Using compost to build and maintain soil carbon

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Introduction

It is widely recognised that maintaining higher levels of organic carbon improves soil structure, health and function. Increasing soil carbon is also seen as a way to achieve carbon abatement /sequestration, but there is some uncertainty about how much soil carbon will remain in the soil under farming systems, particularly if drying climate trends continue. Land management practices, soil types and periodic climate extremes can make it difficult to build and maintain soil carbon levels in many parts of Australia. This is particularly the case on dryland cropping land, lighter soils and in areas with variable rainfall and extended dry periods.

The challenge of building and maintaining soil carbon

Labile forms of carbon from retention of stubbles and other residues as well as the use of cover crops and green manures can build 'short term' soil carbon stocks but these can be rapidly depleted with tillage, fertiliser application and/or extended dry periods. The rate at which labile carbon is converted into more stable humic and fulvic compounds and humins *in situ* is generally low and not always reliable. This makes it more challenging to be confident that such practices will result in long-term carbon abatement and those wanting to claim 'carbon credits' for such abatement have the risk of not being able to maintain target levels of soil carbon under extended dry periods.

Composting converts labile carbon to more stable forms

Composting is a controlled, aerobic and thermophilic process that uses natural biological processes to heat compost piles to >55°C for extended periods. In addition to pasteurising materials and building beneficial microbial populations, thermophilic composting converts labile carbon into more stable forms of organic carbon. In addition to concentrating these compounds already present in the cell walls of degraded organic matter, the main thermophilic bacteria, as well as *Actinomyces* and other common composting bacteria and fungi also produce humic/fluvic compounds and humins in their own cell walls. This means the thermophilic composting micro-biota convert a high proportion of 'fast' forms of carbon in sugars and starches into 'slow' and more stable forms. This does not happen to a great extent for organic materials biodegrading at lower temperatures. Matured thermophilic composts typically have organic carbon levels of 30-40% be weight, and in the order of 80% of this can be in more stable forms. This means compost can provide a concentrated source of 'slow' carbon that can be used to build and maintain soil carbon.

Degradation rates and accumulation of slow carbon

Stable carbon in composts can build and maintain the levels of 'slow' carbon in soil. With appropriate land management (such as reduced tillage, stubble retention, pasture phases, cover crops, green manures and more efficient application of nitrogen), a significant portion of this carbon can persist on the soil for decades. The compost also contributes to soil health and function, leading to improved plant growth and productivity. This increases the capacity of soils to grow and hold carbon.

Figure 1 shows modelled degradation curves for slow carbon in compost. This shows that between 30-55% of slow carbon in compost can be expected to be present after 25 years, and 1-10% after 100 years. The rate of degradation will depend on land management practices, soil type and climate, but slow carbon be expected to persist longer than labile carbon grown *in situ*.

Figure 1: Modelled degradation of organic carbon (OC) from compost application

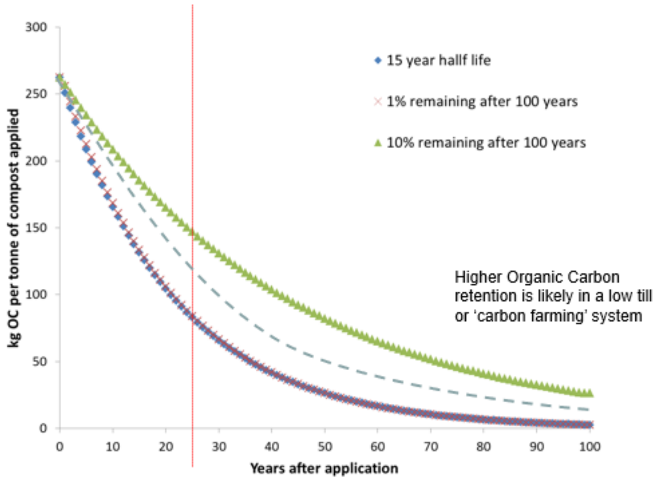
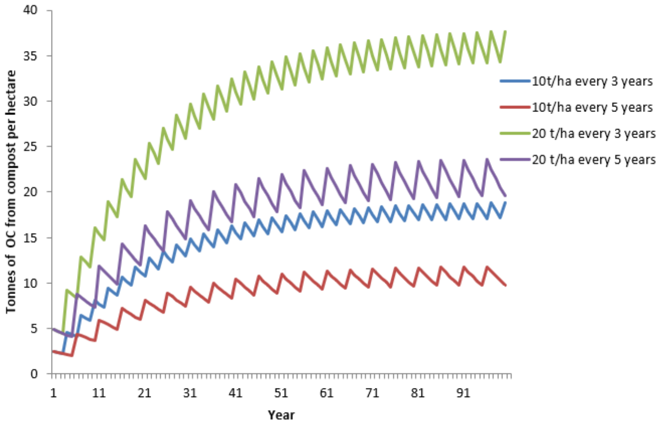


