Regenerative Product Systems

December 4, 2019

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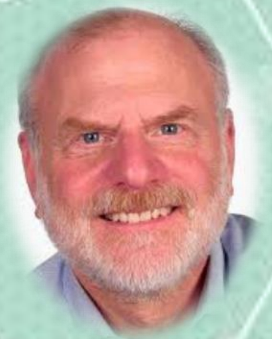

Arlan Peters, Head of Sustainability, Novozymes North America

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Framework for the design of regenerative product systems

Presented by Martin Wolf

BizNGO Webinar

4 December 2019

Outline

- Introduction
- Some definitions
- Product systems
- Ecosystems
- The Regenerative Factor
- A framework for regenerative systems
- Conclusions & Discussion

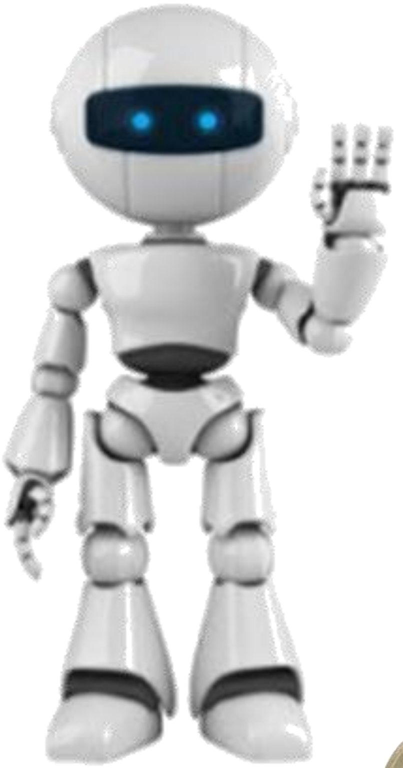
Definitions

- Impact – an effect on the environment
- Sustainability – meeting the needs of the present without compromising the ability of future generations to meet their own needs – Brundtland
- Restoration – return of a damaged system to a prior functional state –
- Regeneration – autonomous return of a damaged system to a prior functional state
- Evolution – gradual, progressive change usually making systems more diverse & resilient

Definitions

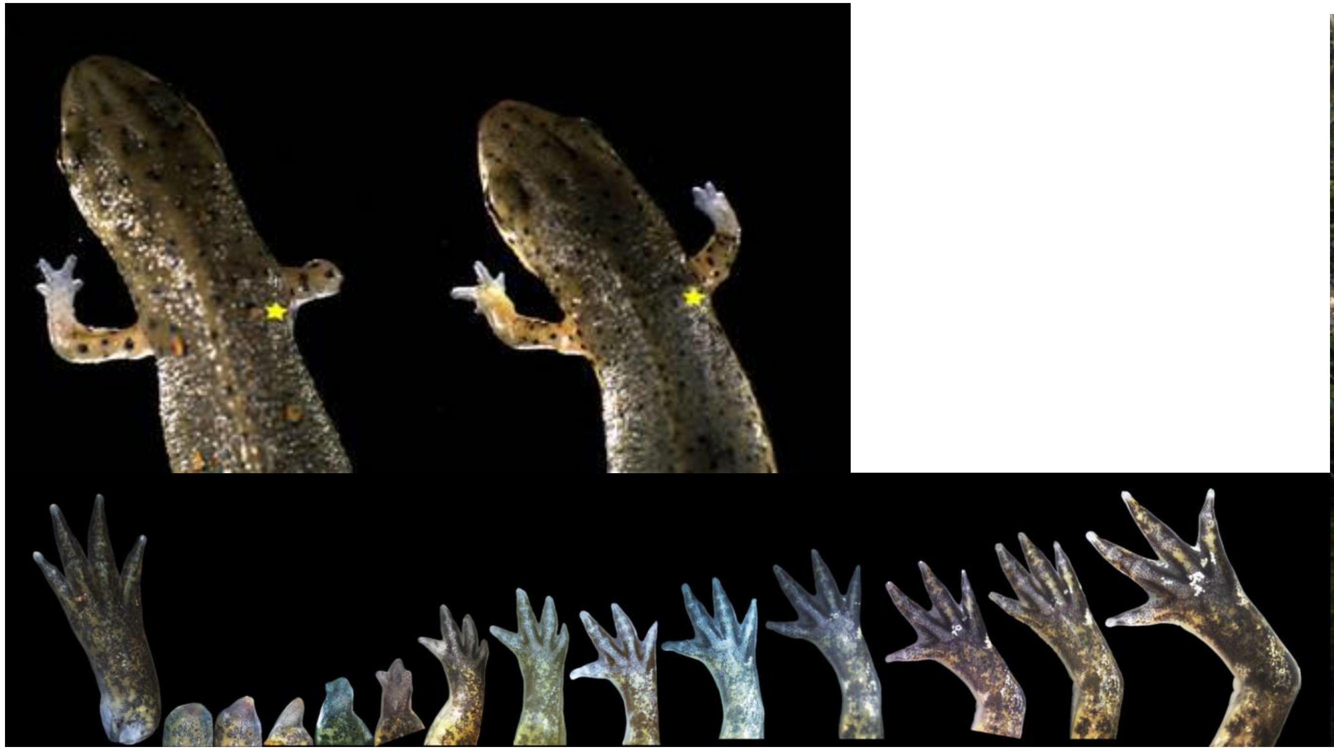
- System - a set of objects and processes that together perform a function not obtainable by the objects and processes alone
  - Closed system - a system whose elements, including all mass and energy flows, lie within a boundary
  - Open system - a system whose elements lie within a boundary that allows mass and energy flows across the boundary
- Product - a substance or article that is grown, processed, or manufactured to serve a purpose
- Product system – a set of objects and processes that together function to produce a product or service

Can A Product Be Regenerative?

