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RE	Final Product Life Cycle Analysis Results

This report provides the key findings and recommendations resulting from a third-party product Life Cycle Analysis performed by Trayak and facilitated by the Pet Sustainability Coalition. The content in this document is focused on:

- Providing a clear comparison of the environmental impacts of Miscanthus and Powdered Cellulose over the course of the life time of the products;
- Proposing next steps to facilitate sharing the contents of the report.

Specific Content Includes

Overview	Overview of the project and process.
Life Cycle Report	Details about the life cycle analysis, including assumptions, product phases considered, and categories of environmental impact calculated.
Key Findings	Key findings and environmental equivalencies.
Appendix A - Life Cycle Analysis Results	Detailed environmental analysis report from Trayak.

Overview

The Pet Sustainability Coalition (PSC) worked with MFiber and Life Cycle Analysis (LCA) consultants, Trayak, to conduct an LCA to quantify the environmental impact of their product Miscanthus Giganteus, compared to Powdered Cellulose. Miscanthus Giganteus and Powdered Cellulose are ingredients used in pet food to provide fiber for gastrointestinal health, elimination, and in cases of pet obesity, to reduce the caloric density of pet food.

This study does not focus on the nutritional, health and safety elements of the two products. Rather, it is a comparison of the environmental impact over the full life cycle of the two products as they are used as an ingredient in pet food.

To begin the project, PSC worked with Trayak to develop a data request that was delivered and reviewed with MFiber. Trayak performed initial results which were reviewed with PSC and MFiber. After this initial call, the project team launched forward with the comparison of the two products:

- Miscanthus - MFiber miscanthus is from the perennial Miscanthus Giganteus and is grown in the Midwest region of the United States.
- Powdered Cellulose – A pulp from a raw fibrous plant material, most typically wood from trees, that is mechanically and chemically cleaned, processed and disintegrated.

Trayak delivered initial the results to PSC and MFiber for comments and additional data verification and clarification. Trayak then delivered final results to PSC and MFiber. PSC took those results, incorporated data interpretation and suggested next steps, and delivered this final report.

Life Cycle Analysis

As mentioned in the project overview, the LCA calculated the environmental impacts of two products, Miscanthus and Powdered Cellulose.

The following assumptions were included in the analysis:

- All analysis was performed with the functional unit of 1,000,000 pounds material.
- For the basis of this comparison, Miscanthus and Powdered Cellulose are considered an ingredient supplied to pet food manufacturers and therefore Impacts related to transportation and use phases were considered the same.
- Used as a source of fiber in pet food, the end of life phase for both Miscanthus and Powdered Cellulose is digestive elimination and therefore assumed to be identical.

The total environmental impact was modeled in the following phases:

- The **material phase** measures the environmental footprint of extracting and processing materials.
- The **manufacturing phase** calculates the impact of the manufacturing or conversion processes that companies use to add value and create the product.
- The **use phase** includes the environmental impact during the useful life of the product. Typically, the use phase impact is due to the consumption of resources like electricity, fuel, or other consumables.

- For the **transportation phase**, the impact is calculated based on the mode of transportation (road, rail, air, sea) as well as the distances travelled. For the purposes of this report it is assumed both products are shipped from the producers in North America to the same pet food manufacturer, and therefore there were no differences in the transportation phase. Given MFiber is produced in North America and Powdered Cellulose can be produced globally, Powdered Cellulose may have added transportation impacts not considered in this report.
- The **end of life phase** impact calculation incorporates the most likely fate of the product/package and its components based on typical waste management. End of life of the two products in this report is considered digestive elimination, and therefore assumed to be identical.

