Valley, Pemberton Valley, and Vancouver Island)

KEY TAKEAWAYS

- Phosphorus and nitrogen can **contaminate water resources** if these nutrients are lost from farm fields through runoff or leaching.
- Applying compost to meet crop nitrogen needs is a common practice on organic farms, particularly in areas where compost and manure are abundant. However, this practice typically results in **over-applying phosphorus** beyond crop requirements.
- We found that applying compost to meet crop phosphorus needs and a high nitrogen fertilizer to meet crop nitrogen needs is **most likely to achieve both environmental and economic goals** of vegetable farmers using organic nutrient sources.

Figure 1. Measuring cabbage yield from research plots. Photo by Dr. Kira Borden.

HOW CAN THIS RESEARCH BE USED?

- Farmers can consider using a **combination of compost and a high-nitrogen fertilizer** to meet crop phosphorus and nitrogen needs, respectively, particularly in areas with moderate to high soil phosphorus.
- If using this strategy, we encourage farmers to **monitor soil carbon levels**. Additional sources of carbon, such as cover crops, may be needed to maintain soil organic matter.
- The suitability of this nutrient management strategy depends on factors unique to each farm, such as compost cost, fertilizer cost, and baseline soil properties, such as soil phosphorus levels.

WHY WAS THIS RESEARCH DONE?

To better understand the tradeoffs farmers face between nutrient management strategies, we evaluated three different approaches in two years of field trials across 20 mixed vegetable farms located in Pemberton, Vancouver Island, and in the Fraser Valley.

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Like many crops, vegetables require relatively large amounts of nitrogen **(N)**. Applying compost at rates to meet crop N needs can provide large amounts of carbon to build soil organic matter, however, this practice leads to over-applying phosphorus **(P)**, which can build up in the soil and become an environmental risk. High nitrogen fertilizers, like feather meal, blood meal, and alfalfa meal, can provide N with minimal P. However, these fertilizers can be expensive and lack the carbon benefits of compost, which may result in declining soil organic matter.

We evaluated the following nutrient management approaches:

- ***'High Compost'***: We applied a large amount of compost to **meet crop N needs**. Over time, repeated applications of this quantity of compost can lead to P buildup in the soil and increase environmental risks.
- ***'Low Compost + N'***: We applied a smaller amount of compost to **meet crop P needs,** and also applied feather meal, a high-nitrogen fertilizer, to **meet crop N needs**. This management strategy prevents excess P from building up in the soil while also meeting the N requirements of the crop.
- ***'Typical'***: This method follows each farmer's usual nutrient application practices, varying by farm.

Figure 2. *High Compost* application (left-centre) versus *Low Compost + N* application (bottom right). Photo by Amy Norgaard.

WHAT WAS THE OUTCOME?

Observed farm characteristics (soil and compost properties)

We observed that soil P on the farms before the study started varied by region (Figure 3). Many farms in the lower Fraser Valley had surplus soil P, which is a result of past P applications exceeding what the crop needs. In contrast, Pemberton farms had lower soil P, where farms might see yield benefits from additional P.

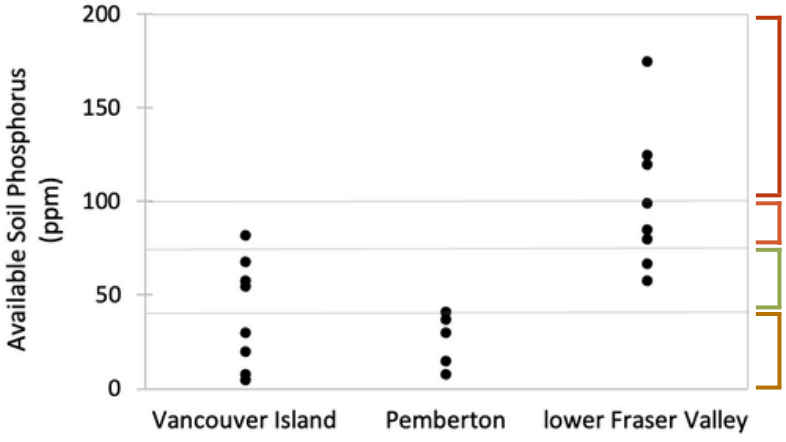

Figure 3. Baseline available soil phosphorus of farms that participated in the research study, measured before the study started. Each dot is a data point representing one farm.

excess (>100 ppm): reduce soil P levels

high (75-100 ppm): consider reducing soil P

medium to optimum (40-75 ppm): maintain

low to medium (<40 ppm)

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We observed a surprising amount of variation in compost nutrient content and costs. Composts used by farms on Vancouver Island (in the study) tended to be lower in N and P (i.e. beef/horse manures, and composts made on-farm), whereas composts were higher in nutrients in the lower Fraser Valley (i.e. poultry manures) (Figure 4). Composts in Pemberton tended to have moderate amounts of N and P and were made with yard and food wastes. The average cost of compost was similar between Vancouver Island and Pemberton, whereas compost was much cheaper in the lower Fraser Valley (Figure 5).

