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Cost Benefit of Soil Health Management in Field Tree Nursery Production

Nursery Soil Health

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Executive Summary

In this report prepared by Vineland Research and Innovation Centre (Vineland), we take a first step in supporting field nursery tree producers in understanding the value proposition for soil health-centric production practices. We completed a review of the literature to understand and provide an overview of the existing cost-benefit analysis (CBA) resources that can be used by field tree nursery producers. From those findings we have provided an analysis of the type of information that is available for field tree nursery producers on CBA. The information that is explicitly linked to field tree nursery production is sparse and where information is available it is generally related to orchard and vineyard applications. While there are resources available on the cost-benefit of soil health and soil management, most resources are based on orchard and vineyard crops, which presents an indirect comparison for the investment and effort required to manage woody perennial nursery crops that are eventually removed from the field for sale or resale.

In order to help field tree nursery producers develop value propositions for investing in soil health enhancing management practices, we have developed a framework for performance indicators that can be used as a basis for making decisions on soil health and for monitoring the efficacy of soil health management practices.

Introduction

Farmers are demonstrating a growing interest in soil health and understanding how to improve the quality of their soils through changing management practices. Soil management is the suite of operations, practices, and treatments that can be used to protect, improve or enhance soil performance. It can include beneficial soil enhancing conservation practices, or the active restoration of soil qualities through the use of cover crops or the addition of amendments. Soil management, however, can also include practices like clean cultivation that degrade soil health. Soil health is a measure of the capacity of a soil to provide ecosystem services. Therefore, optimal soil management is the operations or practices that can be used to enhance soil health.

Although soil is inherent to field production practices, relevant information, tools and data pertaining to soil management for tree nurseries are scarce. A comprehensive review of the existing literature identified only 15 articles and reports directly concerned with soil management practices for tree nursery production, published between 1970 and the present. Many of the tree related resources that have been developed are focused on seedling-sized trees and associated production practices, as they pertain to commercial forestry operations. Detailed data designed to support the production of larger, caliper-sized nursery trees, in the form of peer-reviewed articles, technical reports or other relevant resources; are limited and therefore difficult to obtain.

Despite growing interest amongst tree producers, soil health can often be a secondary consideration when faced with other management needs. Where the vast majority of nurseries prioritize soil health in their current field management, 54% of growers surveyed indicated that soil health is often superseded in practice by other management requirements. The day-to-day demands of field management can easily detract and defer efforts to build and improve soil health in favour of response and mitigation activities that are required to manage the various soil level challenges associated with field production. In order to justify a change in practices towards supporting soil health, producers need greater clarity of the economic cost and benefits affecting their operations.

Overview of Approach

In 2021, we completed a comprehensive review of the literature to identify resources that can be used to inform soil health CBAs for field tree nursery producers. The review surveyed both the extent of available grey or technical literature obtained via a standard web search (Google) as well as peer-reviewed scientific literature obtained using an academic resource database (Web of Science). The search was conducted by identifying and inputting key phrases and sorting the resulting resources by relevance until no new relevant articles emerged.

The key words used for the search criteria included: cost benefit analysis and soil health; soil management; regenerative agriculture; soil health vineyard; soil health orchard; soil health tree nursery, as well as, soil health tree farm; economics and soil health; regenerative agriculture, as well as, financial costs of soil degradation, emerging benefits of soil health practices and soil carbon sequestration; waste conversion; compost; water. All

documents were screened to only include resources containing information on the economics associated with various soil health metrics.

Results

What information is available on cost benefit for field production?

