

SOIL HEALTH ON ORGANIC FARMS AN INVESTMENT IN FARMING'S FUTURE

A NOTE TO OUR INVESTORS

Iroquois Valley Farmland REIT has over a decade of experience assisting farmers in their transition to organic agriculture. We are working to shift farming systems, to make organic agriculture the norm in the United States, for the future of farming and for soil health. Our approach is twofold: we work to target both the health of the ecosystem and the financial health of each operation. Our strategies to support soil health for the farmers we work with, requires an understanding of soil health as it relates specifically to organic systems. We have four theories of system change we are testing.

- Transitioning to a system that more closely mimics nature improves soil health
- Healthy soils result from system management, not a check-list
- Secure land tenure encourages farmer investment in a system of soil health
- Organic agriculture provides economic benefits to both farms and their surrounding communities

What follows is a deeper dive into these ideas, and existing research that supports them. Iroquois Valley Farmland REIT is proud to be able to nurture the link between investors and farmers so organic agriculture can become the norm in the United States.



TABLE OF CONTENTS

Improving Soil Health Through Organic Agriculture	3
Organic Farming Is A System Not A Checklist	6
Encouraging Conservation Through Secure Land Tenure	8
Socio-economic Impacts of Soil Health Improvements	10
Looking Ahead	12





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METHOD

Iroquois Valley sought to compile and synthesize the latest research on the soil health outcomes under organic management. This synthesis is supported by a literature review using Google Scholar, UChicago's Library database and our project partner, Delta Institute. In most cases, papers were included post-2014, to reflect the more recent advancements in research and were either U.S. based or from areas with a soil order found in the U.S. and similar climatic conditions.



ACKNOWLEDGMENTS

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IMPROVING SOIL HEALTH THROUGH ORGANIC AGRICULTURE

Iroquois Valley's farmers recognize that soil is a living system and they have an important role in improving and keeping it healthy. Healthy soils enable healthy plants, animals, and humans. Through practices such as diverse crop rotations, cover cropping, and integrated livestock Iroquois Valley farmers work to mimic the processes of the natural environment without synthetic inputs. Organic farming systems are prohibited from using synthetic inputs.

Research suggests that:

- Organically managed farms have better soil quality compared to farms that use synthetic fertilizers and pesticides.¹
- Eliminating synthetic fertilizers, amendments, and switching to organic inputs can:
 - improve soil structure
 - increase the abundance and diversity of organisms living in the soil
 - support soil function
 - create a healthy environment for crops to grow

Iroquois Valley encourages its farmers to go beyond the USDA organic standard and manage soil health closer to how nature would, reducing the need for inputs overall. This enables healthier soil and more financially healthy farms.



QUICK FACTS

 Soils on organic farms can average 19% higher total soil organic carbon, a central component of soil organic matter⁴ which is critical in the fight against climate change.

• Applying synthetic fertilizers increases the acidity of the soil. Increased soil acidification can affect the soil's nutrient availability.³

Pesticide application negatively impacts soil health by significantly decreasing the microbial abundance and diversity of the soil.¹⁰

Long-term application of pesticides interfere with the biochemical balance of the soil, which can reduce soil fertility and productivity.¹¹

Synthetic fertilizers negatively affect long-term soil structure and fertility by decreasing abundance and diversity of microbial organisms in soil.⁷

• Using organic amendments improves soil health by increasing aggregate stability, water holding capacity and soil's ability to maintain nutrients.⁹

• Intensive agriculture without organic amendments reduces soil's carbon content & microbial biomass, which can lead to increased erosion, nutrient leaching, and runoff.⁹

 Organic manure improves soil structure by increasing the amount of microbes in soil which stabilizes soil aggregates.⁴

 Soils treated with synthetic fertilizers are more likely to be affected by soil compaction, which can decrease nutrient retention & increase runoff.⁴

A long-term research study examining soils treated with only organic amendments compared to soils treated with synthetic fertilizer found that microbial biomass increased by 8.7% in the organically treated soil relative to the synthetically treated

