Written evidence from Applied Microbiology International (MET0017)

What lessons could the UK learn from abroad?

Earlier this year AMI hosted an online event which involved the company Mango Materials[1]. Based in the US, Mango Materials is a start-up company that produces biodegradable polymers from methane emissions, using methanotrophs. Not only do their products replace polluting plastics and polyester, but their process encompasses a 'closed loop' system, where no new emissions result from their processes. Their products (which include fibres for apparel/textiles and rigid goods such as jars, caps and moulded applications) are completely biodegradable, leaving no trace in the environment, including the marine environment. Mango Materials can partner with all types of industry including agricultural sites, wastewater treatment plants and landfill as a source of methane. They have also been working on scaling their solutions.

We therefore recommend exploring the potential impact of technologies such as that used by Mango Materials within the UK.

Are there emerging technologies, such as methane suppressant feed products or approaches to slurry management, that could aid with methane emissions reduction in agriculture? What impact could they deliver?

Anaerobic digestion and timely composting of manure products could help reduce methane emissions in agriculture.

Anaerobic digestion (AD) of waste is a technology that could be used in waste management, to reduce methane emissions in agriculture.

Currently, in agricultural settings crop and animal waste can be left in place for long periods of time, leading to odour issues, ammonia emissions (an air pollutant) and methane emissions if anaerobic conditions (conditions where oxygen is absent) occur.

AD takes place in an Anaerobic Digestor; these are airtight tanks that mix and heat organic waste to produce two useful products:

- Digestate (the material that remains after anaerobic digestion of waste, which consists of indigestible material and dead microorganisms) which can be used to produce organic fertilisers[2]; a more sustainable alternative to synthetic fertilisers. It is also thought that organic fertiliser use could further help regulate methane production, due to the controlled addition of nitrogen into soils, however further research is needed to confirm this.

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[1] https://www.mangomaterials.com/

[2] https://www.biogas-info.co.uk/about/digestate/

- It could create renewable energy since anaerobic digestion produces methane-containing biogas which is a renewable energy source[3]. Teesside University has soon to be published data, which shows that varied crop wastes can be utilised within AD to produce biogas (more information on this in the last question).

AD can be implemented from small to large scale. Where appropriate volumes of waste are handled on-site, AD could be cost effective and would benefit from incentivisation and training to increase uptake. Where AD is not cost-effective on-site, access to shared AD facilities would be beneficial. Regarding the latter research would be needed to ensure mixed input to AD tanks would still result in adequate biogas production, with clear guidelines for what should not be included provided to those using the facilities.

Better **compost management** would also help in reducing harmful agricultural emissions, including methane. Teesside University are working with compost producers within the poultry industry to manage manure more effectively. Manure storage on farms requires a permit due its environmental pollution risk, making manure removal the simplest solution for agricultural workers, however this not only results in emissions but also can still lead to environmental pollution as manure is often stored in field middens.

Additionally, to reduce odour, agricultural workers are advised to spread manure within 24 hours when using it as compost, which leads to anaerobic breakdown and methane production. Modern layer systems also require manure to be removed from site every four days, meaning manure is stored until there are suitable spreading conditions or there is a crop requirement which also leads to methane emissions. Incentives to produce composts from manure which is dried and pelleted would reduce methane emissions released during manure storage and spreading, as well as enhance the manure's beneficial properties as compost, since it increases its nutrient stability.

How can efforts to mitigate methane emissions in agriculture be integrated into broader approaches to facilitate and incentivise climate and nature-friendly farming practices?

Better utilising **anaerobic digestion (AD)** on site would not only help reduce methane emissions, but also ammonia and nitrous oxide emissions (classified air pollutants). Better **compost management** would also reduce environmental pollution by reducing nutrient leaching and greenhouse gas emissions from compost production and storage. In the UK, agriculture contributes 69% of total nitrous oxide and 89% of total ammonia emissions. Since the Clean Air Strategy (2019) plans to reduce ammonia emissions by 16% in 2030, the changes suggested here would closely align with government policies.

Synthetic ammonia production – which is used to create synthetic fertiliser – uses 2% of global energy production, with 80% used in agriculture. Therefore, capturing ammonia and nitrates from waste sources to offset this should be

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[3] https://www.nationalgrid.com/stories/energy-explained/what-is-biogas#:~:text=Biogas%20a%20renewable%20fuel%20that's,where%20there%20is%20no%20oxygen.

prioritised. This could be done by composting manure products and utilising more organic forms of fertiliser (by producing fertilisers from AD digestate following biogas production) or by more closely monitoring nitrogen dynamics within farmland. This would ensure that only the amount of nitrogen needed would be applied and would enable identification of the most effective time for application to minimise nitrogen loss.

