FROM GREEN WASTE TO NET ZERO

Wilson Inlet Catchment Committee (WICC)

BACKGROUND

The WICC project, "Green Waste to Net Zero," is a response to the challenge of effectively managing green waste, plastics, Fogo (food organics, garden organics), and dairy waste generated in the region. With current disposal methods proving expensive and environmentally sub-optimal, the growing populations require an innovative solution to meet net zero targets.

CHALLENGE

For the Shire of Denmark and its neighbours Shire of Plantagenet and City of Albany, growing populations and agricultural intensification is increasing the volumes of green waste, plastics (in particular silage netting and wrap), Fogo, and high-nutrient wastewater are all becoming a major challenge. As these waste volumes grow, the natural environment and waterways are less able to tolerate further wastes because of the high eutrophication risk, in addition to growing awareness of the macro and microplastic pollution risks. WICC partnered with the Shire of Denmark, DPIRD, Energy Farmers Australia, and Murdoch University to explore innovative waste management solutions.

Currently, the disposal of green waste undergoes uncontrolled burning, releasing considerable smoke and emissions near the Denmark Waste Transfer Station where many people work and visit. Burning is a high-risk and expensive activity, particularly in summer. Trials of composting of the larger woody components is not practical and many seeds remain viable. Transporting the green waste is expensive and impractical and increased fossil fuel emissions. Fogo transportation to a composting facility and the associated gate fees is a very expensive solution, and does not sufficiently deal with the approximately 2% plastic waste by weight contamination that is largely consistent across Australia. Moreover, agricultural wastes including silage wrap and netting are not often disposed of in a suitable manner. Initiatives of recycling this plastic are largely impractical, require sorting and or cleaning, and can be very expensive and energy intensive processes. High nutrient wastes, such as dairy wastes are also a challenge as there are not practical solutions to remove the high level of nutrient concentrated at one point.

The challenge transcends mere waste management; it's intrinsically tied to a broader imperative. The proper handling and conversion of these waste streams is essential in an effort to achieve net-zero carbon emissions. Ideally this solution is not cost-prohibitive – and ideally profitable on a commercial basis.

SOLUTION

Green Waste to Net Zero proposes a solution centred around pyrolysis technology. Pyrolysis involves the controlled heating of organic and plastic wastes to produce biochar with minimal contaminating emissions. Unlike traditional combustion methods, pyrolysis results in a solid product rich in carbon, creating bio-based charcoal (biochar).

IMPLEMENTATION

The project is currently in the feasibility stage to assess its economic viability and safety before proceeding to full operation. WICC has collaborated with Dr. Xiangpeng Gao from Murdoch University to lead the research, process design, and techno-economic analysis of the pyrolysis component of the project. The research team aims to ensure the concept is both technically and economically viable, meeting safety and carbon sequestration standards while reducing waste disposal costs. Initial data shows the pyrolysis samples of greenwaste taken from Denmark achieves good conversion to biochar at all temperatures tested, and contamination levels in the resultant biochar was below detection levels, showing a safe biochar product. The plastics were also pyrolyzed under the same temperatures and was found to have completely combusted to ash at higher temperatures. This means that organic wastes can have plastic co-mingled and can still be safely converted to biochar while any plastics are converted to carbon-dioxide and water. This overcomes the greatest challenge to cost-effective Fogo processing.

BENEFITS

Carbon Sequestration

Biochar's exceptional capacity to sequester carbon is a key opportunity to achieve net zero emissions. Once integrated into soil, biochar has the potential to securely lock away carbon for centuries. It can be described as the reverse of using fossil coal. Producing biochar removes carbon dioxide from the air as the plants grow, and because around half remains in the biochar, each tonne of dry biomass pyrolyzed to biochar removes around one tonne of carbon-dioxide equivalent. The carbon stored within quality biochar remains stable and is far less susceptible to decomposition compared to organic matter, making it a robust long-term carbon storage solution.

Improved Health and Agricultural Production

Biochar use can improve yields and nutrient conversion efficiencies of both plants and animals. Biochar's porous nature creates a hospitable environment for beneficial microorganisms and significantly enhances soils water holding capacity and nutrient use efficiency. Consequently, biochar use has been found in some circumstances to improve crop yields, animal growth rates, and overall farm productivity. Research demonstrates that biochar-amended soils boast increased water-holding capacity, exhibit superior nutrient availability, increases soil biology, enhances soil aeration, and reduces nutrient leaching, contributing to the resilience of agricultural ecosystems.

Feed Additive Potential

Biochar exhibits great promise as a feed additive for livestock. Emerging studies suggest that integrating biochar into animal diets yields a multitude of benefits including improved gut health and increased productivity. Within the dairy industry, research has found that the inclusion of biochar in feed can result in a substantial increase in milk production, often exceeding 1.4 litres per day per cow*#. Research into its potential among beef cattle is currently underway. This dual advantage – bolstering both agricultural productivity and animal well-being – underscores the versatility and potential of biochar in advancing sustainable farming practices.

Biochar could play a pivotal role in achieving a sustainable agriculture system. The global demand for biochar underscores its significance on a worldwide scale, opening doors for its application in diverse agricultural and environmental contexts. This project serves as a compelling testament to the collaborative synergy between academic research and community-driven initiatives, illustrating how innovative concepts can be translated into tangible solutions for sustainable waste management, carbon reduction, and agricultural advancement.

NEXT STEPS

WICC is planning to establish a pilot plant biorefinery using Energy Farmers Australia as technology providers, ensuring that the project's objectives align with economic viability, local content, and sustainability goals. The technical results, biochar market analysis, and the overall economic analysis to date shows a high-quality biochar can be produced at a very low cost from the existing green waste volumes, in addition to solving plastic contamination issues. However, the demand for biochar is much greater than the green waste volumes at present, demonstrating that additional waste can be included as the volumes increase. If successful, this initiative has the potential to revolutionise waste management practices, be carbon negative over the long-term, operate on a commercially profitable basis, and enhance agricultural productivity in the region.

The next steps of the biorefinery includes optimised open microalgal oxidation ponds that make use of the pyrolysis exhaust to increase algal productivity growing in the ponds. This will be led by Prof Navid Moheimani at Murdoch University, in collaboration with Dr Xiangpeng Gao. The microalgal ponds are designed to accept high-nutrient waste effluent and high moisture Fogo and convert it to profitable products, including high protein fodder, bioplastics, lipids, and even nutraceuticals. This can enable a 'closed loop' where farms are able to return nutrients from accessing local food wastes and agricultural wastes. These high-carbon nutrient-enriched products are free of chemical, heavy metal, and biological contamination, and enable them to be carbon negative and source sustainable forms of fertiliser and soil amendments which displace fossil equivalents.

References

*McCallum, Q. (2021). Biochar boosts Fleurieu dairy production. Stock Journal (First published 7 June 2020, updated 14 April 2021). https://www.stockjournal.com.au/story/6781583/biochar-boosts-fleurieu-dairy-production/

#Rebbeck, M. (2020). Biochar Dairy Trial and Farm Health Benefits. https://youtu.be/LaCbEJm_c3U?si=QxtCDQxfcK2rWfuK