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# Lucent Bio &
# A Circular Future

Lucent Bio


# Science Driven. Field Proven. Bio-Activated.

## Increase microbial biomass with Soileos bio-available micronutrients

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Lucent Bio delivers solutions for crop nutrition that accelerate the transformation of agriculture to sustainability.

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## Executive Summary

Reducing the impact of agriculture requires nothing less than a complete systematic change from our primarily linear economy to a circular one. This whitepaper aims to educate about and support the transition to a circular and sustainable agri-food sector.

A circular economy is a robust way to reach climate action targets because it has a smaller environmental impact while providing the agri-food sector with resiliency and greater profits.

Transitioning the agri-food sector into a circular model is an intricate and multifaceted challenge. It requires innovations in technology, products, practices, business, and sociocultural attitudes. Global climate action policy and plans such as the European Union's *Green Deal and Canada's Healthy Environment and a Healthy Economy* have developed aggressive targets that aim for net-zero emissions by 2050. These targets will have to be met at the same time as food security needs to be increased for a growing population. And producing more food needs to done with an ever-decreasing environmental impact.

A circular economy is a robust way to reach climate action targets because it has a smaller environmental impact while providing the agri-food sector with resiliency and greater profits. But how does this method become mainstream? Recommended strategies include understanding and utilizing our planet's natural technology, an approach that has roots in past farming techniques but is being amplified through innovation and modern technologies. Specifically, by using natural and renewable materials, circular agriculture and food systems could also prevent, recover, or repurpose waste.

Lucent Bio's flagship technology—Soileos®—supports this strategy using biomimicry, an approach to innovation where sustainable solutions emulate natural systems. Our technology allows agricultural practices that are more regenerative than conventional approaches to nutrient delivery.

Lucent Bio is taking steps to achieve a sustainable, circular management of resources by focusing on healthy soils, leveraging demand power, collaborating with farmers, and taking a holistic systems level approach to the supply chain. This has been done by developing a clean manufacturing process that upcycles agriculture and food processing cellulose-rich co-products into a sustainable source of crop nutrients. Soileos®, a plant based bioactivated fertilizer, has been formulated to be stable in the soil, increase nutrient bioavailability and minimize fertilizer negative environmental impacts such as groundwater pollution. Soileos® is positioned to replace less effective and polluting fertilizers with non-polluting, sustainable alternatives that increase yields; improve crop nutrient density and flavor; improve soil health; and increase soil carbon levels.

## Setting the Scene

Circular strategies can create long term success for business, contribute to a community's ability to thrive, and help tackle some of the world's most pressing problems by cutting excessive material consumption, and by repurposing and upcycling resources.

For over a century, modern industrial practices have created adverse environmental impacts, including over exploitation of natural resources; soil and water pollution; land use changes; biodiversity loss; and excessive greenhouse gas (GHG) emissions.[1] In the upcoming decades there are going to be profound changes in global food systems. The International Panel on Climate Change (IPCC) warns that by midcentury the world may reach "a threshold of global warming beyond which current agricultural practices can no longer support large human civilizations."[2] Impacts of climate change on agricultural systems—such as higher temperatures and changes in global precipitation patterns—will increase the likelihood of decreased crop yields and increased weeds and pests.[3] Another formidable challenge is that global food production will need to increase by an estimated 60-70% by 2050 in order to feed an additional 2 billion people with adequate levels of nutrition.[4] And because developing countries will have the largest population increases, these regions in particular will have to double their production.

These challenges invite innovation and provide opportunities to develop circular economy solutions to address them.

According to the United Nations, extraction and processing of natural resources are responsible for around half of all global GHG emissions and over 90% of global biodiversity loss and water stress.[5] Current linear economy approaches are widespread and can be categorized as "take-make-waste". That is, resources are often extracted for a single use or purpose, and then disposed of.

However, companies like Lucent Bio envision economic approaches where products are designed to restore and protect the natural world instead of degrading it. Circular strategies can create long term success for business, contribute to a community's ability to thrive, and help tackle some of the world's most pressing problems by cutting excessive material consumption, and by repurposing and upcycling resources.[6]

# Circular Economy—Solutions to Global Challenges

## What is the Circular Economy?

The Circular Economy (CE) model is recognized as the way for businesses to implement sustainable development [7] [8] and ultimately achieve sustainability[9], but what does it actually mean? It turns out that there are almost as many definitions for CE as there are researchers in this space (which constitutes a serious challenge for scholars).