Figure 2 shows modelled accumulation of carbon in soils from repeated periodic application of compost. This shows increasing stocks of carbon from compost, not including other sequestered carbon from improved plant growth and soil function.

Figure 2: Modelled cumulative effects of periodic compost application on soil organic carbon content



Sourcing mature thermophilic compost

The *Australian Standard for Composts, soil conditioners and mulches* (AS 4454-2012), specifies the minimum quality management systems and product attributes for a range of composted products. At a minimum AS4454-2012 compliant compost will have undergone thermophilic processing and will contain a high level of more stable organic carbon. AORA members meet AS4454-2012 standards and can provide suitable products for building and maintaining soil carbon.

Potential sequestration from compost

Compost needs to be used with other 'carbon farming' practices such as reduced tillage, residue retention, cover crops and pasture phases. One tonne of thermophilic compost will typically contain at least 200-250kg of slow carbon. With good soil management, over 50% of this can be expected to be present in the soil after 25 years, and 5-10% after 100 years. This does not include the synergistic soil carbon benefits that composts contribute to by improving soil depth, structure and plant growth. Australian Carbon Credit Units s are currently valued at $14/t CO_2-e.

Modelling suggests the value of the carbon 'in' compost for a soil carbon project with a 25-year permanence period is in the order of $7 per tonne of compost applied. This will not cover the cost of using compost, but can make the use of compost viable where it was previously marginal.

Other benefits of compost

Using compost can also:

- improve soil quality and productivity
- improve soil structure
- improve soil depth and organic carbon down the soil
- increase nutrient availability
- increase plant-available water.

Compost has been shown to increase both crop quality and production and decreasing the level of irrigation and fertiliser inputs needed. Compost can also improve soil structure and this helps to moderate against unexpected fluctuations in temperature and moisture levels that can cause plant stress and crop failure. Improved plant growth can also boost soil carbon.

Conclusions

Repeated application of thermophilic composts will help to build and maintain soil organic carbon levels when combined with other 'carbon farming' practices. Composts can also improve the function and productivity of soils, and increased soil depth and improved plant growth will also help to build and maintain soil carbon.

AORA members can supply AS4454-2012 compliant compost products with known quantities of organic carbon.

aora australian organics recycling association

The Australian Organics Recycling Association works on behalf of its members to raise awareness of the benefits of recycling organic resources. It aims to act as an advocate for the wider organics resource recovery and beneficial reuse industries and to represent their views in a constructive dialogue with policy makers. The Association envisages an industry in which best practice is shared, standards are maintained and surpassed, and makes a positive contribution to safeguarding the environment. The Association consists of a national body represented by a Board. State divisions operate in defined geographical areas (e.g. states or territories of the Commonwealth of Australia) and manage their operations appropriately for their region. The AORA Board provides coordination across the divisions and a means of addressing state and national matters as well as being the administrative managers of the business.

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