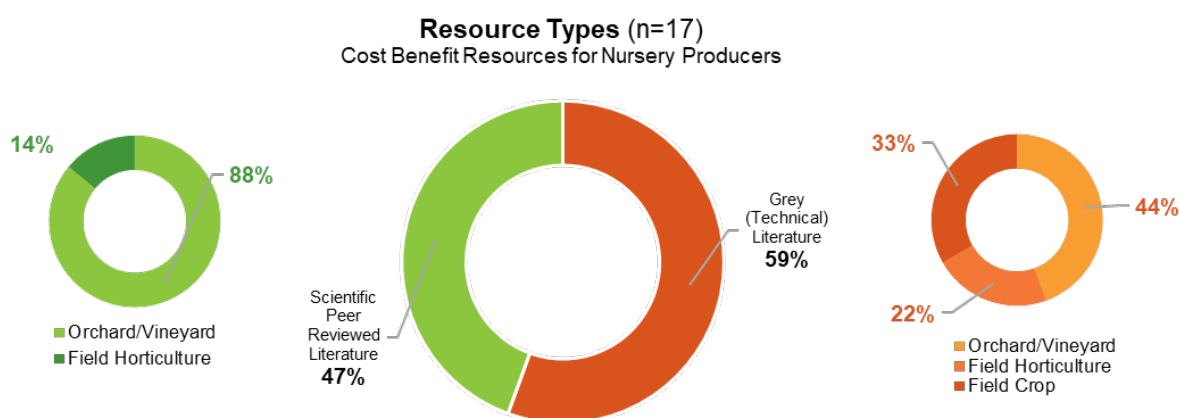


Figure 1. Overview of resource types identified through the comprehensive review of scientific and technical literature pertaining to cost-benefit in field tree nursery production.

A total of 17 resources were identified in the comprehensive review of both scientific and technical literature surrounding the cost-benefit of soil health practices in tree nursery production. 59% of resources were obtained from the technical literature, whereas 47% came from evidence based, peer reviewed studies. Of the limited resources identified, 35% of documents spoke to the management of field crops (grains, cereals) and field horticultural crops (tomatoes, potatoes), while the remaining 65% outlined information on the cost benefit of soil management in orchards and vineyards. Of the 17 resources, 59% provided information relevant to North America, all of which were based on research trials and case studies conducted in the United States. The comprehensive review identified no resources that directly addressed cost-benefit of soil management practices as they pertain to the field production of ornamental plants or trees and no resources spoke to the value proposition of soil health for Canadian or Ontario based tree producers.

How is cost benefit measured in field production?

Of the existing knowledge base, the 65% of resources outlining cost-benefit for orchard and vineyard production are likely to be most comparable and accordingly, most applicable to field tree nursery producers. Where performance indicators are central to characterizing cost-benefit of soil health enhancing management practices, our review sought to first identify how orchards and vineyards measure cost-benefit as it relates to their associated field and soil management practices.

The comprehensive review found that the primary indicator of performance used to measure cost-benefit in orchard and vineyard applications is yield, specifically the impacts of different soil management practices on the quantity of fruit produced during a growing season. Overall, resources evaluating cost-benefit in orchards and vineyards showed that soil health and other systems-based field management practices are typically associated with reduced yield as compared to conventional management. Benefits from alternative management practices including winter cover cropping, mulching and the application of organic amendments were accrued largely in measures of product quality, as well as through grants, economic policy and improved environmental performance.

These findings demonstrate that yield and like indicators of performance do not function as primary benefits or indicators of soil health and other systems-based field management practices. Metrics associated with product quality as well as the larger environmental, sustainability and socio-ecological benefits are more likely to reflect the benefits associated with alternative practices and should be used as primary measures for evaluating cost-benefit at the production level.

How does this apply to field tree nursery production?

In the case of field tree nursery production, cost-benefit metrics and associated indicators are multifaceted and complex. Unlike orchard and vineyard crops that are produced for the purposes of consumption and therefore characterized by a linear cost-benefit chain, ornamental plants and trees contribute toward short and long term benefits at both the farm and landscape levels. Yield is an insufficient measure of soil enhancing practices in other agricultural operations, similarly, the value proposition for soil health within field tree nursery production needs to be founded on indicators related to the quality of the production process as well as that of the resulting product.

