CCA ADVANTAGE

The Voice of the Certified Crop Adviser Program
American Society of Agronomy
www.agronomy.org/cca

Making the Most of the CCA Program

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The Certified Crop Adviser (CCA) Program has an impressive but short 10-year history. It has become a great success story for production agriculture. At times, though, the question arises regarding value of the designation to those that hold it.

What is the value of being a CCA? Value is "worth in usefulness or importance to the possessor," according to the *American Heritage Dictionary*. Only you as a CCA can truly answer this question because it is slightly different for each individual.

I'd like to build a case for the value in being a CCA and ask you to think about why you first entered the program and what keeps you in it today.

There are 14,869 CCAs throughout North America. That is an impressive, number, considering the program is only about 10 years old. There are 37 local CCA Boards representing over 400 volunteers from all segments of agriculture and natural resource management.

It is important to know what you are part of, and the strategic plan that guides the program helps you to do that.

CCA Mission: The CCA Program validates the credentials of professional crop advisers by establishing standards for knowledge, experience, ethics and continuing education.

CCA Vision: To be the most valuable certification a professional crop adviser can hold by establishing CCAs' essential role in agricultural production, food safety and environmental stewardship.

GOALS FOR 2003-2005

1. Increase the value of CCA Certification.

Objectives —
- Increase the value of certification to the individual CCA.
- Continuously refine and communicate criteria for quality assurance.
- Establish relationships with the food supply chain.
- Be actively engaged in the development and implementation of public and private policy.

2. Implement an effective marketing and promotional plan for the CCA Program.

Objectives are marketing efforts directed toward —
- CCAs and their employers.
- Producers.
- The food supply chain.
- Government agencies, legislators and educators.
- The general public, interested parties and organizations.

3. Improve relevance, quality and delivery of continuing education as the foundation and strength of the CCA Program.

Objectives —
- Highlight the importance of the CCA Code of Ethics.
- Broaden the use of emerging information delivery technologies.
- Expand self-directed CEUs.
- Develop current and relevant educational objectives for continuing education, complementary to those for the exam.

4. Increase and improve standardization of the CCA Program.

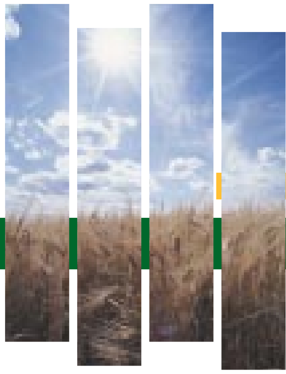
Objectives are to improve standardization of —
- Continuing education requirements.
- The examination process.
- Program fees and governance structure for local boards.
- Guidelines for use of the CCA logo.

5. To effectively and efficiently administer the CCA Program.

Objectives —
- Ensure that budget projections reflect new goals and objectives.
- Maintain self-supporting cost-effective structure.
- Continue to look for quality improvement opportunities.
- Maintain financial accountability to CCAs and the organization.

This plan was developed by CCAs for CCAs. It is impressive when you con-

continued on page 36



sider how strongly board members felt about enhancing the value of certification.

A CCA is part of and helping to create a standard of excellence for crop advising. This has helped establish crop advising as a profession. Only 60 to 65 percent of those who start the process toward certification actually achieve it. We estimate that over 70 percent of the crop acreage in the U.S. and Canada is impacted in some way by a CCA.

A CCA meets a standard and agrees to practice ethically. The code of ethics is a key component to the foundation of the program. It adds value if it is adhered to and enforced. If not, it also can take away value.

Growers know the CCA program by the CCA who walks on their farm. Whether that CCA conducts himself or herself ethically or not paints a picture in that grower's mind of what the CCA program is all about. People know the program by the individual CCAs they conduct business with.

The code is not a fail-safe system, though. It only works if we follow the step-by-step process outlined in the policy and procedures manual found on the Web site at *www.agronomy.org/cca*. If a CCA is violating the code of ethics, enforcement begins with a written and signed complaint letter. This is important so that due process can be followed. We want the system to be enforceable and fair to all parties.

