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Dry anaerobic digestion:
A sustainable, water-wise, waste-to-energy solution

By Ashira Roopnarain and Haripriya Rama, ARC-Natural Resources and Engineering

Imagine an ideal world where cattle manure, crop waste and food scraps do not end up accumulating in landfills but are used to light up homes, cook meals, heat schools, and fertilise gardens. This is not a far-fetched idea thanks to dry anaerobic digestion or AD, a clean, sustainable technology that is rapidly gaining recognition and momentum worldwide.

From rural villages in South Africa to high-tech farms in Japan, dry AD is proving to be a catalyst in the fight against waste accumulation, climate change, energy poverty, and reliance on fossil-fuel derived energy and chemical fertilisers.

Anaerobic digestion explained

Dry AD is a natural process that occurs in the absence of oxygen, whereby special microorganisms, including bacteria and archaea, break down organic matter such as animal manure, food waste, and crop residues. The products of this process are biogas and digestate. Biogas is a renewable energy source rich in methane that can be burned for cooking, heating, and even electricity generation. The semi-solid material produced during the process is referred to as digestate, which is nutrient-rich and ideal for agricultural applications.

Anaerobic digestion is classified as wet or dry, based on the amount of solids in the system. Unlike traditional wet AD, dry AD works with waste that has a much higher solid content (15 to 45%). This means it requires substantially less water, thus providing a huge advantage in water-scarce regions.

Let's explore how dry AD may be adopted in South Africa, Mozambique, and Japan. These three very different countries are united by one common goal, namely turning waste into treasure in a water-wise manner.

South Africa: Empowering rural communities by tackling waste management and energy poverty

Rural areas in South Africa are plagued with improper waste management systems leading to disease and environmental pollution. Moreover, livelihoods are impaired due to a lack of reliable and eco-friendly energy sources. Dry AD in these regions may provide a decentralised solution, requiring lower water input. The often-times underutilised on-farm waste may be used by producers to power biogas digesters. Dry AD is particularly promising because it is not limited to regions with access to copious amounts of water but can be applied in arid regions such as the Karoo and Limpopo province.

The adoption of this technology in South Africa is expected to deliver several benefits. These include providing clean energy for cooking and lighting, improving soil health and crop yields through the use of digestate, reducing reliance on unsustainable energy sources such as fuelwood and coal, and lowering greenhouse gas emissions generated from fuelwood combustion. With sufficient training and investment, dry AD has the potential to make a significant contribution to off-grid energy independence in rural areas of the country.

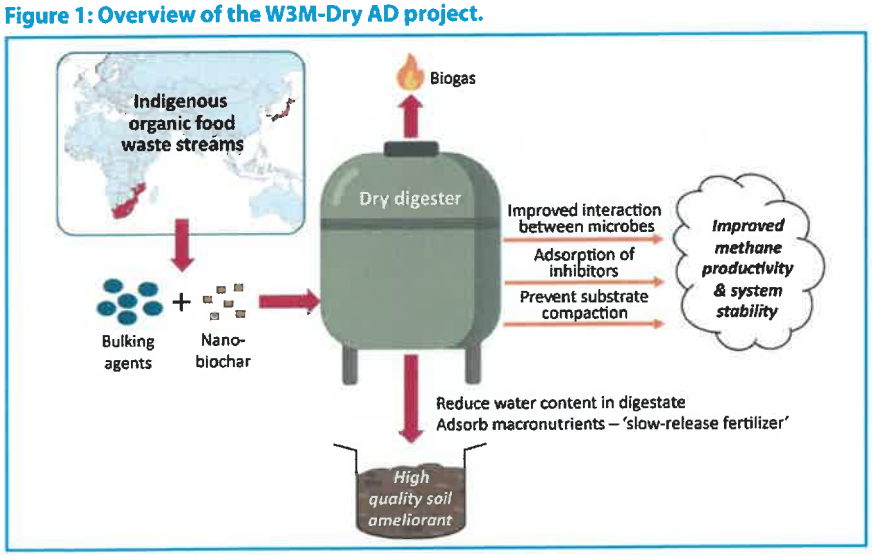
Mozambique: Decentralised energy provision, and turning waste into opportunities

Rapidly growing urban waste management challenges in Mozambique, especially in cities such as Maputo, emphasise the need for alternatives to landfilling. A large portion of the municipal solid waste that is generated consists of organic waste, which is commonly dumped or burned, releasing harmful pollutants into the environment.

The adoption of dry AD in Mozambique offers a sustainable solution for managing organic waste. By reducing reliance on landfilling and waste burning, this technology supports cleaner waste practices while generating decentralised energy for households and public facilities, such as restaurants.

It also has the potential to create green jobs in areas such as waste collection and foster specialised skills in the construction and operation of AD plants. Moreover, the digestate produced through AD systems can be transformed into nutrient-rich fertiliser, helping to boost agricultural productivity.

Figure 1: Overview of the W3M-Dry AD project.



Japan: High-tech efficiency in a developed economy

Japan is internationally recognised as a leader in green technology and efficient waste management. In this context, the adoption of dry AD offers a unique contribution compared to its application in African countries. Given Japan's space constraints and high population density, the technology's reduced space requirements make it particularly attractive relative to conventional wet AD systems. Compact dry AD systems can be utilised to manage food waste from households, supermarkets, and restaurants.

Dry AD plants in Japan can also be modified and optimised to incorporate various pre-treatment processes and augmenting agents to maximise biogas yields. Furthermore, artificial intelligence (AI) could be integrated to optimise system performance, with the lessons learned relayed globally. Rural households stand to benefit as well – using dry AD to convert manure and household organic waste into green energy and fertiliser.

Global potential

Dry AD is a sustainable, scalable waste-to-energy technology with the potential to address both waste management and energy poverty on a global scale. Its application is not limited to South Africa, Mozambique, and Japan; however, these countries are the current focus due to a recently launched collaborative research project titled "Water wise waste management: Two ends of the size scale, macro and nano augmentation for dry anaerobic digestion optimization (W3M-Dry AD)."

The W3M-Dry AD project aims to develop an augmenting agent composed of nano and macro elements to optimise the dry AD of agricultural waste streams. This approach supports sustainable agricultural practices while enhancing renewable energy production (*Figure 1*). The project is expected to generate strategies that improve dry AD performance in the three participating countries, thereby demonstrating the full potential of the technology and encouraging its broader global adoption.

The project also establishes a platform for knowledge exchange between the countries, the shared goal being the advancement of green energy security.

The W3M-Dry AD project emphasises that dry AD is not just a technology, but a vital link between waste management and clean energy. Whether implemented in a rural village in South Africa, on a small farm in Mozambique, or in high-tech facilities in Japan, its benefits remain universal. Dry AD offers a tangible pathway towards our shared global vision of a greener, cleaner future.

The South African project team is funded by the National Research Foundation (NRF) and includes members of the Agricultural Research Council (ARC), the University of South Africa (UNISA), and the University of Venda (UNIVEN). SF

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