

# NEWS & VIEWS

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Dr. Adrian Johnston,  
Northern Great Plains  
Director  
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## Balancing Nutrient Inputs with Removal

A tool for nutrient management planning from [www.ppi-ppic.org](http://www.ppi-ppic.org)

**NUTRIENT** management planning (NMP) has always been an important component of profitable crop production. It is now also receiving increased attention in areas where nutrients are negatively impacting the environment. In some parts of North America, farmers are required by legislation to use NMPs as a means of documenting their land management practices, and assuring they do not exceed established standards. While soil testing continues to be the definitive means of quantifying soil nutrient levels, understanding the impact of nutrient input and removal on soil fertility can also be of help in planning.

**For the vast majority of farmers who use fertilizer to meet soil nutrient deficiencies and balance nutrient removal, understanding the balance of nutrient inputs and crop removal can be useful.** Over time, soil test results can provide some indication of soil nutrient level changes and how these might impact crop production. Where nitrogen (N) levels are measured in the soil they can change significantly from year-to-year, reflecting the impact of crop grown and environmental conditions. Nutrients like phosphorus (P) and potassium (K) tend to change less from year-to-year, reflecting the ability of the soil to retain a supply of these nutrients and buffer against significant changes. It is with nutrients like P and K that understanding and monitoring the balance between annual inputs and removal can help to avoid their drawdown or accumulation.

**Nutrient removal refers to the P or K removed from the field with the harvest of a crop.** In most instances with grain crops, this amounts to the P and K in the seed. However, where the entire crop is harvested, as in the case of perennial and annual forages, or when the straw is removed for livestock bedding, the nutrient removal can be considerably greater. The majority of P taken up by grain

### Interested in earning a Continuing Education Unit (CEU)?

**The Prairie Provinces (Alberta, Manitoba, and Saskatchewan) Certified Crop Adviser** program has approved the accompanying exam for one (1) CEU in Soil Fertility. After reading this article, complete and return the exam page. A score of 70% or higher will earn the CEU credit.

crops ends up in the harvested seed. In the case of K the opposite is true, with the majority of K uptake remaining in the crop residue. As a result, the crop grown and the crop components removed from the field will ultimately impact on the removal side of a nutrient balance equation.

**Keeping track of your nutrient balance can also help when you are trying to build the soil nutrient supply on soils that currently limit productivity.** While knowledge of crop removal rates is important to minimize soil P and K drawdown with production, you can also consider building soil P and K levels. For example, on most near neutral and alkaline soils it takes 20 to 22 lb  $P_2O_5/A$  to build Olsen soil P levels by 1 part per million (ppm)...equivalent to 2 lb P/A...in the surface 6 in. horizon. Similarly, it takes 8 to 10 lb  $K_2O/A$  to build soil K levels by 1 ppm (2 lb K/A). It is important to remember these are soil building rates of fertilizer P and K that must be applied in addition to the removal by the growing crops. Using these soil building "rules of thumb", the crop adviser and farmer can make plans to address nutrient supply concerns on individual fields.

### PKalc Program

The PKalc program was developed to help crop advisers and farmers balance P and K nutrient inputs and removal from individual fields. PKalc is a Microsoft Excel spreadsheet which contains crop removal coefficients for most crops grown in North America. The user inputs crops grown, the rate and analysis of nutrients added, and crop yields. Then, using a defined time period, the PKalc program calculates an estimate of net change in soil P and K as a result of management practices.



Agronomic market development information provided by:  
**Dr. Adrian Johnston**  
Northern Great Plains Region Director  
Potash & Phosphate Institute (PPI)/  
Potash & Phosphate Institute of Canada (PPIC)  
Suite 704 – CN Tower, Midtown Plaza  
Saskatoon, Saskatchewan, Canada S7K 1J5  
Phone: (306) 652-3535  
E-mail: [ajohnston@ppi-ppic.org](mailto:ajohnston@ppi-ppic.org)

**It is important to remember that PKalc only estimates nutrient balance.** Errors can exist when quantifying the amount of P and K added, particularly for manures with highly variable analyses or applications with significant spatial variability, as well in estimating quantities of nutrients removed by harvested crop portions. While many tables present one removal estimate per harvest unit of a particular crop (such as 0.50 lb P<sub>2</sub>O<sub>5</sub>/bu wheat grain),