Worth was mentioned earlier. Here are some examples: job enhancement/advancement/placement (I hear this often from those in the job market. Those doing the hiring typically ask them if they are a CCA); professional achievement; formalized continuing education process; USDA-NRCS recognizes it, and it is required to be a TSP; the public demands it, and customers appreciate it, if they know about it.

Promote the value by placing the logo and initials on your business cards and letterhead. Use decals and signage in offices and on vehicles. Tell people that you are a CCA and why, and what you had to do to earn it and have to do to keep it. You are your own best sales person.

In summary, only you can truly answer the "value" question for yourself. It means something slightly different to everyone. You also place the perceived value on it by your actions or lack thereof. If you don't place any value on it by your words and actions, don't expect your customers or anyone else to. You represent a standard of excellence in production agriculture.

Chairman's Corner

Identifying the Compelling Reasons for CCA Membership

Dr. Bob Beck, CCA, Chairman

By Dr. Bob Beck, CCA, Chairman, International CCA Board, Global Sales Training & Development Manager, Pioneer Hi-Bred International, Johnston, IA, phone: 515/334-6778, e-mail: robert.beck@pioneer.com

I would like to share a new opportunity with you. I joined Tom Bruulsema (past chair) and Steve Dlugosz (vice-chair) representing CCA at the Tri-Societies Shared Leadership workshop. We have a formal relationship with the American Society of Agronomy and this workshop gave us an opportunity to address some issues regarding our relationship. We reviewed a benchmarking survey of the members of the Tri-Societies to understand the concerns and strengths perceived by leaders of the staff and boards.

Future Members

A key item the survey identified was the issue of membership. They are struggling with the questions of "Who are the future members of the Tri-Societies? How can we best serve them?" The leadership of the Tri-Societies is willing to examine a model of membership that would identify compelling reasons for being a member both under the current structure and in a new structure, if one can be created. It's one of the issues your ICCA board struggles with as well.

We learned some very interesting techniques in working with volunteer leaders of a nonprofit board and staff. One model is so powerful that I would like to share it with you. It is called "The Ladder of Inference," a tool for understanding how interactions can go awry.

The ladder is a tool of Action Science, developed by theorists Chris Argyris and Donald Schon, that traces the "leaps of inference" that lead us to form mental models. An interesting read that I recommend is *Shadows of the Neanderthal, Illuminating the Beliefs That Limit Our Organizations*, by David Hutchens, published by Pegasus Communications *(http://www.pegasuscom.com)*.

Hutchens describes the steps of the ladder as follows:

- I begin at the foot of the ladder, surrounded by observable data about the issue I am faced with.
- I select data from the pool. Possibly a statement made during a discussion.
- I add meaning to the data I have selected regarding that statement.
- I make assumptions based upon the meaning. This is my world of reference.
- I draw conclusions from the assumptions.
- I adopt beliefs.
- I take actions.
- I get results, creating more data to add to the pool at the ladder's base.

Hutchens gives an example of the leap of inference, a process of racing up the ladder, which occurs in our subconscious thoughts almost instantaneously.

- I select data: "When I proposed an idea at the meeting, no one said anything."
- I add meaning: "There is no follow-up to anything I am saying."
- I make assumptions: "No one appreciates my ideas, or how valuable I could be to this team."
- I draw conclusions: "I'd better not say anything else during meetings."
- I adopt beliefs: "I must not be competent."
- I take action: I stop speaking at meetings.
- I get results: People stop looking to me for input. I then notice this "data" and decide my belief is true that I am not competent.

He points out we make these leaps of inference instantly, even multiple times during one simple interaction.

The reason for mentioning this ladder of inference and example is to share the learnings from the interactions at the shared leadership workshop. The Tri-Societies are looking at their membership model and beliefs. They are trying not to scramble up the ladder of inference when someone asks the question "Who should our members be?" In the pool of possibilities, you are being considered.

