Why is soil organic matter so important?
Subsurface drip irrigation in Ontario
Selecting a reliable soil-testing lab
Drift awareness and prevention
Precision soil sampling
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Soil organic matter is a small, but critical component of the soil. This article demonstrates the value of enhancing soil organic matter for increasing the functionality of soils.

In a recent analysis of 10 years of observations over a conventional tillage corn–soybean system in the Midwest, Dold et al. (2016) found that there was a loss of nearly 1,000 lb of carbon per acre per year, which would equate to 0.1% per decade of farming. Especially affected is the 6-inch top layer where approximately 660 lb of organic carbon per acre per year have been lost (Dold et al., 2017). We can also visually observe the decrease in soil organic matter from our fields by the changing coloration of topsoil from darker to lighter, and the variations we observe within fields in terms of productivity and water availability are directly related to the soil organic matter content (Hatfield, 2012).

Why is organic matter so important?

Soil organic matter is a small fraction of the soil. We get excited about changes from 2 to 3%, and yet this component plays such a critical role in soil. Without organic matter in the soil, the functions we need to sustain life would not be possible. Managing our soils to preserve and enhance this organic matter is necessary if we want to increase the functionality of soils.

In a recent analysis of 10 years of observations over a conventional tillage corn–soybean system in the Midwest, Dold et al. (2016) found that there was a loss of nearly 1,000 lb of carbon per acre per year, which would equate to 0.1% per decade of farming. Especially affected is the 6-inch top layer where approximately 660 lb of organic carbon per acre per year have been lost (Dold et al., 2017). We can also visually observe the decrease in soil organic matter from our fields by the changing coloration of topsoil from darker to lighter, and the variations we observe within fields in terms of productivity and water availability are directly related to the soil organic matter content (Hatfield, 2012).

By Jerry L. Hatfield, Laboratory Director and Supervisory Plant Physiologist, Ken Wacha, Research Postdoctoral Scholar, and Christian Dold, Research Postdoctoral Scholar, National Laboratory for Agriculture and the Environment, Ames, IA
The intent of this article is to demonstrate the value of enhancing soil organic matter. The current emphasis on soil quality can be summarized very simply as a path towards restoring the resilience of soil that begins with restoring the organic matter within the soil. Around the world, there is a large difference in the soil organic carbon content of soils (Fig. 1).

To begin that journey towards understanding the value of soil organic matter, we need to understand that soil organic matter plays a vital role in the soil. For example, soil organic matter has been positively associated with

- Increased biological activity
- Increased aggregate stability
- Enhanced infiltration rates
- Decreased soil bulk density
- Reduced soil compaction
- Enhanced nutrient cycling for all macro- and micro-nutrients
- Improved water storage and reduced nutrient leaching
- Enhanced gas exchange between the soil and the atmosphere
- Reduced greenhouse gas emissions through a combination of C sequestration and enhanced gas exchange

These changes in soil attributes are noticeable in soils with increased organic matter; however, they are derived from management practices that enhance the soil biology as the first step. Enhancing the soil biology requires four components: food, water, air, and shelter. These are the basic needs for life, and soil biology is no different than any other living organism. Figure 2 is a simple diagram depicting how soil changes when soil biology is enhanced with the stabilization of the soil biology being the first step in changing the soil organic matter content. Changes in soil organic matter manifest in the invisible processes of organic matter decay and nutrient cycling and finally in the visible processes of improved aggregate or soil structure and water availability.

There has been a question about the source of the organic material that is converted into organic matter. In an elegant study, Cambardella and her student used radioisotope-labeled carbon to determine whether the organic material from roots or shoots were the source of soil organic matter (Gale and Cambardella, 2000; Gale...
et al., 2000a, 2000b). They found that soil organic matter was determined by the root material in the soil. If we extend this finding to how we manage the soil, then the negative effect of tillage on soil organic matter can be seen and could be summarized as tillage and residue removal being the primary factors causing a reduction in soil organic matter content and the primary causes of soil degradation (Hatfield, 2014). The studies by Gale and Cambardella do raise a question about the role of the surface residue if the primary source of active fraction of soil organic matter is from the roots. The role of residue

The role of residue on the surface is multi-faceted; however, it serves a vital purpose in stabilizing and protecting the soil microclimate to satisfy two of the critical needs of soil biology for water and shelter. Soil without crop residue cover experiences wide variation in temperature and soil water content. Across the Midwest in the spring, bare soil surface temperatures can exceed 120°F during the middle of the day with soil water contents close to air dry. This type of environment is not conducive to biological activity. A residue-covered soil exhibits maximum temperatures that are in the high 80s, and the presence of the residue layer reduces the soil water evaporation rate so that the area near the soil surface is often moist. During the middle of the summer, you will find crop roots very near the surface under crop residue because of the available soil water and an environment that allows them to actively grow. With no residue on the surface, it is difficult to find plant roots, except at a depth where the soil microclimate becomes more stable with fewer extremes in temperature and moisture.

One of the complaints about residue on the soil surface in the upper Midwest is that it keeps the soil too wet and cold during the spring. Sauer et al. (1996) found that corn residue did reduce the soil water evaporation rate, which decreased the rate of warming; however, the largest impact is on the diurnal variation in temperature more than the mean temperature. Hatfield and Prueger (1996) compared different tillage systems and found that maintaining crop residue in the fall decreased the rate of cooling of the soil, which maintained soil biological activity into the fall and had minimal effect in the spring. Management of soil to create the stable microenvironment requires the presence of crop residue to moderate the temperatures and moisture extremes at the soil surface. Lastly, in addition to the vital role that residue plays in providing shelter and food supply to biota, residue also physically protects the soil surface from raindrop impact. During a rainfall, the kinetic energy of raindrops is transferred into the soil surface, dislodging soil particles and organic material that can be easily swept away when runoff conditions develop (Papanicolaou et al., 2015).

The stabilization or increase of organic matter in the soil is determined by the quality of the residues. Soil organic material is often referred to as either labile or passive where the labile fraction is the most recent and active component of soil organic matter while the passive or recalcitrant fraction is the older component that is more resistant to decomposition (Alvarez and Alvarez, 2000). Whether a soil fraction is susceptible or recalcitrant to mineralization is determined by aggregate size and its chemical and physical properties. In general, macro-aggregated, easy digestible (e.g. non-ligneous), and/or free (i.e., not protected within aggregates) soil organic matter is more prone to mineralization than organic matter associated with or within micro-aggregates and chemically easy digestible material.

Plant material in agriculture deposited by roots and crop residue that may have been moved into the soil by earthworms or manure or compost represents the most active fraction of the soil organic material. This is the food source for the biological community, and this fraction is most readily decomposed. The active fraction is referred to as particulate organic matter (POM) and has become the fraction that is most affected by management practices, e.g., tillage, residue management, crop rotations, and cover crops (Carter, 2002; Franzluebbers et al., 2000). For example, Kantola et al. (2017) found significant changes in POM contents among cropping systems, and POM mainly originated from the incorporation of crop residues. As mentioned before, the POM fraction in the soil leads to the rapid release of nutrients contained in this organic matter but does not necessarily contribute to an increase of soil organic carbon due to its rapid turnover. Yet, even within the POM fraction, there are sub-fractions of differ-
ent turnover rates, depending on the chemical composition and whether the organic matter is protected within POM aggregates. These POM sub-fractions may contribute in the long run to the more stable fraction of soil organic matter, especially under constant input of plant material and soil protection management practices (Ontl et al., 2015; Liao et al., 2006). Both measurement of POM and stability of aggregates are therefore essential methods to determine soil quality. The measurement of POM has been developed by Cambardella and Elliott (1993), and these methods have become the standard utilized today in research studies.

