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PROMOTING SOIL HEALTH IN ORGANICALLY MANAGED SYSTEMS

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Abstract: Little information is given to farmers on specific combinations of organic amendments, crop types, sequences, rotation duration, or weed management strategies that lead to improved soil health. Although there are numerous studies that compare organic systems to conventional systems, there exist few studies that compare organic systems to each other for determining how to improve soil health metrics. In this review, we focused on 11 indicators of soil health. Overall, the published research focused on four key practices: (1) cover crops; (2) rotation diversity and length; (3) tillage; and (4) organic amendments. We found that including a semi-perennial crop, like alfalfa, consistently improved soil carbon (C), nitrogen (N), and aggregate stability. There is a great deal of variety and nuance to organic systems and more research should focus on how to optimize practices to improve and maintain soil health.

Introduction: Organic agriculture does not use synthetic fertilizers or pesticides, and instead relies on rotating crops, managing pest naturally, and providing crops with nutrients via compost, manures, and legume residues. Although management practices can vary widely from farm to farm, overall, organic practices tend to increase sustainability metrics such as species richness and abundance, soil fertility, nitrogen uptake by crops, and water infiltration and holding capacity (Bengtsson et al.).

Unfortunately, little information is available to farmers on specific combinations of organic amendments, crop types, sequences, rotation duration, or weed management strategies that will lead to improved soil health in organic systems. In order to translate these intentions into action, organic farmers require science-based management strategies. *This review discusses the management opportunities available to organic farmers that will promote soil health and long-term sustainability.*

Material and methods: We focused our literature search on 11 indicators of soil health from the Tier 1 Soil Health Indicators and the Cornell Soil Health Manual: aggregate stability, nitrogen, organic matter content, water holding capacity, phosphorus, microbial respiration, infiltration/porosity, potassium, macrofauna abundance and diversity, erosion/runoff, and weed seed bank. We used Web of Science to search for studies focusing on organic agriculture and

including at least one of these indicators. We only included studies that compared two or more organic treatments as it was not the focus of this work to compare organic practices to conventional practices. Through the course of the research, several key practices emerged: (1) cover crops; (2) rotation diversity and length; (3) tillage; (4) organic amendments. For example, studies that examined rotation length compared organic systems where crop rotations consisted of 2-year cycles vs. 6-year cycles. Cover crop studies compared different species of cover crops different methods of killing cover crops (Teasdale et al., 2012), and combining cover crops with other organic amendments. Studies on tillage effects compared no-till, reduced-till, and conventional tilled organic farms. Studies examining the effects of organic amendments on soil health compared different organic fertilizer “cocktails” or combinations. There were fewer studies that compared the effect of cover crop management on soil health metrics among organic systems. We identified 24 long term field experiments across the globe that include more than one organic management system and different studies on these field trials provide the bulk of the research synthesized in this review.

Results: *Cover crops*

We found that there was not a strong effect of cover crop species, termination strategy, or amendment combination on soil health outcomes. Further, regardless of which species of cover crops were used or how cover crops were killed (disked vs. rolled), weed suppression required high levels of biomass accumulation (Evans et al., 2016; Smith et al., 2011; Teasdale et al., 2012). Although legumes increased soil N compared to grass cover crops in organic systems (Lee et al., 2015), there was no effect of cover crop type on SOC, soil respiration, earthworm biomass, or aggregate stability (de Cima et al., 2016).

Rotation diversity and length

We found that alfalfa-based systems increased biological soil health over grain-based systems in trials conducted in Wisconsin, Manitoba, and Nebraska. Specifically, alfalfa-based systems had higher soil C (Jokela et al., 2011) and higher soil biological activity (Braman et al., 2016). On the other hand, Wortman et al. (2011) found higher SOC in topsoils of grain-based systems, however, after 10 years of management the organic, grain-based system had similar soil C levels as the organic alfalfa-based system, despite almost two times greater carbon inputs (via manure) in the grain-based system (Wortman et al., 2011). Soil N tended to be higher in alfalfa-based systems due to the N-fixing ability of legumes (Jokela et al., 2011), while other nutrients (P, K, Mg, and Zn) were higher in the topsoils of grain-based systems (Wortman et al., 2011).

Tillage

There is a good deal of literature (we identified 29 published articles that fit our search criteria) on the effects of tillage on soil health outcomes in organic systems. Overall, we found strong evidence that reducing tillage can increase soil C compared to conventional till systems, however, other metrics of soil health have mixed responses to tillage. Some of this variability may be due to diversity within the term “reduced till”, which may range from chisel ploughing to shallow inversion tillage. Studies are emerging that compare different methods of conventional and reduced tillage on soil health indicators (Peigné et al., 2018). More research in this area will help optimize strategies that promote multiple parameters of soil health.

Organic amendments

It appears that even with organic amendments, cultivation can degrade SOC over time (Fliessbach et al., 2007), but that fields receiving organic amendments have higher SOC than fields receiving mineral fertilizers (Gattinger et al., 2012). Increasing the “diversity” of organic inputs may increase soil health. Overall, they show that the combination of cover crops (as green manure) with animal manures can improve soil health indicators such as N use efficiency (Torstensson et al., 2006), soil N availability (Chirinda et al., 2010), and soil respiration (Chirinda et al., 2010).

Discussion: Improving and maintaining soil health is critical to the persistence and sustainability of agricultural systems. Organic farmers have lacked precise, data-driven management strategies to date. In this review, we found that the inclusion of a perennial-like crop, such as alfalfa, can improve many soil health indicators. Further, while no-till can improve soil C sequestration, weed pressure in organic systems makes this practice very challenging. Reducing tillage, as much as possible, such as the practice of shallow, non-inversion strategies, can halt the loss of SOC while suppressing weeds, and maintaining higher crop yields. Combinations or organic fertilizer “cocktails” can enhance more soil health indicators than relying on one organic input alone. Similarly, the more soil conservation strategies a farmer can employ simultaneously, the more she will be able to maximize soil health indicators.

References: Bengtsson, J., Ahnstrom, J., Weibull, A.-C., 2005. The Effects of Organic Agriculture on Biodiversity and Abundance: a Meta-Analysis. J Appl Ecol 42, 261–269.

Braman, S., Tenuta, M., Entz, M.H., 2016. Selected soil biological parameters measured in the 19th year of a long term organic-conventional comparison study in Canada. Agr Ecosyst Environ 233, 343–351. doi:10.1016/j.agee.2016.09.035

Chirinda, N., Olesen, J.E., Porter, J.R., Schjønning, P., 2010. Soil properties, crop production and greenhouse gas emissions from organic and inorganic fertilizer-based arable cropping systems. Agr Ecosyst Environ 139, 584–594. doi:10.1016/j.agee.2010.10.001

de Cima, D.S., Tein, B., Eremeev, V., Luik, A., Kauer, K., Reintam, E., Kahu, G., 2016. Winter cover crop effects on soil structural stability and microbiological activity in organic farming. Biological Agriculture & Horticulture 32, 1–12. doi:10.1080/01448765.2015.1130646

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