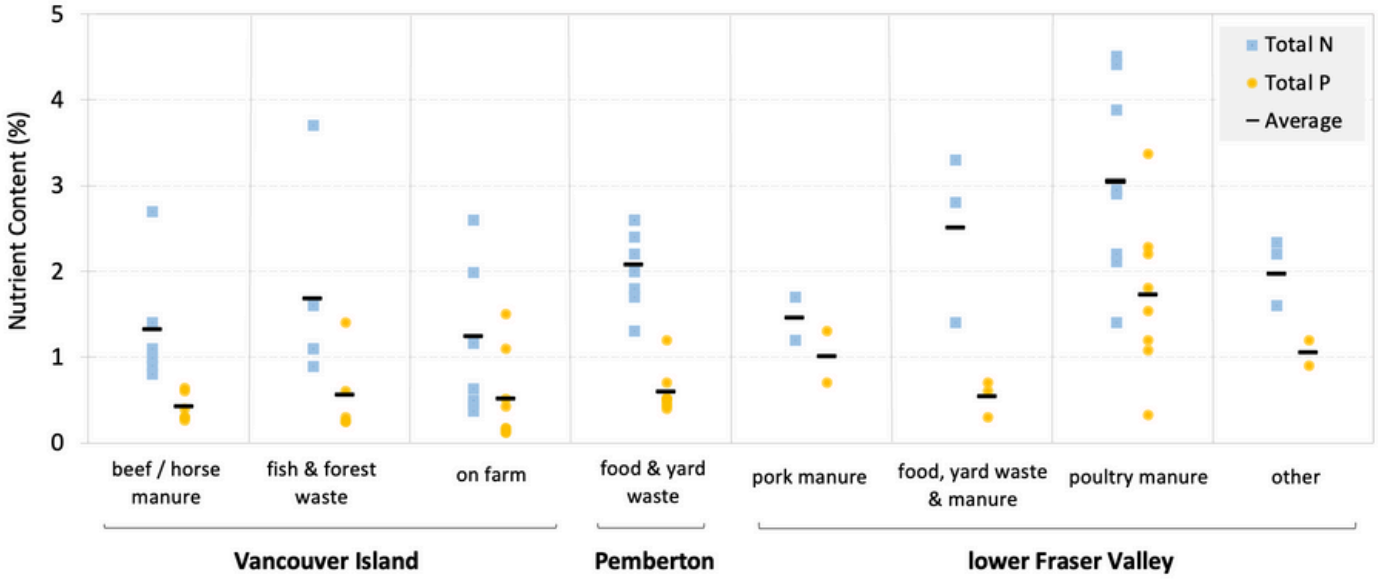

Figure 4. Phosphorus and nitrogen content of different composts, by region and feedstock (type). Each dot is a different data point, and black bars are averages.

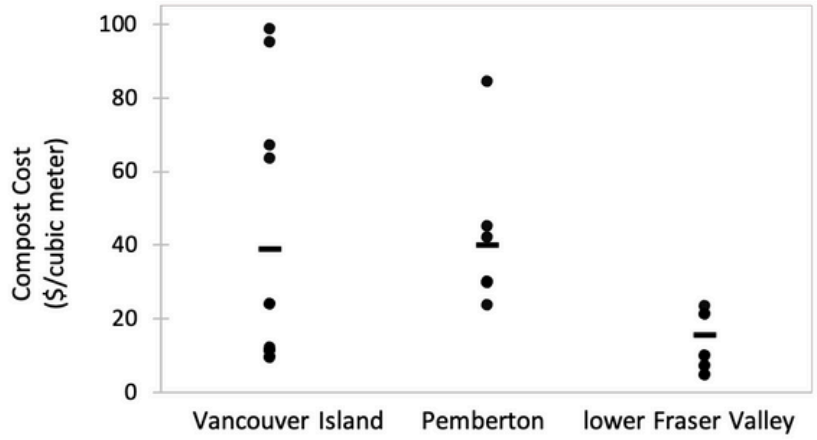

Figure 5. Cost of compost used on farms in the study. Each dot is a different data point representing one farm, and black bars are averages.

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Impacts of nutrient strategies on yield, soil properties, and costs

Keeping in mind that we only studied short-term impacts in this two-year study, we found that, of the three strategies, applying both compost (to meet crop P needs) and a high nitrogen fertilizer (to meet crop N needs) is the most likely to meet both environmental and economic goals of vegetable farmers relying on organic nutrient sources.

The three nutrient strategies did not lead to notable differences in post-harvest soil nitrate or soil 'active' carbon. Only small differences were found in terms of yield and input costs. In year two of the study, *High Compost* led to greater yield than *Typical* in the Fraser Valley. This suggests that amendment application rates based on site-specific but simple nutrient budgets can help prevent under- or over-fertilization and optimize yields. In the lower Fraser Valley, the cost of the *Typical* strategy was less than both other nutrient strategies (Figure 6). Overall, the cost of *Low Compost + N* varied the least because it was the least affected by the highly variable cost of compost.