In recent studies, there has been more attention paid to observations of soil carbon dioxide (CO₂) concentrations in the soil as a surrogate for the activity of soil biological systems because of the availability of instrumentation required for these observations. Since soil biological systems represent living organisms, they respire, leading to a rapid increase in CO₂ released from the soil.

**Soil aggregate size, stability**

Organic material is the glue that binds soil particles together in the form of soil aggregates (Gale et al., 2000b). Therefore, soil aggregates can be a visible sign of biological activity occurring within the soil. It is not only the size of the aggregate, but the stability of the aggregate that becomes important for soil function. This is shown in Fig. 3 where a contrast is made between a soil with poor aggregate stability and one with high aggregate stability. A soil with low biological activity may have aggregates; however, these are not stable and rapidly change when the soil becomes wet during a rainfall event.

One of the current methods used for soil quality is the wet aggregate stability test (Fig. 4) where a soil sample is placed in a water column to evaluate how rapidly the soil aggregates dissolve. For soils with low aggregate stability, the structure of the aggregates fails under the force of water, and the finer fractioned material that was held within the aggregates begins to clog pore spaces, restricting infiltration and causing runoff conditions to quickly develop during a rainfall event (Hatfield et al., 2017). As the depth of runoff increases, larger soil particles and residue can be mobilized by the flow and transported down the hillslope. This is exaggerated when there is no residue cover to absorb the raindrop energy. Soils with high aggregate stability maintain pore space and infiltration rates during a rainfall event because the aggregates don’t change. Producers who have improved their soils will often report being able to “handle a 4-inch rain without any runoff while the
neighbor’s field is moving into the ditch.” We can learn a lot about the quality of the soil by merely observing what occurs during rainfall events.

These same factors that affect the infiltration of water also affect the exchange of gases between the soil and the atmosphere. There are two critical gases for biological activity, oxygen ($O_2$) and $CO_2$, and stability of the soil aggregates affect the exchange of both gases. One of the benefits of soil organic matter is enhanced infiltration and reduced bulk density, but we rarely consider these changes in the context of gas exchange. When the aggregate structure is reduced, then gas exchange becomes limited and biological systems below the surface become deprived of oxygen.

What’s it worth?

A question that is often asked is what is organic matter worth in soils? It is difficult to place a value on soil organic matter, but we can show the value of what some of the characteristics of soil mean in terms of agricultural production. An analysis by Hudson (1994) revealed the linear relationship between soil organic matter and soil water-holding capacity with a different curve for each soil type (Fig. 5). The role of increased organic matter is to increase the volume of water a soil can hold, and this relationship is only part of the process. Soil can only store water if it is able to enter into the soil, and the role of the stable aggregates at the surface is a vital part of that process in order to be able to infiltrate as much water as possible. The process of infiltration is a necessary step in being able to store soil water. It is not merely the amount of water the soil can hold and make available that affects plant growth, but the impact of that soil water on crop productivity. High production is derived from crops with high water use efficiency, and enhancing soil water availability is one key to enhanced productivity (Hatfield et al., 2001). An example of this impact is shown in Fig. 6 where the results from Fig. 5 are replotted to show the days of available soil water for a corn crop transpiring at the maximum rate during grain filling. As we increase soil organic matter, there are more days of available soil water with four more days in which the corn crop is not water stressed during grain filling at 4% compared with 2%. The effect of the increased availability of soil water could be extremely significant in years with more variable rainfall.

The value of enhanced soil water was observed in the results obtained by Egli and Hatfield (2014a and 2014b) where they found a linear relationship between the average county yield for corn and soybean in Iowa and Kentucky and the quality of the soil. Available soil water was the primary factor affecting the ability of a given soil to produce a yield. These same factors determine yield variation within fields, and enhancing the soil organic matter to increase available soil water will pay dividends in terms of being able to stabilize crop yields.

The positive benefits of soil organic matter encompass a range of soil properties; however, the driving force is soil biological activity and the management of the soil microclimate to provide the functional needs for these living organisms. The effect of the increased biological activity on the stability of the soil aggregate affects all of the other positive benefits in terms of increasing infiltration of water and exchange of soil gases. Managing our soils to increase and maintain soil biological activity is the foundation for enhancing them and increasing their capacity to produce crops.
Self-study CEU quiz

Why is soil organic matter so important?

Earn 1 CEU in Soil & Water Management by taking the quiz for the article on pages 4–8 at www.certifiedcropadviser.org/education/classroom/classes/550. For convenience, the quiz is printed below. Cost: $20.

1. In a recent analysis of 10 years of observations over a conventional tillage corn–soybean system in the Midwest, Dold et al. (2016) found that there was a loss of nearly _____ of carbon per acre per year.
   a. 250 lb  
   b. 500 lb  
   c. 750 lb  
   d. 1,000 lb

2. What is the first step in changing the soil organic matter content of the soil?
   a. Tilling in crop residue.
   b. Creating a stable environment for soil biological systems.
   c. Adding more compost.
   d. Adding more nitrogen.

3. Soil organic matter is positively associated with all of the following EXCEPT
   a. reduced soil compaction.
   b. decreased aggregate stability.
   c. enhanced gas exchange between the soil and atmosphere.
   d. enhanced nutrient cycling for all macro- and micronutrients.

4. From Fig. 2, which of the following “steps” in the soil aggradation climb is NOT invisible and dynamic?
   a. Biological activity.
   b. Improved water availability.
   c. Organic matter turnover.
   d. Improved nutrient cycling.

5. Residue on the soil surface serves a vital role in the stabilization and protection of the soil microclimate to satisfy two of the critical needs of soil biology for
   a. water and food.
   b. shelter and air.
   c. water and shelter.
   d. air and food.

6. Sauer et al. (1996) found that the largest impact of corn residue on soil was
   a. diurnal variation in temperature.
   b. mean temperature.
   c. soil water evaporation rate.
   d. water infiltration.

7. Which of the following forms of soil organic matter is least prone to mineralization?
   a. Macro-aggregated.
   b. Non-ligneous.
   c. Not protected within aggregates.
   d. Within micro-aggregates.

8. It has been determined that as soil organic matter increases, there are more days of available soil water with four more days in which the corn crop is not water stressed during grain filling at ____ compared with ____.
   a. 2%, 1%.
   b. 6%, 3%.
   c. 5%, 3%.
   d. 4%, 2%.

9. From Fig. 5, the available water content (%) is greatest for which soil type?
   a. Silt loam.
   b. Sand.
   c. Silty clay loam.
   d. Loam.