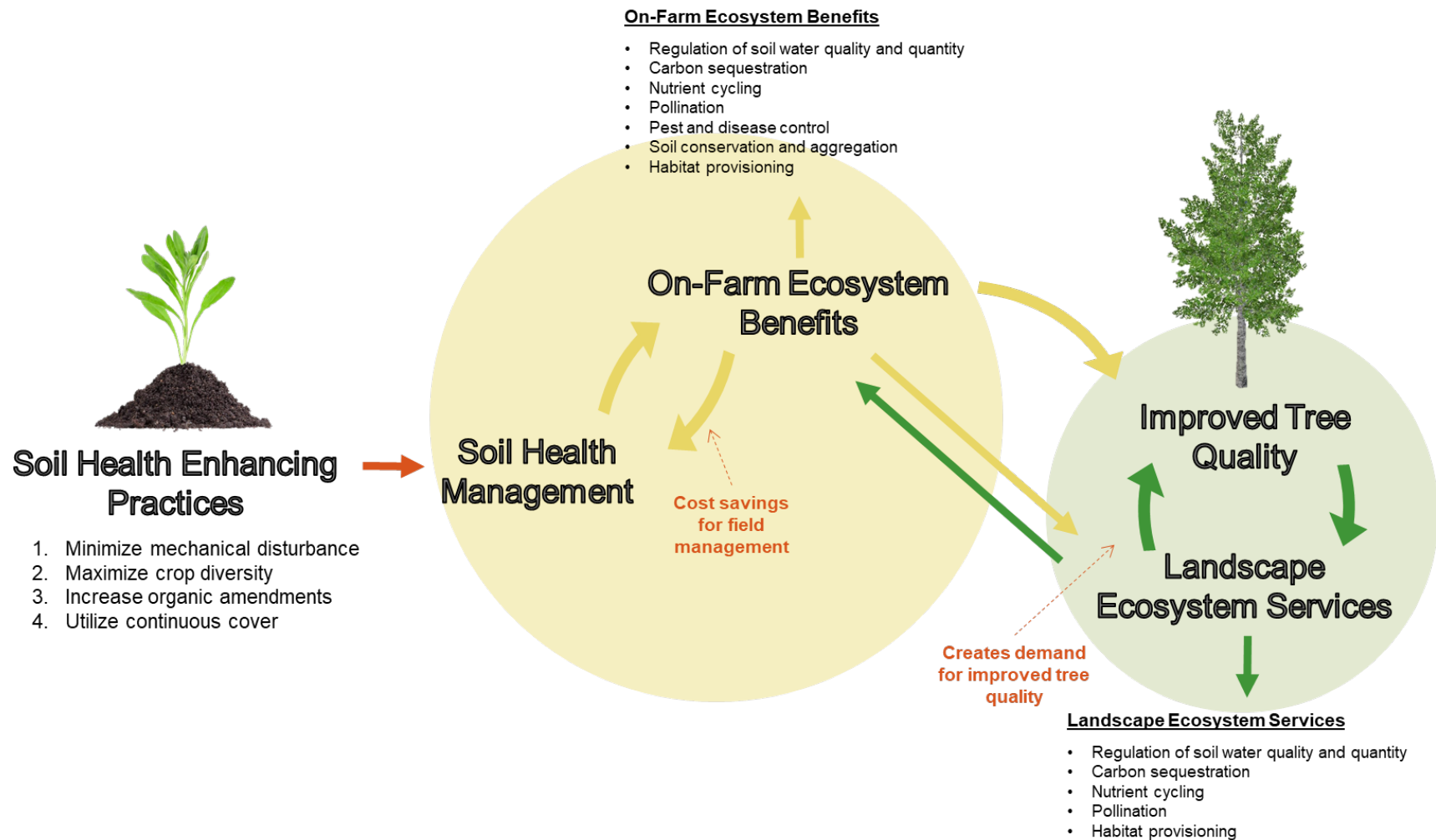


Figure 2. Envisioned cost-benefit system for soil health management in field tree nursery production. Both on-farm management (production) and tree quality (product) benefits can be attained through implementation of soil health enhancing practices.

