Plantstone carbon opportunities for grain farmers

By Dr Jeff Parr[1] and Professor Leigh Sullivan[1]

We have recently discovered that a process, which occurs naturally in plants (especially grasses such as sugarcane, wheat, rice, tall wheat grass and so on), can be used by farmers to play an important role in countering CO_2 emissions and global warming.

This process is termed 'plantstone carbon'.

Our research shows that plantstone carbon has been extracting around 300 million tonnes of CO_2 every year from the atmosphere and storing it securely for thousands of years.

What are plantstones?

Plantstones form as microscopic grains of silica in plant leaves of pastures and crops such as wheat and sorghum (Figure 1a). During plant growth a small proportion of organic carbon becomes encapsulated within the microscopic silica grains (Figure 1b).

Regardless of whether the plant dies, burns, is eaten, or is harvested, the carbon entrapped in the plantstone is highly resistant to decomposition. So unlike most plant matter, which readily decomposes and returns CO_2 to the atmosphere, the carbon in plantstone effectively removes CO_2 from the atmosphere.

The plantstone process indicates that the crop and pasture choices made by farmers every year make a major contribution to the reduction of CO_2 from the atmosphere.

It also indicates that this process could create new additional income streams to farmers from trading the carbon that is stored in the plantstones their crops and pastures produce.


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Crop type and plantstones

Our research in plantstone carbon yields from agricultural crops has shown that different plant types produce greatly varying amounts of plantstone carbon. Some crops have been identified as producing over 1000 times more plantstone carbon than other crop types. Moreover, varieties within a single crop type, such as wheat and sorghum, have been

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found to produce widely differing quantities of plantstone carbon.

This indicates that farmers' decisions of choice of crop type and/or cultivar have a considerable impact on the amount of CO_2 extracted from the atmosphere and securely stored in their farm's soil.

Importantly, it demonstrates that careful selection of the cultivars of the crops that grain farmers intend to grow will result in considerably different amounts of plantstone carbon produced and hence considerably different amounts of potentially tradable (and valuable) carbon.

Whilst the latest plantstone research shows that sugarcane is the clear cham-

FIGURE 1a: Plantstones (also referred to as phytoliths or plant opal) are microscopic silica structures formed within plants as a result of silicic acid $Si(OH_4)$ uptake from soil

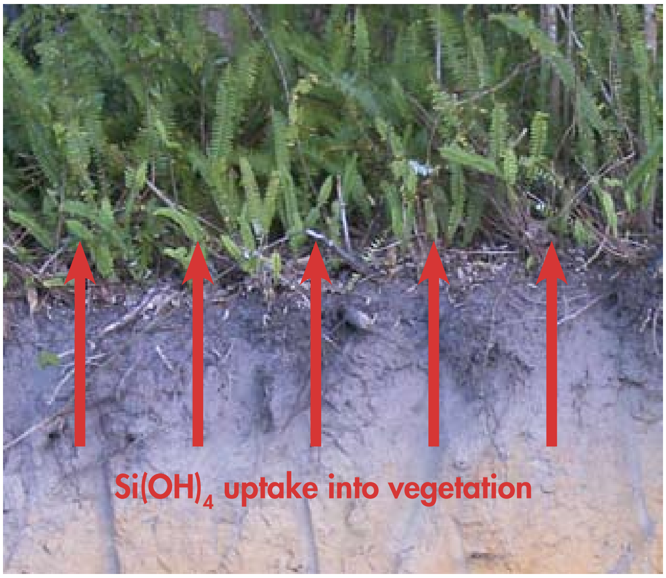
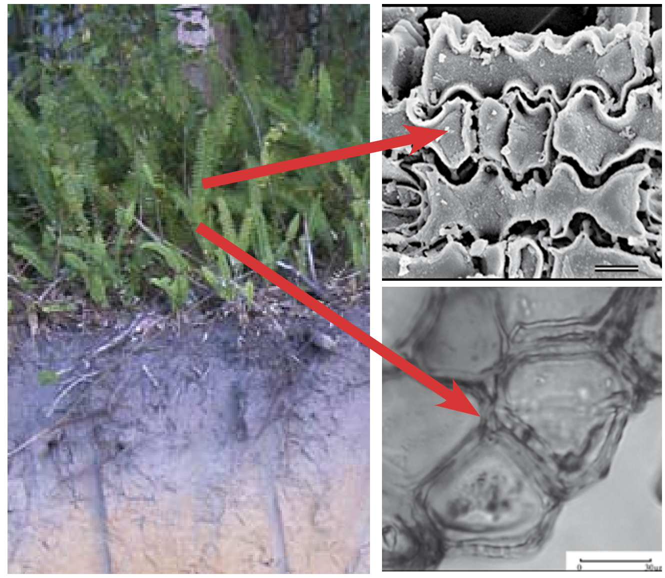
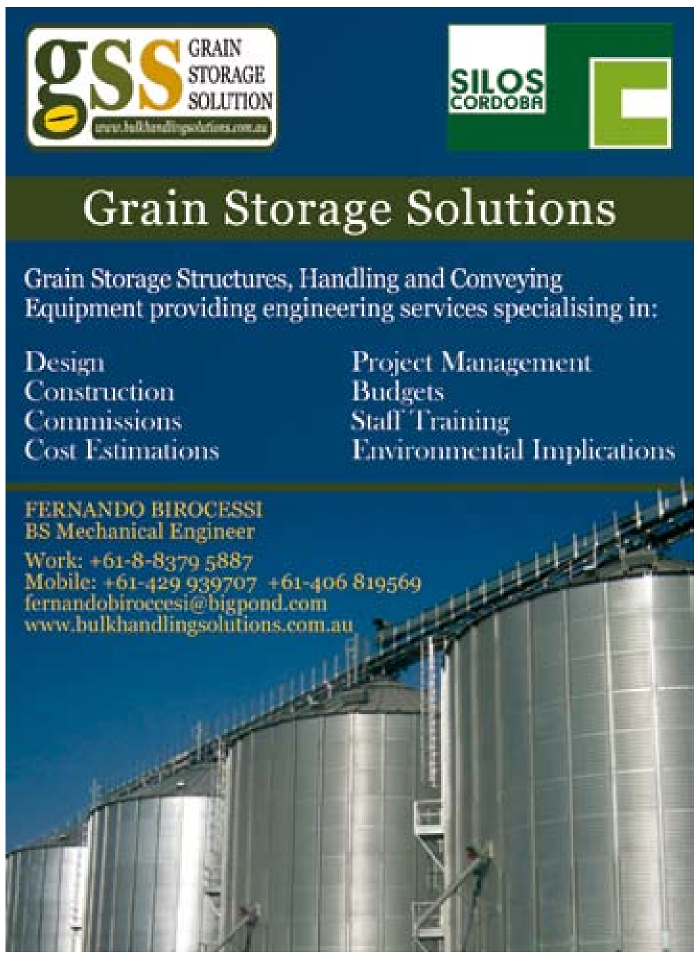