<u>How can efforts to reduce methane reduction be balanced against other important considerations in the agricultural sector, including food security?</u>

A whole system approach is needed to do so. For example, with the UK poultry industry, supermarkets are pledging to stop selling colony-caged eggs by 2025, which will mean current poultry sites must convert to barn production. This will incur costs for new equipment and facilities. However, strict permitting rules from the IPPC means it is difficult to get permission to expand poultry sites. This will inevitably cause an increase in egg prices, with a predicted increase of 40% to allow conversion to barn production facilities. Air cleaning systems that could help reduce this cost increase result in slurry production (a mixture of water and manure which is used as fertiliser) which is considered a waste product by the Environment Agency. Therefore, there is conflicting legislation / guidance between welfare and environmental impacts with regard to increasing the number of free-range poultry animals. Legislation must therefore consider all aspects of food production, so the UK can compete with international markets.

<u>What further progress could be made in the waste and waste management sector on reducing methane emissions? Are there interventions and/or technologies that could bring emissions down?</u>

In addition to the interventions already mentioned which could improve waste management in the agricultural sector, optimised anaerobic digestion could be used in other sectors including wastewater treatment, to reduce reliance on fossil fuels for energy production.

<u>Are there further methane reductions that could be made in the UK fossil fuels sector (e.g., oil, gas or other fossil fuels), or at a faster pace?</u>

Funding to support scientific research within the area would also see increased mitigation strategies be developed such as the use of methanotrophs (microorganisms that capture and use methane for energy) within industrial processes. Methanotrophs have been widely studied for their application in environmental biotechnology since these microbes have the natural ability to convert methane into usable fuel[4]. There are however still a lot of research gaps in this area therefore funding is needed to further study how methanotrophs can be used across industry to reduce methane emissions and reliance on other fuel sources.

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[4] *Ho, A., Kwon, M., Horn, M.A., Yoon, S. (2019). Environmental Applications of Methanotrophs. In: Lee, E. (eds) Methanotrophs. Microbiology Monographs, vol 32. Springer, Cham. https://doi.org/10.1007/978-3-030-23261-0_8*

One potential use of methanotrophs is to produce biogas, which is a renewable energy source produced by microorganisms that breakdown food and animal waste in the absence of oxygen. It can be used as vehicle fuel or as a natural gas replacement (and therefore used for processes that historically use natural gas such as cooking/heating etc).

Biogas energy has many advantages and its deployment would help in working towards several of the UN Sustainable Development Goals (in particular UN SDGs 7, 11 and 13, which relate to affordable & clean energy, sustainable cities & communities, and climate action accordingly). For example:

- The material used for producing biogas is called feedstock. Grasses are being considered as a potential feedstock for biogas production. Due to its low water consumption compared to other crops, and the ability to cultivate grasses in non-arable lands, this is a major benefit as it avoids biogas production being in direct competition with food crops. Although biogas production is limited by the characteristics of the feedstock, this could be taken care of via pretreatment procedures.
- Reducing waste – increasing waste is a growing problem as the world population increases. Using waste to produce biogas appears to be one of the most ecofriendly and promising solutions for waste management. Biodegradable waste types being considered as feedstock for biogas production include fruit peels and vegetables, tea leaves, tissue paper, eggshells, hair, leaves, dead flowers, and municipal waste.
- Farm animals generate huge quantities of manure, which can be used in a similar way to produce biogas or other biofuels, such as bioethanol[5].
- Research on using agricultural biomass to produce methane (the main component of biogas) is increasing due to the need to move away from the reliance on fossil fuels. An important next step would be investigating the methane productivity of different livestock waste types, both individually and when combined, in order to determine the most optimal mixing ratios of various slurries.

About Applied Microbiology International
Applied Microbiology International is solving some of the world's greatest challenges by bringing the applied microbiology community together, across borders and disciplines, to enable meaningful collaboration that delivers scientific impact. With a strong focus on influencing international policy, we are organised around seven core UN Sustainable Development Goals and encourage partnership between academia and industry to increase our impact. We are responding to this consultation since one of the seven UN SDGs we are supporting is UN SDG 13, Climate Action.

[5] https://www.researchgate.net/publication/353161700_Potential_use_of_piggery_excreta_as_a_viable_source_of_bioethanol_production