Extension Education Methods

Development and Evaluation of a Training Program on Whole Farm Nutrient Planning for Organic Farms

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Summary. Organic growers have indicated a need for help with the challenge of nutrient management. To address this challenge, an intensive training program for agricultural educators was convened to study this issue. Through the program, existing soil and compost analysis recommendations were modified to make them more relevant for organic growers; computer-based whole farm nutrient planning tools were evaluated using situations common to organic farms; and educational materials on using organic nutrient sources were developed for grower audiences. Educational workshops, presentations, and farm visits reached 714 growers and publications reached over 2575 people. Survey respondents of the intensive training program rated their ability to help organic growers with nutrient management as 3.50 before and 5.50 (7-point scale, with 7 = excellent) after the sessions. About 1 year later, all survey respondents rated their ability to help growers using organic nutrient sources as excellent or above average. Grower knowledge of using organic nutrient sources improved to 5.92 from 3.92 as a result of a workshop and to 5.62 from 3.89 (7-point scale, with 7 = excellent) after a 1-day class developed by intensive training participants. Methodology used allowed for expansion of individual and collective knowledge of a complicated topic and development of high impact, relevant, and effective educational programming for clientele.

Nutrient management on organic farms can be challenging (Clark et al., 1999; Pimentel et al., 2005) for two main reasons. First, typical organic nutrient management strategies include the use of compost, manures, other organic amendments, and green manures, which slowly release nutrients. Second, nutrient availability is often unpredictable with organic nutrient sources. This is particularly true of nitrogen (N) with first year availabilities ranging from less than 20% to over 40% (Loecke et al., 2004; Richard, 2004). As a result, a common practice is to over-apply organic nutrient sources to insure sufficient N for good crop yields. This can lead to excessive application of other nutrients in the organic source relative to plant demand and the accumulation of salts in the soil. Other associated problems are the loss of profits due to the cost of over applied nutrients, indirect losses from decreased yields associated with high salt or nutrient levels in the soil and weed competition, and pollution of surface and groundwater.

Over 22 years in two organic cropping systems, one relying on aged dairy manure, the other on legumes for supplying N, nitrate-N loss through leaching was above the 10 ppm U.S. Environmental Protection Agency drinking water limit (Pimentel et al., 2005). During the transition to organic farming, studies have shown limited N availability appeared to give weeds a competitive advantage and contributed to reduced crop yields. Slow N release and immobilization of N were cited as possible reasons for deficiency (Clark et al., 1999; Liebhardt et al., 1989; Pimentel et al., 2005). In addition, recent soil tests from organic farms and nutrient budget analysis indicated that organic nutrient amendments often do not supply the optimum balance of nutrients that crops require, resulting in soil nutrient loading of phosphorus (P) and N (Drinkwater et al., 2005). In a study of 11 organic farms, those that were vegetable farms often had accumulations of P and N attributed to excessive compost use. In a recent survey of organic vegetable farms in five northeastern states, soils often had above optimum P and N levels (Morris et al., 2004). Despite this, in some cases, N mineralization calculations for compost and green manure crops predicted crops would be N deficient.

An informal focus group comprised of three organic vegetable growers was

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
1.1209	lb/acre	$kg \cdot ha^{-1}$	0.8922
1	ppm	$mg \cdot kg^{-1}$	1
1	ppm	$mg \cdot L^{-1}$	1

convened to assess needs for information on using organic nutrient sources. Several practices and issues were revealed. Organic growers take a systems approach to nutrient management and often apply nutrients once every few years for a number of different crops grown in rotation. They often have difficulty interpreting and/or using the information provided by conventional soil and compost test analyses to apply organic nutrient sources, meeting the N needs of their crops with organic nutrient sources, and using compost without accumulating excess salts and nutrients in the soil that may promote weeds or even pose an environmental hazard.