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**The following table shows what information is and is not generated by PKalc:**

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<b>PKalc does these:</b>	<b>PKalc does NOT do these:</b>
Totals P and K additions	Provide exact P and K budgets
Totals P and K removals	Utilize soil test data
Estimates P and K balance (total additions – total removal)	Predict changes in soil test levels
	Determine agronomic, economic, or environmental impacts of historical or future P and/or K management

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the actual amount of P and K removed from a specific field or field area can vary significantly from such an estimate. The presence of yield/quality limiting factors, hybrid/variety, and environmental conditions all combine to influence the amount of nutrients taken up in harvested portions of crops. Therefore, when looking at a nutrient balance generated by PKalc, the user should remember these and other sources of error. The greater the positive or negative results, the more confidence the user will have that P and K soil reserves are being built up.

**PKalc includes enough flexibility to be customized to local conditions.** Crop and nutrient lists can be tailored to local areas. The list of crops from which users can choose is restricted, however, to only those crops for which P and K nutrient removal estimates exist. When they are available, local estimates of crop removal can be entered and must be done in a responsible manner.

**PKalc is therefore an assessment tool.** It provides an easy way to estimate P and K nutrient budgets. Such budgets can be combined with other information, such as soil test levels and indicators of possible environmental impact, to help farmers and their advisers understand how best to manage P and K under local conditions.

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## PKalc Program Exercise

1. Setting the security level in Microsoft Excel.
  - Microsoft ships the Excel program with the security level set on high. In order to allow macros in the PKalc program to run this needs to be adjusted.
  - Open a blank worksheet in Excel (click **Start / Programs / Microsoft Excel**).
  - On the toolbar click **Tools / Macro / Security** – select **Medium** – close by clicking **OK**.
  - Now close the Excel program as you are ready to download the PKalc program.
2. Downloading the PKalc program
  - Using your web browser, enter the address for the PKalc program: >[www.ppi-ppic.org](http://www.ppi-ppic.org)<
    - a) Then click on “Toolbox” under the “Features – Quick Links” menu heading toward the right side of the page.
    - b) Then click on “PKalc” to select it.
    - c) Select the first option, which reads:
 

*The spreadsheet **PKalc v1.13** is an interactive tool that allows you to keep track of historical nutrient additions and removals for a field or field area. Take it with you on a laptop or just carry a one page print-out of your results.*
    - d) Click on the **PKalc v1.13** link, and select **Save** as your option in the dialog box which appears.
  - You will now be asked for a location to save the Excel program. You can select an existing location on your computer, create a file to store the program, or simply save it to your desktop.
  - Once the file is transferred, you can exit the website and open the file on your computer.
  - Before opening the file, Microsoft Excel will ask if you would like to Disable or Enable macros. Select **Enable macros**.
3. On the page labeled *FormMain*
  - Replace the MidAmerica Business with your name

- Enter in the project line **CEU Example**.
- Enter in the period from **05/1998** to **12/2003**

You are now ready to start entering information on nutrients added and crops grown.

4. Begin by selecting **Add Nutrients** – this will take you to the **FormNutr** page of the Excel workbook. Here you add the P and K sources used on the field. Enter:

P/K nutrient source	Source type	Analysis		Analysis units
		P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	
MAP	Commercial fertilizer	51	0	%
Potash	Commercial fertilizer	0	62	%
Hog manure	Manure (liquid)	12	15	lb/1,000 gal

- For “source type” you can use the drop down menu to select commercial fertilizer or manure type (the information in the **gray shaded box** (Analysis units) will appear with the selection of the Source type).
- The P/K nutrient sources MAP, Potash, or Hog manure need to be typed in, and also the Analysis, as shown above.

Once you have entered the P/K sources, click on **Main** in the upper left corner to return to the front page of the workbook.

5. Next select **Add Crops** to take you to the **FormCoeff** page, where we will enter the crops grown in our example.

- Under the crop column use the drop down menu to select the crops wheat, canola, and alfalfa in the first 3 rows.
- On selecting the crops, the spreadsheet will automatically enter the **Unit** and **PPI removal coefficients** (gray shaded areas) using information from the PPI Nutrient Removal database in the program.
- If you had P or K nutrient removal data that more accurately represents a specific crop or production area, it could be entered under **User-defined removal coefficients**. Values entered here will be used rather than the PPI coefficients. For this example we will use the coefficients provided in the program.