A comprehensive meta-analysis found organic amendments improved soil health over synthetic fertilizers by increasing the amount of soil organic carbon by 38%, total nitrogen by 20%, microbial biomass carbon by 51% and microbial biomass nitrogen by 24%.³

Most fungicides and bactericides have significant negative effects on the chemical structure of soil by decreasing the soil's microbial biomass carbon and nitrogen.¹²

IMPACT OF FERTILIZER

Iroquois Valley knows that helping a farmer transition land to organic means the end of the use of harmful substances that can degrade soil health. Synthetic fertilizers negatively impact soil's microbial communities,⁷ which can change the physical structure of soil. Adding synthetic fertilizers also decreases the diversity and abundance of microorganisms,⁴ an essential component of improving soil's aeration and water holding capacity.

Synthetic fertilizers can also affect the acidity of the soil. The application of synthetic fertilizers increases soil acidification, which can lead to decreased soil fertility.^{2,3} Evidence indicates synthetic fertilizers can have little effect

on soil organic carbon levels, but in some cases can decrease soil organic carbon levels.^{4,5,6}

We support organic farmers, knowing that organic management improves soil health. Organic amendments support increased communities of microbial organisms in soil.^{7,8} Compared to plots where synthetic fertilizer is applied, organically farmed plots are less affected by soil compaction, which can decrease nutrient retention and increase runoff.⁴ Using organic amendments increases aggregate stability, water holding capacity, and soil's ability to maintain nutrients.9

Organic amendments increase soil organic carbon, an essential component in establishing

healthy soil.^{4,5} Soils on organic farms average 19% higher total soil organic carbon, an important consideration for mitigating climate change.⁴

Iroquois Valley supports a transition in nutrient management, acknowledging that adoption is on a spectrum. Adoption could mean:

- substituting organic amendments for synthetic fertilizers
- using naturally-occurring substances for pest management
- complete system change to reduce overall input usage Iroquois Valley encourages system change, as these approaches are shown to be more environmentally beneficial

than single practice adoption.¹³



Iroquois Valley supports farmers in transitioning away from pesticides. The Company encourages farmers to go beyond input substitution and instead manage pests holistically by using crop rotation and/or introducing natural enemies. This approach improves soil health and reduces risk for farmers. investors, and eaters alike.

Pesticides produce varied impacts on soil health depending

IN SUMMARY

Iroquois Valley supports organic and transitioning farmers because of the soil health benefits organic agriculture provides. Organic agriculture works to mimic natural processes by eliminating off farm synthetic inputs.

Synthetic fertilizers negatively impact soil health by decreasing communities of microbial organisms⁷ and therefore making the soil more susceptible to runoff and compaction. Synthetic fertilizers also affect soil health by impacting soil acidification and interfering with the nutrient balance needed for healthy soil.^{2,3} Research suggests that pesticides often negatively impact soil health by affecting the physical, chemical and microbial properties of the soil.^{10,1}

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on type, number of applications, and dosage levels.¹⁰ Research demonstrates that pesticides negatively impact the healthy structure of soil by decreasing the diversity of microbial organism populations.¹⁰ Extended use of pesticides is likely to interfere with soil health by decreasing organic carbon and total nitrogen levels.¹¹ These changes can disturb the soil's nutrient balance and thus reduce soil fertility and productivity.



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ORGANIC FARMING IS A SYSTEM NOT A CHECKLIST

Organic farms do not follow a recipe. Each farm is embedded in a different ecologic context. As nature is an interconnected system of activities, so is each organic farm. Comprehensive management change, such as organic adoption, has an increased positive impact on ecosystem services over single practice adoption.³ Iroquois Valley takes a systems-based view of soil health.

Iroquois Valley supports organic adoption and soil health principles because this system of management improves soil health and can mitigate negative soil health outcomes associated with tillage.

Organic farmers, in the absence of pesticides, often use tillage to combat weeds.¹ Tillage, if done incorrectly can disturb the soil and contribute to soil compaction, erosion and loss of organic matter.² The impact of tillage as a management tool for organic farmers depends on context. The type of tillage tool used, for what purpose, and under what conditions are all factors in a system of organic management.