What's Missing

I am asking you to contact members of your ICCA board of directors to help us understand concerns you have regarding your certification and what's missing for you if you are not a member of American Society of Agronomy, Crop Science of America or Soil Science Society of America. I am not inviting you to scamper up the ladder of inference. I am asking you to stop on each rung and see what you unconsciously believe. Is there an opportunity for us to create more value to you as a certified crop adviser? What would it be?

We will be communicating with the leaders of the Tri-Societies as they look toward change and consider how they can be of value to individuals who desire membership.

Continuing Education Self-Study Course

Nutrient Management

CCA 1 CEU

Using Soil Phosphorus Profile Data to Assess Phosphorus Leaching Potential in Manured Soils

By Peter J.A. Kleinman, Brian A. Needelman, Andrew N. Sharpley, and Richard W. McDowell

Earn one CEU!
All CCAs may earn up to 20 Continuing Education Units (CEUs) per two-year cycle as board-approved self-study articles which will include CCA Advantage articles. The CCA CEU logo (above) marks all pre-approved material, with the CEU value indicated by the number in the middle. To receive one CEU in nutrient management, read this article, fill out the attached exam and mail the tear-out form, along with $10, to the American Society of Agronomy.

Phosphorus, an essential nutrient for crop and animal production, can accelerate freshwater eutrophication. The U.S. EPA identified eutrophication as the most ubiquitous water quality impairment in the U.S., with agriculture a major contributor of P. Identifying soils where P leaching can contribute to surface water P loading remains an important scientific need given the general paucity of data connecting specific soils with subsurface P transport.

Subsurface flow pathways can be important to P transport in certain landscapes. Subsurface transport is dominated by preferential flow through soil macropores, and environmentally important losses to surface waters are facilitated by artificial drainage, which provides connectivity between subsurface macropores and surface water. In addition, factors such as soil P sorption saturation (P_{sat} – the degree to which P sorption sites in soil have been already filled with P) and oxidation-reduction cycles can greatly increase P mobility through soils. Where no direct P leaching data exist, investigators have turned to evidence of long-term P movement within soil profiles as an indicator of P leaching potential.

The objective of this study was to determine if soil P profile data could be used to assess P leaching potential in heavily manured soils. Bulk and clay film samples collected from soil horizons were analyzed for evidence of P movement. To validate conclusions drawn from P profile data, tile-drain monitoring data and column leaching experiments were assessed.

Methods

The study area is the Susquehanna River Basin, part of the Appalachian Valley and Ridge Physiographic Province of the northeastern U.S. A hill slope of Buchanan and Hartleton soils in an intensively monitored watershed was selected. The hill slope is located in a conventionally tilled field under corn-soybean-wheat rotational cropping. Approximately 5 Mg ha^{-1} yr^{-1} poultry manure, corresponding to 85 kg P ha^{-1} yr^{-1}, is applied annually to soils in the area prior to cultivation. A 15-cm ceramic tile line, established approximately 35 years ago at a depth of 50 to 60 cm, drains lower positions on the hill slope.

Three 2-m deep pits were excavated along the hill slope and intact samples were collected from each horizon for laboratory analysis. Two 30-cm deep columns and two 50-cm deep columns were collected from each of the three locations.

The two soils found lower in the hill slope, labeled Lower Buchanan and Upper Buchanan, fit all criteria of the Buchanan series except drainage. They are somewhat poorly drained while the Buchanan series is moderately well drained. The third soil is assigned to the Hartleton series. Intact peds from each horizon were dissected.

Two experiments were conducted on the soil columns to directly assess P leaching potential. In the first experiment, soils were leached prior to manure addition. The last field application of manure to these soils was 9 months before the leaching experiment. In the second experiment, poultry manure was applied to the soil surface at a total P application rate of 85 kg ha^{-1}, representing a typical P application for the site. Leaching experiments were conducted 1 day after manure application.

Poultry manure was applied to soil at field capacity. Soil columns were irrigated with a system delivering water at 0.6 cm h^{-1}. As estimated infiltration capacities of Hartleton and Buchanan soils range from 1.2 to 15 cm h^{-1}, no ponding occurred during the leaching experiments. Soils were drip irrigated every 6 hours for 72 hours, resulting in a total application of 7.5 cm over the study period. This corresponds with a precipitation event with a 1-year return period.

