

May 2025

The Environmental Footprint of Soileos



Soileos



Science Driven. Field Proven. Bio-Activated.

Climate-smart crop nutrition for healthier soil and higher yields

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Soileos Granules

Soileos & Lucent Bio

Lucent Bio, developer of Soileos, is a Canadian Ag-tech company and focused on creating sustainable science-based fertilizer solutions.

Learn more at [lucentbio.com](https://www.lucentbio.com)

Executive Summary

Soileos, developed by Lucent BioSciences, was designed to accelerate the transition to a sustainable agri-food system, using circular economy principles, it provides a non-polluting climate positive solution.

Soileos is a soil-applied, climate-smart nutrient delivery system. It enhances yields, crop resilience, and soil health with on-time nutrient delivery and sustained bioavailability, allowing the crop to maximize its genetic potential. Soileos connects agri-food processors with agricultural inputs, creating a sustainable and efficient supply chain for enhanced crop productivity. Our patented technology binds micronutrients—zinc, iron, manganese, etc.—to cellulose fiber and uses the soil's natural biological activity to release nutrients to the crops in an efficient manner. Soileos is made from upcycled agrifood processing cellulose such as pea, lentil hulls and oat husks. Unlike conventional products, Soileos improves microbial activity in the soil and enhances soil organic carbon levels.

In addition to its low manufacturing emissions, field trials suggest Soileos may also enhance soil carbon storage, with observed sequestration rates of up to 2.3 tonnes CO₂e per acre. The net result is higher crop yields, improved nutrient density, and healthier soils.

Independent consulting firms, Viresco Solutions and SAISS Consulting, were contracted to provide insight into the environmental benefits of manufacturing and using Soileos Zinc and Soileos Iron and to assess the carbon emissions related and other environmental benefits of using Soileos Zinc.¹

Key Findings:

1. The GHG manufacturing footprint of Soileos is about 1/4th of the footprint of Zinc EDTA and about 1/6th of the footprint of Iron EDTA.
2. The manufacturing process of Soileos requires around 1.5x less water usage, 4x less energy and generates 5x fewer air pollutants than the manufacture of EDTA.
3. Increases in soil organic carbon (SOC) levels and land use-related benefits far outweigh the GHG manufacturing footprint of Soileos.
4. Field trials indicate that Soileos use may lead to soil carbon sequestration rates of up to 2.3 tonnes CO₂e per acre,

Soileos production capacity significantly increased in 2023 with the completion of the new 20 tonnes per day manufacturing facility in Rosetown, Saskatchewan. This facility, which operates as AGT Soileos,² will manufacture enough product to treat 1.5 million acres of cropland.

1 Note that the carbon emissions profile has only been assessed to date for Soileos Zinc and Soileos Iron.

2 AGT Soileos is a partnership between Lucent Bio and AGT Food and Ingredients, funded in part by Protein Industries Canada. Soileos & Lucent Bio



Sustainable Farming Starts Here

Designed For the Future of Farming

In the upcoming decades, global agri-food systems will profoundly change as we adapt to more sustainable food production and distribution approaches. Growers are currently being challenged to meet the needs of the present without compromising the ability of future generations to meet their own needs.

Soileos is designed to help growers meet sustainability demands, improving soil health, boosting yields, and reducing carbon emissions from farm to fertilizer.



Soileos

Cutting Emissions From Factory to Field

Soileos Innovation focuses on optimizing resource use and minimizing our environmental footprint to support the development of more sustainable, climate-smart agriculture. We partner with food processors to upcycle low-value crop processing co-products into high-value revenue streams, and provide an innovative crop nutrition delivery system for the agriculture industry.

Soileos, an innovative soil-applied, crop nutrition product, enhances yields, crop resilience, and soil health with on-time nutrient delivery and sustained nutrient bioavailability, allowing the crop to maximize its genetic potential. It's patented technology binds micronutrients to cellulose fiber and uses the soil's natural biological activity to release nutrients—such as zinc and iron—to the crops. Soileos replaces the use of conventional and synthetic technologies such as oxysulphates and EDTA. Soileos is made by upcycling low value cellulose derived from crop processing residues such as pea, lentil, or oats hulls. Unlike conventional micronutrient delivery systems, Soileos' organic substrate means soil organic carbon levels are enhanced through its use. The net result is higher crop yields, improved nutrient density, and healthier soils with higher carbon levels.