SYSTEM TYPE

The impact of tillage is dependent on system type. When tillage versus mulching was compared in an organic tree fruit operation, tillage was not associated with a decline in SOM, and mulching did not increase SOM over three seasons.⁸ Iroquois Valley works with all types of organic systems, acknowledging that systems of soil health management may look different from farm to farm.



QUICK FACTS

Iroquois Valley supports whole farm system change, which provides greater enhancement of ecosystem services over single practice approaches.³

• Organic management increases organic matter in the soil, which is the primary marker of soil health. ^{1,4,6}

• Organic farming can decrease soil erosion by 30% over conventional farming.⁹

Organic management increases nutrient availability.¹

 Organic management can increase soil organic carbon by 19% over conventional no-till and can increase nitrogen in the soil by 23% over conventional no-till.⁶

Iroquois Valley encourages farmers to keep soil covered. Cover crops can double the amount of water absorbed in the soil in organic systems.¹⁰

ORGANIC & TILLAGE

We support organic management with the understanding that organic farming, with tillage as part of an overarching system, can improve soil health. Research suggests tillage can negatively impact soil organic matter (SOM), but whether the land is organically managed also determines impact. SOM provides nutrients to plants, contributes to soil structure, water-holding, and provides habitat for soil microorganisms. Research demonstrates that organic management can increase SOM,^{1,6} which is considered the most important baseline measurement of soil health.⁴ SOM is often measured via its primary component, Soil Organic Carbon (SOC). Evidence supports that organic management, with tillage, is associated with higher levels of SOC, than conventional no-till at deeper depths.¹ Conventional no-till is generally

associated with higher levels of SOC near the soil surface⁵, but in some cases, organic management has been shown to outperform at all depths.⁶

Research supports organic with tillage outperforming conventional no-till on the availability of nitrogen, a major limiting nutrient to plant growth. According to one study, nitrogen mineralization potential was greater in an organic system with tillage than a conventional no-till system after 14 years.¹

Direct measurements of erosion are not widely studied under organic management, but existing evidence suggests that organic management is associated with a reduction in erosion.^{6,7,9}

Organic management and strategies to increase cover and diversity can all improve soil health, however, tillage

is still associated with some negative outcomes, therefore the intensity and frequency should be closely managed.

For example, organic no-till has been shown to provide the greatest improvement in SOC over conventional no till or organic with tillage.⁷ When tillage is examined within organic management systems, reduced tillage is associated with less surface runoff than intensive tillage. Tillage similarly increases soil erosion under conventional management.⁹

There are some limitations to current research, as tillage is often referenced in broad categories, and not by the specific tool, method used, or the overall environmental conditions under which it is done. This limitation creates prevents deeper exploration of the difference in impacts within the category of reduced tillage.



Organic farms are complex systems that involve implementing an integrated suite of soil health principles. Maintaining soil cover and increasing crop diversity can improve soil health even more when coupled with organic management.

In a comparison of both organic and conventional no-till systems with cover crops, organic outperforms conventional in regards to SOC.¹ An increase

no-till with cover crops.¹

Organic management, and the increase in soil cover associated with it, reduces surface runoff overall. Research also suggests that cover crops can decrease erosion under organic management with tillage.¹⁰

IN SUMMARY

Tillage is one tool that a farmer has to manage their system to meet a variety of economic and environmental outcomes. Although tillage has been correlated with some negative soil health outcomes, organic management has shown to improve soil health through a reduction in erosion, an increase in soil organic carbon below the soil surface, and an increase in nutrient availability. An increase in diversity and soil cover is also shown to be an important factor that can mitigate impacts of tillage.

Multiple studies cited the trade-off between improved soil health and weed prevalence in the case of organic no-till.^{7,10} Given a larger context that shows a struggle to maintain yield without tillage in organic systems, and in recognizing the benefits of a systemsbased approach, Iroquois Valley supports the integrated use of tillage, when implemented with careful planning and done in concert with other soil health-promoting practices.