Tile drainage and leachate from the soil columns were analyzed for dissolved and total P was measured on unfiltered leachate.

Results and Discussion

Soil morphology: Given the difficulty in differentiating between active and inactive macropores, the clay film scrapings collected in this study could not be restricted solely to macropores.

Despite the contrasting permeabilities of Buchanan and Hartleton soils, macropore distribution in these soils is likely important to P transport in all soils.

The Lower and Upper Buchanan soils have well-developed fragipans. The absence of a fragipan in the Hartleton soil is most likely because of the high rock fragment content. Fragipans cause seasonally perched water tables and are key to the variable source area hydrology of this location. In addition to serving as a cause of saturation-related overland flow, fragipan-perched water tables cause lateral flow that represents an important P transport mechanism. Therefore, in these soils, tile drains enhance the transport of P to the stream channel.

Finally, the lithologic discontinuity within the solum of all three soils is of particular note to this investigation. The discontinuity is demarcated by a rapid change in rock fragment content and characteristics.

Chemical analyses of samples taken from individual horizons reveal similar gross trends in P distribution within the three soil profiles.

Oxalate-extractable elements: Oxalate-extractable soil P (P_{ox}) data show some evidence of P leaching via soil macropores. Specifically, P_{ox} concentrations in the clay films of four of the subsoil horizons are significantly higher than P_{ox} concentrations in corresponding bulk samples. This suggests that P has been translocated along soil macropores, possibly as colloidal P during lessivage or as dissolved P that is now sorbed to macropore walls.

One striking trend observed in all three soils is that P_{ox} concentrations in the lower solum are significantly higher than in the upper argillic horizons. Such a disparity in P_{ox} concentrations could result from the dissolution and mobilization of P from saturated and reduced overlying argillic horizons. Trends in bulk sample Fe_{ox} with depth reveal significantly greater Fe_{ox} concentrations, and hence greater P sorption capacity, below the lithologic discontinuity where P_{ox} concentrations are greater than in the overlying argillic horizons.

Soil phosphorus sorption saturation: Soil P sorption saturation has been linked to P leaching potential in a variety of studies. As P_{sat} incorporates both sorbed P (P_{ox}) and P sorption capacity (as represented by oxalate extractable Al plus Fe in soil) in its calculation, differences in P_{sat} distribution by horizon and morphological fraction offer valuable insight into trends affecting potential P movement. Near the surface, P_{sat} in bulk soil samples ranges from 11 to 22 percent, whereas subsoil P_{sat} ranges from 0.2 to 3.7 percent. Annual fertilization through manure additions and subsequent sorption of added P clearly explain the high P_{sat} of the Ap horizons. Most trends observed in P_{sat} appear to follow those of P_{ox} described above. In all three soils, P_{sat} increases significantly below the lithologic discontinuity. Phosphorus sorption saturation is elevated in most clay films relative to corresponding bulk samples, offering further evidence of P transport via preferential flow pathways.

Water-extractable phosphorus: Water extractable soil P is strongly correlated with dissolved P losses in runoff. Elevated water-extractable soil P at depth would suggest that these soils have a potential to desorb P to drain water. Water-extractable P declines from the surface to the subsoil, with the highest concentrations occurring in the surface and subsurface horizons of the Hartleton soil. In the subsoil, water-extractable P is significantly higher in the Bt1 horizons of all soils than in lower horizons. The changes in water-extractable P with soil depth highlight the role of manure additions as a source of this highly labile fraction, as well as the high P buffering capacities of the subsoil, which result in low absolute concentrations. The high water-extractable soil P concentrations in the bulk samples of the Bt1 horizons, relative to the lower argillic horizons, indicate limited translocation of dissolved P from the soil surface horizons, possibly by matrix flow. However, the absence of elevated concentrations of water-extractable P lower in the profile, where artificial drainage is installed, indicates that leaching of dissolved P through the soil matrix may not be important to subsurface P transport in these soils.