10. The effect of the _____________ on the stability of the soil aggregate affects all of the other positive benefits in terms of increasing infiltration of water and exchange of soil gases.
    a. reduced soil bulk density
    b. increased biological activity
    c. enhanced nutrient cycling
    d. increased soil bulk density

Soil organic matter [continued from p. 55]


Subsurface drip irrigation in Ontario

By Rene van Acker, Ph.D.,
Department of Plant Agriculture, and
Dean, Ontario Agriculture College,
University of Guelph, Guelph, ON

Subsurface drip helps Ontario growers to improve yields and be better prepared to deal with low-water/drought situations, more rigorous water permitting, and the growing impact of climate change. Earn 1 CEU in Soil & Water Management by reading this article and taking the quiz at www.certifiedcropadviser.org/education/classroom/classes/535.

The soil and climate of the Sand Plain region, covering some one million acres in southern Ontario, in many respects make this area the most suitable in Canada for crop production. There are large areas of coarse Plainfield sand and some finer, Fox sands. These soils are well drained and rapidly permeable but have relatively low water-holding capacities and a potential for problems of summer droughtiness. The more recent shift away from pasture and cereals to cash crops has seen a marked increase in grain corn and soybean production along with traditional crops like tobacco, fruit, and vegetables. However, supplemental irrigation is necessary for tobacco and most other high-value crops. Southwestern Ontario has recently experienced extended periods of low rainfall and high temperatures (Table 1). With the exception of 2014, July rainfall from 2012 to 2017 was less than 40% of the long-term average.

Water shortage problems are likely to increase over time due to a combination of factors. Water supplies are decreasing due to extended droughts and diversion of water from irrigation to municipal and other uses. This presents challenges for water use efficiency. Compounding the challenge of water allocation among a growing population is climate change (O’Neill and Dobroworski, 2011). This could result in an increase in the frequency and duration of low water conditions in southern Ontario. Future water shortage problems require concentrating efforts on improving water management and highlight the need for on-farm water use efficiency. Water stress can have a significant impact on crop growth, development, and yield, and growers are concerned about the impact of drought and the need to sustain yields long term.

The newest advancement in irrigation is subsurface drip irrigation (SDI). Interest in SDI to irrigate crops in Ontario is increasing. Subsurface drip irrigation is a more water efficient irrigation system
where water is applied below the soil surface (>12-inch depth) by microirrigation emitters (Fig. 1, opposite page), to deliver water and nutrients directly to the crop’s root zone. Subsurface drip irrigation gives improved control over water and crop nutrients and maximizes the benefits of added water and other crop inputs such as N and micronutrients. By reducing evaporation, runoff, and leaching, very little irrigation water is lost to the environment. Efficiency with SDI is up to 95% compared with 80 to 90% with central pivot and even less with sprinklers. Subsurface drip irrigation has better resource use efficiency, including the efficient use of all farm inputs, e.g., water, energy, labor, machinery, chemicals, and nutrients.

Although studies with SDI corn have been conducted in other areas (Payero et al., 2008), data on the response of corn growth and yield with SDI in Ontario is lacking. The agronomic response of crops to irrigation with SDI over time is needed to be better able to evaluate the economic and technical feasibility of using SDI under local conditions and provide practical information to users on best management practices for SDI. The interaction of climate, soils, and production practices presents unique combinations that require local research to fine-tune the system.

Our research has evaluated SDI for irrigation and nutrient application to help Ontario corn growers better manage and conserve water. Growers used on-farm ponds as a source of irrigation water. Emitters, spaced 60 cm apart, delivered an application rate of one-fourth to one-third of an inch over six hours for each irrigation zone. The water was delivered to the lateral drip lines through a filtration unit, chemical injection unit, solenoid valves, pressure regulators, air-vented pressure relief valves, and PVC pipelines. Flow meters measured volumes of water applied. A flow meter and pressure gauge are essential to monitor the performance of the system and provide early warnings of leaks and blockages. Crop evapotranspiration data and soil moisture sensors were used to accurately determine when and how much water to apply. This is achieved by using both evapotranspiration and moisture sensor data. Time domain reflectometry (TDR) sensors were used to monitor soil moisture levels at specific locations in and below the crop root zone (Fig. 2). Real-time soil moisture monitoring was accomplished by connecting the TDR sensors to a wireless cellular data logger. Scheduling was based on soil moisture thresholds according to TDR measurements. Moisture levels were allowed to depreciate to approximately 70% available water in the rooting zone before irrigation events were initiated. The goal was to raise the soil moisture to 75 to 80% of field capacity in the root zone, at each irrigation. Monitoring continued throughout the growing season. Natural rainfall and irrigations events were monitored in real time. Nutrients were applied through the drip lines to compare the benefits of fertigation (i.e., addition of water-soluble nutrients through the irrigation system) with conventional application of N, P, K, and micronutrients.

Since SDI delivers water directly to the plant’s root zone, leaving the soil surface dry, fewer weeds are encouraged to germinate (Shrestha et al., 2007). This research will help Ontario corn growers to better manage and conserve water as well as applied N, P, K, and micronutrients. It also demonstrates that SDI will improve corn yield and quality as well as irrigation and nutrient application efficiency while reducing risk and vulnerability for corn production, especially in coarse-textured soils. This will allow corn growers to adapt to climate change.

### Table 1. Precipitation (inches) from 2012 to 2017 at the Simcoe Research Station during July and August.

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>3.8</td>
<td>0.8</td>
<td>2.1</td>
<td>6.3</td>
<td>1.7</td>
<td>1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>August</td>
<td>3.3</td>
<td>3.9</td>
<td>3.4</td>
<td>2.0</td>
<td>3.9</td>
<td>1.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Total</td>
<td>7.1</td>
<td>4.7</td>
<td>5.5</td>
<td>8.3</td>
<td>5.6</td>
<td>2.8</td>
<td>2.7</td>
</tr>
</tbody>
</table>

### Table 2. Corn yields on loamy soil at the Simcoe Research Station in 2017.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fertility</th>
<th>Total N</th>
<th>Corn yield†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-irrigated</td>
<td>125 lb N sidedressed</td>
<td>250</td>
<td>245 b</td>
</tr>
<tr>
<td>Irrigated</td>
<td>125 lb N sidedressed</td>
<td>250</td>
<td>272 a</td>
</tr>
<tr>
<td>Irrigated</td>
<td>125 lb N, fertigated</td>
<td>250</td>
<td>268 a</td>
</tr>
<tr>
<td>Irrigated</td>
<td>125 lb N, fertigated plus P+K + micronutrients</td>
<td>250</td>
<td>280a</td>
</tr>
</tbody>
</table>

† Means followed by the same letter do not significantly differ.
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<td>125 lb N, fertigated plus P+K + micronutrients</td>
<td>250</td>
<td>280a</td>
</tr>
</tbody>
</table>

† Means followed by the same letter do not significantly differ.

by having the capability to produce maximum yields even in drought situations and expand corn production in the Sand Plains region and other drought-prone areas in Ontario.

An SDI system requires a higher initial investment. An average cost for installation is about $1,500 (amortized over 15 to 25 years) per acre. Yield increases of 100 bu/ac are achievable. In 2017, a very dry year, yield increases of 154 bu/ac (127 bu/ac versus 281 bu/ac) were achieved for corn grown on coarse-textured sand in a grower’s field. Yields of 250 bu/ac (Table 2) are readily achievable, and with more knowledge on corn varieties, plant populations, and fertigation and moisture monitoring to schedule watering, higher yield increases are possible.

