Forum: Nothing new under the greenhouse - A historial turn around the carbon cycle

GEORGE DYKE

In 1843, John Bennet Lawes, scientist, entrepreneur and farmer, founded the Rothamsted agricultural research station at Harpenden in Hertfordshire (now part of the Agricultural and Food Research Council's Institute of Arable Crops Research). It is less well know that Lawes later became one of the first to realise that agriculture and coal burning were likely to increase the concentration of carbon dioxide in the atmosphere.

In 1864, Lawes gave a lecture to the Royal Dublin Society entitled 'On the chemistry of the feeding of animals for the production of meat and manure'. After remarking that farm animals convert 'crude vegetable products (into) that which is necessary for the luxuriant growth of cereal grain .. ', he continued:

'Were it not for such compensations, by the increase of man and other animals upon the surface of the earth (if it could take place at all), and by the enormous quantities of carbonic acid evolved into the atmosphere from the combustion of coal and from other sources, and by the gradual destruction of forests, which are the chief natural agents for restoring the balance, the purity of the atmosphere would become affected. But the grasses, which supply so large a proportion of the food of beasts, and the cereals and the other plants of the same great family, which supply food to man in almost every climate, serve to re-use the carbon given into the atmosphere in the form of carbonic acid.

‘It may seem at first sight strange that the humble grasses, and the corn crops, reaching only a few feet from the surface of the ground, should be able to take up more carbonic acid, and evolve more oxygen, over an acre of land than an acre covered with forest trees. Still there can be little doubt that more carbon is fixed in an acre of luxuriant wheat than over the same area of woodland; and there can be as little (doubt) that an acre of sugar cane would fix more than an equal area of the most luxuriant tropical rain forest.’

In 1881, in a paper in the Philosophical Magazine, 1, (5th series), p 206, entitled ‘On the formation and decomposition of carbonic acid’, he published firm estimates for the amount of carbon given off in Britain as carbonic acid per acre per annum.

——————————— By coal 3942 lb By imported products 300 lb By home-grown products 1275 lb Total 5517 lb ———————————

At this rate, Lawes calculated, if there were no circulation of the atmosphere, the amount of carbon dioxide in the air over Britain would be doubled in three years.

He then discussed the amount of carbon dioxide fixed by plants; where land is losing fertility (which Lawes equated almost completely with organic matter) inevitably more carbonic acid is produced than is absorbed. Land laid down to grass, however, steadily adds to the fixed carbon of the soil.

Then he considered the amount of carbon in the ocean (which, he said, also contained ‘large quantities of nitric acid’). ‘There may be a corresponding increase of organic carbon in the ocean, and in this way the balance may be kept up.’

Lawes used recent analyses by Sir Edward Frankland (professor of chemistry at the Royal Institution) to show that, to a depth of about 1400 metres, ‘which is less than half of the estimated average’, the amount of organic carbon per unit area in the sea was about three times as much as the carbon, in the form of carbon dioxide, in the atmosphere about the same area. ‘When we consider the immensity of the ocean, it is evident that the operations of animal and vegetable life in it must have a vast influence upon our atmosphere, of the value of which we appear to be altogether ignorant.’

There were prophets of doom around by 1899, when Lawes wrote to Sir Henry Gilbert: ‘The assimilation of carbon is a very important subject as there are people who are already predicting a dearth of oxygen owing to the destruction of woods.’

Lawes was aware that nitrate was wasted if it was leached down beyond the range of the roots. The rapidly developing agriculture of the US drew his attention to maize, and he soon saw that, with its prolonged growing season, it could absorb and use nitrate (‘nitric acid’, he wrote) formed in late summer when soil conditions favoured nitrification but when the roots of wheat would be dead (the reference comes from an offprint in Rothamsted Library; the original is probably in Rural New Yorker or Albany Cultivator). But, even without maize, farmers in England would lessen the losses of nitrate substantially; Lawes estimated in the American Naturalist that amounts of nitrogen ‘washed away’ (in pounds per acre) were as follows:

——————————————— From soil without vegetation 40 ————————

——————————————— From soil with wheat (15 lb retained by crop) 25 ——

——————————————— From soil with wheat and seeds (eg timothy,

clover and rye-grass; 15 lb retained by wheat, 25 lb by seeds) 5 ——————————————————

Lawes’s substraction sum seems to have gone a bit wrong, but his message is clear.

George Dyke is author of John Bennet Lawes: the record of his genius, published recently by Research Studies Press. He worked at Rothamsted for 25 years, retiring in 1981.