Unlike P_{ox} and P_{sat}, we anticipated significantly lower water-extractable P in the clay films than in the bulk samples because of increased sorption of solution P in the clay films related to their greater reactive surface area and elevated sorption capacities. In five of the 11 clay film samples, water-extractable P is significantly lower than in the corresponding bulk samples. Notably, in one horizon, water-extractable P was significantly higher in the clay film than in the bulk sample. In this case, the clay film sample had a considerably high P_{sat} relative to the bulk sample, which may explain the elevated water-extractable P concentration, as P desorption to water is strongly correlated with P_{sat}.

Mehlich-3 phosphorus: Mehlich-3 extractable soil P, an indicator of plant available P, ranges from 9 to 177 mg kg^{-1} at the soil surface to 0.3 to 3.0 mg kg^{-1} in the argillic horizons and 1.4 to 8.6 mg kg^{-1} below the lithologic discontinuity. As a point of reference, in Pennsylvania, a crop response threshold has been estimated at a Mehlich-3 P concentration of 65 mg kg^{-1}, above which the addition of fertilizer P is not expected to increase crop yield. As such, Mehlich-3 P concentrations in the surface horizons of the Upper Buchanan and Hartleton soils are well in excess of crop requirements. Mehlich-3 P concentrations in the surface horizon of the Lower Buchanan soil are below crop requirements.

Origin of phosphorus in the lower solum: To further see if elevated P in the lower solum resulted from long-term leaching or from varied parent materials within the regolith, we collected samples beneath the solum of each of the three soils. Concentrations of P_{ox} in the C horizon cores are not significantly different from the lower solum concentrations. Similarly, P_{sat} in the C horizons is not significantly different from P_{sat} in the lower solum. Thus, the elevated P concentrations in the lower solum appear to be authigenic (i.e., because of a discontinuity in soil parent materials). It is unlikely that leaching of surface-applied manure P would uniformly enrich the matrices of the lower solum and C horizons and that sufficient manure P has been moved to account for the mass of P_{ox} found in the regolith.

Leaching observations: Following poultry-manure application, mean concentrations of leachate dissolved and total P were significantly higher than before manure application, as were mean loads. On average, dissolved P accounted for 73 percent of total P concentration after manure application, as opposed to 5 percent of total P before manure application. Total P loads in leachate represented 0.03 to 1.11 percent of total P applied to the columns in manure. As before manure addition, leachate dissolved P concentrations did not differ significantly between 30-cm and 50-cm deep cores.

Results from the leaching experiment indicate the importance of manure addition to P leaching, and confirm the potential to leach P to the lower solum, approximately the depth of the tile drain, in all three soils. As manure was added at a rate corresponding with the annual average, and manure is typically applied to these soils in the spring, when soils are wet, it is likely that this experiment accurately simulates field conditions.

Because there was no systematic difference in leachate P losses between the 30- and 50-cm deep cores, results suggest that P is transported via preferential flow pathways. If matrix flow was the dominant mechanism of subsurface P transport, then one would expect dissolved P concentrations in leachate to be greater from the 30-cm cores than from the 50-cm cores. In fact, the greatest leaching losses among all replicates were consistently observed from a 50-cm core (Lower Buchanan). Furthermore, the ranking of total P losses from individual cores after manure application was identical to the ranking of total P losses prior to manure application, such that the Lower Buchanan 50-cm core consistently had the highest losses while the Lower Buchanan 30-cm core had lowest losses. Such a consistent response illustrates that P transport from the soil surface, particularly from manure P, is responsible for subsurface P concentrations and that an active macropore flow pathway is necessary for P transport.

