

April 2024

# The Environmental Footprint of Soileos



Lucent Bio



# Science Driven. Field Proven. Bio-Activated.

Increase microbial activity with Soileos bio-available crop nutrition

## TABLE OF CONTENTS

Executive Summary	3
Sustainable Solutions for Agriculture	4
We Have a Plan	4
Emissions Reductions Across the Entire Value Chain	4
Good for the Grower and Good for the Environment	6
Expert Input	7
Environmental Footprint Analysis	8
Assessment Scope	8
How Does Soileos Stack Up to Conventional Products?	9
Carbon Emission Offset Potential	10
Assessment Scope	10
How Does Using Soileos Create GHG-Related Benefits?	11
Our Approach	12
Acronyms	13
Appendix	14
About This Whitepaper	14
Caveats	14
Reporting Period	14
Performance Data	15

## Executive Summary

Lucent BioSciences, Inc. (“Lucent Bio”) is on a mission to accelerate the transition to a sustainable agri-food system through innovative crop input solutions that are climate-positive, non-polluting, and based on circular economy principles.

Lucent Bio's flagship product—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. The net result is higher crop yields, improved nutrient density, and healthier soils.

Lucent Bio contracted two independent consulting firms, Viresco Solutions and SAISS Consulting, 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.<sup>1</sup>



Soileos Pellets

### 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 does 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.

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<sup>2</sup>, 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.



## Sustainable Solutions for Agriculture

### We Have a Plan

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.

Vancouver-based Lucent Bio is looking to help mitigate these challenges by delivering a climate-positive and bio-activated crop nutrition system that improves yield and soil health while increasing soil carbon levels.



**Soileos**

### Emissions Reductions Across the Entire Value Chain

Innovation at Lucent Bio focuses on how we can better use resources and minimize 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 nutrient delivery system for the agriculture industry.

Lucent Bio's flagship product—Soileos®—is a soil-applied, climate-smart, crop nutrition solution. It enhances yields, crop resilience, and soil health with on-time nutrient delivery and sustained nutrient bioavailability, allowing the crop to maximize its genetic potential. Our 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 or lentil hulls or rice husks. 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 promotes the activity and growth of the microbiome. Research conducted by Lucent Bio 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.





## Good for the Grower, Good for the Environment

Soileos delivers climate-positive crop nutrition, enabling growers to enhance short-term profitability while facilitating long-term stewardship of farmland and natural resources. With Soileos, growers don't have to choose between profitability and sustainability. By adopting Soileos, growers cultivate an environmentally sound bottom line. Strategically designed to increase yields without contributing to run-off pollution, Soileos remains in the soil for long-term benefits that boost return on investment (ROI).

In addition, the efficacy of Soileos in enhancing yields has been validated through extensive field trials across diverse agricultural landscapes. These trials consistently demonstrate significant yield increases, providing growers with tangible evidence of Soileos' effectiveness in optimizing crop productivity while enhancing environmental responsibility.

**TABLE 1.**  
Field Proven: 3 years of field trials demonstrated yield increases

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

# 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.





## Expert Input



Lucent Bio contracted two independent consulting firms, Viresco Solutions and SAISS Consulting, to provide insight into the carbon emissions offset potential of using Soileos Zinc and the environmental footprint of manufacturing Soileos Zinc<sup>3</sup> and Soileos Iron.<sup>5</sup> 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 soy 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.<sup>6</sup> 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 the impact of products such as Soileos.

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

<sup>4</sup> "Streamlined Greenhouse Gas Assessment for Soileos". Viresco Solutions, Edmonton, December 2023.