From an extensive review, a comprehensive, albeit wordy, definition comes from Kirchherr et al. (2017). They defined the CE "as an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling, and recovering materials in production/distribution and consumption processes... with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity, and social equity, to the benefit of current and future generations. It is enabled by novel business models and responsible consumers."[10]

The Ellen Macarthur Foundation, a leader in the transition to a CE, shortens this definition to "a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution."

Fundamental to the CE is long-term thinking that seeks the "optimization of resource yields by keeping materials in use for the longest possible technical and biological cycles."[11] In this way, the CE is positioned as an approach that alleviates stress on the environment while generating economic gains. Both policy and technological changes will be needed to truly advance the CE.

## Take-Make-Waste vs Reduce-Reuse-Recycle-Renew

The linear and circular economy models are fundamentally different; transitioning from linear to circular requires more than just recycling or incremental tweaking of the current system to close the loop.[12] Current linear economic approaches have short term vision, and do not fully consider the longer-term maintenance of resources, either physically or economically. In contrast, circularity looks at long term, multiple life cycles. Economic evolution from linear to circular is a vitally necessary paradigm shift that "changes the way in which value is created and preserved, how production is made more sustainable and which business models are used."[13]

## Pillars of Sustainable Development

Successful implementation of the CE will need to take a holistic view, examining each of environmental quality, economic prosperity, and social equity—the three dimensions of sustainability.

Sustainability is typically understood as meeting the needs of the present without compromising the future. Successful implementation of the CE will need to take a holistic view, examining each of environmental quality, economic prosperity, and social equity—the three dimensions of sustainability. "The CE model aims to contribute to the sustainable development of countries and regions by increasing the offer and use of renewable sources, the replacement of natural resources with secondary materials, the use of clean technologies, and more efficient processes and other actions oriented towards the reduction of emissions and waste, decreasing the impact on the environment."[14] A CE understanding that fails to incorporate all three pillars of sustainable development can result in CE implementation that is not sustainable."[15]

Innovative companies and forward-thinking managers are finding ways to increase the degree of circularity in their businesses. The circular economy is how society can make capitalism regenerative. Regenerative capitalism refers to business practices that restore and build rather than exploit and destroy and goes beyond net-zero emissions to a net-positive impact on the planet.

## Circular Policy

Circularity offers many advantages, but it does require facilitating policies to be in place if CE-related benefits are to be realized. Many countries are aware of this and are rolling out circular strategies and sustainable agenda. However, there needs to be more industry-academia-government collaboration and programs that effectively support innovative cleantech solutions, that scaleup activities, and that fill in policy gaps.

The European Union's (EU) *Green Deal*, for example, is an economic growth strategy that will reform current linear practices into sustainable—circular—ones. It is "an ambitious package of measures ranging from ambitiously cutting greenhouse gas emissions, to investing in cutting-edge research and innovation, to preserving Europe's natural environment."[16] This initiative seeks to transform Europe into the first climate neutral continent by 2050.

" ... Like the bioeconomy, circular agriculture and agri-food uses biological and renewable materials, but further seeks to also prevent, recover, or repurpose waste."

*—Smart Prosperity Institute*

Canada is not as far along the path to a circular economy as is the EU but has taken some recent steps. First, it hosted the World Circular Economy Forum in 2021, the first time the WCEF has been held in North America.

In 2020, Environment and Climate Change Canada asked the Canadian Council of Academies (CCA) to "examine the potential economic, environmental, and social impacts of advancing a circular economy in Canada."[17] The CCA released its report, "Turning Point", in late 2021. One of the Panel's recommendations was for Canada to strive to achieve circular agriculture. "The interconnected infrastructure of food systems makes this sector particularly suited to a CE, not only because CE principles are highly applicable to food waste but because food systems readily lend themselves to a framework focusing on communities and relationships."[18]

We need our food system to provide sufficient healthy, accessible food for everyone. But how does the Agri-food sector get there in a circular way? The Ellen Macarthur Foundation recommends:

> "[A strategy] that recognizes the complexity and resilience of our planet's 'natural technology,' the mechanisms and processes that have produced our rich and fertile rainforests, forests, and grasslands. Such a path could not only feed our growing human population with diverse and high-quality food, but do so in a way that rebuilds, rather than degrades ecosystems, and helps reverse catastrophic climate change. This approach is called 'regenerative agriculture'"—Ellen Macarthur Foundation

> "Regenerative agriculture is a key pillar of circular agriculture, however circular agriculture and agri-food also includes the processing, distribution and consumption, disposal, and recovery of food. Like the bioeconomy, circular agriculture and agri-food uses biological and renewable materials, but further seeks to also prevent, recover, or repurpose waste."[19]—Smart Prosperity Institute

Lucent Bio's bioactive fertilizer technology supports this strategy fully by working with nature to help nature. Our technology allows agricultural practices to depart from extractive activities that withdraw from earth systems and instead invest in endeavors that strengthen them. Our tech has three main regenerative outcomes:

1. Produce more high-quality food
2. Improve agricultural and the surrounding ecosystems
3. Support on farm profitability with decreased input costs and larger return on investments

Another important Canadian policy document is *Healthy Environment and a Healthy Economy*.[20] In this document, Canada pledges to reduce emissions from fertilizer by 30% below 2020 levels. Fertilizer Canada says that the fertilizer industry has a significant role in "the government's target to net-zero emissions by 2050 and reaching $75 billion in agri-food and seafood exports by 2025."[21]

Canada pledges to reduce emissions from fertilizer by

**30%**

below 2020 levels


**FIGURE 1.**
Agricultural lands in Canada—where the effects of a 30% emissions reduction will hit the hardest.

Small and medium-sized enterprises account for approximately

**99%**

of all firms, contribute to about

**70%**

of total employment

Associations like Fertilizer Canada are observing gaps in national policy and creating solutions that support the goals of reducing greenhouse gas emissions and increasing the efficiency of agricultural practices. For example, the 4R framework is a tool to measure sustainable nutrient management—it has been endorsed by The Food and Agriculture Organization (FAO), the United Nations Global Compact, the World Business Council, and the International Joint Commission. The 4R framework is a data driven method of applying the Right Source of fertilizer at the Right Rate, Right Time, and Right Place. 4R Nutrient Stewardship is "an innovative solution to support the government's agricultural goals of reducing greenhouse gas emissions and increasing the efficiency of agricultural practices for enhanced food production."[20] Where policy gaps exist, initiatives such as the 4R Nutrient Stewardship framework enable farmers to positively contribute to Canada's commitment to sustainable agriculture.

Small and medium-sized enterprises (SMEs) are key to the success of sustainable agendas. They account for approximately 99% of all firms, contribute to about 70% of total employment and are "major contributors to value creation, generating between 50% and 60% of value added on average".[21] Innovative and high growth SMEs like Lucent Bio help sustainable agendas achieve a modernized industry with a circular—future proof—business model for a fair and healthy agro-food system.

# Lucent Bio—A Circular Bio-Based Business Model

Lucent Bio adopts a holistic management approach that regenerate the value of utilized resources, support climate action plans, and expedite new regulations.

Lucent Bio's flagship product—Soileos®—boosts nutrient density in crops, regenerates soil, does not pollute agro-ecosystems, and is a part of the circular economy. Soileos® upcycles food processing co-products into bioactive nutrients that then create the next harvest.

This technology addresses four important UN sustainable development goals: Goal 2—Zero Hunger, Goal 12-Responsible Consumption and Production, Goal 13—Climate Action, and Goal 15—Life on Land. Lucent Bio wants to place farmers on the forefront of economic evolution and help them lead the transition to more sustainable agriculture.


**GOAL 2**
ZERO HUNGER

End hunger, achieve food security and improved nutrition and promote sustainable agriculture.


**GOAL 12**
RESPONSIBLE CONSUMPTION & PRODUCTION

Ensure sustainable consumption and production patterns.


**GOAL 15**
LIFE ON LAND

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.


**GOAL 13**
CLIMATE ACTION

Take urgent action to combat climate change and its impacts.