Across all regions, the *High Compost* treatment led to 21% higher post-season soil P than the Low *Compost + N* treatment, indicating a potential environmental risk. On average, *High Compost* applied 8 times the amount of P needed to replace the P removed with harvest. Similarly, *Typical* nutrient applications often resulted in over applying P, which can build up in the soil over time.

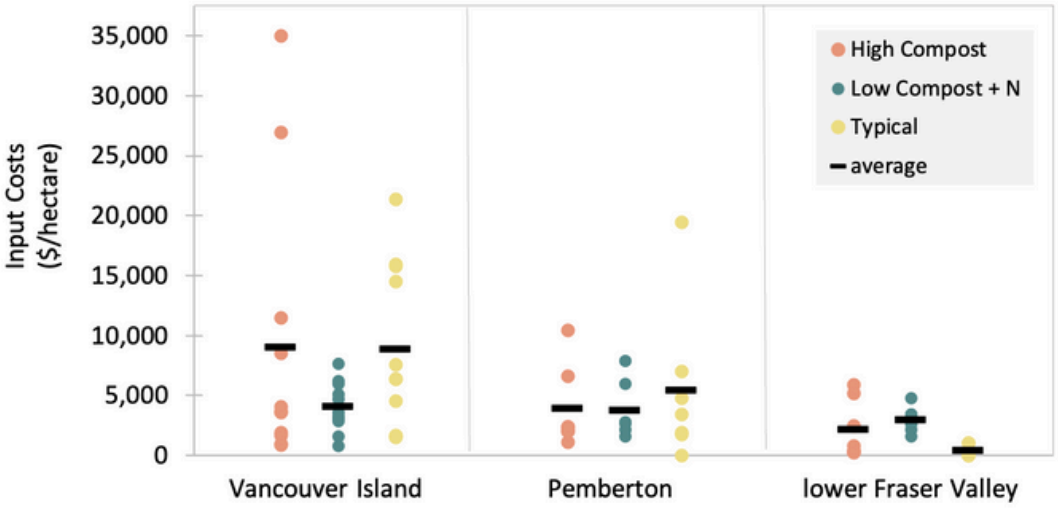

Figure 6. Input costs by region and nutrient strategy. Each dot is a different data point, and black bars are averages.

WHAT'S NEXT?

Farms could benefit from simple nutrient budgets to prevent nutrient deficits or surpluses each season. For example, yield differences in the lower Fraser Valley during the first year of the study were likely caused by both under- and over-application of nitrogen.

Future research should consider economic factors beyond input costs, such as labour, crop quality, and nutrient analysis. Although this study did not account for cover crops, further research on how different cover crop mixes affect farm nutrient budgets could provide BC farmers with an additional nutrient management tool to help meet both production and environmental goals. Legume cover crops can supply additional N through nitrogen fixation, which can help balance N budgets while also providing carbon.

HOW WAS THE RESEARCH DONE?

Field trials were conducted for two growing seasons (2018 and 2019) on 20 mixed vegetable farms across the lower Fraser Valley, Pemberton Valley, and Vancouver Island. A map showing the location of study sites can be found online at the landing page of this research brief. All three nutrient strategies were tested on each farm. The research plot sizes depended on the size of the farm and ranged from 6.3 to 100 m^2. The farms primarily relied on organic nutrient sources such as compost, manure, and organic fertilizers to provide crop nutrients. Most farms were certified organic, but not all. Crops in the study included beet, broccoli, carrot, cauliflower, potato, pickling cucumber, cabbage, and onion.

We evaluated the impact of nutrient management strategy on economic factors (crop yield and input costs) and environmental factors, which included the following soil properties:

- Available N (in the form of nitrate and ammonium)
- Available P (using the Kelowna method)
- 'Active' carbon (in the form of permanganate oxidizable carbon (POXC))

We took compost samples from each farm and analyzed them for nutrient and chemical properties. Input cost data was collected from each farmer and includes the compost/fertilizer cost and shipping/transportation costs.

Figure 7. Using tarps to measure a farm's *Typical* compost application rate. Photo by Amy Norgaard.

ABOUT THIS BRIEF

This brief is based on the following scientific journal article:

Norgaard, A. E., Lewis, D., Borden, K. A., Krzic, M., Carillo, J, & Smukler, S. M. (2022). Trade-offs in organic nutrient management strategies across mixed vegetable farms in Southwest British Columbia. *Frontiers in Sustainable Food Systems, 6*. https://doi.org/10.3389/fsufs.2022.706271

Want to learn more?

- For any questions regarding this research, contact Amy Norgaard at amynorga@alum.ubc.ca
- Watch a presentation on this research: https://www.youtube.com/watch?v=FbcNbl3KkRE
- Explore a nutrient management planning tool online: https://agri-nmp.apps.silver.devops.gov.bc.ca/
- Learn more about nutrient management resources for BC producers: gov.bc.ca/nutrientmanagement

To listen to a podcast episode about this research, scan the QR code or visit: https://organicbc.org/captivate-podcast/nutrient-management/

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