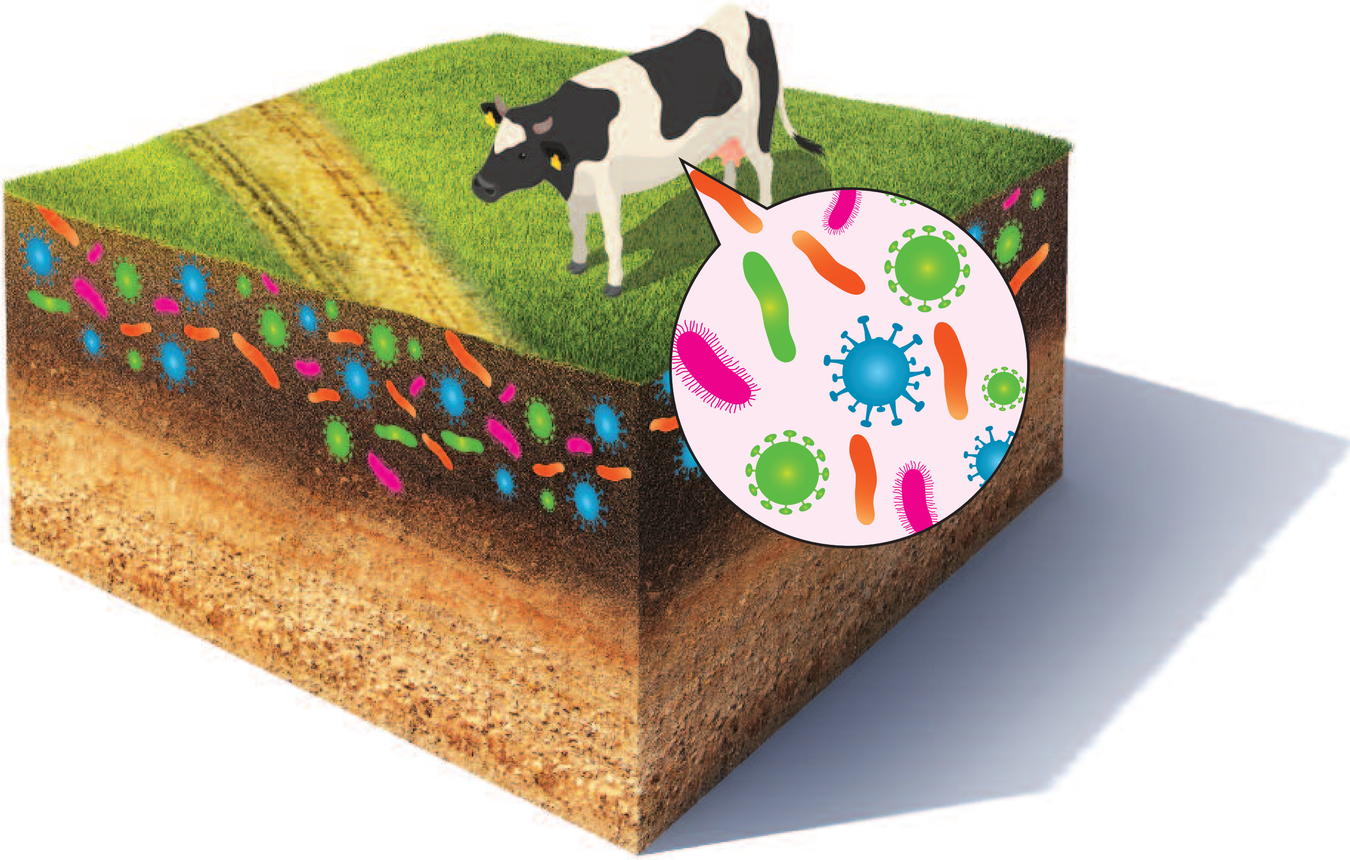

Harnessing the power of agricultural microbiomes

TEAGASC researchers recently hosted an international conference, entitled 'Microbiomes Underpinning Agriculture', that focused on the diverse roles played by microorganisms in agricultural systems, and on exploring what microbiome research can offer to agriculture.

