Putting farming on a sustainable footing is a huge challenge. A lot of attention is now given to direct carbon emissions from all sectors, but to be truly sustainable we also need to consider how we deliver nutrients to land. This will help mitigate greenhouse gas emissions from artificial fertiliser production, and ‘close the loop’ between vital nutrients which end up in waste food, sewage and slurry, and future food production. We also need to consider the supply of phosphorus, which is a finite resource with the potential to put serious strain on food production in decades to come.

Nutrients such as nitrogen, phosphorus and potassium are critical to plant life and therefore to all forms of food production. They are found in all of the potential feedstocks for AD, including food waste, slurry, sewage and purpose grown crops. WRAP has therefore been clear that “digestate is a valuable source of available plant nutrients, particularly nitrogen”.

**Artificial fertilisers**
- Globally, the production and use of artificial fertilisers are the largest single source of nitrous oxide, a greenhouse gas 310 times more damaging than carbon dioxide
- Making one tonne of artificial fertiliser takes a tonne of oil and 108 tonnes of water, emitting seven tonnes of carbon dioxide
- Emissions from the manufacture and delivery of nitrogen fertilisers account for an additional 14% of total greenhouse gas emissions from UK agriculture and 1.1% of the UK’s total greenhouse gas emissions

**Phosphorus Production**
Phosphorus is vital to food production. It is an essential macromineral for plants and often a limiting factor in many environments, i.e. the availability of phosphorus governs the rate of growth of many organisms. Phosphorus makes up around 12% of commercial fertilisers, and is irreplaceable.

The UK imported around 206,000 tonnes in 2007, with nearly 80% coming from four countries across North Africa: Morocco (estimated to supply around 50%), Tunisia, Algeria and Egypt. EU countries import 9% of the world’s phosphorus. 34% of this ends up in waste water and 80% of that is wasted.

According to a 2008 study, the total reserves of phosphorus are estimated to be approximately 3,200 MT. In 2008 phosphate rock experienced its first significant price shock – a 700% increase from $50/tonne to $350/tonne in just 14 months. 90% of global reserves is controlled by five countries: Morocco, China, South Africa, USA, and Jordan. America’s resource is predicted to run out by 2050, and China imposed a 135% export tariff in 2008.

Estimates suggested that the world could hit ‘peak phosphorus’ production of 28 MT/year in 2034. Dana Cordell, a senior researcher at the Institute for Sustainable Futures at the University of Technology in Sydney, said: “At current rates, reserves will be depleted in the next 50 to 100 years.”

Meanwhile, estimates predict the world population to rise to 9.1 billion by 2050. In 2010, an article in Foreign Policy said: “If we fail to meet [the challenge of making phosphorus renewable], humanity faces a Malthusian trap of widespread famine on a scale that we have not yet experienced. The geopolitical impacts of such disruptions will be severe, as an increasing number of states fail to provide their citizens with a sufficient food supply.”

**The Role of AD**
Digestate from the AD process retains the nutrients – including phosphates – from the input material which would otherwise be lost, allowing it to be returned to land as a biofertiliser. This is something which is technologically ready, and already happening. Professor Brian Chambers has called for an expansion of AD for this purpose, saying that “the technology and understanding is advanced enough to increase phosphate recycling”.

Typical values for nutrients in digestate are:
Nitrogen: 2.3 - 4.2 kg/tonne
Phosphorous: 0.2 - 1.5 kg/tonne
Potassium: 1.3 - 5.2 kg/tonne

The nutrients are considerably more 'bioavailable' than in raw slurry, which is often spread to land without processing, meaning it is easier for plants to make use of the nutrients.

WRAP has calculated that the nutrient value alone from unavoidable food waste in the UK alone is worth around £50m. The nutrients in all waste are therefore worth around £200m, and the value of digestate as a low carbon, renewable fertiliser is likely to be higher still as the market develops.

Returning nutrients in waste to land – rather than wasting them in landfill or incineration – is critical to the future of food production and sustainable farming. As a driver for AD development, this has often been secondary to energy production and waste management, but is likely to take on ever-greater importance.

It is also a strong argument for maximising the contribution of purpose grown crops (PGCs) in AD as a form of bioenergy which – unlike most others – returns nutrients to land and supports food production. PGCs can also help soil quality and nutrient levels more widely by being grown as a break crop in agricultural rotations.

Policy Implications

The clear benefits of returning nutrients to land need to be much better recognised in the government's waste policy. It is clearly wrong to be sending the nutrients in biodegradable waste to landfill, and the UK government should implement a ban on biodegradable waste going to landfill by 2020. Having recognised that AD realises the "greatest environmental benefit" of any treatment for food waste, they should also give clear guidance to local authorities that organic waste which cannot be eaten should be source segregated and prioritised for AD.

Government should also set up a proper framework of support for bioenergy, which recognises the value of purpose grown crops in AD in improving soil quality, returning nutrients to land and supporting food production.