How does your garden grow?

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Corn grown in coal waste is shown above corn grown in coal waste with added biofertiliser. Credit: Peter Leggo

Food and biofuel crops could be grown and maintained in many places where it wasn't previously possible, such as deserts, landfills and former mining sites, thanks to an inexpensive, non-chemical soil additive.

The additive, a simple mixture of organic waste, such as chicken manure, and zeolite, a porous volcanic rock, could be used to support agriculture in both the developed and developing world, while avoiding the serious environmental consequences associated with the overuse of chemical fertilisers. The mixture permits a controlled release of nutrients, the regulation of water, and an ideal environment for growing

crops.

Researchers from the University of Cambridge have demonstrated that with the addition of the biofertiliser, biofuel crops can be successfully grown and – more importantly, sustained - even on coal waste highly contaminated with metal residues.

Using coal waste from the site of a former colliery in Nottinghamshire as a substrate, the researchers grew rapeseed, flax, sugar beet and maize, with different additives: manure, zeolite, lime, or biofertiliser, as well as coal waste alone and regular garden soil. Plants grown in the coal waste with added biofertiliser achieved nearly twice the weight and yield of those grown in garden soil or in coal waste with added manure, and more than twice the weight and yield of those grown in coal waste with added zeolite. The results are published in the August issue of the *International Journal of Environment and Resource*.

The coal waste contains chemical elements that can be ionised by the biofertiliser, making nutrients which are essential to growth available for uptake by the plants. As the organic waste in the mixture decomposes, it produces ammonium ions which build up on the surface of the zeolite.

When the mixture is added to soil, it boosts the population of micro-organisms responsible for nitrification, which is essential for plant nutrition. The biofertiliser also helps plants develop dense root systems which stabilise the soil against erosion.

In addition to the coal waste, the team is working with marginal soils, such as those in desert climates, which normally require large amounts of water and chemical fertilisers in order for plants to grow. Control experiments have shown that water held in the zeolite increases the moisture content of soil in desert conditions. After initial watering, early-morning dew is held in the pores of the zeolite and released during the

hottest part of the day. Plants grown with the biofertiliser achieve greater weight, and in the case of fruits and vegetables, a better taste, than those grown with chemical fertilisers.

Nitrogen is critical for crop development, yet is deficient in many types of soil. Over the past century, chemical fertilisers have been used to boost nitrogen levels and crop yields, helping global food supply keep pace with population growth. However, this has come at a cost as they are detrimental to long-term soil health. Without a regular input of organic matter, soil microbial diversity decreases and the carbon concentration is lowered. The overuse of chemical fertilisers causes the soil to lose both its ability to hold water and its overall structure, leading to greater runoff and groundwater pollution. Nitrogen-rich fertiliser runoff is the primary cause of oxygen depletion in oceans, lakes and rivers, leading to aquatic 'dead zones.'

"This is a whole new approach to plant nutrition," says Dr Peter Leggo of the Department of Earth Sciences, who developed the material. "Previously, you'd douse crops with chemicals, and it's caused a huge reduction in soil microbial diversity. It has reached the stage that in certain parts of North America enormous dust bowls have developed as a consequence. The material we've developed takes less energy to produce, improves soil structure and enables you to grow crops on almost any type of soil."

The team has plans to commercialise the material where there are large deposits of zeolite, and export it to other markets. There are also plans to collaborate with charities and social enterprises to create sustainable farmland for small hold farmers in the developing world.

More information: The paper, 'Enhancing the Growth of Plants on Coal Waste Using a Biological Fertilizer' is available at www.ij-er.org/paperInfo.aspx?ID=2302

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