A yearlong intensive training program for agricultural educators in Pennsylvania, New York, and New Hampshire was convened to prepare them for addressing nutrient management issues on organic farms. Fourteen educators from university extension services, the Natural Resources Conservation Service, and the Rodale Institute in Pennsylvania and New Hampshire participated in three 5.5-h-long intensive training sessions. The educators developed soil and compost analysis recommendations for organic farms, evaluated three whole farm nutrient planning tools using situations common to organic farms and refined and created extension materials, and developed workshops to extend knowledge gained to growers. A Professional Development grant from U.S. Department of Agriculture, National Institute of Food and Agriculture, Northeast Sustainable Agriculture Research and Education (NESARE) program provided funding that covered the costs of this training program and subsequent educational programs. Surveys were administered to access program impact.

Developing soil and compost analysis recommendations

Before attending the training sessions, each participant was asked to meet with an organic grower to discuss his/her current nutrient management strategies and thoughts on current compost and soil analysis recommendations. Educators were also asked to take soil and compost tests for analysis from the farm they visited. Grower experiences and nutrient analyses were used to develop nutrient management recommendations for using organic nutrient sources.

The first training session, held on 17 Aug. 2007, had the main purpose of refining existing soil and compost analysis recommendations. The session began with each participant presenting the soil and compost analysis and current nutrient management strategies used on the organic farm they visited. Several themes were identified: 1) growers tended to apply compost based on the amount on hand rather than by calculating the amount to apply based on nutrient needs of the crop grown; 2) in general, compost was not analyzed before use; and 3) soil on many of the farms had above optimum P, potassium (K), magnesium (Mg), and calcium (Ca) levels. A specialist from The Pennsylvania State University (Penn State) presented information on compost use. Participants reviewed current information accompanying soil and compost analysis reports from Penn State's Agricultural Analytical Services Laboratory (2000, 2002). Subsequently, modifications to soil and compost analysis reports were suggested and implemented to better suit the needs of organic growers in the following ways: 1) A statement to address hazards when P, K, Mg, and/or Ca levels exceed crop needs was added to recommendations: "Soil nutrient levels exceeding crop needs can be as bad as deficient levels. High soil nutrient levels not only might represent an economic loss, but they may also result in crop, animal or environmental problems. Very high P levels (above about 310 lbs P_2O_5/acre or 140 lbs P/acre) in the soil may lead to nutrient deficiencies, especially of iron and zinc. If K, Mg, and/or Ca levels are high, serious nutrient imbalances can occur. When K levels are above about 5% saturation; Mg levels 15%; and Ca levels 80%, soil nutrition is beginning to get out of the optimum range. Use best management practices to avoid increasing nutrient levels that exceed crop needs." 2) Nutrient levels on soil test reports were changed from "below optimum," "optimum," and "above optimum" to "deficient," "optimum," and "exceeds crop needs." It was believed that "above optimum" could be interpreted as positive. 3) The unit used to report ammonium-N content in compost was amended by including percent in addition to milligrams per kilogram to facilitate using the calculation for applying compost based on plant needs. Additionally, a fact sheet on using organic nutrient sources, including an example calculation for determining how much to apply, was determined to be important and a subgroup initiated its writing.

Evaluating whole farm nutrient management computer-based tools

The second training session, held on 14 Nov. 2007, had the main purpose of examining whole farm nutrient management computer-based tools for their suitability for organic vegetable farms. A specialist from Penn State presented on the mass balance concept used in the tools. Next, participants examined the Cornell Nutrient Budgeting Tool (L. Drinkwater, personal communication) and I-Farm (I-Farm, 2010) tools as a group. Each participant was then asked to evaluate the tools independently before the third training session using site-specific information from the organic farm they visited.

Discussion of tool effectiveness during the third training session resulted in the following suggestions for improvement: 1) address the practicality of using the tools for small-acre farms. The tools were scaled for large-sized operations growing large areas of single crops, while most organic vegetable growers in this area operate smaller farms of diverse crops. 2) Have printer-friendly outputs. Suggestions were shared with three persons involved in the development of the tools, who were in attendance. Additionally, a new tool was being developed at the University of Vermont and suggestions were shared with the principal developer.