Fertigation

Fertigation is a very effective management tool with SDI to maximize grain yield while obtaining high efficiency of water and nutrient use and reducing the risk of nutrient loss to the ground water (Aubert et al., 2016). Subsurface drip irrigation is ideally suited to adding nutrients because it allows for quick delivery to the crop root zone, nutrient requirements can be adjusted with immediate effects, less labor is required compared with conventional application methods, and less water and N are used, resulting in reduced runoff and leaching. Nutrient use efficiency is increased by better matching nutrient supply with plant demand. Applying fertilizers during periods of greatest crop demand, at or near the plant roots, and in smaller and more frequent applications all have the potential to reduce losses while maintaining or improving yields and quality. Fertigation is the best option to combine agronomic productivity with environmental sustainability.

Our study shows that adequate management of drip fertigation, while contributing to the attainment of water and food security, may also provide an opportunity for climate change mitigation. Modifying N fertilizer application timing and application methods are a greenhouse gas (GHG) mitigation strategy. Nitrous oxide (N₂O) is a major GHG product of intensive agriculture with fertilizer N application accounting for almost 80% of total emissions of N₂O from this sector. Timing of fertilizer N application with plant N demand is an important factor in determining soil N availability and, potentially, emissions of N₂O from row crop agriculture. The placement of N fertilizer in the soil and near the zone of active root uptake may both reduce surface N loss and increase plant N use, resulting in less N that can be emitted as N₂O (Halvorson and Del Grosso, 2013).

Other crops

More recently, there has been interest in SDI for other crops. Asparagus is historically grown without irrigation in the Sand Plains region of Ontario. Increased incidence of summer drought and increased disease pressure require more intensive crop production practices. Although asparagus is deep rooted and relatively drought tolerant, soil moisture availability during fern growth is an important determinant of future crop yields. Previous studies elsewhere indicate a variety of positive responses from irrigation on asparagus. Drought stress limits the capacity of plants to produce carbohydrates in the roots necessary for high yields in subsequent seasons. Stressed plants may also be more susceptible to fungal diseases, including Fusarium and Phytophthora, that increasingly plague the industry and may be an important factor contributing to the long-term decline in asparagus yield. During the critical period of fern growth and carbohydrate replenishment (July–August), rainfall is often well below evapotranspiration, demand, resulting in drought stress in non-irrigated fields. Increases in productivity are necessary to ensure adequate return on the large financial investment involved in establishing an asparagus crop.

Warmer temperatures and more variable rainfall patterns observed in Ontario in recent years make irrigation an increasingly important tool for reducing risks of yield loss in asparagus production. Under weather conditions similar to those experienced in the Sand Plains region of Ontario in July and August 2016 and 2017 (rainfall less than 50% of the 30-year average), irrigation would increase yield and plant health more than enough to justify the added costs of irrigation for Ontario asparagus growers. Supplemental irrigation increases asparagus stem numbers, weight per spear, root carbohydrates, and fern biomass. Fertigation and chemigation through drip tape are common in many vegetable crops but have not been extensively explored in asparagus. By targeting agrichemicals directly to the root zone through subsurface drip tubing, losses through leaching and volatilization are minimized. Some Ontario asparagus growers have begun to adopt irrigation into their production systems, but little information is available to guide them in their choices.
regarding delivery system (subsurface vs. surface). Field trials evaluating the impact of drought stress and irrigation can help with these decisions.

Subsurface drip irrigation systems not only save water and fuel costs, but also minimize the risk of foliar disease by avoiding leaf wetting. By avoiding wetting the soil surface, SDI systems are less likely to stimulate weed (Shrestha et al., 2007) and foliar fungal growth (e.g., rust). Before asparagus growers will consider less familiar alternatives like SDI, however, they need data on its potential economic advantages. While southern Ontario is not an arid environment, even with a drought-hardy crop like asparagus, supplemental irrigation can be of substantial value for ensuring consistent, optimum production levels. Irrigation systems will not necessarily provide a substantial benefit every year in southern Ontario, but the increased yield in dry years in conjunction with higher plant survival over time due to better plant health should keep fields in higher production longer.

Since SDI prevents wetting of leaves with reduced foliar diseases, some apple growers are installing SDI in their orchards (Fig. 3). This can be a cost-effective alternative to other irrigation systems in orchard management. Fertilizers can be applied near the center of the crop root zone. There is plenty of potential for SDI on tree fruit, not only in course-textured soils, but even in a clay soil where lack of moisture can cause stress to the trees. With drought, there are more undersized apples, and these are ending up in the less profitable juice market.

Conclusions

Subsurface drip helps Ontario growers to improve yields and be better prepared to deal with low-water/drought situations, more rigorous water permitting, and the growing impact of climate change. In the U.S. Midwest, SDI is widely adopted for corn production (Lamm, 2014). Because of the deep placement (>12-inch depth), the system longevity is expected to be up to 25 years, making SDI more economical than traditional irrigation.

No irrigation system is perfect, however, and SDI does have some drawbacks. The system has to last 10 years to recoup the initial installation cost, rodents can chew through the lines (but finding the source of the leak is a quick fix), SDI water filtration systems need to be monitored often, and particulates and bacterial growth require periodic system flushing to prevent clogging. Subsurface drip irrigation requires good management, including time management and greater attention to detail than other irrigation systems. Filtration, flushing the system on a regular basis and periodic treatment with mild acid, and repairing leaks when they happen is essential. Proper management prolongs the life of the system with a lifespan of up to 25 years in some cases. In the future, with increased fertilizer regulation, SDI will be particularly important in devising nutrient management plans.

Project contacts

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References


1. Which of the following was NOT mentioned in the article as a challenge faced by farmers in the Ontario Sand Plain region?
   a. Well-drained soils prone to drought.
   b. Extended periods of low rainfall and high temperatures.
   c. Shift from pasture to grain corn and soybean production.
   d. Increased potential for summer flooding.

2. In August 2017, recorded rainfall at the Simcoe Research Station (Table 1) was ____ inches less than the long-term average of 3.3 inches.
   a. 1.2  c. 2.1
   b. 1.5  d. 2.7

3. The efficiency of SDI systems is up to
   a. 80%.  c. 90%.
   b. 85%.  d. 95%.

4. In the study evaluating SDI in corn in Ontario, soil moisture levels were allowed to deprecate to approximately _____ available water in the rooting zone before irrigation events were initiated.
   a. 50%  c. 70%
   b. 60%  d. 80%

5. Key components to an SDI system include _____ to provide early warnings of leaks and blockages.
   a. flow meter and pressure gauge  c. moisture sensors
   b. filtration unit  d. relief valve and rodent detector

6. The author states that in 2017, a very dry year, yield increases of ______ bu/ac were achieved for corn grown on coarse-textured sand in a grower’s field.
   a. 100  c. 154
   b. 128  d. 175

7. From Table 2, what was the difference between the mean corn yield in the irrigated, sidedressed treatment and the non-irrigated, sidedressed treatment?
   a. 23 bu/ac.  c. 30 bu/ac.
   b. 27 bu/ac.  d. 35 bu/ac.