## Let's Break Down Lucent Bio's CE Oriented Innovation:

### Circular Bio-Based Business Models

Lucent Bio's business model builds resilience between companies in the agri-food sector by regenerating and reevaluating how agricultural co-products are used. Support from Protein Industries Canada streamlined the industrial symbiosis-based connection between Lucent Bio with global companies like AGT Food and Ingredients. This is a truly circular economy model, where lower value cellulose is converted into a high value bioactive fertilizer or fertilizer ingredient which can be used as a standalone pellet, or a formulant to existing soil amendment, fertilizer, and seed coating companies.

By reframing low value food processing co-products into a higher value resource, we create more value and an avenue for growers to improve their ROI at the same time as lead the transformation of agriculture to sustainability.

| BENEFITS TO PROCESSORS | BENEFITS TO FARMERS |
|---|---|
| • Low value co-products can be converted into a high revenue stream<br>• Sustainable fertilizer that increases yield and nutrient density for the farms they work with | • Increases crop yield<br>• Provides an ROI of 3X or better<br>• Improves microbial biomass<br>• Increases soil organic carbon<br>• Doesn't tie up in soils<br>• Low salt index<br>• Works in alkaline soils |

Soileos

## Product Design

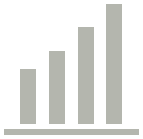
Soileos® is designed with effective residual management to produce zero wastewater and zero waste chemicals.

Lucent Bio has developed a clean manufacturing process that upcycles agriculture and food processing cellulose-rich co-products into a sustainable source of crop nutrients. Soileos®, a plant-based fertilizer, has been formulated to be stable in the soil, to increase nutrient bioavailability, and to minimize such negative environmental stresses as groundwater pollution. And Soileos® is positioned to replace less effective and polluting fertilizers with non-polluting, sustainable alternatives that increase yields; improve crop nutrient density and flavor; improve soil health; and increase soil carbon levels.

Lucent is using the following CE principles to design out waste:

- Using biomimicry and innovating based on natural design
- Maximizing resource efficiency by favoring local resources—waste as income
- Adopting the cradle-to-cradle approach to ensure eco-effectiveness
- Practicing Industrial symbiosis and eradicating the idea of a 'waste-product'
- Reinvesting in natural capitalism—closing the loop on systems
- Supporting regenerative design—reusing materials, managing carbon, ensure water stewardship and social equity






**ENVIRONMENT = PROTECTED, FARMS = REGENERATIVE, ECONOMIES = CIRCULAR**

## Sustainable Materials

Innovation at Lucent Bio focuses on how we can make better use of resources and become a catalyst in the industry. Before Lucent Bio, our partner AGT Foods sent their pulse fiber to be used as an ingredient in pet and livestock food.—Lucent Bio's use for the pulse fiber is a better option because more value is created through making Soileos! As stated earlier, increased resource efficiency is a major trait of the CE. Our technology not only optimizes how co-products are used but we also close the loop; Environment = protected, Farms = regenerative, Economies = circular.

## Social Sustainability

Lucent Bio creates an avenue for the agri-food community to enhance their environmental stewardship, improve their resource management, and become leaders in regenerative agriculture.

Lucent Bio creates an avenue for the agri-food community to enhance their environmental stewardship, improve their resource management, and become leaders in regenerative agriculture. Our tech is made to support farmers with data-driven decisions to help them be more profitable and contribute to climate change mitigation. And our facilities operate in keeping with Lucent Bio's philosophy of meaningful work, equal opportunity, and promote inclusive value chains.

Another circular aspect of our business relates to the construction of our first commercial scale manufacturing facility, slated to commence operations in rural Saskatchewan in late 2022. Rather than building an entirely new facility, Lucent Bio, and our partner, AGT, will be repurposing an idle pulse depot, including the reuse of a great deal of existing equipment and storage facilities. By reusing steel, we can decrease the GHG impact of scaling up our manufacturing. Currently the steel industry is among the top three largest producers of carbon dioxide—every ton of steel produced emits on average 1.85 tons of carbon dioxide.[22]

The transition to a CE cannot be done immediately as it involves a shift in thinking and culture—this is where the challenges lie. Through the use of our technology, the agri-food sector has an opportunity to increase crop yields to satisfy the needs of a growing world, improve soil health, increase the nutritional quality of crops, and improve ROIs for both food processors and farmers. Lucent fully expects that such compelling circularity-based benefits will accelerate the shift to more sustainable agriculture and mainstream nature positive food.

# Endnotes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