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MAINTAINING SOIL COVER & MAXIMIZING DIVERSITY

in SOC is associated with increased soil productivity. In another study at the same site, available nitrogen was higher in the organic systems with cover crops than conventional Research shows no significant variation in aggregate stability between organic treatments with or without cover crops or tillage.¹⁰ Some evidence suggests that cropping system diversity, not conventional versus organic management, is the most important factor affecting soil aggregation.⁶

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ENCOURAGING CONSERVATION THROUGH SECURE LAND TENURE

It is vital that agricultural production does not continue to degrade soil and pollute waterways. Despite billions of dollars offered through voluntary cost-sharing programs, farmer adoption of conservation and soil health improving practices remains low. By focusing on organic farming, Iroquois Valley supports a network of farmers to do just that through a variety of approaches.

There is a growing body of literature examining factors that influence conservation adoption to inform programming in support of farmer land management to improve soil and reduce negative environmental impacts. An analysis of 30+ research articles listed more than 150 different factors that have been found to significantly affect conservation adoption, ranging from soil texture to community connectedness to commodity prices.¹ The results suggest there is no single factor that consistently leads to increased adoption. Programs that incentivize conservation and soil health practices have to be tailored to the appropriate social, economic, and policy context.

Iroquois Valley's approach is to remove barriers that inhibit long-term organic land management. We make investments in farmers who use systems-based practices that put living soil at the center of their operations.



LAND TENURE ACROSS THE U.S.

Land tenure continues to garner interest as one of the key drivers of conservation practice adoption. The broad consensus recognizes that farmers who own land and make management decisions are more likely to be motivated by long-term outcomes and sitespecific improvements. Farmers who operate on leased land are production-driven and act to maximize short-term benefits. As a result, conservation adoption and investment is expected to increase among farmers who own land. Absentee or multi-generational ownership

may add additional layers of complexity in regard to how land tenure affects land management decisions and actions. Current trends in land ownership suggest that more land is managed by farmers who do not own it.² Land tenure rates vary by region: the Midwest has the lowest percentage of owner- operated land at 54%, 70% of which are cash-rent leases that require annual renewals. This suggests that landowners bear less risk and administrative burden. while farmer renters must spend considerable time and effort re-negotiating contracts.

Although many farmers who lease land continue to lease from the same landlord, there is a perceived lack of longterm access to that land. These conditions suggest that farmers who lease land may be under financial pressure and are disincentivized from investing in long-term improvement. Iroquois Valley offers long-term land tenure through mortgages and leases that enable farmers to become owners when they are ready. The terms offered by Iroquois Valley match a timeline that allows farmers as well as investors to benefit.

IMPACT OF LAND TENURE ON CONSERVATION PRACTICE ADOPTION

A number of studies explore different aspects of land tenure to better understand how it actually impacts conservation adoption.^{1,3}-⁸ Numerous studies examine differences in behavior between landowners and tenants, while some look at how lease terms may also impact conservation adoption among tenants. Absent financial incentives or regulatory checks, results suggest landowners are more likely than tenants to select crop rotations and implement practices that lead to long-term soil health benefits.

Land tenure appears to be a factor in the kinds of conservation practices that are adopted. In British Columbia, farmers who rent land are more likely to adopt crop rotations that maximize short-term returns such as potatoes and other annual cash crops,⁵ while perennial crops were planted on 21% of owned fields and only 5% of rented fields. Similarly, farmers in Iowa who rent land are more likely to plant continuous corn rotations.6

A study from 2014 found there is no difference between landowners and tenants in adopting conservation tillage.⁹ However, farmers are 8.3% less likely to plant cover crops on land they rent. The rationale appears to be

rooted in maximizing shortterm benefits. Another study showed that while lowa farmers who rent land were less likely to rotate their crops, they were equally or more likely to practice conservation tillage.⁶ The type of lease rate can also have an effect on adoption of conservation tillage in particular. A study looking at farmers in 16 different states, including the Plains and the Corn Belt region, found share-renters behave much like owners, while cash-renters are less likely to use conservation tillage.⁷