Soil health practices in field tree nursery production are inherently systems based, they require a systems based approach to understand associated benefits. Systems approaches refer to a series of actions or outcomes that are applied or occur either concurrently or in sequence to comprehensively meet a goal or objective. Figure 2 demonstrates the prospective cost-benefit system relevant to field tree nursery producers and identifies both on-farm management (production) and tree quality (product) benefits accrued through the implementation of soil health practices. Integration of soil health enhancing practices into management can directly support improved production quality through the accrual of on-farm ecosystem benefits such as the regulation of soil water quality and quantity, nutrient cycling, soil conservation and aggregation as well as pest and disease control. These benefits can additionally contribute toward cost saving for field management in both the short and long term by improving soil function and minimizing the need for response and mitigation activities that are required to manage the range of soil level challenges associated with field production.

Extensive research on urban tree survival and growth has found that tree establishment, longevity and overall quality is inextricably linked to soil health. Accordingly, the integration of soil health enhancing practices can support improved product quality, where field produced trees grown under soil enhancing management are likely to demonstrate improved establishment, longevity and provide more sustained contributions to the landscape in the form of landscape level ecosystem services as compared to their conventionally grown counterparts. Higher quality trees, capable of sustained growth in the long term will in turn contribute toward providing landscape level ecosystem services. Improved ecosystem function at the landscape level will feedback into on-farm benefits while sustained tree growth and productivity will further incentivise practices underlying the production of higher quality trees.

This envisioned system of cost-benefit for field tree nursery production is contingent upon the integration of soil health practices in the field. Individual soil health practices vary according to production requirements and associated management objectives but are ultimately derived from four key principles, namely:

1. Minimize mechanical disturbance
2. Maximize crop diversity
3. Increase organic amendments
4. Utilize continuous cover

The ways in which these principles are implemented can be scaled according to investment in soil enhancing practices. Any level of soil health management will initiate the system of cost-benefit to support improved production quality in the form of on farm ecosystem benefits and ultimately increased product quality in form of improved tree quality and landscape level ecosystem services. When integrating soil enhancing practices into soil management, field tree nursery producers may consider implementing and establishing 'Basic' soil health management principles and progressing toward 'Moderate' and 'Comprehensive' application as they gain experience over time. Table 1 provides an overview of basic, moderate and comprehensive soil health practices according to their ease of integration into field tree nursery production operations. Outlined under each category

are a series of soil enhancing management practices that can be integrated into field tree nursery operations.

Table 1. Scaled application of soil health practices and indicators for field tree nursery production (adapted from The Comprehensive Assessment of Soil Health Framework by the Cornell Soil Health Lab)

| Basic | Moderate | Comprehensive |
|--|--|--|
| <ul style="list-style-type: none"> - Perform some mechanical soil loosening - Incorporate high biomass cover crop - Apply stable organic amendments - Maintain year round plant cover in non-production fields | <ul style="list-style-type: none"> - Minimize soil disturbance - Minimize excessive traffic - Plant multi species cover crop (shallow and deep rooting species) - Apply stable organic amendments - Maintain year round plant cover (both during and outside of production) | <ul style="list-style-type: none"> - Reduce tillage - Avoid traffic - Increase rotational diversity - Plant multi species cover crop with shallow and deep rooting species - Apply stable organic amendments - Maintain year round plant cover (both during and outside of production) |

Conclusions

Yield and like indicators of performance do not function as primary benefits or indicators of soil health and other systems-based field management practices. As a result, the value proposition for soil health within field tree nursery production needs to be founded on indicators related to the quality of the production process as well as that of the resulting product. Soil health practices are inherently system-based, therefore, they require a systems approach to understand associated benefits, which include improvement in both production and product quality. The system of cost-benefit for field tree nursery production is contingent upon the integration of soil enhancing practices in the field that are ultimately centered on four key soil health principles, (i) minimizing mechanical disturbance, (ii) maximizing crop diversity, (iii) increasing organic amendments and (iv) utilizing continuous cover. As field tree nursery producers work to integrate soil health practices into their management and operations, it is recommended that they consider a scaled approach whereby basic soil health management is implemented and established prior to the integration of moderate and comprehensive soil health practices. The benefits accrued through the establishment of soil enhancing management practices range from on-farm ecosystem services to improved tree quality and landscape level ecosystem services, all of which function as part of a multifaceted and complex system of cost-benefit affecting field tree nursery production.

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