Microorganisms are of fundamental importance to agricultural and food production systems; however, despite their significance, our understanding of how they function remains limited. New technologies enable researchers to better understand these organisms and exploit knowledge gained within agriculture.

Understanding agricultural microbiomes

Microorganisms play a critical role in agriculture, representing a key resource that underpins the agri-food sector. Soils, plants and animals all have a unique microbiome (the community of microorganisms living together in a given habitat) and these agricultural microbiomes perform an array of pivotal functions essential to system health, sustainability and productivity. An enhanced understanding of these agricultural microbiomes will provide opportunities towards managing agricultural systems in a manner that harnesses the natural power of microbes to provide solutions to global challenges of food safety and security, resource limitation and climate change, and move towards more efficient and sustainable food production systems. Up until relatively recently, insights into these complex microbial communities have been limited. However, the advent of novel molecular technologies has transformed this field, making it possible to study microbiomes in greater depth than ever before through DNA, RNA or protein analysis. This can tell us which microorganisms are present and what they are capable of doing.

Soil microbiomes

Soil microorganisms are critically important to agriculture, food production, and climate regulation. They are the engine of nutrient cycling in soils, playing an active role in soil fertility and nutrient provision to plants. The microbes in soil and on plant roots provide essential nutrients, vitamins and hormones to plants, and prevent pathogen invasion. Greenhouse gases result from microbial processes and understanding their function is key to reducing gaseous emissions that contribute to climate change. Research efforts on the soil microbiome are focused on determining the impact of management, environmental and climatic factors on the soil microbiome, and informing soil management so as to promote soil health, match nutrient availability to plant requirements, and harness the soil immune response to suppress pests and diseases. Knowledge of the soil microbiome is central to the development of sustainable agricultural systems by enabling a reduction in nutrient losses to the environment, increasing carbon sequestration, reducing agricultural inputs, and increasing the resilience of crops to extreme weather events.

Plant microbiomes

While it is generally understood that what you see above the surface typically represents only half of a plant's biomass, what may not be so well known is that microbes co-exist on and within plant structures. These microbes support the plant life cycle, are essential for nutrient cycling and can enhance a crop's performance against environmental change or in withstanding diseases. When it comes to food production, this is critically important. By 2050 we need to be able to sustain a global population of over 9.5 billion people with fewer resources while trying to combat the effects of climate change. Within the EU, this must be achieved within the context of legislation that controls the use of certain plant protection products. Using technologies that characterise a plant's microbiome it is now possible to identify individual 'crop profiles'. The research community is actively testing such profiles to identify strains that can be used by farmers to produce more from less: greater yields with better quality but with a reduced reliance on fertilisers and chemicals.

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Animal microbiomes

Animal microbiomes underpin livestock production. Ruminant animals lack the ability to digest herbage, relying instead on microorganisms within the rumen to ferment cellulose, and other plant components, into compounds that the ruminant can utilise for energy, and subsequently milk and meat production. Certain microbes are capable of influencing ruminant performance by altering rumen fermentation and outcompeting harmful pathogens. Populations of rumen microbes differ between animals, providing the opportunity to breed cattle for desirable microbiome traits such as improved feed efficiency, health and reduced environmental output. Exploiting this unique symbiotic relationship is key to sustainably meeting the growing demand for animal-based proteins, while reducing the ruminant contribution to global methane production. Current research is focused on better understanding the role of the host animal in regulating the rumen microbiome, as well as the impact of diet and prebiotics on rumen function and animal performance.

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Authors

Fiona Brennan
Soil Microbiologist, Soils and Land Use Department, Teagasc Johnstown Castle, Co. Wexford
Correspondence: fiona.brennan@teagasc.ie

Ewen Mullins
Principal Research Officer, Crop Science Department, Teagasc Oak Park, Carlow

Kaye Burgess
Senior Research Officer, Food Safety Department, Teagasc Food Research Centre, Ashtown, Dublin 15

Sinéad Waters
Senior Research Officer, Animal and Bioscience Department, Teagasc Grange, Co. Meath