**SOILEOS FEEDS THE
MICROBES THAT FEED
YOUR CROPS**

Soileos promotes the activity and growth of the microbiome. Research on Soileos, conducted in collaboration with Agriculture and Agri-Food Canada has demonstrated that Soileos activates an increase in microbial biomass by providing biologically available carbon. The microbial community metabolizes the bioavailable carbon, initiating a cycle that releases micronutrients back into the ecosystem in a bioavailable form readily accessible for crop uptake. Nutrients are delivered from Soileos to crops through symbiotic relationships with soil microbes, facilitated by both root interception and microbial mineralization. This is why we call Soileos "Bio-Activated."

Soileos helps growers produce more crops with a higher nutrient content and creates an avenue for the agri-food community to enhance nutrient stewardship, improve resource management, and contribute to a circular economy.





Better for Your Crops, Better for the Land

Soileos helps you grow more—with less compromise. Designed to deliver both high performance and sustainability, Soileos allows growers to increase yields while protecting their soil and the environment. Its unique formulation minimizes nutrient run-off and stays in the soil longer, ensuring a more reliable return on investment (ROI) and long-term soil health.

Backed by data, trusted in the field. Soileos has been extensively tested in field trials across a wide range of crops and growing conditions. The results speak for themselves, consistent yield increases that give growers confidence in its ability to boost productivity while supporting climate-smart agriculture

TABLE 1.

Field Proven: 3 years of field trials demonstrated yield increases

CROP	YIELD INCREASE
Soybeans	7-10%
Wheat	5-10%
Corn	5-12%

Field-Level Carbon Sequestration Potential

In addition to the resource and emissions reductions associated with Soileos production, trials suggest that Soileos use can contribute to measurable increases in soil organic carbon. Observed results show carbon sequestration rates of up to 2.3 tonnes CO₂e per acre. These findings underscore the potential of Soileos to support climate-smart soil management in real-world agricultural systems.

Environmental Benefits of Soileos Crop Nutrition



Climate Positive

Soileos goes beyond net-zero. The GHG benefits from its use far outweigh its manufacturing GHG footprint.



Improved Soil Health

Soileos rebuilds soil by adding carbon, increasing microbial activity and enhancing nutrient cycling.



Non-Leaching and Non-Polluting

Using patented cellulose-based technology, Soileos is water-insoluble and does not leach through the soil profile like EDTA products.



Part of the Circular Economy

Upcycling low-value food processing co-products into climate-positive fertilizer creates a sustainable cycle of production and reuse, supporting future harvests.





Backed by Independent Research

Independent consulting firms, Viresco Solutions and SAISS Consulting, were engaged to evaluate Soileos' environmental impact and provide insight into the carbon emissions offset potential of using Soileos Zinc and the environmental footprint of manufacturing Soileos Zinc^{3,4} and Soileos Iron.⁵ These studies used ISO-compliant standards to compare traditional micronutrient fertilizers based on EDTA to the Soileos delivery system. The results of these studies support Lucent Bio's efforts to develop products that enhance crop production and soil carbon sequestration. This report which initially looked at canola, corn and soybean has recently been updated to include wheat.



Life Cycle Analysis/Assessment (LCA) is a tool used to support decision-making for sustainable development as it evaluates the environmental impacts associated with all stages of a product or process.⁶ SAISS used a "cradle-to-gate" analysis which examined the production of Soileos from resource extraction (cradle) to the factory gate. This LCA approach is grounded in international standards and science-based quantifiers, making it a reliable and consistent means of evaluating



³ "Environmental Benefits Assessment of Soileos Zinc Delivery System in Comparison to Two Alternative Baselines," SAISS Consultants, Toronto, June 2022.

⁴ "Streamlined Greenhouse Gas Assessment for Soileos". Viresco Solutions, Edmonton, December 2023.

⁵ "Environmental Benefits Assessment of Soileos Iron Delivery System in Comparison to an Alternative Baseline," SAISS Consultants, Toronto, July 2022.

