Regenerative Product Systems

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Framework for the design of regenerative product systems

Presented by Martin Wolf
BizNGO Webinar
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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

- Material Processing
- Recycling
- Product Use
- Product After Use
- Reuse
- Landfill
- Raw Material Extraction & Regeneration
Elements of a Regenerative System

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

## Metrics of a Regenerative Product System

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>METRIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abiotic Resource Depletion</td>
<td>MJ (fossil fuel eq.) [1]</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Species per hectare (micro and macro flora and fauna) relative to undisturbed area [2]</td>
</tr>
<tr>
<td>Carbon Sequestration</td>
<td>Kg CO₂ eq. [3]</td>
</tr>
<tr>
<td>Hydrogeology</td>
<td>Water surface area and flow relative to undisturbed area [4]</td>
</tr>
<tr>
<td>Land Use</td>
<td>Percent (fraction) undisturbed area [5]</td>
</tr>
<tr>
<td>Connectivity</td>
<td>Buffer radius and incidence function [6]</td>
</tr>
</tbody>
</table>
Calculating a Regeneration Factor

Using The Harmonic Mean

• Given the set of n factors, $x_1, x_2, \ldots x_n$, with weights $w_1, w_2, \ldots w_n$, respectively, the Regeneration Factor, $RF_w$, is calculated as:

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

• where the factors, $x_1, x_2, \ldots x_n$, 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

Petrochemical-based

Bio-based

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

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Impact</th>
<th>Impact (Normalized)</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Potential (kg/kg)</td>
<td>1.89</td>
<td>1.0</td>
<td>[7]</td>
</tr>
<tr>
<td>Fossil Resource Depletion (MJ/kg)</td>
<td>75.3</td>
<td>1.0</td>
<td>[7]</td>
</tr>
</tbody>
</table>

\[
RF = 1 - \frac{(1+1)}{\left(\frac{1}{1} + \frac{1}{1}\right)} \\
= 1 - \frac{2}{2} \\
= 0.00
\]
## Regeneration Factor of Recycled HDPE Bottle System

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Impact (kg/kg)</th>
<th>Impact (Normalized)</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Potential</td>
<td>0.56</td>
<td>0.56/1.89</td>
<td>[7]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>= 0.30</td>
<td></td>
</tr>
<tr>
<td>Fossil Resource Depletion</td>
<td>8.69</td>
<td>8.69/75.3</td>
<td>[7]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>= 0.12</td>
<td></td>
</tr>
</tbody>
</table>

\[
RF = 1 - \frac{1+1}{\frac{1}{0.30} + \frac{1}{0.12}} \\
= 1 - \frac{2}{3.3 + 8.3} \\
= 1 - \frac{2}{11.6} \\
= 0.83
\]
### Regeneration Factor of Biobased HDPE Bottle System

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Impact (Normalized)</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming (kg/kg)</td>
<td>-2.1/1.89</td>
<td>-2.1</td>
</tr>
<tr>
<td>Fossil Resource (MJ/kg)</td>
<td>18.0/75.3</td>
<td>18.0</td>
</tr>
<tr>
<td>Non-regenerative Agriculture</td>
<td>--</td>
<td>1.0</td>
</tr>
</tbody>
</table>

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
References


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


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

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.
Introducing nature’s toolbox

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

We also work with other proteins, biopolymers and related technologies

- **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
Spectrum of sustainability concepts

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

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
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

Moving the needle towards sustainable product design
Compaction plays a role at multiple points
Cold water wash for sustainability and cost savings

Source: Novozymes Assessment based on LCA calculations, 2013

If all warm and hot wash loads today were washed at cold temperatures, the U.S. could save nearly 7.4 million tons of CO₂.

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

- Cotton cultivation
- Spinning
- Knitting
- Weaving
- Textile treatment
- Finishing & sewing

Assume 20% Extended lifetime

- ~ 4000 m³/ton of fabric
- ~ 4000 m³/ton of fabric
- ~ 100 m³/ton of fabric
- ~ 200 m³/ton of fabric
- > 10 m³/ton of fabric

20% = 1660 m³ water/ton of fabric saved!

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

Green water (e.g. rain)
Blue water (tap water)
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

**Manufacture**
- Renewable energy
- Waste reduction and reuse

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

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

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

**Social**

**Environmental**

**Economic**

**Regenerative**
The shift in agriculture to regenerative aspirations
Pure Strategies provides sustainability consulting

*Working to transform business to create a more sustainable future*

**Experience**
Highly experienced sustainability consulting team with cross-functional strengths

**Solutions**
Custom solutions for sustainability leaders and those looking to get started

**Insight**
Thought leaders with global market research insight; Co-Founder of the Chemical Footprint Project
A pure|strategies® Report

Connecting to the Farm

How Companies are Engaging in Agriculture to Build Regenerative and Thriving Supply Chains
What is regenerative agriculture?

Rebuild

System level

Revitalize
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

Photo: USDA
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

- Bare Soil During Dormant Period
- Tillage and Land Conversion
- Continuous Monoculture

SOIL HEALTH PRACTICES

3x more carbon can be added yearly with widespread adoption

- Use of Cover Crops
- No Tillage and Precision Planting
- Crop Rotation

References: [39, 40, 41]
How are companies engaging in regenerative agriculture?

Holistic system approach: soil, animal, human wellbeing

Focus on soil health
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
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)
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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