Monitoring of tile drainage from May to October 2000 further supports the importance of subsurface flow as a pathway for P loss from these soils. Mean drainage dissolved P concentrations ranged from 0.010 mg L^{-1} during base flow to 0.102 mg L^{-1} during storm event flow. Mean total P concentrations ranged from 0.019 mg L^{-1} during base flow to 0.283 mg L^{-1} during storm event flow. Although base flow volume was greater than storm flow volume, loads of dissolved and total P were substantially higher during storm flow than during base flow. Increases in drainage P concentrations during storm flow more than offset the greater flow volumes observed during base flow. The elevated losses of P in tile drainage during storm events support the conclusion that rapid, subsurface P transport can be significant within this system. In fact, storm flow concentrations are frequently above eutrophic criteria established for streams or other flowing waters not discharging directly into lakes or impoundments.

Concentrations of dissolved and total P in leachate from the 30- and 50-cm lysimeters before manure addition were not correlated to any of the soil P fractions, or to Fe_{ox}, measured in bulk and clay-film samples taken from corresponding depths. Furthermore, concentrations of soil P fractions from surface horizons were not correlated with leachate P concentrations. These poor correlations indicate that profile P data provide poor quantitative prediction of P leaching potential.

Conclusions

Despite strong evidence of water-soluble P translocation in bulk samples of shallow subsoil horizons, samples collected deeper in the profile exhibited no evidence of such movement. As such, leaching of dissolved P from the matrix of these soils is likely not of environmental importance. However, the most compelling evidence that P leaching had occurred in these soils was provided by clay-film samples, some of which exhibited significantly elevated P_{ox}, P_{sat}, and Mehlich-3 P concentration relative to bulk samples. This indicates that subsurface P transport via macropores may occur to tile-drain depths. Not all clay films, however, possessed P concentrations greater than the bulk samples. Nor were all clay films necessarily associated with active macropores.

Increases in P_{ox}, P_{sat}, and Mehlich-3 P concentrations in bulk samples of the lower solum may be explained by two competing theories: (1) discontinuity in parent material (at the fragipan boundary in Buchanan soils); and, (2) preferential flow of P from the soil surface to the lower horizons (i.e., bypass leaching). Based upon P profile data alone, we cannot discount the first theory, as rock fragment quantity and type differences within the subsoil indicate that two stratified parent materials are present in all three soils.

This study shows that soil P profile data must be carefully interpreted to properly assess P leaching potential. Bulk horizon samples appeared to provide evidence of P movement, but the elevated P in the subsoil was ultimately attributed to lithological differences. The need for scrutiny of P profile data is because of the dominant mechanism of subsurface P transport: preferential flow. Leachate dissolved P bypasses the matrix of subsoil horizons via select macropores that are not taken into account by bulk sampling of horizons. Indeed, leaching experiments confirmed that the potential to leach dissolved P to the depth of artificial drainage was equivalent to the potential to leach P to shallow depths. Monitoring data revealed an increase in drainage P concentrations with flow, providing clear indication of the importance of bypass flow via soil macropores.

The transport of P by subsurface pathways can be an important mechanism of P transfer from land to water in heavily manured soils, especially those that are artificially drained or have preferential flow pathways connected to stream channel discharge. This study reveals that detailed description and interpretation of soil P profile data provides limited insight into P leaching potential: correlation of soil P fractions with leachate dissolved P from lysimeters was poor.

__Editor's note:__ Content was adapted from the paper "Using Soil Phosphorus Profile Data to Assess Phosphorus Leaching Potential in Manured Soils," which was published in Soil Sci. Soc. Am. J., Vol. 67, Jan.-Feb. 2003, and is courtesy of the authors Peter J.A. Kleinman, Brian A. Needelman, Andrew N. Sharpley and Richard W. Mc Dowell.

Get a CEU!

This exam is worth 1 CEU in **Nutrient Management**. 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 the two-year cycle.

DIRECTIONS

1. Read the self-study article on pages 38-40 carefully.
2. Answer the questions by clearly marking an "X" in the box next to the best answer for each question.
3. Complete the self-study exam registration form on the back of this page.
4. Clip out this self-study examination page, fold and place in envelope.
5. Enclose a check for $10.00 made payable to the American Society of Agronomy, for processing fees. Payment in U.S. funds only.
6. **Mail your self-study exam and fee to:** ASA c/o CCA Self-Study Exam, 677 S. Segoe Road, Madison, WI 53711. *Please allow 60 days for processing.*
7. An electronic version of this test is also available at *www.AgProfessional.com*. Go to the Certified Crop Advisers section (lefthand column) and access the "CCA Advantage" link.