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

<sup>6</sup> 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>



# Environmental Footprint Analysis

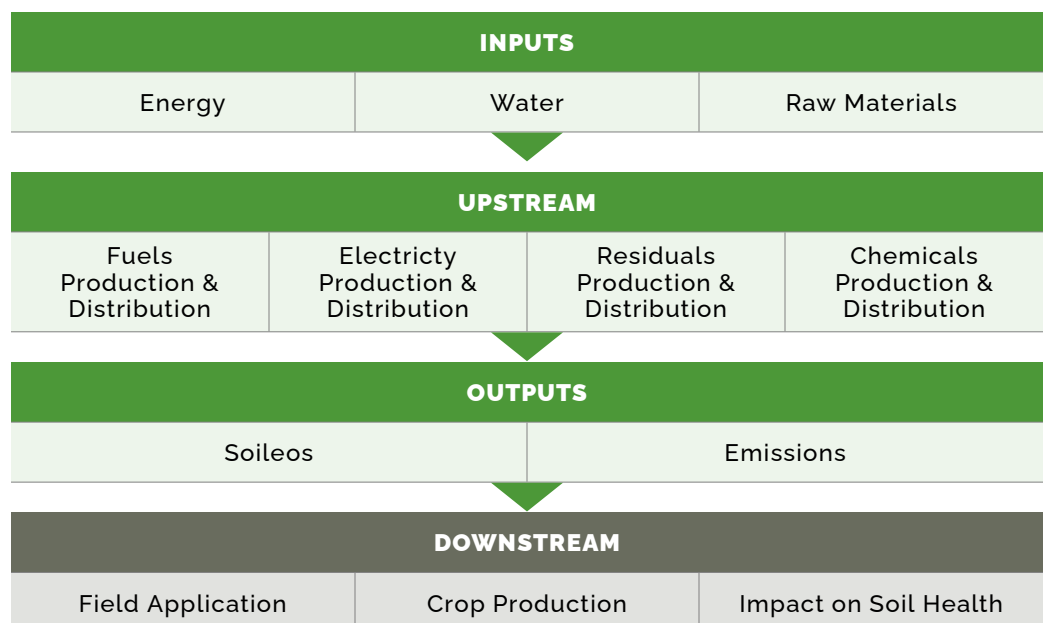
## Key Findings:

1. The environmental footprint of manufacturing Soileos Zinc is estimated to be 1.6 t CO<sub>2</sub>e/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 CO<sub>2</sub>e/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

## Assessment Scope

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**



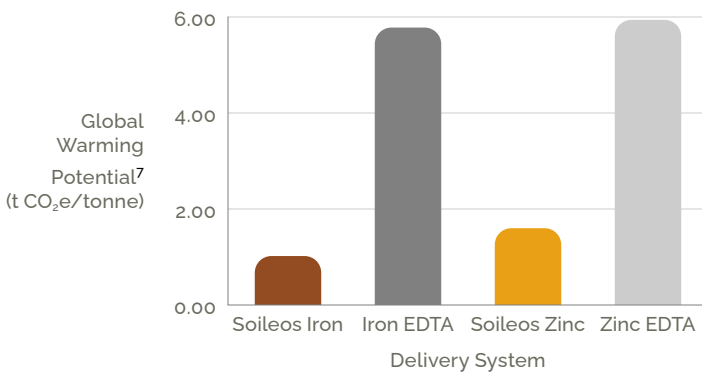
Soileos is an innovative crop nutrient delivery system that solves current micronutrient delivery problems while improving soil health. The proprietary technology behind the Soileos crop nutrition system binds nutrients such as zinc, iron, and manganese to the cellulose fibre replacing the need for synthetic 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

