Farming with rock dust could boost crops, buffer climate

Spreading crushed limestone is already common practice for farmers. Now researchers are investigating whether crushed calcium silicate rock could offer crop gains and climate benefits.

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Instead of lime researchers are experimenting with wollastonite, an alkaline rock mined near Kingston.

If you've spent years picking stones from your fields, the idea of putting more rock onto the land might sound balmy. But if that rock is crushed calcium silicate, researchers say the payoff could be improved soils, higher yields, and more carbon in the ground with fewer green-house gases in the air.

That's the concept behind 'enhanced weathering' (EW). The approach mimics the soil-building process that converted rock to soil over thousands of years. EW fast-forwards the breakdown by crushing rocks that are rich in calcium, silica and magnesium and spreading the dust on fields. The technique is akin to spreading agricultural lime, but with greater climate dividends, says University of Guelph environmental engineering professor Rafael Santos.

Along with fellow engineering professor Emily Chiang, Santos is experimenting with wollastonite, an alkaline rock mined near Kingston. It's typically a mix of silicon and calcium, with smaller amounts of magnesium, iron, potassium and sulphur and traces of nitrogen, copper, manganese and zinc.

When crushed and incorporated into the soil, wollastonite's calcium and magnesium react with soil water, drawing carbon dioxide from the air and converting it into stable inorganic carbon. The process is quick enough that Santos and Chiang's team could measure additional carbon accumulating in the soil during a 14-week alfalfa trial.

The climate payoff also looks promising. Santos' conservative estimate is that every tonne of wollastonite sequesters something like three-tenths of a tonne of solid inorganic carbonates in the soil.

Throw in the impact on plant growth, and wollastonite's carbon sequestration looks more impressive. In 1999 researchers at the US Forest Service's Hubbard Brook Experimental Forest applied 3.4 tonnes per hectare of wollastonite to almost 12 hectares of New Hampshire hardwood bush.

The experiment focused on restoring calcium to the soil. But it had a happy side-effect: during the next 15 years, the weathering of the wollastonite and the additional growth of the bush netted somewhere between 8.5 and 11.5 additional tonnes of carbon dioxide per hectare in the soil.

Wollastonite raises soil pH and its silicon bolsters plant tis-

sues and cell walls. The result is improved plant growth, although Santos says more studies are required to get a handle on that. "We are running dedicated field trials now, so we will have more accurate values in the future about real-world crop benefits."

Enhanced Weathering may be little known in agriculture, but it's been kicking around in the scientific literature for at least 15 years. Proponents such as British botanist David Beerling tout it as a win-win: good for farmers and good for the climate. "The idea is to draw CO2 down by changing the way we manage our croplands," Beerling told CBC Radio's science program, Quirks and Quarks, in 2019.

Beerling favours basalt, a common volcanic rock that's a source of silicon, calcium, magnesium, phosphorus and potash. "Societies have long known that the volcanic regions of islands are more productive for agriculture, and that's because the volcanic rocks release nutrients that are important for the plants,' Beerling said in the CBC interview.

"If we sprinkle crushed basalt, which is a natural volcanic rock onto the croplands, it's not only going to draw down CO2 but fertilize crops as well, help increase yields and help restore nutrients in the soils."

At Guelph, Santos and Chiang selected wollastonite because it's the fastest-weathering natural silicate in the marketplace. "Some farmers were already using the material, so that enabled us to go to farms where they're using it and analyse their plants and soils." Santos says.

"Right now it's only happening with farmers who are interested in trying something different." One of those growers is Matt Gauthier, farm manager of Markham-based Fairgreen Sod Farms. He tried wollastonite after hearing strawberry growers were using it to make their plants more resilient against pests. Now Gauthier applies wollastonite on up to 500 acres of sod, typically at a rate of one tonne per acre every other year.

This past season the crushed rock cost roughly $54 per tonne, including trucking to the farm. Gauthier says reduced pesticide costs and better drought resistance make the application worthwhile. "We're seeing stronger plants, and we're seeing reductions in the amount of chemical applied to control insects."

"Agriculture is going to play a really important role for us," says Canadian Wollastonite president Bob Vasily. The firm has been producing the mineral at its mine near Kingston since 2013 and sells bagged wollastonite under the trade name CW Grow. Bulk product ships by truck or train to farm and industrial buyers. This past year the bulk price was $39 per tonne at the mine.

When it comes to adjusting soil pH, wollastonite "is about 80 per cent as effective" as agricultural lime, Vasily says, "so if you're using calcitic lime, you would multiply the amount you're using by 1.2 to get the amount of Wollastonite."

He adds the additional plant heath benefits from silicon and climate buffering will give the product a marketing edge. Under the federal government's carbon pricing regime, the cost of releasing a tonne of carbon dioxide is slated to $170 in 2030. If growers can get carbon sequestration credits for using wollastonite, "when the cost of credits is above $80, the product would essentially be free of cost for farmers. As a result, Vasily adds, "we believe that over time, farmers that are using lime will be shifting over to silicate sources of calcium."

For his part, Prof. Santos says additional research and on-farm demonstrations could nudge Enhanced Weathering towards the agricultural mainstream. "We have a number of demonstration sites we're operating" he says. "We need more robust models for enhanced weathering, so we can say for this soil, and this crop, how much CO2 you can expect to sequester."