8. Which of the following was NOT mentioned in the article about using SDI for fertigation?
   a. Nutrient requirements can be adjusted with immediate effects.
   b. It requires more labor.
   c. Less water is used, with reduced runoff and leaching.
   d. There is potential for reduced N₂O emissions.

9. Which drought-tolerant crop was specifically mentioned as having the potential to benefit from SDI?

10. With proper installation and maintenance, the article states that an SDI system can last up to
    a. 10 years.  c. 25 years.
    b. 15 years.  d. 30 years.

Climate and Crops iBook [from p. 53]

The diversity and differences that make the agricultural production in the U.S. Southeast unique also challenge farmers to produce crops, sometimes under adverse conditions. They must cope with frequent droughts, several crop pests and diseases, and degraded soils with low organic matter. In recent years, Southeast farming has been also challenged by climate variability and extreme weather events. Coping with these farming scenarios implies adaptation of current management practices and adoption of proactive new strategies.

Numerous efforts have been made to understand the relationship between climate and crop production and help farmers increase resilience in their operations. Here we are just a few: 1) assessing the impact of weather and climate on crops, 2) making climate forecasts more accessible to farmers so they can be used as a crop management tool, and 3) identifying adaptation strategies to cope with climate variability and extreme weather events. Multiple studies have shown that El Niño Southern Oscillation (ENSO) is the main driver of climate variability in the Southeast. The onset of an ENSO phase (El Niño, La Niña, or Neutral) on the eastern Pacific will result in changes in precipitation (Sharda et al., 2012; Ropelewski et al., 1986) and ambient temperature patterns (Sittel, 1994). These changes, in turn, are likely to have some impact on crop production. For example, changes in these two parameters were found strongly related to the yield variability of major crops planted in Georgia (Alexandrov...
Two bills have been introduced in the U.S. House of Representatives that recognize the professional expertise of CCAs. Both bills aim to improve soil health and nutrient management by, in part, making it easier for the private sector to deliver conservation technical assistance.

This comes as there is greater recognition that CCAs play an increasingly important role in addressing natural resource challenges and improving conservation outcomes. As the trusted farm adviser, CCAs are well positioned to help farmers meet both profitability and environmental goals.

Representatives Mike Bost (IL) and Darren Soto (FL) introduced the *Nutrient Management Technical Service Provider Certification Act* (see http://bit.ly/2CQF5Hh) to allow qualified individuals, including CCAs, to act as Technical Service Providers for nutrient management. The bill is supported by The Fertilizer Institute, Agricultural Retailers Association, Land O’ Lakes, and the Illinois Fertilizer and Chemical Association.

Congresswoman Marcia L. Fudge (OH) introduced the *Collaborative Water and Soil Enhancement Act of 2018* (see http://bit.ly/2CQUk2K) to reduce soil erosion and improve water quality. The legislation also provides a streamlined certification process for third-party service providers that have a 4R Nutrient Management Specialty or a Sustainability Specialty certification from the American Society of Agronomy. This will allow CCAs with these certifications to provide conservation technical assistance. The Nature Conservancy and the American Water Works Association both support the Fudge legislation.

The three representatives sit on the House Agriculture Committee and will be part of the upcoming farm bill negotiations.

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The information war in the field is intensifying as growers and CCAs look to gain an edge on productivity by gathering soil data for increasing precision.

In many areas, CCAs are moving from traditional composite, whole-field soil sampling to zone and grid sampling to gain more detailed soil nutrient information and deeper insight for better nutrient management.

Alain Bellicot, CCA at Crop One, Inc., in Clarkfield, MN, says that over the years, it has been a steady and constant migration to more intensive soil sampling methods.

“We used to do composite whole-field soil sampling years ago. We would collect 40 to 50 probes from the field and mix it all up and send one sample bag to the lab for testing. Now we have evolved into grid sampling and collecting a soil sample from each 2.5-ac or 4.4-ac grid,” says Bellicot, adding that he also does zone sampling where fields are divided into several management zones with soil samples collected and tested for each zone.

Bob Wolf, CCA at AgroTech Consulting in Henderson, MN, also offers more intensive soil sampling methods such as grid sampling to his customers. He knows his farmers are continually seeking more ways to fine-tune their fertility programs by minimizing fertility costs and maximizing productivity in all their fields. Fields with
More variability, he says, require more intensive soil sampling methods.

Most of the soil sampling that Wolf does today is grid testing. Some management zone-based sampling is done based on soil type, he adds, but that sampling approach has diminished over the years.

The 2.5-ac grid is most common size, he notes, but he has done grid samples as small as 1.0 ac for individuals who want even more detailed nutrient and soil property data. Some fields in his region of Minnesota, Wolf points out, are quite variable, and grid samples smaller than 2.5 ac can provide better information than samples with a larger grid size.

Making a more intensive soil sampling approach economically feasible, however, may not work for all regions and situations, CCAs warn. Lower-value crops with thin profit margins may not justify the cost of 2.5-ac grid sampling. Zone sampling that can capture most soil nutrient variability if soils have a history of lower rates of fertilizer application where natural fertility gradients still persist may be a better fit. Since zone sampling involves fewer samples per field, it can reasonably be done every year to address changes in residual soil nitrate.

But despite low commodity prices, intensive soil sampling methods like grid and zone sampling are increasing in popularity. CCAs say, with farmers requesting more detailed soil nutrient information to have better control over their nutrient management options.

**Topography and field history**

In the gently rolling hills of west-central Minnesota where corn, soybean, and sugarbeet are the most common crops, Bellicot says grid sampling is the most common soil-sampling method. Bellicot points out that with the rolling topography of the area he serves, there is no hard-and-fast rule on soil sampling.

“We have some fields that have more pronounced elevation,” Bellicot notes, explaining that while a field may have many knolls, each knoll may be a clay knoll or a gravel knoll. The grids must be adjusted so that each knoll is represented by its own soil sample, he says.

Some grid samples may represent an area less than 2.5 ac, Bellicot points out. Fields with many steep slopes and eroded knolls will have more grid samples collected to capture more field variability.

Some hills in his area can have a 3 to 6% slope with soil erosion and nutrient runoff following heavy precipitation.

“Because the hills become eroded, we have to show what we have for nutrient availability in that small area. Most of the time on hills, we see excess P and K because [the farmer] has been fertilizing the same across the field,” he says, explaining that because of lower crop yields on hills, nutrient removal is lower, which allows P and K to accumulate in the soil, resulting in higher soil test levels. Hills in the region also have higher pH from excess calcium carbonate from exposed subsoil, he adds. The lack of topsoil on these eroded areas and the high pH can reduce nutrient uptake and yield performance.

That variability requires a more intensive approach to soil sampling. Bellicot says. While grids on flatter fields with minimal variation in soil types and topography are sampled on a 4.4-ac grid, Bellicot will often shrink the grid size to 2.5 ac to gain a clearer understanding of the soil types and fertility of individual hills for fields with changing topography.

“On a rolling field, I might go to 2.5-ac grids regardless of if the customer wants it or not, so we can pick out the peaks and the valleys and the hillsides,” he says. “To me, people benefit the most from it.”