The environmental impacts of the two products were calculated in 7 different categories including:

- **Fossil Fuel Use (MJ deprived).** This is the total quantity of fossil fuel consumed throughout the life cycle reported in megajoules (MJ) equivalents deprived. This calculation uses the IMPACT World+ method and assumes fossil resources mainly used for energy purposes. Fossil fuels include coal, petroleum, and natural gas. Inputs for nuclear fuel such as uranium are accounted for in the MINERAL CONSUMPTION metric.
- **GHG Emissions (kg CO_2 eq.)** This is the total quantity of greenhouse gases (GHG) emitted throughout the lifecycle reported in kilograms of CO_2 equivalents. This calculation follows the latest IPCC 2013 method and considers climate feedback loops.
- **Water Use (liters)** This is the relative available water remaining per area in a watershed after the demand of humans, aquatic ecosystems, and manufacturing process has been met. This metric accounts for water scarcity and the result represents the relative value in comparison with the average liters consumed in the world. Essentially, the total water consumed to make the product is multiplied by the region's scarcity factor which will either increase or decrease the water usage value based on the scarcity or excess availability of water in a specific region, respectively.
- **Mineral Resource Use (kg deprived)** This indicator uses the material competition scarcity index from de Bruille (2014) as a midpoint indicator. The factor represents the fraction of material needed by future users that are not able to find a reliable substitute for the mineral. It is expressed in units of kilograms of deprived resource per kilogram of resource dissipated. It considers mineral scarcity and viable substitutes.

- **Human Impact (DALY)** This is the quantity of environmental emissions resulting in particulate, cancer, and toxic non-cancer impacts to humans released throughout the lifecycle. The metric reports these three measurements in Disability Adjusted Life Years (DALY). It is calculated using Impact World+ and considers severity factors of any adverse effects.
- **Freshwater Eutrophication (kg PO_4 eq.)** Eutrophication is the abnormal increase in chemical nutrients that results in excessive plant/algal growth and decay resulting in an anoxic condition in freshwater systems. (The major consequence are algal blooms.) Typically, these are emissions of phosphorus compounds released during the production of materials. It is reported in phosphate (PO_4) equivalents and is calculated with Impact World+ characterization factors.
- **Freshwater Ecotoxicity (CTUe)** This is the quantity of environmental emissions resulting in aquatic toxic impacts released throughout the lifecycle reported in Comparative Toxic Unit ecosystem (CTUe). CTUe corresponds to a fraction of disappeared species over a cubic meter of freshwater (or marine water) during one year. This is a measure of ecotoxicity impact of chemical releases to air, water, and land using aquatic toxicity factors and is calculated using characterization factors from USEtox 2.0.

Key findings

A table of key findings (based on functional unit of 1 million pounds product) from the life cycle analysis is provided below. The environmental impacts of Miscanthus is considerably less than Powdered Cellulose across all seven categories. The full analysis, broken down by product phase, can be found in Appendix A.

	Powdered Cellulose	Miscanthus Fiber	Environmental Impact % Difference
Fossil Fuel Use (MJ deprived)	7,327,243.61	1,019,066.98	86.09
GHG Emissions (kg C02 eq)	559,895.01	73,108.65	86.94
Water Use (liters)	594,550,000	14,646,155.27	97.54
Freshwater Eutrophication (kg P04 eq)	685.23	247.81	63.84
Mineral Resource Use (kg deprived)	6,232.19	519.98	91.66
Human Impact (DALY)	0.7887	0.06563	91.68
Freshwater Ecotoxicity (CTUe)	4,397,163.23	357,068.11	91.88

Simple environmental equivalencies are included for Fossil Fuel Use, GHG Emissions and Water Use. While analysis of Mineral Resource Use, Freshwater Eutrophication, Human Impact and Freshwater Ecotoxicity are important to consider, they require considerable consumer education to understand. However, these indexes will be appropriate for specialized audiences, such as land managers, nutritional specialists and scientists.

Fossil Fuel Use (MJ deprived)	
Barrels of Oil Saved	1031.11
Average Homes Powered Yearly	168.51

GHG Emissions (kg C02 eq)	
Passenger Vehicles Driven Yearly	104.24
Miles Driven by Passenger Vehicles Yearly	1,193,103.82
Liters of Gasoline Consumed	207,346.23
Acres of U.S. Forests in one year	12,614.31
Tree Seedlings grown for 10 years	572.69

Water Use	
Gallons of Water Saved	153,210,000
Average Showers	8,907,876.03
People Showering Daily for a year	24,405.14
Olympic Sized Swimming Pools	231.96