⁶ Brusseau, M. L. (2019). Sustainable development and other solutions to pollution and Global Change. *Environmental and Pollution Science*, 585–603. <https://doi.org/10.1016/b978-0-12-814719-1.00032-x>

Soileos vs. Traditional Fertilizers Environmental Impact

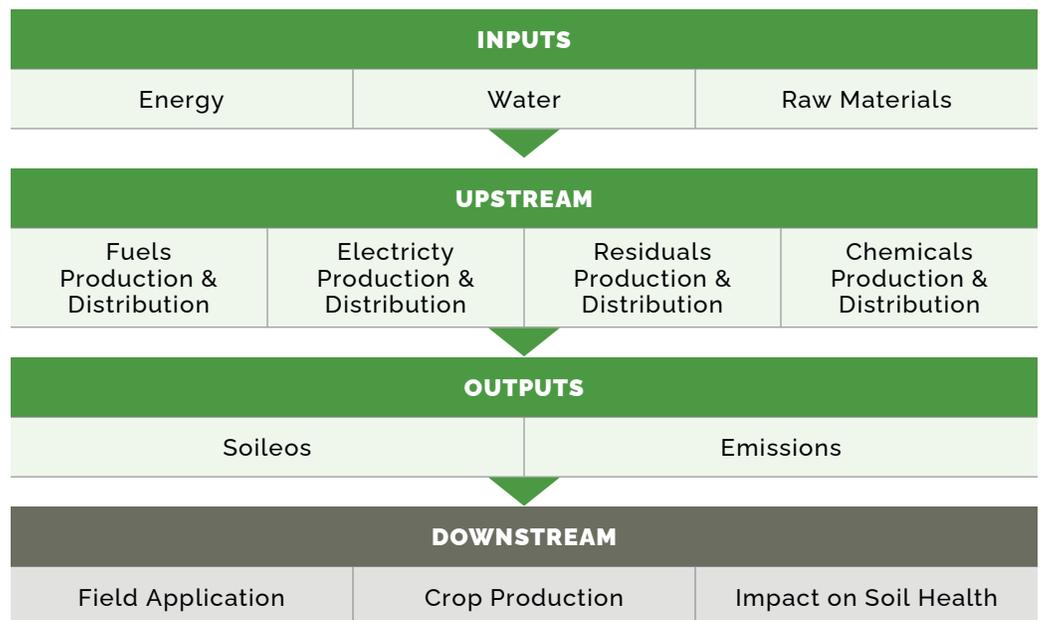
Key Findings:

1. The environmental footprint of manufacturing Soileos Zinc is estimated to be 1.6 t CO₂e/t of Soileos produced, about 1/4th of the footprint of Zinc EDTA.
2. The environmental footprint of manufacturing Soileos Iron is estimated to be 1 t CO₂e/t of Soileos produced, about 1/6th the footprint of Iron EDTA.
3. The manufacturing process of Soileos Iron requires 1.5x less water usage, 5x less energy and generates 5.5x fewer air pollutants than EDTA
4. The manufacturing process of Soileos Zinc requires 1.5 less water usage, 3.5x less energy and generates 4x fewer air pollutants than EDTA

What Was Measured (And Why it Matters)

Lucent Bio commissioned an environmental footprint assessment of Soileos Zinc Delivery System in Comparison to Two Alternative Baselines by SAISS Consultants, Toronto in 2022, to evaluate the manufacturing processes of Soileos Zinc and Soileos Iron, comparing them against conventional EDTA-based micronutrient fertilizers. The assessment considered various environmental dimensions, including Global Warming Potential (GWP), air pollution, primary energy use, and water consumption, throughout the cradle-to-gate life cycle. The findings revealed that both Soileos Zinc and Soileos Iron exhibit lower environmental footprints compared to conventional EDTA products.

TABLE 2. Environmental Impact Assessment Framework



Soileos is an innovative crop nutrient delivery system that solves current micronutrient delivery problems while improving soil health. The proprietary technology behind the Soileos crop nutrition system binds nutrients such as zinc, iron, and manganese to the cellulose fibre replacing the need for synthetic chelating agents such as EDTA. The Soileos formulations also deliver macronutrients, specifically potassium and sulphur in addition to the above mentioned micronutrients.

How Does Soileos Stack Up to Conventional Products?

On a per tonne of fertilizer produced basis, Soileos has a lower environmental footprint than both iron and zinc EDTA.

FIGURE 1.

GHG Footprint from Manufacturing a Metric Tonne of Product

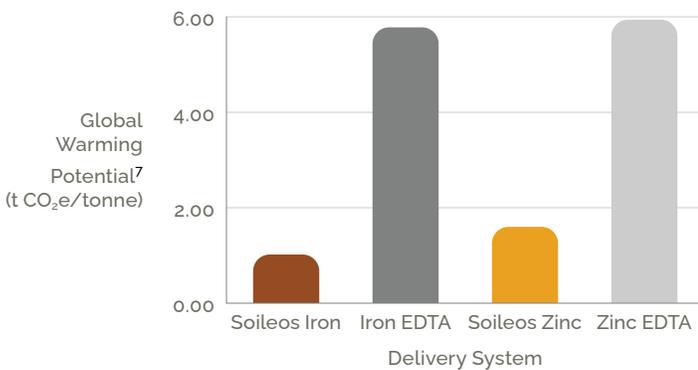


FIGURE 2.