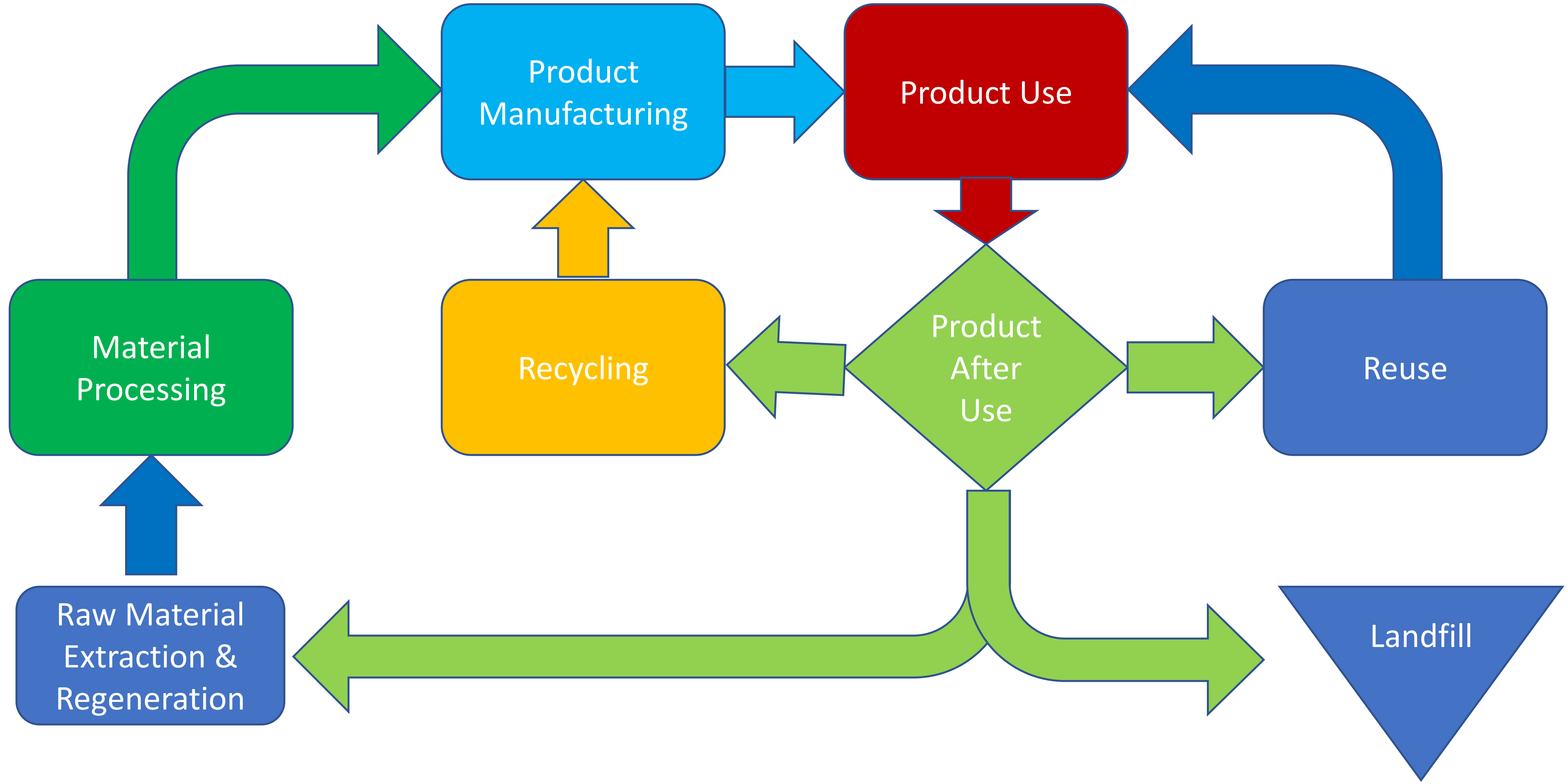


Can a Product System Be Regenerative?

- Living systems can be Regenerative.
- By incorporating a living system a product system can be Regenerative (but usually isn't)

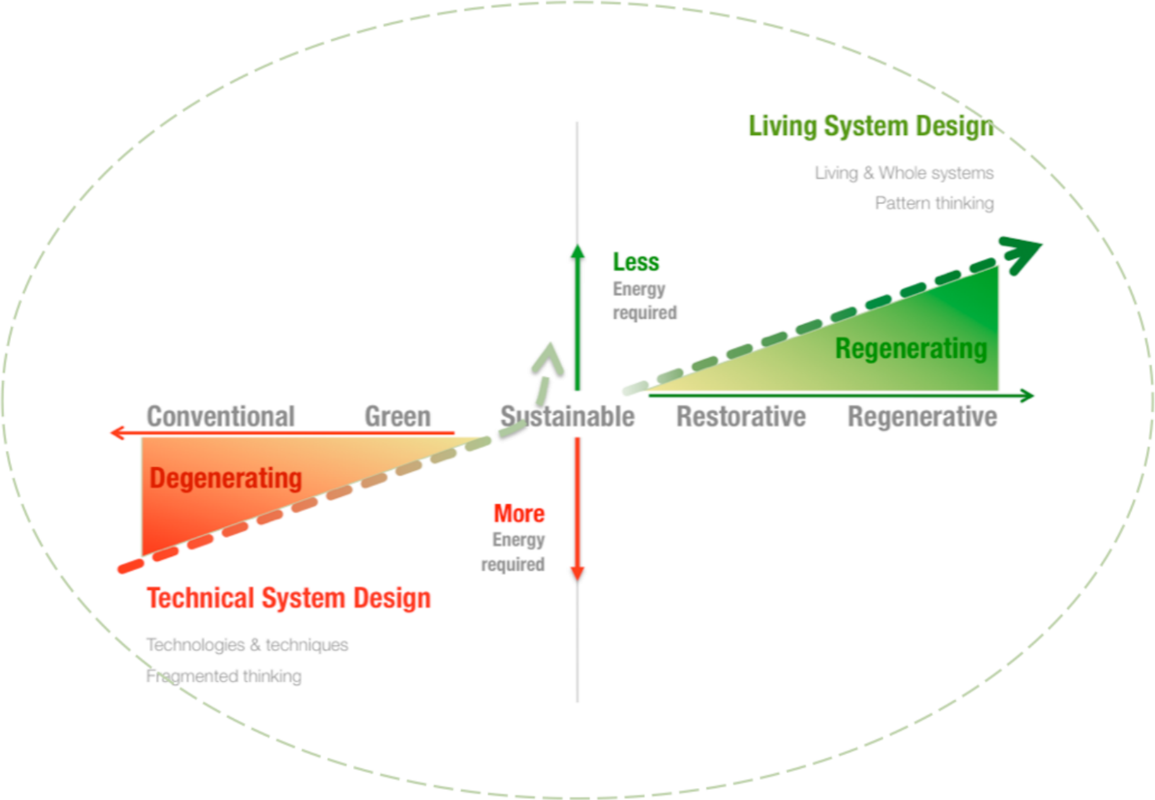


Product System – Zero Waste & Regeneration



Elements of a Regenerative System

- Abiotic resource depletion
- Biodiversity
- Carbon sequestration
- Hydrogeology
- Land Use
- Connectivity



McKay S. K., I. Linkov, J. C. Fischenich, S. J. Miller, and J. Valverde 2012. *Ecosystem restoration objectives and metrics*. EBA Technical Notes Collection. ERDC TN-EMRRP-EBA-12-16. Vicksburg, MS: U.S. Army Engineer Research and Development Center. *http://cw-environment.usace.army.mil/eba/*

Metrics of a Regenerative Product System

ELEMENT	METRIC
Abiotic Resource Depletion	MJ (fossil fuel eq.) [1]
Biodiversity	Species per hectare (micro and macro flora and fauna) relative to undisturbed area [2]
Carbon Sequestration	Kg CO_2 eq. [3]
Hydrogeology	Water surface area and flow relative to undisturbed area [4]
Land Use	Percent (fraction) undisturbed area [5]
Connectivity	Buffer radius and incidence function [6]

Calculating a Regeneration Factor

Using The Harmonic Mean

- Given the set of n factors, x_1, x_2,…x_n, with weights w_1, w_2,…w_n, respectively, the Regeneration Factor, RF_w, is calculated as:

$$RF_w = 1 - \frac{w_1 + w_2 + \cdots + wn}{\frac{w_1}{x_1} + \frac{w_2}{x_2} + \cdots + \frac{w_n}{x_n}}$$

- where the factors, x_1, x_2,…x_n, are the impacts that must be corrected to restore the system:

x_1 = GHG emissions (kg CO2eq.)

x_2 = Fossil feedstock depletion (kg petroleum)

x_n = n^{th} impact factor

Metric: The Regeneration Factor

- Defined by a Regenerative Factor (RF)
- RF = 1 + "Quality" Factor

RF < 1
System is being harmed by factors inhibiting full regeneration

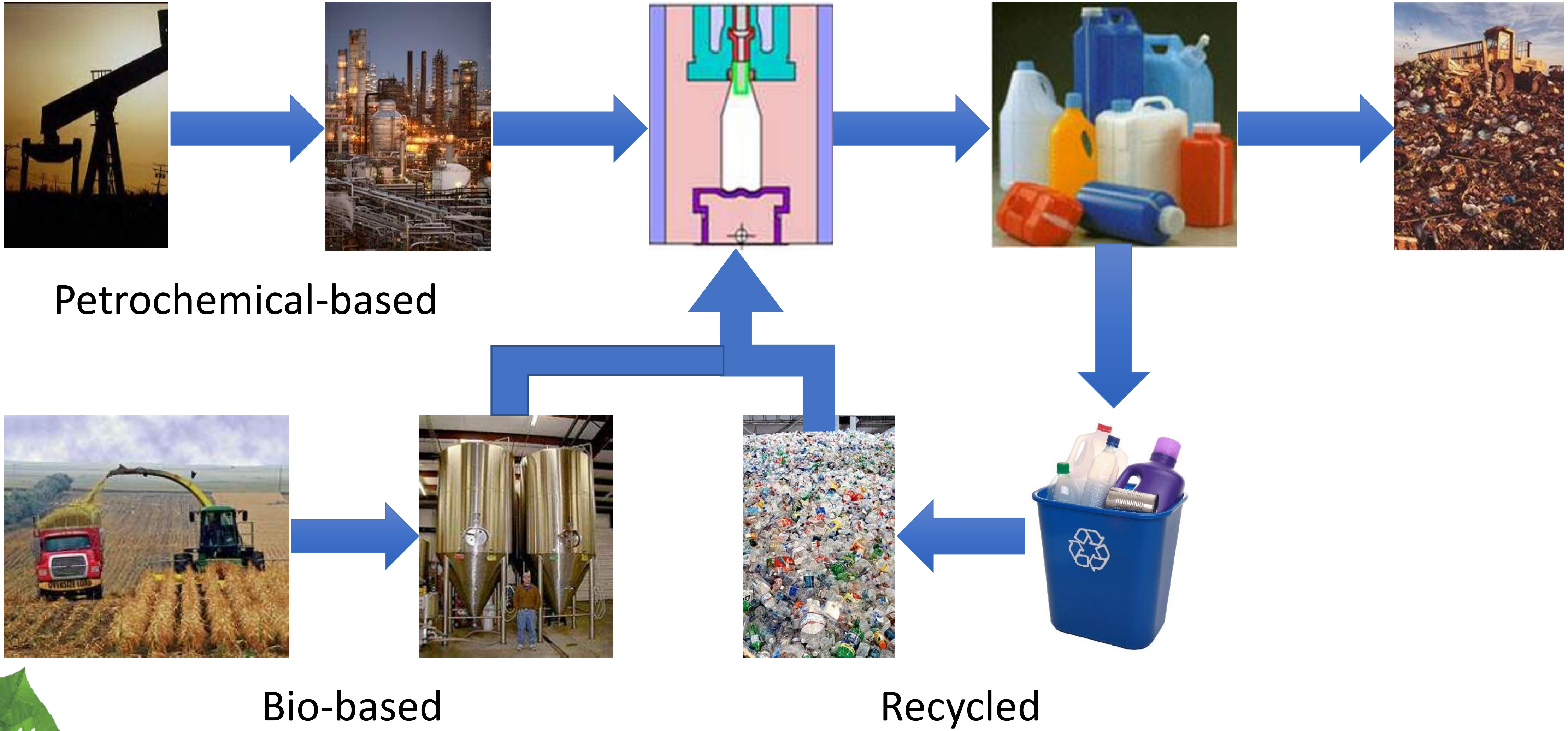
RF = 1
System that is perfectly balanced

RF > 1
System is evolving

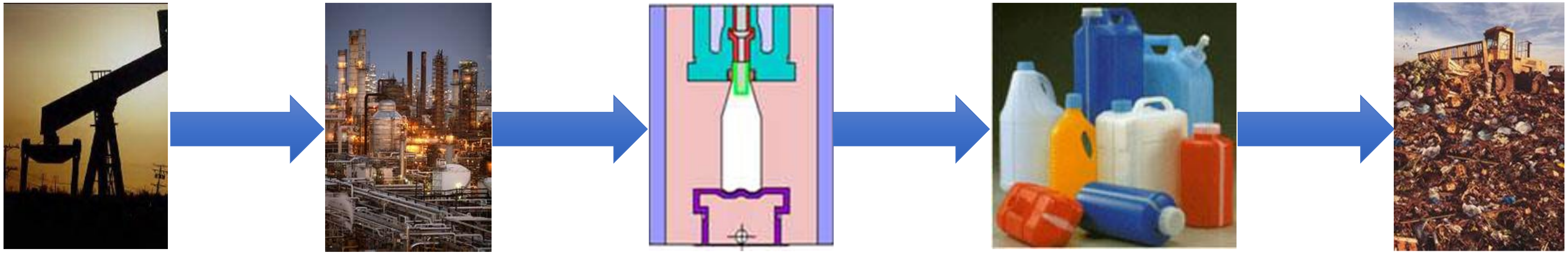
Examples

- Regeneration Factor of a petrochemical HDPE resin system
- Regeneration Factor of a recycled HDPE resin system
- Regeneration Factor of a biobased HDPE resin system

Case Study: Plastic Bottles



Regeneration Factor of Petrochemical HDPE Bottle System (No energy or material recovery)



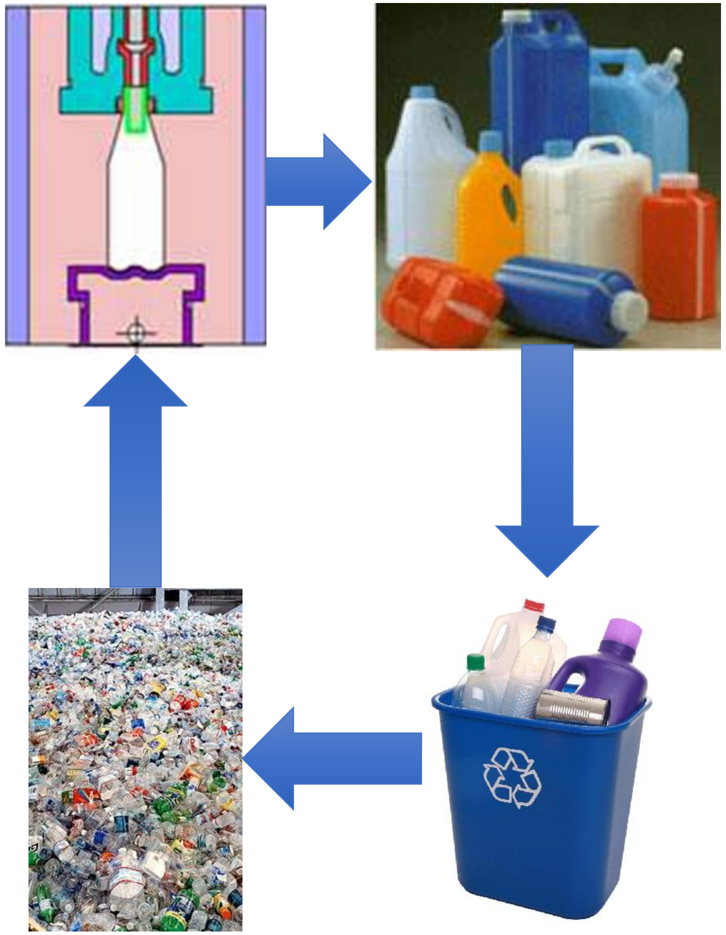
Impact Category	Impact	Impact (Normalized)	Ref
Global Warming Potential (kg/kg)	1.89	1.0	[7]
Fossil Resource Depletion (MJ/kg)	75.3	1.0	[7]

$$\begin{aligned} RF &= 1 - (1+1)/(1/1 + 1/1) \\ &= 1 - 2/2 \\ &= 0.00 \end{aligned}$$

Regeneration Factor of Recycled HDPE Bottle System

Impact Category	Impact	Impact (Normalized)	Ref
Global Warming Potential (kg/kg)	0.56	0.56/1.89 = 0.30	[7]
Fossil Resource Depletion (MJ/kg)	8.69	8.69/75.3 = 0.12	[7]

$$
\begin{aligned}
RF &= 1 - (1+1)/(1/0.30 + 1/0.12) \\
&= 1 - 2/(3.3 + 8.3) \\
&= 1 - 2/11.6 \\
&= 0.83
\end{aligned}
$$



Recycled

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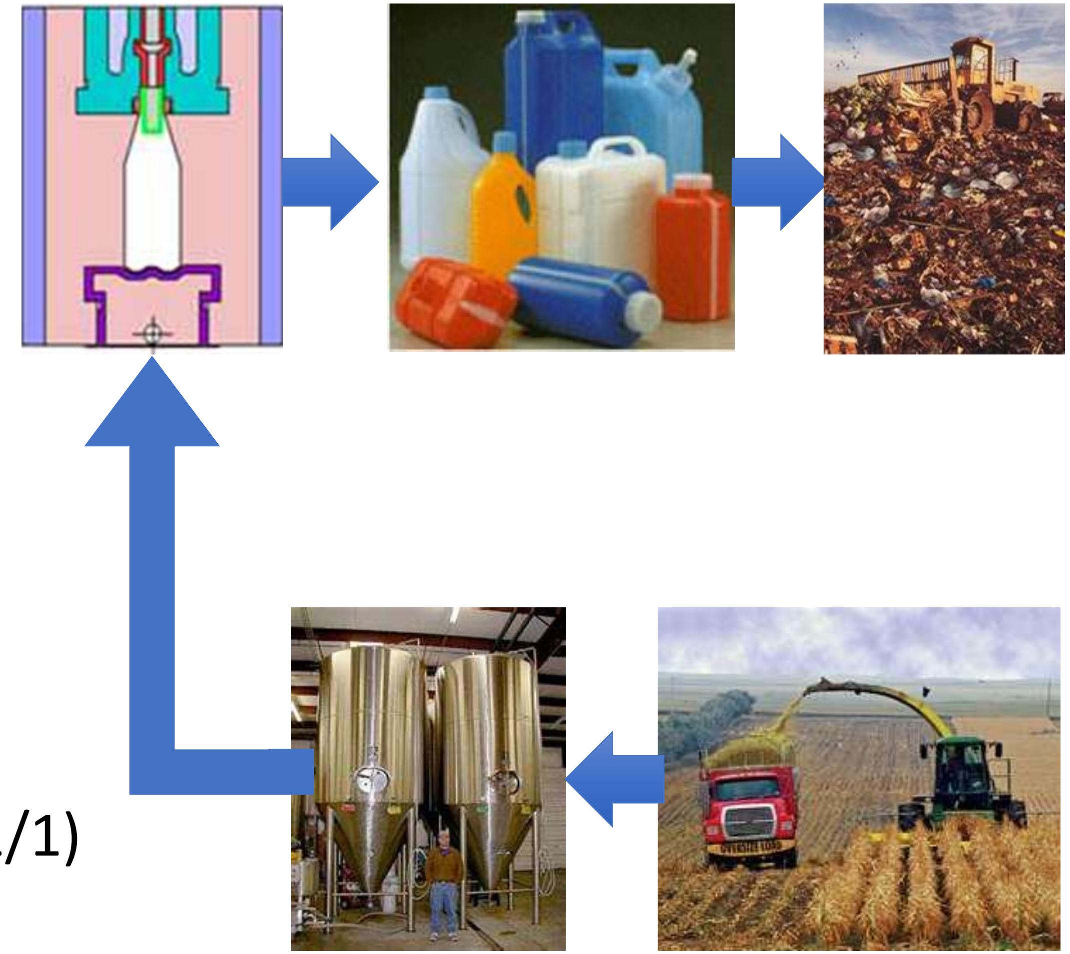
Regeneration Factor of Biobased HDPE Bottle System

Impact Category	Impact	Impact (Normalized)
Global Warming (kg/kg)	-2.1	-2.1/1.89 = -1.1
Fossil Resource (MJ/kg)	18.0	18.0/75.3 = 0.24
Non-regenerative Agriculture	--	1.0



Bio-based

$$RF = 1 - (1+1+1)/(1/(-1.1) + 1/0.\ 24) + 1/1)$$
$$= 1 – 3/(-0.9 + 4.6 + 1)$$
$$= 1 – 3/(4.7)$$
$$= 0.36$$

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References

1. Huijbregts M.A.J., Steinmann Z.J.N., Elshout P.M.F., Stam G., Verones F., Vieira M., Zijp M., Hollander A., van Zelm R. ReCiPe2016: a harmonised life cycle impact assessment method at midpoint and endpoint level. Int J Life Cycle Assess (2017) 22: 138: https://link.springer.com/article/10.1007/s11367-016-1246-y

2. University of Cambridge Institute for Sustainability Leadership, 2018. Healthy ecosystem metric framework: biodiversity impact

3. Huijbregts M.A.J., *Ibid.*

4. University of Cambridge Institute for Sustainability Leadership, Ibid.

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6. McKay S. K., I. Linkov, J. C. Fischenich, S. J. Miller, and J. Valverde 2012. *Ecosystem restoration objectives and metrics*. EBA Technical Notes Collection. ERDC TN-EMRRP-EBA-12-16. Vicksburg, MS: U.S. Army Engineer Research and Development Center. *http://cwenvironment.usace.army.mil/eba/*

7. The Plastics Division Of The American Chemistry Council, Inc., 2010, Life Cycle Inventory Of 100% Postconsumer HDPE And PET Recycled Resin From Postconsumer Containers And Packaging

8. Christin Liptow and Anne-Marie Tillman, A Comparative Life Cycle Assessment Study of Polyethylene Based on Sugarcane and Crude Oil, J. Industrial Ecology, Volume (2012), 16:3, 420-435.

Less bad versus more good: a supplier's perspective on sustainable systems

Arlan Peters

Novozymes

December 4, 2019

TOGETHER WE FIND
BIOLOGICAL
ANSWERS FOR
BETTER LIVES IN A GROWING
WORLD
LET'S RETHINK TOMORROW

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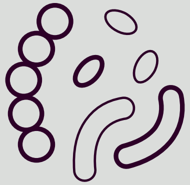
Introducing nature's toolbox

Sometimes the greatest answers in life are found in its smallest components

Enzymes

Microorganisms



Catalyzing processes and building up or breaking down molecules

Cleaner clothes
with biodegradable bio-based ingredients

Better nutrition
with less food waste

Green fuel
to reduce our dependence on oil

Higher yields
and fewer pesticides

We also work with other proteins, biopolymers and related technologies

Spectrum of sustainability concepts

“Regenerative design is creating even better conditions to support the life-enhancing qualities of ecosystems.”

- Efficiency
- Lower impact
- **Operations**

- Circularity
- Closed loop
- **Supply Chains**

- Regenerative
- Net positive
- **Ecosystems**

Nugent, S. (2016, Aug 8) *Living, Regenerative, and Adaptive Buildings* Retrieved from https://www.wbdg.org/resources/living-regenerative-and-adaptive-buildings

Cooling Tower Water Reduction

A cooling tower has to add fresh water to the system to prevent the ion concentration from getting too high from evaporated water loss.

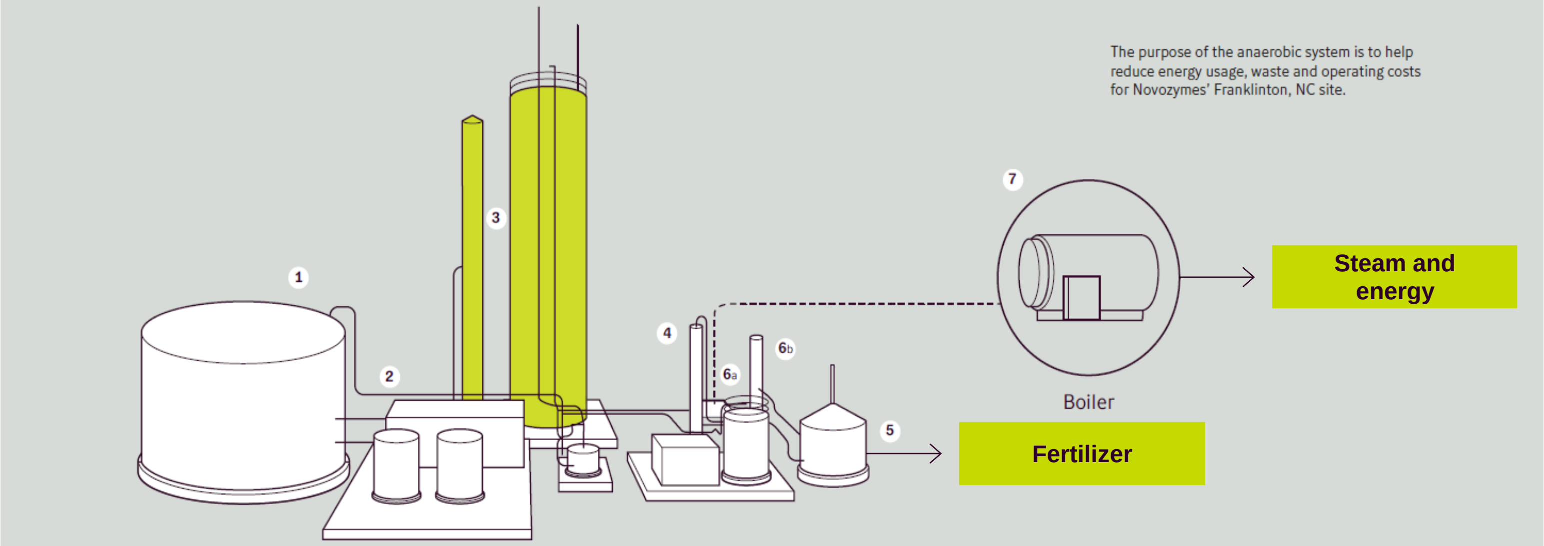
Piloting a new treatment system that uses a bank of charged electrical cores to remove ions from the bleed water and recycles it back to the tower to save fresh make-up water.

~ 10,000 m^3

water saved per year

Circular setup generates energy and fertilizer

Novozymes Anaerobic Pre-treatment



Organic waste is converted to methane to power

~570 | **homes could be served with the energy created**

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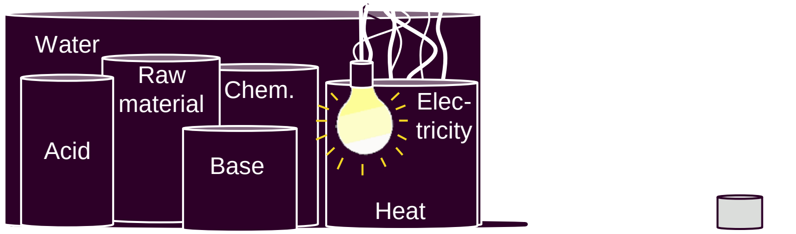
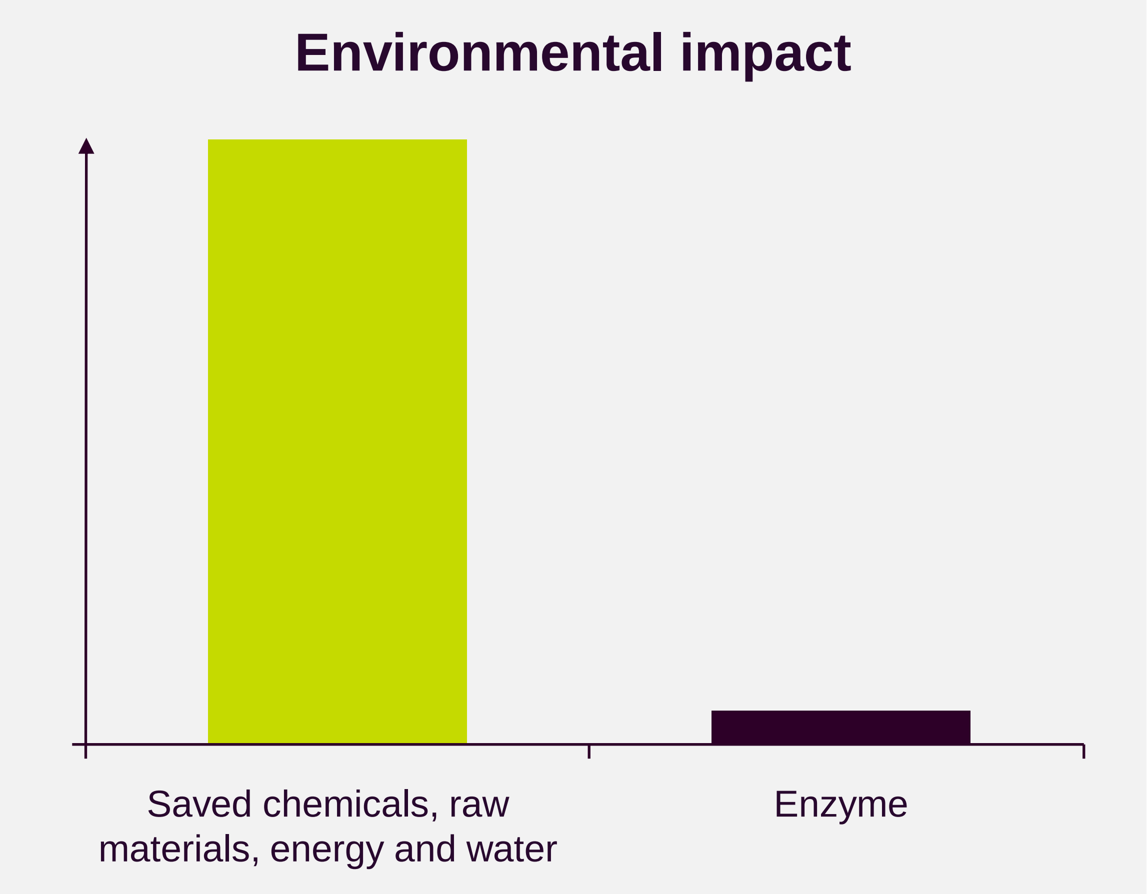
Enzymatic solutions: Net positive impact on environment

- Small amounts of enzyme can in many cases replace large amounts raw materials, chemicals energy and water in industry
- Environmental impact of enzyme production is usually low compared with impact of saved chemicals, raw materials, energy and water
- Enzymes can help industries producing more with less and contribute to a sustainable development



Chemicals, raw materials, energy and water

Enzyme



https://www.novozymes.com/en/about-us/sustainability/lca

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Moving the needle towards sustainable product design

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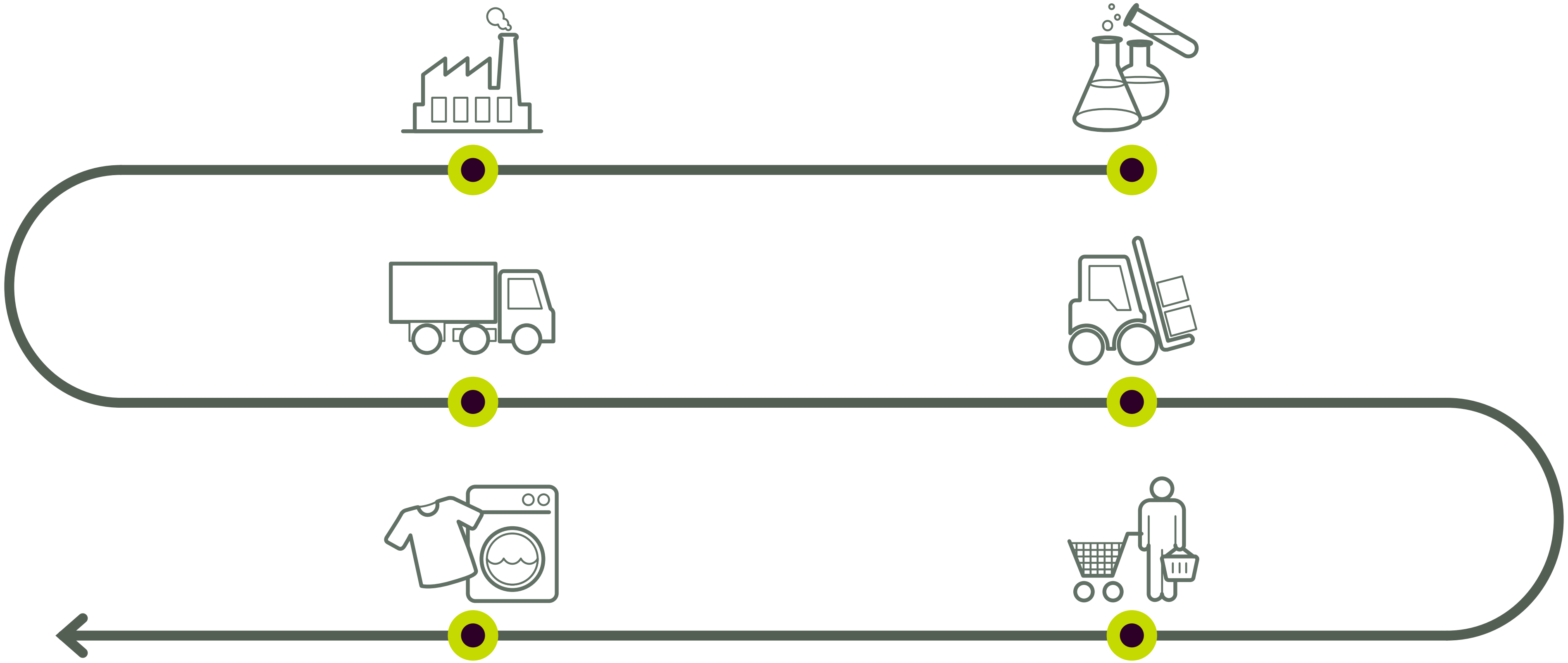
Compaction plays a role at multiple points



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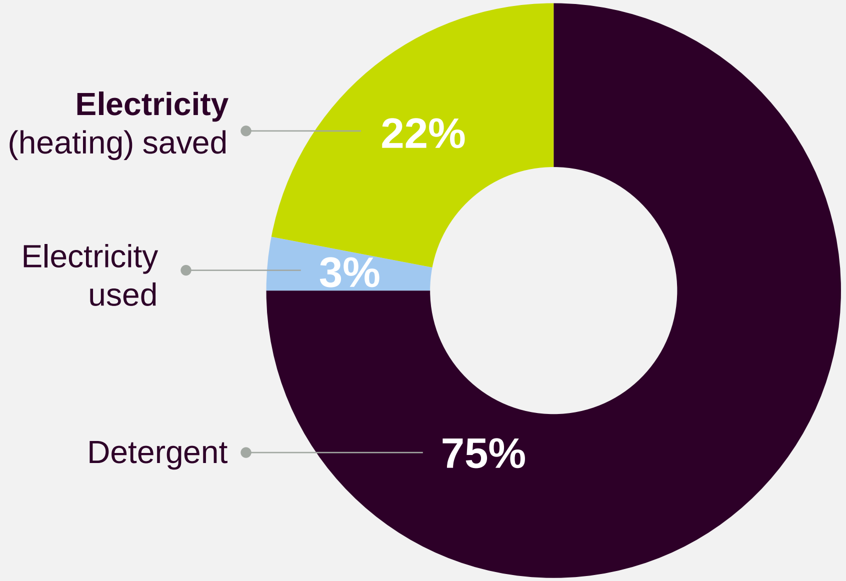
Cold water wash for sustainability and cost savings

Better for the environment

If all warm and hot wash loads today were washed at cold temperatures, the U.S. could save nearly **7.4 million tons of CO_2**

Saves costs



On average, U.S. consumers can save **22% of their annual washing costs** by reducing the wash temperature from 86°F to 59°F

Source: Novozymes Assessment based on LCA calculations, 2013

Extending the life a garment reduces water impact

Assume 20% Extended lifetime

~ **4000 m^3/ton** of fabric

~ **4000 m^3/ton** of fabric

> 10 m^3/ton of fabric

~ 200 m^3/ton of fabric

~ 100 m^3/ton of fabric

LINT

GREY FABRIC

FABRIC

20% = 1660 m^3 water/ton of fabric saved!

Green water (e.g. rain)

Blue water (tap water)

Sources:
- Novozymes
- Chapagain et al (2005)
- The water footprint of cotton consumption by UNESCO-IHE Institute for Water Education

What does it mean to be regenerative?

Regenerative design is creating even better conditions to support the life-enhancing qualities of ecosystems.

Agricultural practices that work in harmony with the natural environment to **improve soil health, water quality,** and **sequester carbon**

Regenerative practices are tightly connected to “place” i.e. sustainable practices for a local context, nested within larger systems

Envisioning a regenerative product from a life cycle perspective

Raw Materials

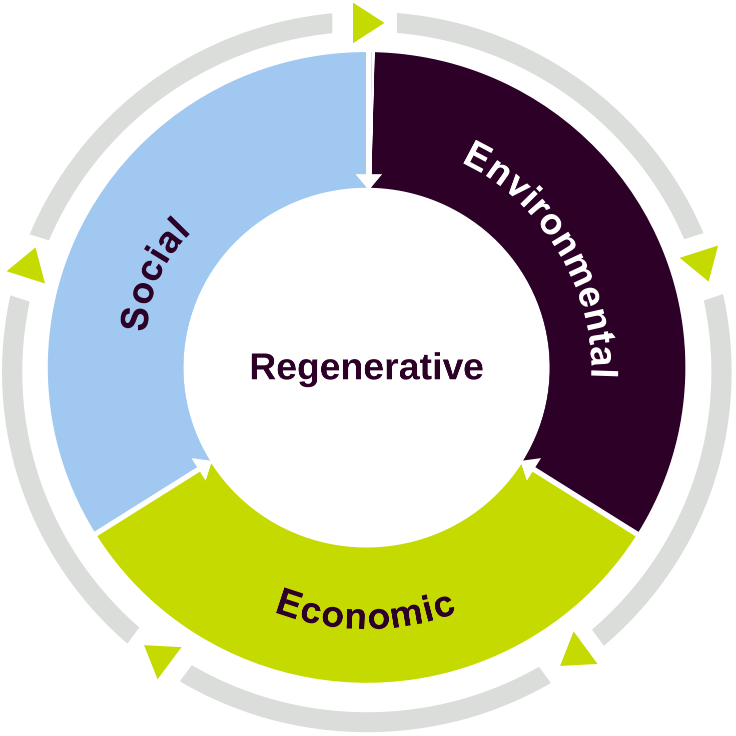
- Bio-based materials sourced from sustainably grown feedstocks
- Direct source or segregated supply

Consumers

- Less GHG and less water
- Positive impact on clothes
- Closing the loop

Manufacture

- Renewable energy
- Waste reduction and reuse



Transportation

- Compacted product to ensure less transportation weight
- Renewable energy, possibly from bio-based waste

Packaging

- Minimal packaging
- Bio-based packaging sourced from sustainably grown feedstock
- Reuse wastes in another phase of cycle

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Rethink Tomorrow

pure|STRATEGIES

SOLUTIONS FOR A SUSTAINABLE FUTURE

Certified B Corporation

The shift in agriculture to regenerative aspirations

Pure Strategies provides sustainability consulting

Working to transform business to create a more sustainable future

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Solutions

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Insight

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A pure|STRATEGIES® Report
Connecting to the Farm
How Companies are Engaging in Agriculture to Build Regenerative and Thriving Supply Chains
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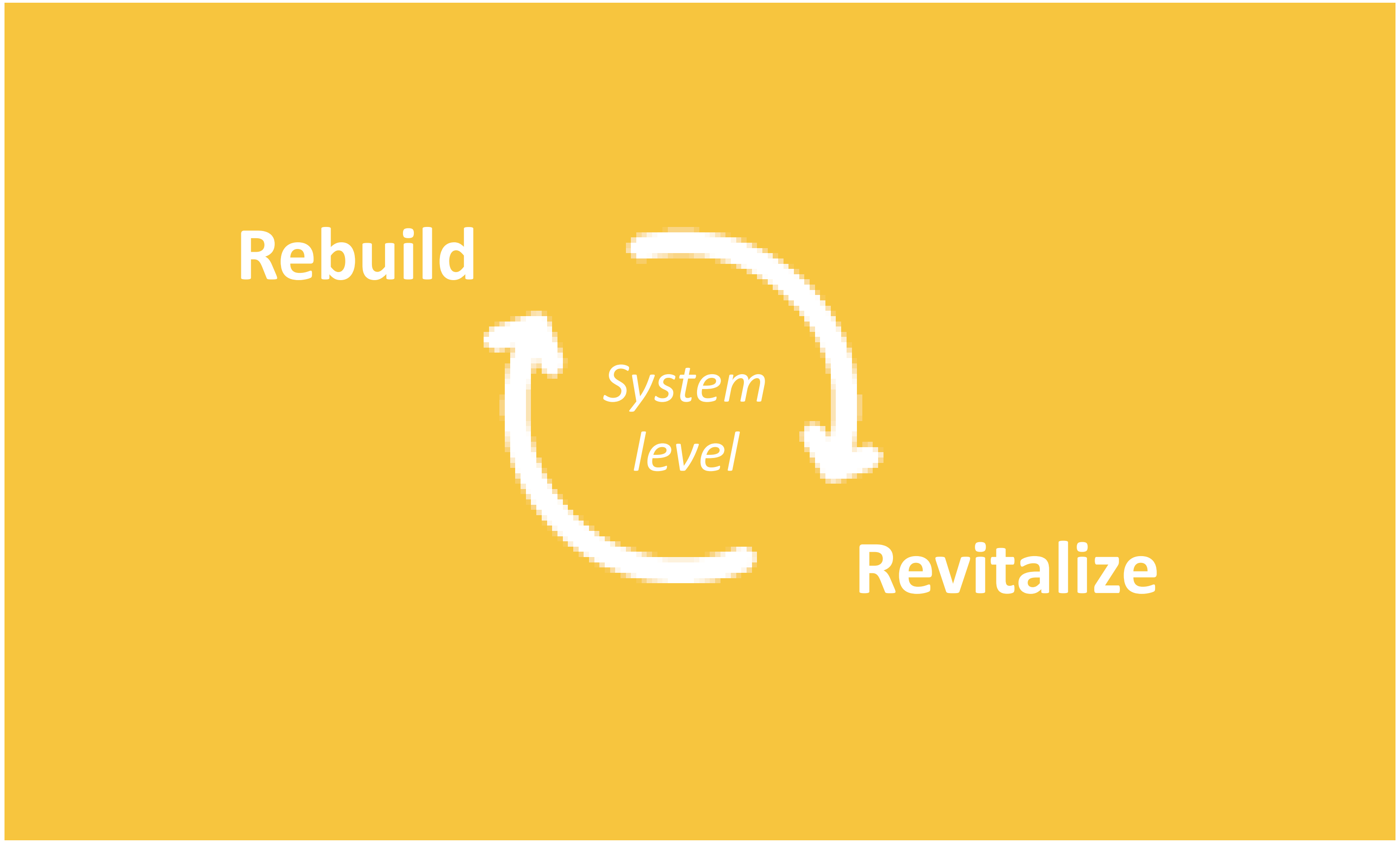
What is regenerative agriculture?



What is regenerative agriculture?

Holistic system approach: soil, animal, human wellbeing

Focus on soil health

Soil loss afflicts many growing regions globally

- 70% of the world's soil are degraded
- In the U.S., half of the historic soil organic carbon has been lost and continues to decline

According to the FAO, if current rates of degradation continue, all of the world's top soil could be gone within 60 years.