Once again, return to the front page of the workbook by clicking on **Main** in the upper left corner.

Now that we have entered the nutrient sources that were added to the field, and the crops we grew, it is time to enter the actual rates of nutrients applied and yields of crops harvested.

6. Begin by clicking on the **Edit** tab next to **Total additions**. This takes us to the spreadsheet page **FormAdd**. Now we can enter the fertilizer and liquid swine manure application information:

Date	P/K nutrient source	Source rate
05/1998	MAP	40
05/1998	Potash	25
05/1999	MAP	50
10/2000	Hog manure	5000

- Enter the month and year using numbers separated by a back-slash (/).
- You can use the drop down menu to select the P/K nutrient sources.
- Use the source rates shown above for this example.
- The spreadsheet automatically enters values in the **Rate units, Analysis, Analysis units** and **Nutrients added** columns, resulting in a **Total additions** being calculated.

Once again, return to the front page of the workbook by clicking on **Main** in the upper left corner.

7. Next click on the **Edit** tab next to **Total removal**. This takes us to the spreadsheet page **FormRem**. Now we can enter the harvest date, crop grown and yield information:

Date	Crop	Yield
09/1998	Wheat	35
09/1999	Canola	28
09/2000	Alfalfa	2.2
09/2001	Alfalfa	3.1
09/2002	Alfalfa	2.4
09/2003	Alfalfa	1.7

- Once again, enter the month and year using numbers separated by a back-slash (/).
- The drop down menu for **Crop** gives a listing of the crops we included under the Add Crops section above. Select the crops as shown above.
- Enter the yields as shown above for the wheat, canola, and alfalfa crops.
- The spreadsheet automatically enters values in the **Unit**, **Removal factors**, and **Nutrients removed** columns, resulting in a **Total removal** being calculated.

Once again, return to the front page of the workbook by clicking on **Main** in the upper left corner.

8. The front page of our workbook now provides us with an **Est. net change** for both  $P_2O_5$  and  $K_2O$ , indicating whether we are building soil nutrient levels, depleting the nutrients, or have a zero balance between inputs and removals.
9. **To complete this exercise for one (1) Soil Fertility CEU**, click on the **Print Project** key to get the summarized results of the exercise. Information from the introduction on the PKalc program and the summary results will be required to answer the questions in the CEU Self-Study test attached.

## Interpretation of the PKalc Example

**The summary sheet provides the details on nutrient additions, crop removals, and the balance between the two.** A quick comparison shows that the  $P_2O_5$  inputs with wheat and canola were very similar to the crop removal. Similarly, the  $K_2O$  addition with wheat was slightly more than crop removal. While the single hog manure application provided the largest additions of  $P_2O_5$  and  $K_2O$ , the 4 years of alfalfa harvest resulted in very high nutrient removal.

If a soil analysis of this field indicated low P levels and very high K levels, it is likely that the P removal associated with alfalfa production could negatively impact soil P supply and future crop production. Soils testing high in K, but used for forage production, should be monitored regularly to ensure that the forage crop harvesting does not lower the soil K levels into the marginal range.

**The PKalc program should be viewed as a nutrient management tool.** Using it in combination with a soil testing program, the crop adviser and farmer can develop a better understanding of how management practices have influenced soil fertility status. Output from the PKalc program can become an important part of documenting the impact of agricultural practices on farm fields and the surrounding environment.

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## *Continuing Education Self-Study Test (Prairie Provinces of Canada Only)*

### *Soil Fertility*

#### **Interested in getting a CEU? If so, read on.**

This exam is worth one (1) CEU in Soil Fertility for CCAs in Alberta, Manitoba, and Saskatchewan. An exam score of 70% or higher will earn CEU credit. The International CCA program has approved self-study CEUs for 20 of the 40 CEUs required in a 2-year cycle.