Using Soil Phosphorus Profile Data to Access Phosphorus Leaching Potential in Manured Soils

April Self-Study Examination

DETACH HERE

1. An essential nutrient for crop and animal production, phosphorus can:

[ ] a. decrease fresh-water eutrophication.
[ ] b. increase fresh-water eutrophication.
[ ] c. improve water quality.
[ ] d. be difficult to detect.

2. Subsurface transport is dominated by:

[ ] a. capillary action.
[ ] b. preferential flow through soil macropores.
[ ] c. textural gradients.
[ ] d. structural changes.

3. In the subsurface horizons of all three soils, oxalate-extractable soil P concentrations were greater:

[ ] a. below the lithologic discontinuity.
[ ] b. above the lithologic discontinuity.
[ ] c. in the upper argillic horizons.
[ ] d. in the A horizons.

4. In the sub-surface horizons of all three soils, soil P sorption saturation:

[ ] a. remains the same throughout the soil profile.
[ ] b. decreases significantly below the lithologic discontinuity.
[ ] c. increases significantly below the lithologic discontinuity.
[ ] d. readings determined capillary action was the primary mechanism for P transport.

5. In Pennsylvania, addition of fertilizer P is not expected to increase crop yield when Melich-3 P concentration is above:

[ ] a. 35 mg kg^{-1}.
[ ] b. 45 mg kg^{-1}.
[ ] c. 55 mg kg^{-1}.
[ ] d. 65 mg kg^{-1}.

6. Elevated P in the lower solum resulted from:

[ ] a. long-term leaching.
[ ] b. varied parent material.
[ ] c. could not be determined.
[ ] d. was insignificant.

7. Results suggest that P is transported via preferential flow pathways because:

[ ] a. concentrations in leachate were greatest in the 30 cm cores.
[ ] b. concentrations in leachate were greatest in the 50 cm cores.
[ ] c. there was no systematic difference in leachate P losses between the 30 and 50 cm cores.
[ ] d. matrix flow does not reach 50 cm in most soil solums.

8. Profile P data:

[ ] a. provides limited insight into P leaching.
[ ] b. provides good insight into P leaching.
[ ] c. provides excellent insight into P leaching.
[ ] d. was not available for this study.

Over

9. Surface application of poultry manure:
- [ ] a. had no effect on leachate P concentrations.
- [ ] b. decreased leachate P concentrations.
- [ ] c. increased leachate P concentrations from all soils.
- [ ] d. increased leachate P in 30-cm columns only.

10. Storm flow concentrations in tile drainage are frequently:
- [ ] a. important sources of nutrients for surface water ecosystems.
- [ ] b. below eutrophic criteria established for streams not discharging directly into lakes or impoundments.
- [ ] c. above eutrophic criteria established for streams not discharging directly into lakes or impoundments.
- [ ] d. an example of matrix flow.

DETACH HERE

SELF-STUDY EXAM REGISTRATION FORM

Name: ______________________________

Address: ______________________________

City: ______________ State/Province: ______________ Zip: ______________

CCA Certification #: ______________________________

Credit Card #: ______________ Type of Card: Visa ❑ Mastercard ❑ Discovery ❑ Am Express ❑

Expiration Date ______________ Name on Card: ______________

A $2 processing fee will be added to all credit card charges, or enclose $10 check payable to American Society of Agronomy.

X ______________________________

Signature of Registrant as it appears on Code of Ethics

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

This exam issued April 2004 expires April 2007.

SELF-STUDY EXAM EVALUATION FORM

Rating Scale: 1=Poor 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

Graphics/tables were appropriate and 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 addressed the stated competency area and performance objective(s): 1 2 3 4 5

Briefly explain any “1” ratings: ______________________________

Topics you would like to see addressed in future self-study materials: ______________________________