FIGURE 1b: This soluble silica moves throughout the plant eventually cementing cell walls, forming thick coatings of silica opal within the leaves and stems of the plant





pion crop at carbon sequestration (for example, sugarcane can sequestrate up to 0.66 tonnes of CO_2 per hectare per year in plantstones), this technology is also very relevant for the grains industry.

This means the benefits that farmers provide to society are not just limited to the more obvious benefits such as the grain, fodder or meat they produce, but also to the environmental services that they provide by locking up carbon in the plantstones that their crops and pastures produce.

Increasing carbon sequestration by plantstones is by no means limited by a need to change the types of crops that a farmer grows. It can be business-as-usual by simply choosing to grow a higher plantstone carbon yielding cultivar of a particular crop to enhance carbon sequestration on the farm.

For a sugarcane farmer, the relatively simple decision to choose to grow one cane variety instead of another can result in an extra 0.5 tonnes of CO_2 per hectare per year being securely sequestered in the soil inside plantstones.

Same technology for grain crops

The same technology also works well for grain crops. For example, for wheat farmers the data is also promising indicating that the relatively simple decision to choose to grow one wheat variety instead of another could result in an extra 0.1 tonnes of CO_2 per hectare per year being securely sequestered in their soils inside plantstones.

Although these amounts are relatively small compared to the carbon sequestration rates that can be achieved in the short term (reforestation for example), the carbon locked away in plantstones is very securely stored and is not subject to loss back into the atmosphere as CO_2 from burning, disease or conversion of forested land back to agriculture.

Globally this extra 0.1 tonnes of CO_2 per hectare per year being securely stored away inside wheat plantstones represents the potential to reduce global CO_2 emissions by around 20 million tonnes of carbon dioxide equivalent (e-CO_2) every year.

Even at the relatively low currently suggested Australian carbon trading prices of $20 per tonne e-$CO_2$ for 2010, this plantstone carbon process has the potential to offer the global wheat industry a new revenue stream worth potentially $400 million per year. This is essentially an additional, and previously unrecognised, environmental service that the wheat industry provides to society.

Similar values apply to other grain crops and pastures.

In addition, the potential value of this process that applies to existing crop varieties could be substantially increased by targeted plant breeding for this crop trait.

No yield penalty

Importantly, the research to date shows that there are no crop yield penalties involved in choosing to grow high plantstone carbon yielding cultivars over low plantstone carbon yielding cultivars.

For grain crops such as wheat and sorghum (for which there are readily available data), some of the highest yielding cultivars currently grown are also those that produce the greatest amounts of plantstone carbon.

What soil types?

