CANADIAN WOLLASTONITE INC
A WHITE MINERAL FOR A GREEN WORLD

P (613) 387 2734
F (613) 387 3934
W canadianwollastonite.com

6675 Highway 15
Seeley's Bay, ON
K0H 2H0

Wollastonite: An Agricultural Overview

A Permanent Carbon Capture Solution

Replacing lime with wollastonite is a shovel ready solution that captures CO_2 while increasing soil pH and crop yields in a changing climate. Wollastonite can capture up to 620 kg CO_2 for every tonne applied to the soil through a process called accelerated weathering. Limestone left in the quarry is an inorganic mineral form of CO_2 permanently stored as calcium carbonate. When limestone is ground to a flour and applied to soil, much of this CO_2 is released. Calcium carbonate (lime) contains up to 44% CO_2, therefore up to 440 kg of CO_2 release can be avoided for every tonne of lime that is not applied.

Tonne for tonne, by replacing limestone with wollastonite, one tonne of CO_2 can be eliminated from the atmosphere. For comparison, 25.6 trees planted and grown to maturity can capture one tonne of CO_2; however, this is a short-term form of organic carbon storage. When wollastonite is applied to soil it rapidly turns CO_2 into inorganic minerals that wash down through the soil for permanent storage measured in the tens of thousands of years. Plus, wollastonite contains abundant amounts of silicon, known to boost insect and disease resistance as well as improve yields during temperature extremes and drought.

About Wollastonite

Wollastonite is a valuable and uncommon calcium-silicate mineral ($CaSiO_3$) created when impure limestone is subjected to high temperature and pressure. Wollastonite is only available for industrial and agricultural applications in a few places worldwide with three mines currently in operation in North America. Wollastonite is a white mineral with a granular texture and reacts quickly in soil releasing the following nutrients:

- Calcium %26.5 CaO
- Silicon %55.2 SiO_2
- Magnesium %6.62 MgO
- Iron %2.23 Fe_2O_3
- Potassium %1.55 K_2O
- Sulphur %1.66 SO_2

Wollastonite is an excellent source of calcium and silicon. Silicon is a lesser-known nutrient that is developing a big reputation as a cost-effective way to boost plant growth while reducing damage from pests, diseases, and environmental extremes. Spreading wollastonite is the safest and easiest way to supply silicon to agricultural fields. Wollastonite can be applied at a rate of 1.2x the rate of lime for a similar effect on soil pH.

Canadian Wollastonite

Our wollastonite has exceptionally low levels of heavy metals and other hazardous contaminates and is now available across North America. We own and operate a zero waste and zero contamination above-ground mine outside of Kingston, Ontario where wollastonite is carefully harvested and processed on site to a fine sand. Canadian Wollastonite is registered with the CFIA as a fertilizer and certified by OMRI for use in organic agriculture in Canada and the US.

Wollastonite is a carbon-negative lime replacement with big benefits

Lime is composed of up to 44% CO_2 by weight, whereas wollastonite is free of carbonate and contains a balanced ratio of calcium and magnesium plus high levels of silicon. Wollastonite has been shown to capture up to 64% of its weight in CO_2 for permanent inorganic carbon storage. Wollastonite captures CO_2 by reacting with carbonic acids in the soil forming carbonate ions. When a soil is moderately to slightly acidic the carbonate ions wash down away from the soil surface into aquifers and eventually to waterways and then into the oceans for 1,000-to-100,000-year storage. By combining the captured CO_2 in the soil (0.62 mt) and the prevention of CO_2 release by replacing lime (0.4 mt), every tonne of limestone replaced with wollastonite, up to 1000 kg of CO_2 emissions can be avoided and removed from the atmosphere.

The following is a concise review of the multiple benefits wollastonite can provide agricultural crops with links for further reading:

1) **Wollastonite captures carbon from the atmosphere**

Once applied, wollastonite rapidly sequesters CO_2 from the atmosphere through a combination of increases in plant growth and capturing carbon directly in the soil by transforming it into a mineral form for permanent storage.

a. Inorganic carbon capture through accelerated weathering

Carbon dioxide from the atmosphere is absorbed into rainwater and percolates into the soil. The slightly acidic rainwater reacts with the calcium in wollastonite transforming CO_2 into carbonate minerals in a process called accelerated weathering. The transformed carbon is now in a liquid mineral form that flushes deep into the soil for permanent storage. This is the same mineral weathering process that has sequestered and stored 99% of all CO_2 that has ever entered the atmosphere. This ancient CO_2 is stored as carbonate minerals in limestone rocks all over the world.

Further reading:

Potential for large-scale CO_2 removal via enhanced rock weathering with croplands

Wollastonite is the mineral for rapid carbon sequestration that does not harm the soil

CO_2 sequestration by wollastonite-amended agricultural soils – An Ontario field study

Optimizing inorganic carbon sequestration and crop yield with wollastonite soil amendment in a microplot study

Urban farming with enhanced rock weathering as a prospective climate stabilization wedge

b. Organic carbon capture from plant growth

Wollastonite can increase plant growth for rapid organic carbon capture, especially in trees. Spreading wollastonite in very effective in forests on the Canadian shield and areas affected by acid rain where soil calcium reserves are low. In New Hampshire USA, an entire watershed at Hubbard Brook Research Forest was treated with wollastonite at 3.5 mt per hectare. The treated forest was found to sequester 9.1 mt ha^{-1} more CO_2 in tree growth in 10 years when compared to the adjacent untreated forest. In addition, for each 3.5 mt of wollastonite applied, more than 2 mt of CO_2 was likely captured and stored in carbonate minerals in the soil. Calcium and magnesium (both found in

wollastonite) can also help to stabilize existing soil organic matter preventing its breakdown into CO_2.