Developing educational support materials and extension

The third training session, which was held on 10 Jan. 2008, had the main purpose of developing educational materials and organizing workshops to extend information gained to vegetable growers. A presentation by a specialist from Cornell University on N dynamics and mineralization on organic farms in the northeastern United States started the training

session. This was followed by a group discussion of educational materials needed on using organic nutrient sources for future extension events.

A PowerPoint (Microsoft, Redmond, WA) presentation and workshop on using compost for growing organic vegetables was developed by eight of the participants. The topic was submitted to planners of existing annual agricultural events and presented at eight meetings reaching 235 growers and agricultural educators in Pennsylvania, New York, and surrounding states in 2008–10. Eight educators took the workshop concept further and developed a 1-d class to help attendees develop nutrient management plans for their farms. The class was advertised through Penn State Extension outlets, and about 60 growers in Pennsylvania attended. In addition, the majority of the workshop materials were used in a resident education course, "Principles and Practices of Organic Agriculture," that has been taught twice at Penn State and is now being offered yearly.

A 14-page publication entitled Using Organic Nutrient Sources (Sánchez and Richard, 2009) was developed and includes information for determining if using an organic nutrient source is the best option based on soil analysis, maintaining and improving soil quality with organic nutrient sources, and a table of various organic nutrient sources. The publication includes a calculation and example for determining how much compost to apply using the following format: 1) determine the N content of the compost in pounds per ton; 2) determine how much N in a ton of compost will be available to the plants; and 3) determine the amount of compost to apply. The publication is available free of charge through Penn State Extension. Working with personnel at the Agricultural Analytical Services Laboratory, submission forms for soil tests were modified so that users now can identify themselves as using organic nutrient sources. Once this identification is made, a hard copy of the Using Organic Nutrient Sources publication accompanies soil test reports. Since its publication in early 2009, 2225 hard copies have been disseminated. It is also downloaded from the web. Additionally, six articles were developed and disseminated through extension outlets each reaching over 350 growers and agricultural educators.

Evaluation

Throughout this program, survey instruments were used to determine the impact of these efforts.

Intensive training participants. At the conclusion of the final training session, participants were asked to complete a written survey. Respondents (n = 8), on average, rated their ability to help organic growers with nutrient management as 3.50 before and 5.50 (7-point scale, with 7 = excellent) after the sessions. They rated the changes in soil and compost analysis reports as useful for their educational programming (5.63 on a 7-point scale, with 7 = very useful). Additionally, participants commented: "I plan to meet with all of my organic fruit and vegetable growers to look at their soil testing and soil amendment histories to determine how they should change/improve their nutrient management. Many over-rely on compost as their sole source of nutrients"; "I will select more growers to use the Cornell Nutrient Budgeting Tool"; "plan to use a twilight meeting to present information learned"; "closer work with producers on use of organic N, organic matter in agronomic systems. Also work to create a greater understanding of the overall systems approach to nutrient management in organic systems. Much still to do."; and "when helping people interpret soil tests, I'll have a better explanation of the consequences of having high levels of P and K."

About a year and a half after the training sessions, participants were asked by e-mail to complete a survey administered through SurveyMonkey™ (Palo Alto, CA) to determine if information gained was used to assist clientele. One hundred percent of respondents (n = 7) rated their ability to help growers using organic nutrient sources as excellent (57%) or above average (43%). The majority of respondents used information gained frequently (57%) or all the time (29%) to assist growers using organic nutrient sources. Over half of the respondents cited using whole farm nutrient management computer-based tools (57%). The majority of respondents (71%) incorporated information gained into their educational programming, and 86% cited using or recommending the Using Organic Nutrient Sources publication to growers or others. Respondents indicated that as a group ≈419 growers have been assisted with information gained. When asked what information learned during the training program was most useful to them, they stated: "more efficient use of compost"; "nutrient imbalances (high P) and managing for that"; "sources of information/contacts"; "the changes made to the soil test reports, the publication"; "the new soil test reports"; "compost utilization, value of green manures, exposure to the Cornell Nutrient Budgeting Tool and I-Farm software"; and "current practices of growers using compost, calculating compost application rates."