This technology will be suited to most agricultural soils in Australia. Additionally the effect of different soil types on the plantstone carbon yield is likely to be far less important than the type of crop grown.

This is partly because some crops are known to take up large amounts of silica from the soil (over 15 per cent of the dry

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weight of some of these plants can be silica), whereas others plants take up very little silica from the soil. Furthermore, silicon is the second most common element in the earth's crust, and in Australian soils silicon deficiencies have only been recognised infrequently.

Finally, the stability of plantstones is greatest in the pH range of most Australian agricultural soils – it is only when the pH is very alkaline (such as pH greater than 8.5) or very acidic (pH less than 2.5) that the solubility of phytoliths starts to increase.

Soil remediation

For degraded land such as salt scalds the research to date shows that there are also clear opportunities to enhance plantstone carbon yields by remediation of appropriate salt tolerant vegetation. In these situations the use of high plantstone carbon yielding vegetation, such as tall wheat grass, will maximise the amount of secure carbon sequestration whilst not diminishing the other benefits provided by saltland remediation vegetation.

Features for the grains industry

- Plantstone carbon is easily quantified before the crop is harvested – this bypasses the main problem hindering the entry of soil carbon for carbon trading within agricultural industries.
- Farmers can participate with minimal changes to their farming practices. The use of this technology is as simple as choosing the best cultivar to grow for any of the existing crops they grow.
- The technology is fully compatible with other agricultural management practices used to enhance soil carbon sequestration.

Upon implementation of carbon trading systems – as are currently being examined by governments – it is hoped that incentives will be provided to farmers to grow high plantstone yielding crops, crop varieties and remediation vegetation.

Carbon trading systems should, if implemented appropriately, result in farmers having the potential to earn additional income from carbon sequestration without detracting from existing income streams.

Plantstone carbon research is developing powerful tools to counter global CO_2 emissions and is providing farmers with the opportunity to play an even greater role in the fight against global warming and climate change.

1. Both authors are researchers from Southern Cross University and Plantstone Pty Ltd in Lismore, NSW Australia. ■

PNG: FIRST CONTACT

The initial discovery that carbon is tied up in phytoliths (plantstones) – and locked away from decomposition and subsequent return to the atmosphere – was made when analysing soils from Papua New Guinea.

Jeff Parr and Leigh Sullivan were looking at soil/sediment profiles over the past 4000 years. The scientists were radiocarbon dating the plantstones down the soil profiles to determine the age of the profile at that point and the existing vegetation.

They also compared the plantstones within 200-year-old PNG soils with soils buried 400 to 4000 years ago by a layer of volcanic ash (see opposite). This ash would have prevented the addition of any more organic matter to the soil below the ash layer.

They discovered that the longer a soil had been buried the greater the proportion of carbon contained in the plantstones compared with the rest of the soil. This indicates that other carbon sources, such as humus, release carbon dioxide more rapidly than the plantstones.

Garnaut and agriculture

Farmers escaped the pain of carbon taxing in July's release of the federal government's Carbon Pollution Reduction Scheme Green paper. They now have five years grace to come up with a workable way of estimating emissions from cropping and grazing. The reality is that the agricultural sector is a big polluter, second only to power stations, and it will eventually have to come to the emissions trading party.

But it isn't going to be easy. Gases from cows, soil and trees are much harder to measure and police than what comes out of a smokestack. Scientists are working hard to make sure that by 2013 the farming sector will be able to reduce and trade emissions and still thrive.

In the meantime, the Garnaut *Climate Change Review* has just released its Supplementary Draft Report. This report provides the Review's proposals for emissions reduction trajectories and targets.

The report suggests Australia should aim to initially limit emissions to no more than 550 parts per million (ppm) CO_2-equivalent. To reach the goal of 550 ppm the report states Australia would need to reduces its greenhouse emissions by 10 per cent by 2020 and by 80 per cent by 2050 over 2000 levels.

Agriculture and emissions trading

Snow Barlow, Professor of Horticulture and Viticulture at The University of Melbourne comments on the report.

"No pain, no rain ... Professor Garnaut had it right in his analysis of the potential impacts of inaction in climate change. This interim report is an excellent basis to develop policy action that may put the nation on the 'high' road to low emissions.

"While the report advocates comprehensive coverage it reserves its decision on agriculture on the grounds of measurement and transaction costs and appears to have dodged the methane 'problem'.

"Australian agriculture must address methane regardless of how agriculture is eventually included in a trading scheme, either directly or in an 'upstream' manner. Methane from ruminant animals is second to power generation in terms of our national emissions and must be addressed by the research and development mechanisms.

"In an increasingly hungry and affluent world seeking animal protein, methane from animals is worthy of global, extensive research and one which may help us in our competitive position. The global food equation is going to get much tighter as we value carbon in this way because of increasing competition for land."

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