Water Use from Manufacturing a Metric Tonne of Product

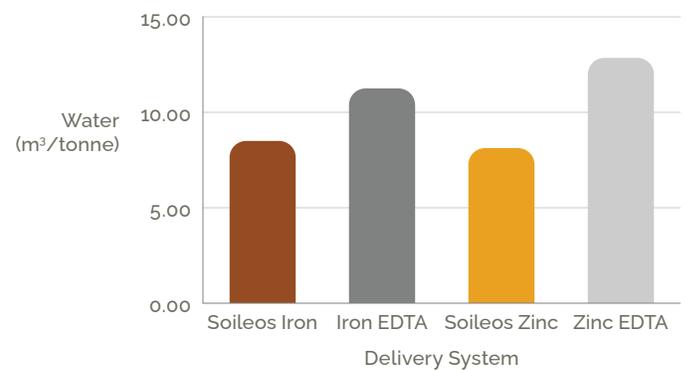


FIGURE 3.

Total Air Contaminants from Manufacturing a Metric Tonne of Product⁸

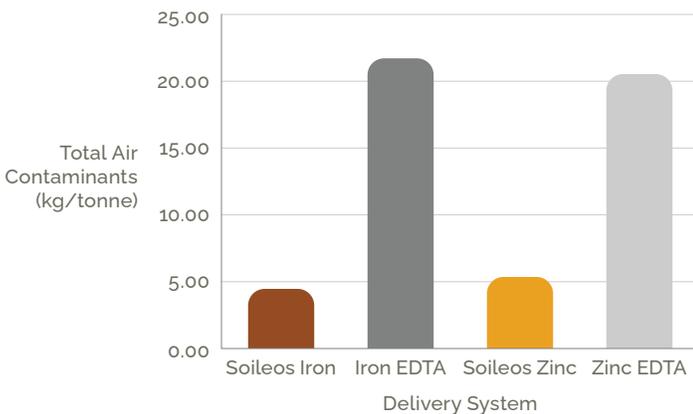
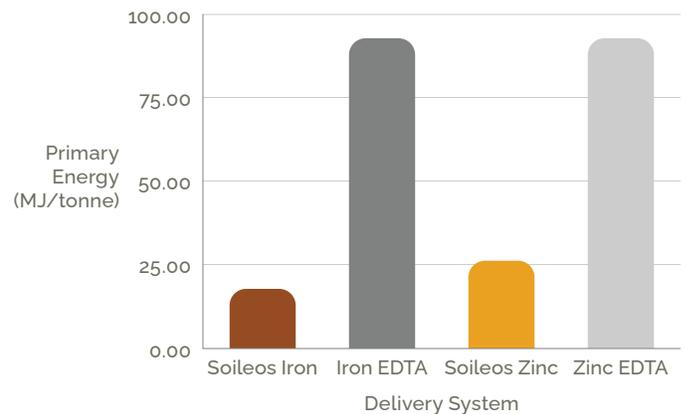


FIGURE 4.

Primary Energy from Manufacturing a Metric Tonne of Product



⁷ The Global Warming Potential metric examines the ability of each greenhouse gas to trap heat in the atmosphere. The higher the GWP, the more heat a specific gas can keep in the atmosphere.

⁸ This chart is the sum of Total Particulate Matter (TPM), Nitrogen oxide (NOx) and Sulphur oxide (SOx).

Carbon Sequestration by Design

Key Findings:

1. Soil organic carbon levels (SOC) and land use related benefits far outweigh the GHG manufacturing footprint of Soileos.
2. The degree of benefit will depend on crop, soil type, weather, etc.

What Was Measured (And Why it Matters)

The second study that Lucent Bio commissioned investigated the potential of Soileos to increase soil organic carbon levels.⁹ The greenhouse gas (GHG) Impact of redirecting food processing residuals from being used as animal feed (the base case) to manufacturing and applying Soileos Zinc (the project case) formed the basis of this study. Four scenarios were examined: soybeans grown in Ontario, corn grown in Manitoba, canola grown in central Saskatchewan, and wheat grown in central Saskatchewan.

