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The hidden costs of carbon sequestration

Globally, soils contain about twice as much carbon as the atmosphere, so it is small wonder that there is much interest in seeing if soil can be used to sequester more carbon, offsetting man-made emissions of carbon dioxide (CO2) to the atmosphere.

Indeed, carbon trading schemes that involve sequestering carbon in the soil have already been set up in many places around the world.

Although many grain growers are enthusiastic about trading in soil carbon, scientists involved in agricultural greenhouse accounting have generally been cautious.

TABLE 1 VALUE OF N, P AND S LOCKED UP PER TONNE OF HUMUS

	Amount (kg)	Price/kg ($) spread	Approximate cost ($)
N	60	2	120
P	12	5	60
S	9	2	18
			≈ 200

Not only is it difficult to increase the amount of carbon stored in cropped soils – even with no-till and when large amounts of stubble are retained – it is also very difficult to quantify any change in the amount of carbon stored, a necessary requirement under the carbon-trading rules of the Kyoto Protocol.

There is also a further major, and not widely recognised, problem: to store carbon (C) stably in the soil, you need considerable amounts of nitrogen (N), phosphorus (P) and sulfur (S), in addition to that needed for crops. Humus, the stable soil organic matter arising from the breakdown of crop residues, contains – as essential structural ingredients – large amounts of N, P and S. Humus will not build up in soil unless adequate amounts of these nutrients are available.

In humus the ratios of C to N, P and S vary a little, but are approximately: C/N = 10, C/P = 50, and C/S = 65 – roughly similar to the elemental composition of the soil microorganisms that create it. The ratios in cereal-crop residues are about five times larger for N and about 10 times larger for P and S. Thus, without additional N – and especially additional P and S – about 90 per cent of these crop residues are typically returned to the atmosphere as CO2 within a year or two as the microorganisms digest them on the way to form humus.

Humus contains about 60 per cent carbon, so that every tonne of it contains 600 kilograms of carbon (equivalent to 2.2t CO2), and about 60kg N, 12kg P and 9kg S. Given that these amounts have to be locked up for as long as the carbon is stored, the question arises of what is the value of these required nutrients? The simplest assumption is that their value equals the cost of replacing them with fertiliser, as illustrated in Table 1.

Carbon trading is normally based on a tonne of CO2 equivalent, of which there are about 2.2 tonnes per tonne of humus. Thus, if the trading price for CO2 is, say, $20/t, then humus would be worth $44/t. This is but a quarter of the estimated value of nutrients locked up, as shown in Table 1.

Although humus does slowly break down, thereby releasing some of the nutrients it contains, any that does break down must be replaced if carbon credits are to be maintained, once again tying up the equivalent of the nutrients that were released.

Given the complexity of nutrient cycles, the multiple roles of organic matter in the soil and the uncertainties surrounding future fertiliser and carbon prices, this estimated value could easily be out by a factor of two. Nevertheless, it casts considerable doubt on the viability of carbon trading schemes based on humus, the stable fraction of soil organic matter.

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