Field history can also necessitate a precision-based approach to soil sampling. Wolf adds. While USDA-NRCS soil survey maps can be a useful guideline for establishing management zones in a field, a farm’s history can have substantial impact on soil properties that won’t show up in the soil survey map. Hilltops and areas located near barns, he points out, may have a greater chance of having had more manure applications compared with other parts of a field if the farm had livestock.

“In this area, we’ve had long history of smaller farms where livestock manure applications didn’t get spread based on soil types,” Wolf explains. “I think there’s been enough manure applications over the years so that I am not comfortable basing a soil sample just on a soil type alone.”

Soil scientists caution that immobile nutrients like phosphorus (P) and potassium (K) tend to build up in areas where manure applications have been made over time and that areas not representative of the whole field should be sampled separately. Non-representative areas might include eroded knolls, saline soils, areas with known manure history, or areas that have been leveled for irrigation.

Wolf’s soil sampling has also become more intensive over the years to account for such variabilities in soil types and farm history. While some fields that Wolf samples for customers are in management zones based on soil type, the majority of his soil sampling is grid based.

The 2.5-ac grid size is very common, he notes, but 1.0-ac grids are often used to gain a more accurate view of fields where soils can vary greater in his region of Minnesota.

“In south-central Minnesota, we have some glacial till areas that have very rolling hills. In these fields, the soils can vary from clay knolls to deep peat within the same field,” he says. “Along the Minnesota River, we will also
have a lot of sand veins and gravel veins on heavier loam-type soil, so to pick up more of this variability, we go to a smaller grid size.”

However, Wolf stresses that the increased density of field sampling on a 1.0-ac grid comes at a higher cost. The economics of collecting that more defined soil data depends on each producer’s circumstances.

“It’s really based on the individual and if they can justify the cost,” he says, “because it does cost more than a 2.5-ac grid.”

**Beyond grid sampling**

In addition to more intensive sampling on 2.5-ac and 1.0-ac grids, Bellicot combines grid sampling and zone sampling.

By combining the two methods of sampling, Bellicot says that grid data layered with zone data and other field information like yield maps gives him more confidence that the variable-rate nutrient application rates are correct.

“For these variable-rate fertilizer decisions, we have layers of yield data, 2.5-ac grids, and then management zone data,” he says. “So in a 100-ac field, we’ll have five management zones, and each zone could vary anywhere between 5 to 30 ac. It’s more reliable and you get better information there.”

Important data from the zone samples are mobile nutrients like nitrogen and sulfur, which can change from year to year. Zone samples are collected either every year or every other year depending on the following crop. The 2.5-ac grid samples provide more detailed information on immobile nutrients like P, K, and zinc (Zn). Grid samples are collected every three to five years because soil test levels for P, K, and Zn are not as variable from year to year.

Bellicot does not stop at obtaining more samples to improve precision. Most grid samples have a 6- or 8-inch depth, but he may also collect samples to deeper depths when needed. Since nitrogen is mobile in the soil profile in the western part of Minnesota, he says, sampling down to 24 inches for nitrate is recommended for that region.

“With most of the soils here, we’ve got anywhere from 1 to 2 ft of heavy black soil with high organic matter, and below that we have clay subsoil,” Bellicot explains. “The nitrogen stays in the clay or on top of the clay because water moves through these soils very slowly.”

For deep-rooted crops like sugarbeet, Bellicot samples to 42 inches for nitrate. Knowing the amount of deep soil nitrate is important in calculating the proper nitrogen fertilizer rate for sugarbeet. Sugarbeet quality decreases if too much nitrogen is applied, and yield is lost if not enough nitrogen is applied.
Subhead

Images on opposite page and below are screenshots from a YouTube video (Tucker Finstad) showing grid soil sampling by Frontier Labs (http://frontierlabs.net).

More precision tools

Bellicot also uses a Veris soil-mapping machine, which measures soil properties like soil texture, electrical conductivity (EC), pH, and organic matter (OM). This machine runs a disc through the soil and records measurements roughly every second.

The detailed information collected helps determine where soil properties like soil texture and salinity change throughout the field. This more granular information is helpful in delineating management zones in addition to grid and zone soil test data and yield maps.

“It has worked well for us,” he says. “Compiling all these data layers over the years has helped us better manage each zone.”

More information

For more information on this topic, see the chapter “Soil Sampling and Understanding Soil Test Results for Precision Farming” from the new book Practical Mathematics for Precision Farming at http://bit.ly/2f6R2G.

See quiz for CEU credit on page 22.

The 1.5 day Sustainable Agronomy Conference, featuring over 20 speakers, provides Certified Crop Advisers (CCAs), Agronomists, and Agri-Sales Professionals with the skills to further implement sustainable agronomy practices through sound science, proven field techniques, and cutting-edge technologies!

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Precision soil sampling: harnessing deeper data for nutrient management

1. According to the article, in fields with rolling hills, what type of sampling would be most informative?
   a. Grid.  c. Composite.

2. Bob Wolf says the most common grid sampling size he uses is
   a. 1.0 acre.  c. 3.0 acre.
   b. 2.5 acre. d. 4.4 acre.

3. It is important to sample P and K levels in non-representative areas in a field. Which of the following was NOT mentioned as an example of a non-representative area?
   a. Eroded knolls.
   b. Fields with a history of livestock grazing.
   c. Fields with a history of monocropping.
   d. Areas leveled for irrigation.

4. According to the article, how frequently should grid and zone sampling be done?
   a. Both taken annually.
   b. Grid every three to five years and zone annually or every other year.
   c. Grid annually and zone every three to five years.
   d. Both taken every three to five years.

5. In western Minnesota, Alain Bellicot takes samples for nitrogen to a depth of
   a. 8 inches.
   b. 10 inches.
   c. 16 inches.
   d. 24 inches.

4R history and recent phosphorus research

1. The maximum crop response to applied phosphorus can only be expected if
   a. fertilizer nitrogen is applied or nitrogen is available from the soil.
   b. soil test phosphorus is considered.
   c. phosphorus is broadcast applied.
   d. excess phosphorus is applied.

2. Grid soil-testing results and grid-mapped crop response
   a. always match.
   b. overlap.
   c. are not always correlated.
   d. do not need to be looked at together.

3. What was the expected level of implementation of reduced tillage practices by 2010?
   a. 40%.
   b. 55%.
   c. 95%.
   d. 100%.

4. Injecting phosphorus fertilizer in rainfall simulation studies resulted in what percent decrease in DRP loss?
   a. 30%.
   b. 66%.
   c. 75%.
   d. 100%.

5. Increased soil test phosphorus concentration _____ the likelihood for phosphorus loss.
   a. increases
   b. decreases
   c. has no impact on
   d. has not yet been analyzed in relation to
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Photos will be judged by:
How well they portray the photo theme

PREFERENCE GIVEN TO PHOTOS THAT:
- Show action;
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- Show human interest (i.e., have people in them);
- Portray the work of CCAs in their profession, preferably in the field; and,
- Represent planting, growing and harvesting.

SPECIFICATIONS:
1. Submitted images must be JPEG files no larger than 10 MB.
2. Both landscape and portrait images may be submitted.
3. Give a 3-6 word title and 10-word caption, and up to 50 word description for each submission.
4. Photographer and submitter must be the same person.

Submission Guidelines & Photo Release forms
Submit your JPEG by the specified deadline at:
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Upon submission, photographers give CCA, ASA, CSSA and SSSA all rights to use the photo.
Harold Watters was recently named the 2018 International CCA (ICCA) of the Year. The award is designed to annually recognize a CCA who delivers exceptional customer service, is highly innovative, has shown that he/she is a leader in their field, and has contributed substantially to the exchange of ideas and the transfer of agronomic knowledge within the agriculture industry.

Watters, a CCA and CPAg since 1994, has enjoyed a career that unites viewpoints. His experience in industry as well as public service, in Ohio and Ukraine, and views as an agronomist and an environmentalist all blend together.

“I’m a realist. I try to make both sides understand,” Watters says. “I’m a moderate in a world where no such thing exists anymore.”

Moderation has been especially important in Ohio where Lake Erie water quality concerns have peaked. Phosphorus in the lake resulted in algal blooms, making Toledo’s main water source temporarily unusable a few years ago (see http://bit.ly/1wx1nHN). Now, growers with more than 50 ac need to be certified in fertilizer application—a training Watters helped spearhead. Approximately 17,600 producers were trained in four whirlwind years to comply with new Ohio legislation. In addition, employees at more than 40 retail locations were certified in the 4R...
Nutrient Stewardship Program (right source of nutrients at the right rate and right time and in the right place).

“It’s all complicated here in Ohio,” Watters explains. “Until the pipes burst in the basement, you don’t really think about the plumbing. It’s the same with farming. But we’ve had great cooperation from commodity groups and growers. They contributed to laws and regulations that are workable and make sense.”

Watters’ work as an associate professor in Extension at The Ohio State University also puts him at the center of a communication hub. Weekly newsletters, monthly columns, field days, academic papers, and presentations at various conferences are part of his repertoire. Experimentation on the 400-ac university research farm (and informally on Watters’ own 200-ac farm) gives growers confidence.

“He continues to incorporate new technology while gaining the knuckle-busting experiences faced by growers on a regular basis,” writes Roger Bender, a CCA who nominated Watters for the award. “His practical, hands-on knowledge of crop production is greatly appreciated by all.”

“The driving force behind Harold’s initiatives has been a desire to bring locally relevant information to the clients he serves,” another nominating CCA, Jonah Johnson, observes. “This starts with listening to the concerns of growers and crop advisers.”

Johnson cites the agronomy plot demonstration area at The Ohio State University’s Farm Science Review as another communication tool for Watters. “Seeing something in class is one thing, but seeing it in the field and getting a chance to hold it teaches you something a lot better.”

For Watters, getting the message out, no matter the method, is key. “Reinforce without repeating! Try to get at different ways to learn things: see, hear, get off the wagon and into the plots, touch it so the learning gets reinforced. I’m looking at my audience, I’m reading their body language, and seeing if they understand what I’m saying. My goal is to help you understand, but we can go at it any way you want,” he explains.

Working together to feed the world

These opportunities don’t stop at the state line for Watters. Over the last six years, he’s taken his agronomic expertise to Ukraine through a USAID program. There, farms are about 10 times the size of those in Ohio with more workers—and more regulations and paperwork. But the need to communicate supersedes all.

“I’ve learned in Ukraine that you’ve got to ask good questions [and] find out what are the limitations. Is it something to do with economics or equipment? It’s made me a better observer here at home,” Watters reflects.

“We’re all in this together. I don’t expect the U.S. alone is going to be able to feed the world. If they have capacity in Ukraine, Argentina, or Brazil, we need to work together and share the knowledge. We all need to do better, including here.”

Watters has been active in the CCA community since first becoming certified. He served on the Ohio and North Central Boards and Continuing Education Committee and as a mentor in the undergraduate Greenfield Scholars program. Ohio State and Wilmington College students may recognize him for his campus visits to promote the CCA program and give pre-exam training seminars.

“One of Harold’s great skills is his ability to connect with young people in the field and guide them in their careers,” Johnson writes. “Harold mentors new extension educators to promote a sense of teamwork with the CCAs in Ohio.”

Continuous and broad learning

Continuous—and broad—learning is a common theme for Watters. “It’s ‘accidental learning,’” Watters remarks. “If something was interesting and I saw a need, I’d jump in and learn. I keep trying to do that for younger people—make sure they understand there are lots of open doors. We try to specialize too much.”

In the end, it comes back to moderation and balance. “I want my children and grandchildren to enjoy a nice environment, and to feed a population, we need to be able to grow crops. The 2050 deadline of 9 billion people on the planet—we’ve got to be prepared for that. It’s coming fast. We grow outdoors and rely on rainfall, so we’re operating in a leaky system. I try to reduce those leaks as much as I can, but we’ll never be able to stop all those leaks. We’ve got to learn some ways to manage it.”

Watters is hopeful about that future and the talent coming up to guide it. “I feel more confident today about the next generation of agronomists. We don’t have enough women in agronomy in general, so it’s been really neat to see young women coming into the classrooms. They are hungry—they want to jump in with both feet. They ask questions and work harder.”

Watters was recognized at the Commodity Classic in February and will be recognized at the American Society of Agronomy (ASA) Annual Meeting in November. The ICCA of the Year Award consists of hotel and travel expenses to both meetings, $2,000 honorarium (which Watters has donated to the Greenfield Scholars program), a commemorative plaque, and a one-year membership in ASA. The award celebrates a level of proficiency that belongs to an individual and not to a company.
Commercial specialty and certified organic crops are increasingly found in our agricultural landscape, and many of these crops are often more sensitive to drift from pesticides used in many agricultural settings. This article is intended to increase awareness of the utility of web map services and how these might help you or your customers reduce potential incidents of drift on specialty or pesticide-sensitive crops. Earn 0.5 CEUs in Integrated Pest Management by reading this article and taking the quiz at www.certifiedcropadviser.org/education/classroom/classes/549.

Commercial specialty crops are increasingly grown across the country; from relatively small gardens and high tunnels mainly targeting urban residents, to fairly large acreages growing fruit and vegetable crops marketed directly to retail grocers or school lunch programs.

For background, there were 8,669 farmers markets listed in USDA’s National Farmers Market Directory in 2016, a 2.3% increase from 2015 (USDA Agricultural Marketing Service, 2016). In 2012, 163,675 farms (7.8% of U.S. farms) were marketing foods locally, defined as conducting either direct-to-consumer or intermediate sales of food for human consumption, according to census of agriculture data. The number of farms with direct-to-con-
consumer sales increased by 17%, and sales increased by 32% between 2002 and 2007; between 2007 and 2012, the number of farms with direct-to-consumer sales increased 5.5%, with no change in direct-to-consumer sales (USDA Economic Research Service, 2015). In 2015, 42% of surveyed school districts participated in Farm to School Nutrition Program activities representing 42,000 schools and 23.6 million students; USDA Food and Nutrition Service, 2016). Certified organic acreage and livestock (which includes pasture and hay land) have been expanding in the United States for many years, particularly for fruits, vegetables, dairy, and poultry (USDA Economic Research Service, 2017).