It was found that crop production using Soileos has excellent potential for offsetting GHG emissions as a result of soil organic carbon sequestration through:¹⁰

- Increased biomass from aboveground biomass (straw)
- Root biomass resulting from increased crop yields
- Biomass from Soileos itself



WHAT THIS MEANS FOR GROWERS

- Grow More, Wastes Less
- Builds Long-term Soil Health
- Cleaner Inputs, Cleaner Fields
- Supports Your Sustainability Goals

⁹ "Exploring the Carbon Emission Offset Potential of Soileos," Viresco Solutions, Edmonton, December 2023.

¹⁰ A further benefit of Soileos use is that it increases the yields of the many crops used to produce biofuels, thereby helping reduce "food vs fuel" tensions.

DID YOU KNOW?

The benefits of applying 1 tonne of Soileos annually to canola grown in Saskatchewan is equivalent to the carbon sequestered by 150 tree seedlings grown for ten years.¹⁴

How Does Using Soileos Create GHG-Related Benefits?

Soileos is more than a carbon neutral fertilizer; it's a climate-positive crop nutrition system. Using Soileos is a climate-smart practice that can make a difference through increasing soil organic carbon levels as well as its ability to increase yields on the existing land base, thereby helping avoid negative land use changes. A GHG net benefit was determined in each scenario that was examined.

TABLE 3.
Real-World Impact: How Soileos Performs by Crop Type

GHG OFFSET POTENTIAL (t CO ₂ e / t of Soileos ¹¹)			
CROP	SOC INCREASE	LULUCF BENEFIT ¹²	TOTAL POTENTIAL GHG BENEFIT NET OF MFG. EMISSIONS ¹³
Corn Manitoba	3.3	3.7	4.6
Soybean Ontario	3.6	1.6	3.0
Canola Saskatchewan	6.2	4.1	8.0
Wheat Saskatchewan	3.7	2.7	4.3



¹¹ Assumptions (the following information was provided by Lucent Bio): Application rate of Soileos for all crops is 22.42 kg/ha; therefore, the total biomass input for every 1 tonne of Soileos application results from 44.6 hectares; based on soil carbon remaining in soils after 100 years; Normal yields for corn, soybean and canola are 10.65 t/ha, 4.31 t/ha and 2.09 t/ha, respectively; Increases resulting from Soileos application for corn, soybean and canola are 4.3%, 6.2% and 10.0%, respectively.

¹² Land Use, Land Use Change, Forestry, and also referred to as Forestry and other land use (FOLU) or Agriculture, Forestry and Other Land Use (AFOLU) is defined as a "greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use such as settlements and commercial uses, land-use change, and forestry activities". In this study, this benefit refers to the ability to increase yields of biofuel feedstocks without any additional land being converted from its natural state to agriculture to grow the same amount of crops.

¹³ This column is the sum of GHG benefits indicated less the GHGs created in making, transporting and using the Soileos on the crops in question in the identified regions, less credit for the baseline scenario; i.e., the scenario in which Soileos is not used.

¹⁴ This equivalency is based on the US EPA Greenhouse Gases Equivalencies Calculator. This calculator uses Global Warming Potentials (GWPs) reported as CO₂e and are calculated using GWPs from the Intergovernmental Panel on Climate Change's Fourth Assessment Report. They can be retrieved from: www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references#seedlings

Our Approach

Soileos is part of the mission to accelerate the transition to a climate-smart agri-food system through innovative crop input solutions that are climate-positive, non-polluting, and based on circular economy principles.

Soileos is developed in partnership with agrifood leaders to develop proprietary and custom formulations for their specific crop and environmental conditions.

Soileos is guided by principles of environmental stewardship by operating with an environmental, social and governance (ESG) strategy. Our team seeks continuous improvement by examining how we can become better value creators, suppliers, employers and partners. From cradle to gate, we are working to minimize adverse environmental impacts and maximize the value of our products.

Soileos production capacity significantly increased in 2023 with the completion of a 20 tonnes per day AGT Soileos manufacturing facility in Rosetown, Saskatchewan. This production facility will enable Soileos to be applied to 1.5 million acres of cropland annually. Partnership interest and manufacturing site development paired with grower level traction will enable Soileos and its partners to bring climate-smart agricultural tools, and their environmental benefits to the greater Agri-food industry.



