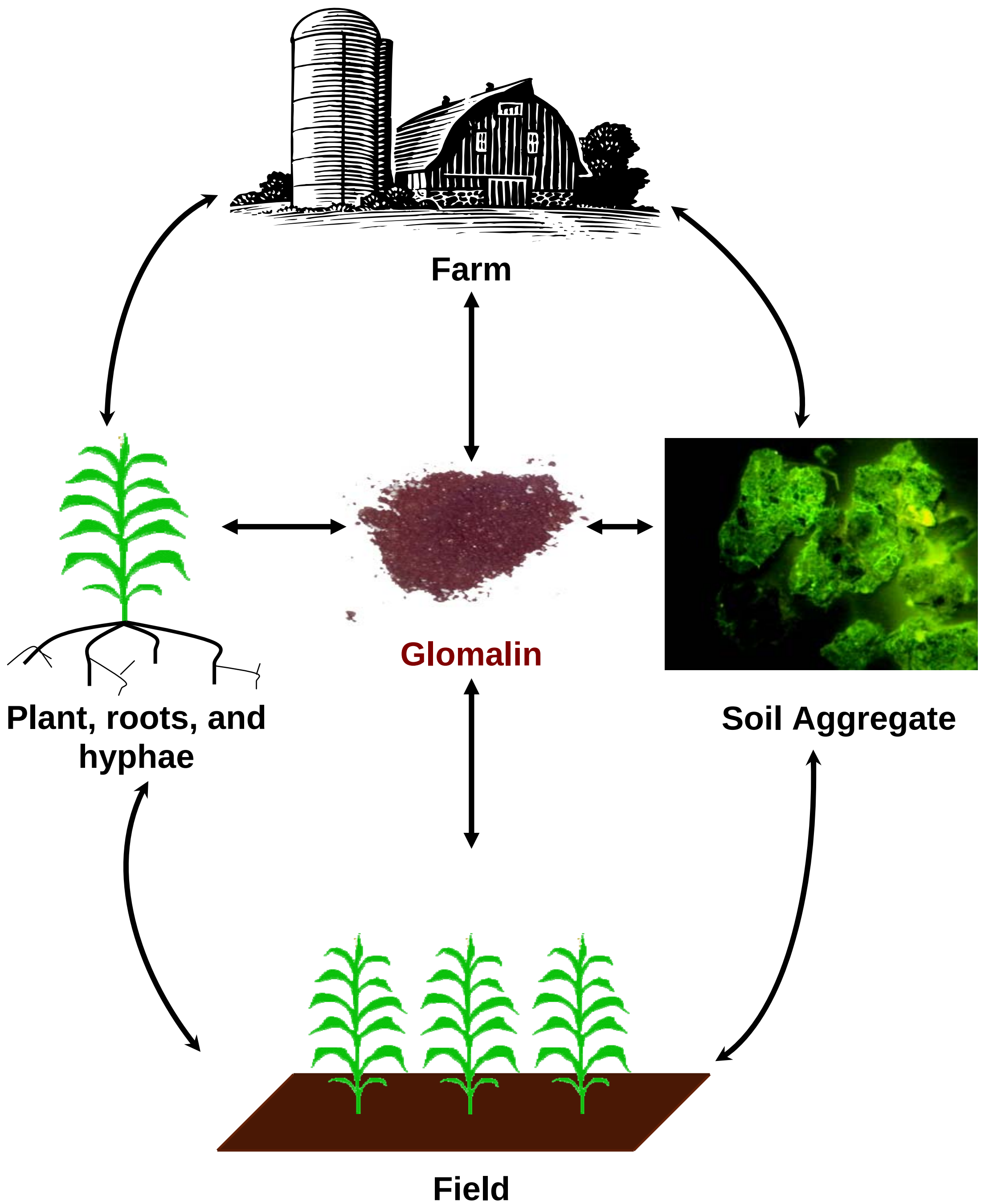
DOES GLOMALIN HOLD YOUR FARM TOGETHER?



What is Glomalin?

Glomalin (Fig. 2) was identified at USDA in the early 1990's on hyphae (hair-like projections) of **arbuscular mycorrhizal fungi (AMF)**. These fungi are ancient microorganisms that evolved with plants to aid in acquiring nutrients, especially immobile nutrients like phosphorus (P). Most plants (about 70 to 80% of the vascular plants) are mycorrhizal. Some nonmycorrhizal plants are canola, cabbage, broccoli and cauliflower.

Hyphae can grow several centimeters (1 to 2 inches) beyond roots (Fig. 1) and access more soil to acquire nutrients more efficiently. This is similar to a tree, where the branches (i.e. hyphae) grow out of the trunk (i.e. root). A tree forms branches to reach more of the sun's rays. Without enough sunlight, the tree would die. Belowground the plant forms a beneficial relationship with AMF or produces many fine roots to get the nutrients that it needs. Hyphae are not covered with bark like tree branches. Instead AMF produce **glomalin** to coat hyphae to keep water and nutrients from getting lost on the way to and from the plant.

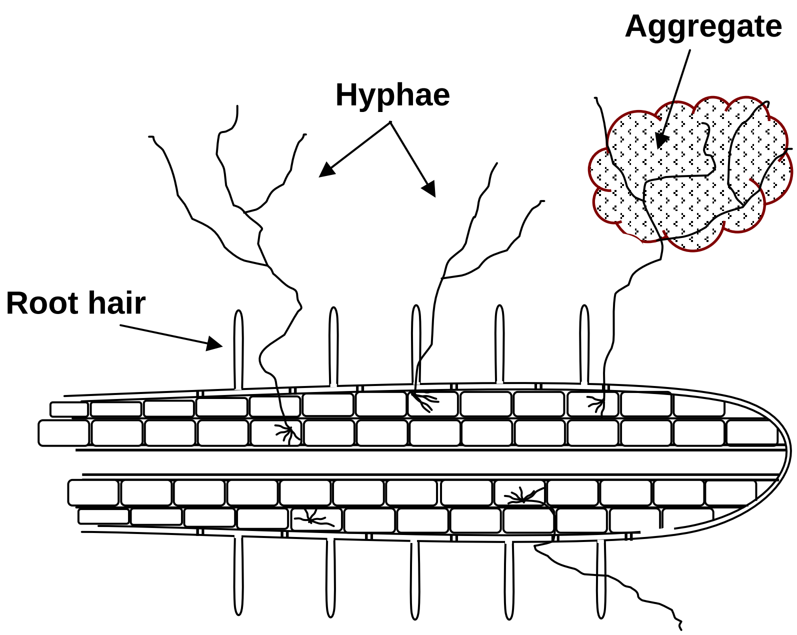


Fig. 1. