‘Bio-based and bio-sourced materials’

7 May 2015
The rediscovery of biomass as a raw material
Bio-materials in a circular economy

**Biological cycle**
- Farming
- Biodegradation (e.g. composting)
- NPK restoration
- Cascades

**Technical cycle**
- Sourcing
- Production
- Use
- Recycle
- Reuse
- Energy recovery

- Landfill

*Leakage—to be minimised*
Systemic considerations

1. Regenerative agriculture

2. Biological by-products as resources

3. Reverse cycles
Regenerative agricultural techniques

- Current high-yield agricultural practices tend to erode topsoil and deplete nutrient levels.

- The application of integrated farming and other permaculture principles has a measurable impact on the preservation of natural capital.

Example of wheat-maize rotation grown in Red Ferralsol soil
Native – Brazilian sugar cane company

- ‘Ecosystem Revitalising Agriculture’
  - **Rising crop yield**, from 98 to 156 tonnes of cane per hectare
  - **Stronger cane** and falling pest numbers,
  - **Reduced use of natural resources**
  - Increasing **biodiversity**

- Large-scale business
  - **75,000 tonnes of organic sugar** in 2013 -- 34 per cent of the world market
  - Aim of **50 tonnes of biodegradable plastic** a year

Source: Wired
Biological by-products as resources
Pinatex – textile from pineapple leaves
Pinatex - Pineapple plant
Veolia – plastic from wastewater and sludge

Other examples include bioplastics from **pulp and paper production waste** or from **cooking oil**
Reverse cycles

Biological cycle

- Farming
- NPK restoration
- Biodegradation (e.g. composting)
- Cascades

Technical cycle

- Sourcing
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Leakage—to be minimised
Ecovative material – to be composted
Coca Cola Plant Bottle – to be recycled
Cascading

Example of clothing cascading

1. Furniture stuffing material can be reused several times
2. Examples of reuse include donation, exchange, resale

Source: Ellen MacArthur Foundation circular economy team
Bio-based materials and bio-refinery are forming a *growing industry*.

Leveraging biomass as a resource offers important *economic opportunities* while leveraging renewable resources.

The *renewability* of the resources, and therefore the long-term viability of this industry, depend on a number of *systemic considerations*. 
The Business Case for the Circular Economy
Contents

- DSM introduction
- Unrealized Value - Why do we care?
- Case Studies
- Conclusion and Discussion
Global Nexus Trends Drive DSM’s Strategy

- **Health & Wellness**
  - Ageing population
  - Healthcare costs
  - Food security

- **Global shifts**
  - Population growth
  - Urbanization
  - Wealth

- **Climate & Energy**
  - Resources constraints
  - Energy security
  - Sustainability

**Health**

**Nutrition**

**Materials**
Risk & Opportunities - Private Sector

Risk
- material price volatility
- supply chain risk
- regulatory risk
- reputation risk
- resource scarcity
- obsolescence and inertia

Opportunity
- risk mitigation
- better knowledge sharing, partnerships and collaboration
- improved productivity, efficiency, less waste, increased profitability
- innovative business models and products - sustainable competitive advantage
- improved license to do business
- capacity to recruit, retain, develop and deploy talent
To Go From a Linear To a Circular Economy
The Ever-Changing Environment of Oilseed Processing
Caustic Refining of Oil is not a Long-Term Solution

From crude to refined oil, it must be:

- degummed to remove phospholipids
- refined, bleached and deodorized

Traditional industry practice is caustic refining. This:

- creates oil yield losses of 2 - 6%
- created undesirable by-products
- is not a sustainable process solution

Picture: Comparison between crude (left) and refined (right) oil
## Add a Little, Do a Lot with Purifine

### AVERAGE PLANT VOLUME

- **5000 MT crushing p/day**
- **1000 MT crude oil p/day**

### SPECIFICATIONS

- Crude soybean oil
- 1200 ppm phospholipids

### VALUE OF OPPORTUNITY

- **3% extra = 30 MT p/day**
- **+ $7 million per year**

*at an oil price of $800 p/MT, 300 operational days per year, excluding savings on chemicals & energy and costs of Purifine*
Additional 40 million people per year could meet their need for vegetable oil.

1.5 million acres more arable land for agriculture.

Equal to the population of California.

If 30% of all soybean oil in the world was refined using Purifine®

480,000 tonnes CO₂ saved yearly.

The same yearly amount of greenhouse gases is produced by

The global gross economic benefit would be increased by 300 MILLION U.S. Dollar / YEAR for soybean oil production alone.

Equal to the size of Chicago.

The whole food supply chain for 100,000 American citizens.
Cornstover Residue on the Field

Case Study 2: Cellulosic ethanol
Becomes An Opportunity in the Circular Economy
Becomes an Business with Biotechnology

![Diagram of biomass conversion to fuel](image)

- **Biomass**
- **Plant cells**
- **Cellulose**
- **Hemi-cellulose**
- **Lignin**
- **Glucose**
- **Xylose**
- **Arabinose**
- **Glucose**
- **Galactose**
- **Mannose**

**Issue** - **Solution** - **Impact**
To Unlock the Potential of Cellulosic Bio-Ethanol

POET-DSM Advanced Biofuels
A Farmer’s Perspective; More Than Biomass Revenue!

- Residue Management
- Potential Yield Advantages
- Disease Pressure
- Nutrient Savings
- Combine Fuel Savings

Profit increases from $12-$123/ac

Biomass Revenue
Towards a Sustainable World in 2050

*DSM’s Science and Innovation themes*

- Sustainable Manufacturing/ Raw Materials Security
- Health Security
- Energy Security
- Food & Nutrition Security

More than 9 billion society in 2050