Acronyms

CAC	Criteria Air Contaminant(s) - air emissions most commonly used to evaluate air quality or pollution levels.
EDTA	Ethylenediaminetetraacetic Acid , a synthetic amino acid, is widely used as a chelating agent.
GHGs	Greenhouse Gases - gases that trap heat in the atmosphere and warm the planet. The leading gases responsible for the greenhouse effect include carbon dioxide, methane, and nitrous oxide.
GWP	Global Warming Potential - a measure of the degree to which a specific compound or substance contributes to climate change.
LCA	Life Cycle Analysis - a method used to evaluate the environmental impact of a product through its life cycle, encompassing extraction and processing of raw materials, manufacturing, distribution, use, recycling, and final disposal.
LCI	Life Cycle Inventory - the data collection portion of LCA. Here the straightforward accounting of everything involved in the "system" of interest occurs.
LCIA	Life Cycle Inventory Analysis - the analysis of the data collected in the LCI.
NOx	Oxides of Nitrogen - gases known to contribute to smog and acid rain. They are typically produced from the reaction between nitrogen and oxygen during combustion.
SOx	Oxides of Sulphur - gases known to contribute to poor air quality, related health impacts, and acid rain. The combustion of fuels containing sulphur creates these oxides.
TPM	Total Particulate Matter - describes the mixture of solid particles and liquid droplets in the air. TPM includes soot, dust, dirt, smoke and can be emitted by industrial operations, fossil fuel combustion, fires, etc.
VOC	Volatile Organic Compounds - these carbon-containing chemicals have compositions that enable them to evaporate under normal indoor atmospheric pressure and temperature. VOCs are part of the photochemical reaction that leads to smog formation and, on their own, can adversely impact human health.

Appendix

About This Whitepaper

This whitepaper on environmental benefits expresses our commitment to continuous improvement. As a data-first company, we value transparency and disclosure as the groundwork for presenting our commitments to our stakeholders.

A Note About Results

The benefits described in this paper are predicated on an annual application of Soileos.

The values in this paper are illustrative. The degree of environmental benefit achieved will vary by such factors as crop type, soil type, other fertilizer treatments, weather, etc..

The complete Viresco and SAISS reports are not available to the public due to the proprietary nature of Lucent Bio's manufacturing process. If you wish to have a more in-depth discussion about any of the attributes of Soileos presented here, please [contact us](#) directly.

Reporting Period

Data presented in this paper reflect activities from Spring 2021 to January 2024.



Supporting Data

TABLE 4

SAISS Life Cycle Inventory Analysis Results

Production of zinc and iron delivery systems (Cradle-to-Gate) per tonne fertilizer compared to EDTA-based products

INDICATOR	SOILEOS ZINC	SOILEOS IRON	ZINC EDTA	IRON EDTA	SOILEOS ZINC BENEFITS vs ZINC EDTA	SOILEOS IRON BENEFITS vs IRON EDTA
GWP (kg CO ₂ -e/tonne)	1,653	990	5,936	5,858	4,283	4,868
CAC (kg/tonne)						
SOx	2.92	2.37	9.77	11.60	6.85	9.23
NOx	1.85	1.30	8.33	8.36	6.48	7.06
TPM	0.72	0.31	2.26	1.92	1.54	1.61
CO	0.52	0.27	3.48	6.21	2.96	5.94
VOC	0.12	0.06	0.68	1.06	0.56	1.00
Primary Energy (MJ/tonne)						
Renewable	6,377	5,956	1,514	1,981	-4,862	-3,975
Non-Renewable	20,215	12,314	88,838	88,976	68,623	76,662
Total	26,592	18,270	90,353	90,957	63,761	72,687
Water (m ³ /tonne)	8.41	8.40	12.9	11.1	4.44	2.69

TABLE 5

Summary of the Total Biomass Input Source Due to the Increased Crop Yields

LOCATION	CROP	INCREASE YIELD AND BIOMASS (T/ha)				
		YIELD	STRAW	ROOT BIOMASS	SOILEOS	TOTAL
Manitoba	Corn	0.463	0.769	0.150	0.017	1.399
Ontario	Soybean	0.267	0.912	0.250	0.017	1.445
Saskatchewan	Canola	0.210	0.897	0.150	0.017	1.274
Saskatchewan	Wheat	0.132	0.250	0.058	0.008	0.316

Ready to Grow More, Sustainably?

Visit www.soileos.com or talk to your local retailer to learn how Soileos can help your farm.