#### **Directions**

1. Complete the PKalc exercise outlined in the article. Print out the project report that provides a summary of nutrient additions, removals, and balance.
2. Answer the questions by circling the best answer for each question.
3. Complete the self-study exam registration form on the back of this page.
4. Mail the exam page to the address at the end of the next exercise.
5. The CCA program will be notified for those respondents who achieve a score of at least 70% and one (1) Soil Fertility CEU will be granted.
6. There is no charge for completion of this self-study CEU.

### **Self-Study Exam**

#### **Use of PKalc to Estimate the Impact of Crop Production on Soil Nutrient Removal**

*Circle the correct answer to the 10 questions below*

1. The PKalc program can be used to monitor fields for:
  - a) changes in soil N levels.
  - b) rates of fertilizer required.
  - c) balance of P and K inputs and removals.
  - d) balance of N and P inputs and removals.
2. Building soil test P by 1 ppm requires:
  - a) 8 to 10 lb  $P_2O_5/A$ .
  - b) 20 to 22 lb  $P_2O_5/A$ .
  - c) 8 to 10 lb  $K_2O/A$ .
  - d) 2 lb  $P_2O_5/A$ .
3. The PKalc program contains a list of:
  - a) fertilizer recommendation rates.
  - b) yield response functions.
  - c) soil nutrient building rates.
  - d) crop removal coefficients.
4. Use of the PKalc program helps the crop adviser and farmer:
  - a) estimate P and K nutrient balance.
  - b) accurately predict changes in soil test levels.
  - c) develop a yield goal function from soil tests.
  - d) establish the environmental impact of fertilizer use.
5. Total additions of  $P_2O_5$  from fertilizer in the example were:
  - a) 40 lb/A.
  - b) 80 lb/A.
  - c) 46 lb/A.
  - d) 106 lb/A.
6. Total additions of  $K_2O$  from hog manure in the example was:
  - a) 91 lb/A.
  - b) 16 lb/A.
  - c) 75 lb/A.
  - d) 59 lb/A.
7. Of the crops grown, which removed the least total  $P_2O_5$  and  $K_2O$ :
  - a) alfalfa
  - b) canola
  - c) wheat
  - d) barley
8. Total estimated  $K_2O$  removal in the example was:
  - a) 185 lb/A.
  - b) 589 lb/A.
  - c) 584 lb/A.
  - d) 498 lb/A.

9. When total removal of  $P_2O_5$  exceeds additions, P is being:
- a) depleted from the soil.
  - b) kept in balance.
  - c) built for future crops.
  - d) stored for high yield years.

10. A large net removal of  $K_2O$  from a soil would not be a concern when:
- a) the field is close to a potash mine.
  - b) soil test K levels indicate a deficiency.
  - c) the soils test very high in exchangeable K.
  - d) low rates of starter K are added each year.

### Self-Study Exam Registration Form

Name: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ State/ Province: \_\_\_\_\_ Postal code: \_\_\_\_\_

CCA Certification #: \_\_\_\_\_

X \_\_\_\_\_ Date: \_\_\_\_\_

Signature of registrant as it appears on Code of Ethics.

*I certify that I alone completed this self-study exam. I recognize an ethics violation may revoke my CCA status.*

**This exam issued March 2004 expires March 2007.**

### Self-Study Exam Evaluation Form

**Rating Scale: 1=poor 2=Below Average 3=Average 4=Above Average 5=Excellent**

Information presented will be useful in my daily crop advising activities: 1 2 3 4 5

Information was organized and logical: 1 2 3 4 5

Completing the computer program exercise enhanced my learning: 1 2 3 4 5

I was stimulated to think how to use and apply the information presented: 1 2 3 4 5

This article/exercise addressed the stated competency area: 1 2 3 4 5

Briefly explain any "1" ratings: \_\_\_\_\_

\_\_\_\_\_

Soil Fertility topics you would like to see addressed in future self-study materials: \_\_\_\_\_

\_\_\_\_\_

Fax the completed self-study exam (front and back of this page) to Dr. Adrian M. Johnston at: (306) 664-8941; phone (306) 652-3535.

Or mail to Dr. A.M. Johnston, P.Ag., CCA  
 PPI/PPIC  
 Suite 704 – CN Tower, Midtown Plaza  
 Saskatoon, Saskatchewan, Canada S7K 1J5