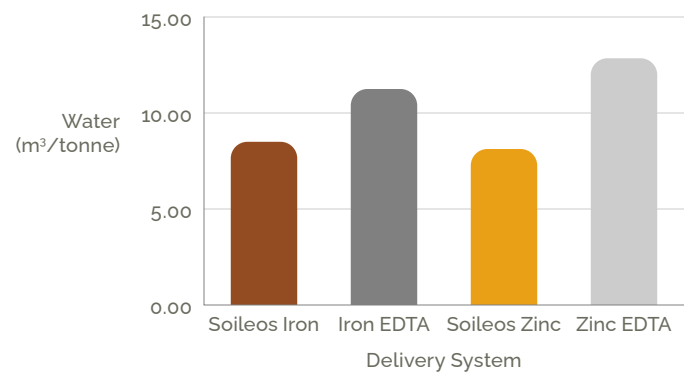
**FIGURE 1.**

GHG Footprint from Manufacturing a Metric Tonne of Product



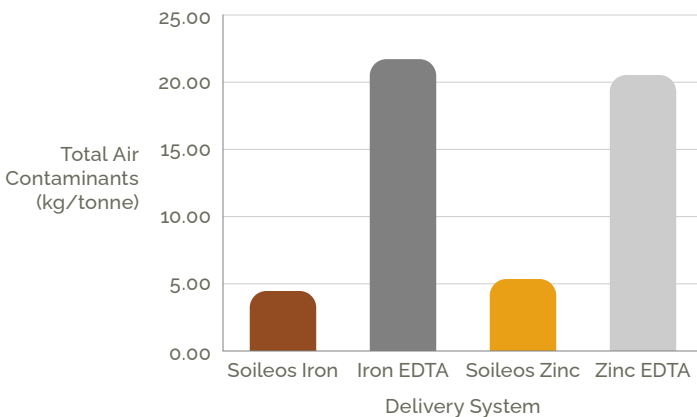
**FIGURE 2.**

Water Use from Manufacturing a Metric Tonne of Product



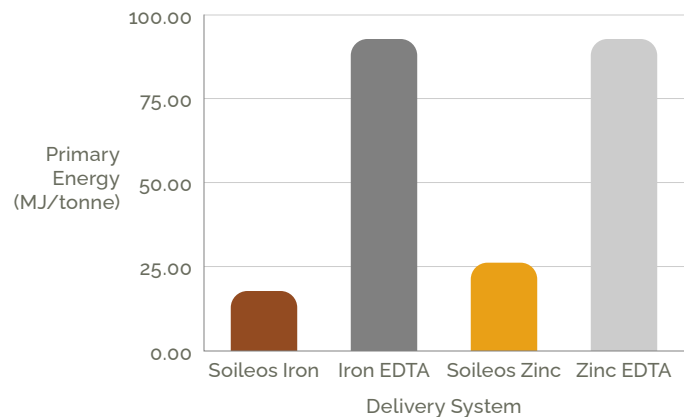
**FIGURE 3.**

Total Air Contaminants from Manufacturing a Metric Tonne of Product<sup>8</sup>



**FIGURE 4.**

Primary Energy from Manufacturing a Metric Tonne of Product



<sup>7</sup> 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.

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

# Carbon Emission Offset Potential

## 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.

## Assessment Scope

The second study that Lucent Bio commissioned investigated the potential of Soileos to increase soil organic carbon levels.<sup>9</sup> 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 the Soileos delivery system has excellent potential for offsetting GHG emissions as a result of soil organic carbon sequestration through<sup>10</sup>:

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



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

<sup>10</sup> 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.<sup>14</sup>

## 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 creates significant climate change related benefits 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 occurred in each crop/location scenario that was examined.

**TABLE 3.**  
**GHG Offset Potential of Soileos by Crop Type**

GHG OFFSET POTENTIAL (t CO <sub>2</sub> e / t of Soileos <sup>11</sup> )			
CROP	SOC INCREASE	LULUCF BENEFIT <sup>12</sup>	TOTAL POTENTIAL GHG BENEFIT NET OF MFG. EMISSIONS <sup>13</sup>
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



<sup>11</sup> 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.

<sup>12</sup> 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.

<sup>13</sup> 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.

<sup>14</sup> This equivalency is based on the US EPA Greenhouse Gases Equivalencies Calculator. This calculator uses Global Warming Potentials (GWPs) reported as CO<sub>2</sub>e 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](http://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references#seedlings)

## Our Approach

Lucent Bio is on a 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.

Lucent Bio works with industry partners to develop proprietary and custom formulations for their specific crop and environmental conditions.

Lucent Bio demonstrates stewardship of all resources 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 the new 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. Partnership interest and manufacturing site development paired with grower level traction will enable Lucent Bio and its partners to bring climate-smart agricultural tools, and their environmental benefits to the greater Agri-food industry.



## Acronyms

<b>CAC</b>	<b>Criteria Air Contaminant(s)</b> - air emissions most commonly used to evaluate air quality or pollution levels.
<b>EDTA</b>	<b>Ethylenediaminetetraacetic Acid</b> , a synthetic amino acid, is widely used as a chelating agent.
<b>GHGs</b>	<b>Greenhouse Gases</b> - 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.
<b>GWP</b>	<b>Global Warming Potential</b> - a measure of the degree to which a specific compound or substance contributes to climate change.
<b>LCA</b>	<b>Life Cycle Analysis</b> - 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.
<b>LCI</b>	<b>Life Cycle Inventory</b> - the data collection portion of LCA. Here the straightforward accounting of everything involved in the "system" of interest occurs.
<b>LCIA</b>	<b>Life Cycle Inventory Analysis</b> - the analysis of the data collected in the LCI.
<b>NOx</b>	<b>Oxides of Nitrogen</b> - gases known to contribute to smog and acid rain. They are typically produced from the reaction between nitrogen and oxygen during combustion.
<b>SOx</b>	<b>Oxides of Sulphur</b> - gases known to contribute to poor air quality, related health impacts, and acid rain. The combustion of fuels containing sulphur creates these oxides.
<b>TPM</b>	<b>Total Particulate Matter</b> - 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.
<b>VOC</b>	<b>Volatile Organic Compounds</b> - 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.

## Caveats

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 <sub>2</sub> -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 <sup>3</sup> /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