Vegetable growers. Attendees of a grower workshop on using organic nutrient sources, developed by participants of the intensive training program and held during the Pennsylvania Association for Sustainable Agriculture's annual conference on 6 Feb. 2009, were asked to complete a written evaluation. Respondents (n = 12), on average, rated the workshop as near excellent (6.33 on a 7-point scale, with 7 = excellent). They rated their knowledge of using organic sources as 3.92 before and 5.92 after the workshop. The majority planned on using the Using Organic Nutrient Sources publication, using soil test reports to determine if compost is a good source of nutrients for their situation and having compost analyzed before use. Several also planned on using a nutrient management decision tool.

Attendees of 1-d classes were also asked to complete a written evaluation. These classes were developed by participants of the intensive training program and had goals of providing information on using organic nutrient sources and developing nutrient management plans for each attendee. Respondents (n = 39) rated the classes favorably (5.72 on a 7-point scale, with 7 = excellent). They rated their knowledge of using organic nutrient sources as 3.89 before and 5.62 after the class. The majority planned on using the Using Organic Nutrient Sources publication, using soil test reports to determine if compost is a good source of nutrients for their situation, calculating how much compost to apply, and having

compost analyzed before use. Several also planned on using a nutrient management decision tool. Other planned changes included using less compost and more green manure crops.

Discussion

The success of agricultural educators is based on high impact, relevant, and effective educational programming (Cloyd, 2005). Programs that do not demonstrate high impact, relevance, and effectiveness or have limited audiences are discontinued in favor of those that do (Cloyd, 2005). As a result, important clientele that comprise smaller groups may lack support from educators (Cloyd, 2005). Historically, one such group is organic vegetable growers (Walz, 1999).

Through this program, a group of agriculture educators from Pennsylvania and New Hampshire developed specialized expertise in the area of organic nutrient management over a period of 1 year. Methodology used allowed expansion of individual and collective knowledge of a complicated topic and development of strong programming for clientele. The program leaders assembled a small-sized group using a multistate, multi-institute, and multidisciplinary train-the-trainer approach. A NESARE Professional Development grant facilitated this approach by providing funding. The train-the-trainer approach has the benefit of creating a multiplier effect for reaching people, which can be logarithmic (Osborne et al., 2005). Additionally, due to the multiplier effect, cost per person trained ends up being very low (Osborne et al., 2005). In this program, 14 educators participated in three intensive training sessions on whole farm nutrient management for organic farms and extended the information through workshops and presentations to at least 714 growers, industry representatives, and agricultural educators and 2575 more people through publications. As has been observed in previous train-the-trainer initiatives (Osborne et al., 2005), accomplishments were likely facilitated by the intensive training program participant's extensive familiarity with their clientele, which was boosted by visiting an organic grower before the start of the program. Also, as has been reported with university students, this success may have been influenced by the relatively small-sized group of participants in the intensive training program. Using small groups can encourage all members to participate and creates a forum where everyone may be more comfortable voicing opinions compared with large groups (Bull and Clausen, 2000; Henneberry and Beshear, 1995; Sánchez and Craig, 2007).

Future recommendations. Participants of the intensive training program were asked on what topic within "using organic nutrient sources" they would like to receive more information. They stated: "developing some basic information for people that do not have background in soils so it helps demystify this. Most information is put out by consultants and usually adds extra cost to the operation"; "using cover crops to fix N and scavenge N"; "I get questions on the effectiveness of organic foliar feeds? How effective are they (cost effectiveness)? Are they better used in early spring when soil temperatures are cooler and mineralization is low?"; and "best application rates." These topics are offered as areas for future study.

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