IMPACT OF LEASE LENGTH & OTHER INCENTIVES

While land access remains an important issue for farmers who want to grow their operation, the barriers to conservation associated with land tenure insecurity can be removed. There is evidence that utilizing lease agreements with longer terms can mitigate land tenure security risks. For example, the difference in cover crop adoption between

owners and tenants is reduced within long-term (over 5 years) lease agreements.⁹

IMPACT OF LANDLORD-TENANT RELATIONSHIPS

Sociological studies on this topic offer perspectives about the differences in decision-making processes between landowners and tenants. Typically, surveys, interviews, and focus groups with farmers and agricultural professionals gather insight into motivations, attitudes, and perceptions.^{3,4} Such studies reveal that many of the barriers

to conservation adoption among tenant farmers are informational, social. or cultural in nature. Tenant farmers also face financial and market constraints beyond the lease structure (e.g. length, cash vs share) that may include informational deficits, and power and trust imbalances between landlord and tenant. These can contribute to a sense

IN SUMMARY

Iroquois Valley works exclusively with organic farmers, which results in a mission-aligned farmer base that is already committed to sustainable agriculture and soil health practices. Furthermore, Iroquois Valley operates in a way that encourages trust and a collaboration with and among its farmers, which helps to eliminate land tenure barriers associated with social dynamics. Iroquois Valley is working to develop and provide additional educational resources focused on soil health practices to help alleviate the lack of information that may prevent adoption of practices.

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Studies also show that when financial incentives, regulatory compliance, or a combination of those factors are present, land security does not impact conservation behavior.⁵-⁷ For example, differences in practice adoption rates were

eliminated when subsidy payments corresponded to compliance with standards for planting on land vulnerable to erosion.⁸ Iroquois Valley works to provide both longterm tenure and to create other incentives that support farmers who are certified or transitioning to organic farming.

of land insecurity. Iroquois Valley supports their farmers by providing flexibility and farmerfriendly land tenure, which forms a basis for the collaborative working relationship needed to advance more conservation on the land. Our relationships with farmers come first, before the transaction of a lease or mortgage payment.

SOCIO-ECONOMIC IMPACTS OF SOIL HEALTH IMPROVEMENTS

Iroquois Valley takes a systems-based view of soil health management. Our approach recognizes soil is a living system and that managing that system well has environmental as well as socioeconomic benefits. Organic farming systems that work to improve soil health have positive economic impacts for both the farms and the communities in which they are embedded.



BENEFITS TO FARMERS

Iroquois Valley supports farmers' transition to organic agriculture, knowing an investment in organic is an investment in the economic outlook of a farm. The adoption of organic agriculture is associated with an increase in net farm revenue, even within the first year of certification.¹This means that an improvement in soil health improves the

economic stability of a farm.

Iroquois Valley encourages its farmers to take a systems approach to managing for soil health. Shifts in management (organic adoption, managing for multiple outcomes, increasing biodiversity, and using cover crops) have greater impacts on soil health than simple practice adoption. Managing

for soil health can positively impact farmer profitability through input reduction and pest management.² An improvement in soil health can also improve the resilience of a farm to extreme weather events, an important benefit with the increasing impacts of climate change.³

BENEFITS TO COMMUNITIES

We support farmers' transition to organic agriculture, knowing organic agriculture can bring economic vitality to a community. Counties in organic hotspots - i.e. counties with a statistically high number of organic operations with neighboring counties that also have a statistically high number of operations – have poverty rates that drop 1.3% and median household incomes that increase by \$2,094.^₄

The elimination of harmful pesticides through the adoption

IN SUMMARY

of organic agriculture helps protect the water supply and the health of aquatic species in streams and oceans.⁸ The integration of soil health practices into organic systems, such as cover crops and crop rotation have benefits to the farm such as improved water infiltration and reduction of soil loss.⁵ The implementation of soil health practices benefits the farm as well as surrounding communities downstream. Practices that increase water infiltration in the field could decrease the amount of surface