Many of these farms are relatively small in size and may not be recognized as commercial operations. However, crops grown on these farms can be high-value crops, ranging from a few hundred dollars per acre for certified organic row crops, to $5,000/ac for grapes, and up to $30,000/ac for processed wine grapes (Ogg et al., 2013; University of Nebraska Pesticide Safety Education Program, 2013; USDA Economic Research Service, 2009). In addition, the crops grown on these farms can be quite sensitive to the pesticide products used in traditional agriculture settings. (The term pesticide used here includes all pest control products, including herbicides, insecticides, and fungicides, among others.) Although herbicides are usually the main product of concern because of plant sensitivity and the potential impact from crop loss, financial losses are also incurred when drift from any type of non-certified organic pesticide occurs on organic crops, including those considered to be non-specialty crops. Certain crops, such as grapes, tomatoes, and peppers, are highly sensitive to dicamba and 2,4-D (Culpepper, 2017). That is, it takes very little active ingredient to cause crop injury. These two active ingredients are also known to drift offsite, either by traditional particle drift, or volatilization. However, drift can occur with any product if applied incorrectly and/or without proper precautions.

Online registries and map tools have been adopted by various states to increase the awareness of pesticide applicators about specialty crops in their trade area, encourage pesticide stewardship and management, and promote communication between specialty crop growers and pesticide applicators (including farmers, commercial applicators, and acreage owners). Pesticide applicators and CCAs who work with applicators are encouraged to become familiar with and utilize the registries described and listed below. Increased technology is making these tools more convenient and accessible to both commercial and private applicators, alike. The author’s intent is to increase awareness of these tools, and attempts were made to identify as many as possible (see sidebar list for URLs); however, only two are highlighted here.

FieldWatch

One of the largest services in geographical extent, and possibly having the most users, is FieldWatch, which includes the DriftWatch and BeeCheck registries. Currently servicing 16 states and one Canadian province with additional states to be added in 2018, FieldWatch allows specialty crop growers the ability to add their crop locations to a Google-based web map, along with their contact and crop site information. Applicators can utilize the service three ways: frequently visit the web map to scout their area before each application, create their own account to receive email alerts when new information is added to their user-defined business area, or receive membership-provided direct mapping software feeds or data downloads. While the data are currently available on mobile devices and tablets, FieldWatch will be launching two new apps in the near future, giving increased access and more functionality to users.

Applicators living near state lines or working in more than one state have the convenience of one service, especially in many Midwest and Great Lakes States. Each state
has an individual, or group of individuals, serving as data steward(s) for FieldWatch. Data stewards are the primary contact and data proofers for the state’s participants, which increases confidence in the use of the registry.

Specialty crop growers are encouraged to make their contact information available to applicators in FieldWatch in order to open the lines of communication; however, this is optional. Similarly, beekeepers may make their hive locations available on the public map, but because of concerns about hive theft, they have the option of making their locations visible only to registered applicators. Some states may also have regulations pertaining to pesticide applications near beehives. Additionally, pesticide product labels may require applicators to reference and document the use of specialty crop registries. All of these factors, including the potential liability of a drift incident, should provide justification for using these communication tools in your state, if available.

**Hit the Target**

Another web application is Hit the Target, which began in 2017 and is offered by Texas A&M AgriLife Research. Hit the Target is currently implemented in Texas but can be expanded to other states. This site features all crops (specialty, organic, conventional with no herbicide technology traits, and herbicide-tolerant crops) using color coded “Flag the Technology” (Baumann et al., 2016). All users must register with Hit the Target for access to view crop sites and associated information, add crop sites, and record future and completed pesticide applications for a site. Growers can share site-specific information with crop consultants and applicators and grant access to applicators for adding pesticide application information. For convenience, Hit the Target can be accessed directly from the web or through the Flag the Technology mobile app (available in iTunes and Google Play stores).

The registries may require annual renewal on the part of specialty crop growers, and there are initial review/approval procedures in place for each state. One goal of any tool like these is to have the most complete and current information possible, and it is often a struggle to reach small specialty crop growers who may be skeptical, or who may not hear about the service in the first place. The local applicator community can help in this regard by encouraging them to participate.
Using tools like these is a good first step. However, communication works both ways. Applicators and those working in the agriculture industry are encouraged to open the lines of communication by contacting specialty crop growers in your area. Simply touching base, letting them know that you are aware of their crop and location, and that you will be doing as much as possible to avoid an incident, would be a good next step. Todd Boller, Fillmore County (Nebraska) Weed Superintendent, like all county weed superintendents in Nebraska, is charged with enforcing the Nebraska Noxious Weed Control Act. All landowners, including the counties themselves, are required to control noxious weeds. He describes the benefits of using a specialty crop registry: “DriftWatch has become a very important part of my spray program. I receive an update when a new producer signs up in my area, and this allows me to open the lines of communication with that person. With a phone number or email address, I’m able to make contact, and we can discuss their concerns, and this allows me to create a game plan if any spraying activities need to be done in the area. I believe the specialty crop producers appreciate this effort.”

As one pesticide technical specialist, who has written numerous articles on drift and drift prevention, recently noted in a blog, “Communication between neighbors can make such a big difference, both in preventing drift and in dealing with an incident if it occurs. Once there’s a face and a name, it’s so much easier to find solutions!” (Deveau, 2018).

Drift awareness and prevention: Adding specialty crop maps and data to your communication toolbox

Earn 0.5 CEUs in Integrated Pest Management by taking the quiz for the article on pages 26–29 at www.certifiedcropadviser.org/education/classroom/classes/549. For convenience, the quiz is printed below. Cost: $10.

1. Between 2002 and 2007, the number of farms with direct-to-consumer sales increased by 17%, and sales increased by
a. 14%. c. 32%.
b. 26%. d. 40%.

2. Certain crops, such as grapes, tomatoes, and peppers are highly sensitive to
a. sulfur and organic insecticides.
b. dicamba and 2,4-D.
c. neutral pH irrigation water.
d. humus applied as a soil amendment.

3. FieldWatch has one of the largest services in geographical extent, serving one Canadian province and ____ states.
a. 10  c. 22
b. 16  d. 31

4. Hit the Target is currently implemented in which state?
a. Texas. c. Iowa.

5. In addition to minimizing herbicide impacts on sensitive crops, these resources identify the location of
a. schools c. bee hives.
b. grazing operations d. hospitals.

Links to known specialty crop registries:
- FieldWatch (fieldwatch.com) currently includes Colorado, Delaware, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Montana, Nebraska, New Mexico, North Carolina, South Dakota, Virginia, Wisconsin, and Saskatchewan.
- Florida apiaries (bit.ly/FLBEEreg)
- Maryland (1.usa.gov/1hcjNCH)
- North Dakota (bit.ly/NDspcrop)
- Ohio (1.usa.gov/1jXvfb)
- Oklahoma (bit.ly/CropOK2)
- Texas (hitthetarget.tamu.edu)

Certified Crop Advisers—if you or your customers work with pesticides, you are encouraged to register with the specialty crop registry in your state(s), if available. If your state is not listed above, you should contact the state department of agriculture to see if there is a similar service there. Search the national directory of state departments of agriculture here: bit.ly/NASDAmap.

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References

Soil organic matter [continued from p. 8]

References


Drift [continued from p. 29]

4R history [continued from p. 38]

References