Could current agricultural practice be tailored to combat climate change?

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Manmade emissions of greenhouse gases such as carbon dioxide and methane have resulted in considerable increases in global atmospheric concentrations of carbon, which have modified natural carbon cycles. Such changes to the carbon cycle can influence and alter numerous global systems. For example, increases in carbon input to the oceans, absorbed from the atmosphere, can have an acidifying effect as carbon dioxide dissolves into water to create carbonic acid, changing the existing pH of oceans which may be harmful to marine life. More famously, atmospheric carbon concentrations also have the potential to influence climate systems as increasing levels of these greenhouse gases enhance radiative forcing, increasing global temperatures.

Warming of the world's climate is now unequivocal. This is driven by changes to the existing balance between incoming energy in the form of radiation from the sun and what portion of that energy is returned back to space. Radiation from the sun is in part absorbed by the Earth's surface and then re-emitted as infrared (long-wave) radiation. This infrared radiation is largely absorbed by certain atmospheric greenhouse gases, which in turn re-emit radiation in all directions. The radiation re-directed downwards serves to heat the lower layers of the atmosphere and the Earth's surface, which is commonly referred to as the 'greenhouse effect'. Thus, as concentrations of these greenhouse gases increases, then the proportion of radiation which can escape our atmosphere decreases and global temperatures rise accordingly.

Greenhouse gases are natural and essential components of the atmosphere, which govern global climate and serve to make the Earth habitable for life. However, changes in greenhouse gas concentrations do have significant influence on climate. Recently concentrations of atmospheric carbon dioxide passed 400 parts per million, which is seen by many climate scientists as a significant milestone and represents levels which are higher than at any other time in human history.

Environmental responses to the change in atmospheric carbon concentrations are difficult to precisely predict due to the complex and chaotic nature of the climate system and due to the influence of interacting factors such as deep ocean temperature which remain poorly understood. Increases in global temperature is expected to manifest as greater frequency of extreme weather events, which could have sizable implications for industries such as agriculture. In addition, increased availability of atmospheric carbon dioxide may have unexpected influence over plant growth and health as greater availability may augment rates of photosynthesis and therefore primary productivity, which is referred to as carbon fertilisation. However, this effect may be limited as it is dependent on the availability of other resources, such as nutrients.

Why is this important?

The effects of climate change are already being witnessed around the globe. From widespread decline of coral reef systems such as the Great Barrier Reef in Australia as a result of rising sea temperatures and acidity, to reductions in sea ice extent and global averages for glacial ice coverage. These indicators may seem far removed from UK ecosystems, however these serve as bellwethers of global environmental change, the like of which is unprecedented. Closer to home the effects of

climate change are expected to be characterised by increasingly unpredictable weather patterns, particularly rising temperatures and changes in patterns of precipitation. This is very likely to have physical and economic influences on UK agriculture.

For the future, there is a great and pressing need to reduce atmospheric carbon concentrations, both via reductions to gaseous emissions and also through capture and sequestration of existing atmospheric gas. As temperatures rise, the melting of sea and land ice sheets becomes increasingly inevitable, resulting in consequent sea level rise. Perhaps of greater concern is the potential for positive feedback mechanisms to increase the rate of change in natural systems beyond which human influences have already done so. As an example, the melting of permanently frozen soils (permafrost), which cover a large proportion of high latitude regions of the globe, can release significant amounts of methane (which is a more potent greenhouse gas than carbon dioxide) from deposits formerly trapped in the frozen soil or via the decomposition of organic matter as it begins to thaw. This effect constitutes a positive feedback as increasing temperature results in greater methane release from thawing soil, which results in further increases in temperature. Even water vapour, which is a less well recognised but also important greenhouse gas, has atmospheric concentrations which are directly dependent on Earth's temperature. As temperatures increase, more water vapour is created through evaporation from the oceans, amplifying the warming effect.

The point where any of the above mechanisms (there are also others which are not mentioned here, such as the perturbation of ocean currents) would constitute what has been referred to as a 'tipping point', whereby the effects of climate change further increase climate change, until ultimately there is a irreversible transition to an alternative climatological state, remains debated and controversial. How close we are to such an event is unclear, but what currently is certain is that this outcome has the potential to be avoided should appropriate measures be taken.

How can agriculture help?

In simple terms, management must focus on reducing atmospheric carbon concentrations whilst limiting the emission of additional greenhouse gases. In the context of agriculture, this could be achieved by increasing carbon input and reducing carbon loss from soil, and by improving carbon sequestration in live vegetation biomass by increasing on farm resources of vegetation such as hedgerows and trees.

The Glastir Small Grants and Glastir Woodland Creation schemes are examples of initiatives to increase farmer involvement in reducing atmospheric carbon concentrations. These schemes are designed to increase the potential for agricultural carbon sequestration by increasing the resource of trees and shrubs on farms, which absorb carbon dioxide as they grow removing carbon from the atmosphere and incorporating it into vegetation biomass.

Vegetation absorbs carbon from the atmosphere during photosynthesis and retains that carbon in tissue. Trees can approximately incorporate in the region of up to 3 tonnes of carbon depending on species, which although could be considered small in comparison to current UK carbon emission rates, when considered alongside other environmental and ecological benefits of such an approach this presents an opportunity to influence climate change through relatively uncomplicated and easy to initiate land management practices.

Combating climate change is potentially the greatest challenge facing humanity and in tackling this issue the agricultural industry has the potential to take a leading role. Nevertheless, whilst measures

such as tree planting to sequester carbon are important, these remain only a part of the picture. Fundamentally, if a meaningful attempt to reduce or eliminate the impacts of climate change is to be made, then this must begin with reductions in the emissions of carbon and greenhouse gases to the atmosphere, from industry and land use change.