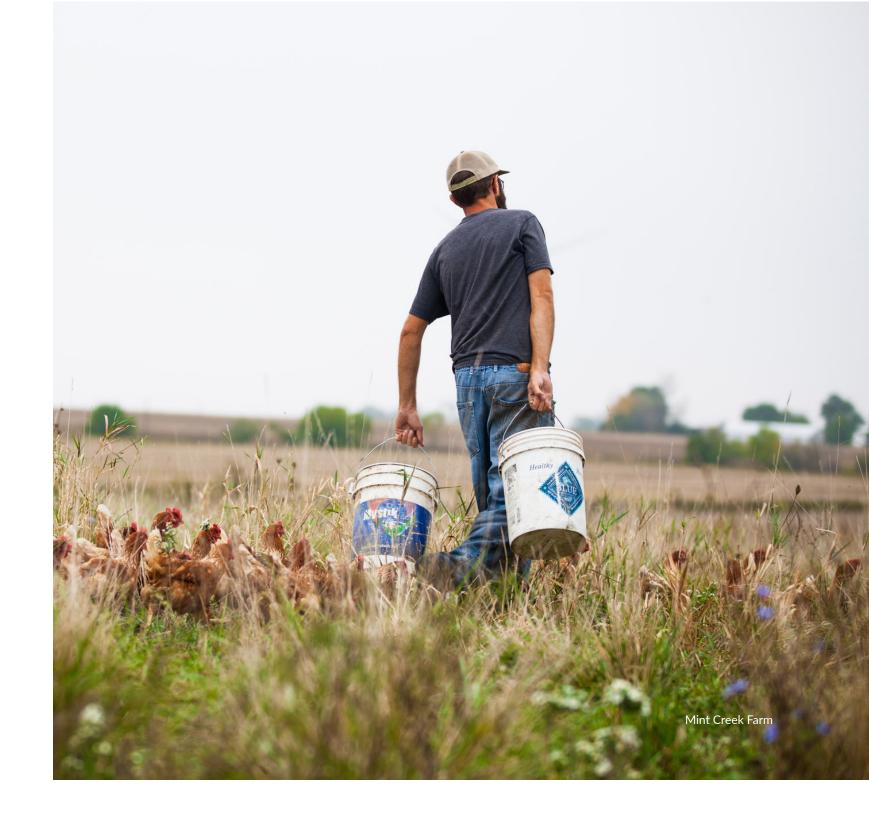
water flowing into nearby streams and rivers - thus mitigating flooding potential – while increasing recreational opportunities in nearby rural and urban communities.⁶ Organic farming can help increase SOC,⁹ and sequestering carbon is also beneficial for communities. Soils with increased soil organic matter could slow water contamination, which has a major impact on local drinking water supplies.7

Organic agriculture, and more broadly, an investment in soil health, improves the returns and resilience of a farm operation and brings economic benefits to the community at large.

Iroquois Valley is committed to supporting its farmers' long-term land stewardship through organic management. Iroquois Valley recognizes that investing in organic farms and famers supports not only healthy soils but healthier communities. Iroquois Valley Farmland REIT is a triple bottom line company that supports its farmers for their direct environmental, economic, and social impacts.

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LOOKING AHEAD

Iroquois Valley Farmland REIT is leading a significant shift in the way farmland is managed in the United States. We have over a decade of experience assisting farmers in their transition to organic agriculture and keeping them in business for the long run. We are working to make organic agriculture the norm in the United States. We work to enable both healthy farming systems and financially healthy operations. This shift requires:

- Ensuring that farmers committed to farming organically and building healthy soils have land security, which enables them to further invest in a system of soil health
- Increasing research on soil health as an integrated system of management around a set of guiding principles and not a checklist of practices
- Improving farm viability for operations already dedicated to land stewardship
- Recognizing that each successful organic farm provides economic and social benefits to their surrounding community
- Investing with mission-aligned organizations like Iroquois Valley working to remove financial barriers for farmers making the organic transition and who are already organic

Iroquois Valley Farmland REIT partners with over 40 innovative farmers across 14 states and is backed by approximately 450 investors who want to see organic agriculture become the norm in the United States.

For more information, visit our website at <u>www.iroquoisvalley.com</u>



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