Further reading:
Increased carbon capture by a silicate-treated forested watershed affected by acid deposition

Calcium-mediated stabilisation of soil organic carbon

2) A shovel-ready lime replacement with benefits

Limestone contains up to 44% CO_2 by weight, large amounts of this CO_2 is emitted when the calcium is released from the carbonate. Wollastonite can be substituted in any soil-based application studied to date to mitigate CO_2 emissions from the breakdown of limestone in soil. Wollastonite offers more nutrients than limestone while supplying a similar amount of calcium. From agricultural fields to forests, wollastonite is a cost-effective carbon negative lime replacement that supplies high levels of silicon and other beneficial nutrients. Wollastonite is also the most affordable form of silicon fertilizer and is easy to work with. To replace a typical lime, use roughly 1.2x the amount of wollastonite to achieve the desired CCE value (Calcium Carbonate Equivalence).

Further reading:
An overview of silicon use in agriculture

Applying wollastonite to soil to adjust ph and suppress powdery mildew on pumpkin

Soil chemical dynamics after calcium silicate addition to a northern hardwood forest

Changes in soil chemistry following a watershed-scale application of wollastonite

3) Wollastonite increases plant growth

Wollastonite has a positive effect on plant growth across a wide range of plant species from lawns, field crops, vegetables, to trees and forests. Calcium and especially silicon can uncover hidden growth potential by helping plants excel during periods of reduced water availability and extreme temperatures. Additional growth gains are made from increases in crop quality and reduced loss to diseases or pests (detailed below).

Further reading:
Co-benefits of wollastonite weathering in agriculture: CO_2 sequestration and promoted plant growth

Optimization of source and rate of soil applied silicon for improving the growth of wheat

Response of sugar maple to calcium addition in northern hardwood forest

4) Wollastonite improves crop quality

Wollastonite has been shown to improve crop quality. Calcium and silicon are both nutrients that contribute to healthy plant growth by enhancing cell wall strength. Stronger cell walls and reduced pest and disease pressure reduce seconds and increase the crop shelf life, quality, and grade while reducing management costs.

Further reading:
Silicone enhances disease suppression

Mineral–soil–plant–nutrient synergisms of enhanced weathering for agriculture: Short-term investigations using fast-weathering wollastonite skarn

Effects of silicon on growth, yield and fruit quality of silicon on cantaloupe

5) Wollastonite increases stress tolerance in plants

a) Pests & Disease
Calcium and silicon work together to enhance cell wall strength in different ways. Calcium accumulates between cell walls, while silicon re-enforces cell walls with a glass-like layer. Both mechanisms make it more difficult for insects to eat and diseases to spread from cell to cell. In addition, silicon is well known to enhance biochemical functions in plants. This adds another layer of protection and defence from pests and diseases by increasing the production of plant protective chemical defenses inside the plant.

Further reading:
Adding silicon to soil can help control clubroot in canola

Silicon and plant disease resistance against pathogenic fungi

Calcium silicate suppressed powdery mildew and increases yield of field-grown wheat

Calcium Chloride and calcium silicate decrease white mold intensity on common beans

Regeneration ecology of sugar maple (Acer saccharum): seedling survival in relation to nutrition, site factors, and damage by insects and pathogens

Towards establishing broad-spectrum disease resistance in plants- silicon leads the way

Pumpkin production practices that reduce cost

Calcium silicate and organic mineral fertilizer applications reduce phytophagy on eggplants

Silicon: Potential to promote direct and indirect effects on plant defense against arthropod pests in agriculture

Silicon enhances natural enemy attraction and biological control through induced plant defences

Calcium silicate suppressed powdery mildew and increases yield of field grown wheat

Optimization of source and rate of soil applied silicon for improving the growth of wheat

Silicon and the development of gray leaf spot of perennial ryegrass turf

The role of silicon in suppressing rice diseases

Silicon suppresses fusarium crown and root rot of tomato

Silicon and plant disease resistance against pathogenic fungi

b) Environmental Stress

Silicon and calcium have both been shown to increase plant growth and yields during temperature extremes and drought like conditions. While the mechanisms are still being studied, silicon appears to trigger a combination of beneficial physical and biochemical changes in plants increasing the efficacy of water use and reducing stress from temperature extremes.

Further reading:

Functions of silicon in plant drought stress responses

Benefits from below: Silicon supplementation maintains legume productivity under predicted climate change scenarios

Increases sugar storage, antioxidant activity and cold tolerance in native red spruce

The role of silicon in higher plants under salinity and drought stress

Calcium addition increases sugar storage, antioxidant activity and cold tolerance in native red spruce (picea rubens)

6) Wollastonite cleans waterways & ponds

When spread along the shorelines of ponds, wollastonite can quickly capture excess nutrients helping to reduce algae growth to bring ponds back into balance within weeks. When applied to soil, wollastonite increases the capacity of the soil to retain excess phosphorus and heavy metals that can otherwise wash away and accumulate in waterways resulting in algae blooms and the movement of heavy metals into wildlife and the human food supply. Wollastonite is a safe and effective way to keep ponds and watersheds healthy without negatively affecting fish or wildlife.

Further reading:

Canadian Wollastonite website – Ponds application page

The effects of a whole-watershed calcium (wollastonite) addition on the chemistry of stream storm events at the Hubbard Brook experimental forest in NH, USA

Phosphate sorption capacities of different substrates in view of application in water treatment systems for ponds

Wollastonite reduces nitrogen concentrations as well as zeolite

Phosphorus removal by wollastonite: A constructed wetland substrate

Calcium silicate neutralizes an acidic stream