Building soil health has many benefits

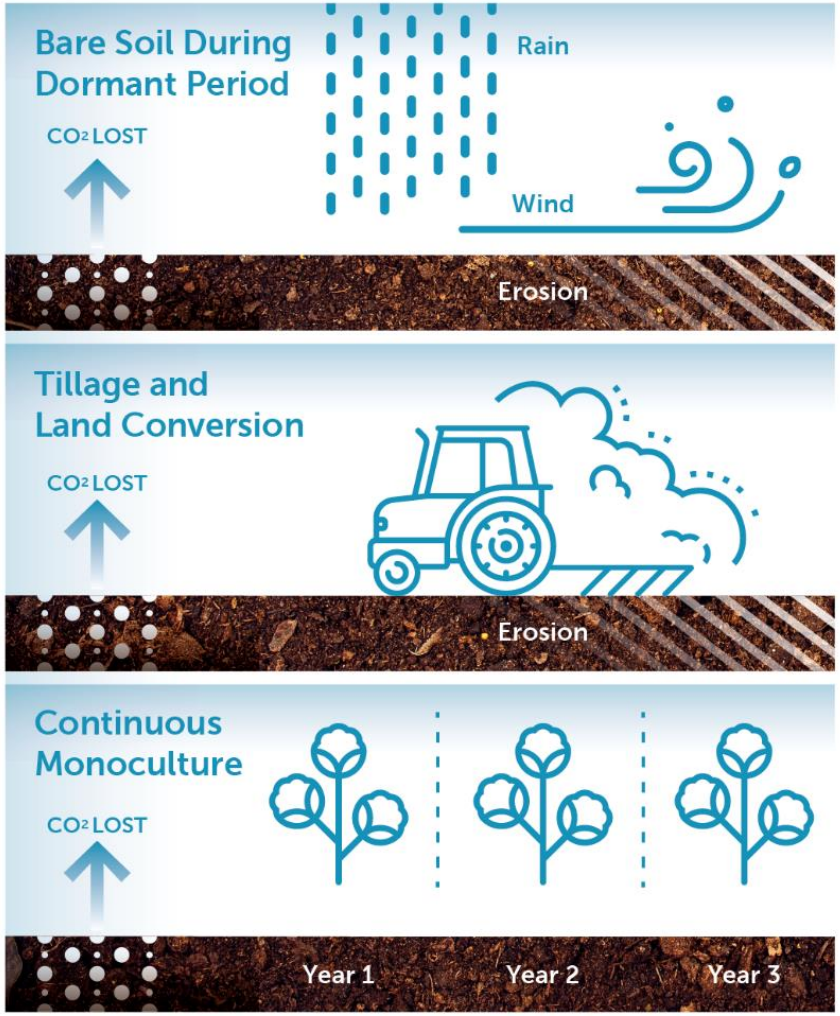
- Reduced soil erosion
- Improved water infiltration and retention (drought resilience)
- Enhanced fertility
- Increased biological activity
- Greater pest suppression
- Better crop rooting and soil condition
- Cooler soil temperature
- Soil carbon sequestration

Four Principles of soil health

Use plant diversity to increase diversity in the soil	Manage soils more by disturbing them less
Keep plants growing throughout the year to feed the soil	Keep the soil covered as much as possible

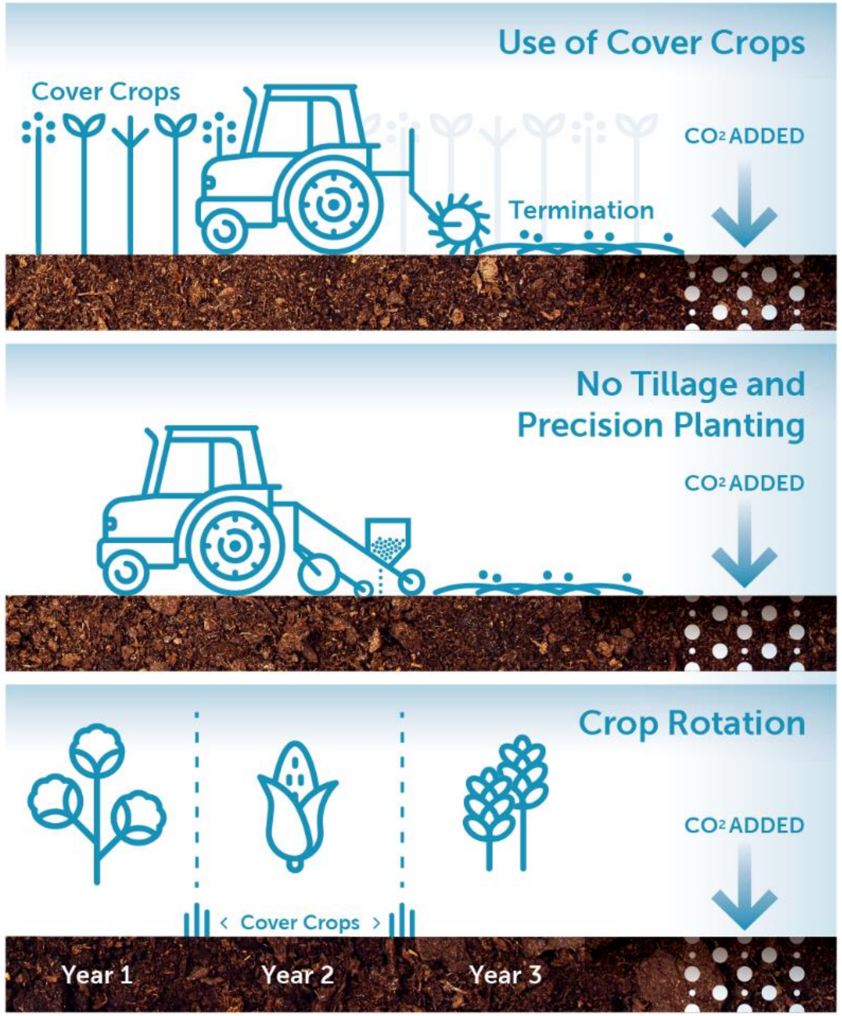
CONVENTIONAL PRACTICES

50% soil carbon already lost[1]



SOIL HEALTH PRACTICES

3x more carbon can be added yearly with widespread adoption[39, 40, 41]



How are companies engaging in regenerative agriculture?

Holistic system approach: soil, animal, human wellbeing

Focus on soil health

Wrangler

Wrangler started with a pilot and is expanding:

- Pilot soil health and land stewardship best practices in key cotton producing states
- Partnered with experts to bring trusted and expert on-the-ground knowledge to implement these practices
- Leveraging external metrics to measure yield, water and energy efficiency, and soil conservation

DR. BRONNER'S ALL-ONE!

Coconut and palm oil projects incorporate:

- Organic agriculture
- Soil health practices
- Agroforestry
- Fairtrade
- Community development

Dr. Bronner's helped rebuild coconut oil market in Samoa

- Demonstration farms to test in prove-out farm-level practices (organic, agroforestry, etc.)
- Train farmers to make the transition
- Provide financing to support the shift
- Establish downstream infrastructure to process oil
- (also pays a premium for the product)

Advance regenerative farming practices on 1 million acres of farmland by 2030

Healthy Soil - Above and Below Ground Biodiversity - Farmer Economic Resilience

- Partnering to develop tools and resources
- Collaborating to researching best practices
- Funding training and technical support
- Financial support for the transition
- Measuring outcomes

Funding 2 and 3-day soil health academies where famers will receive education from leading technical experts.

Plus, funding individualized coaching for farmers to implement regenerative practices on farm and develop 3 to 5-year regenerative management plans.

Key take-aways

- System approach
- Net improvement for the environment, society, and economy
- Key principles and established practices that support the system
- Advance the adoption of practices
- Measure outcomes (to ensure there is a net improvement)

Thank You

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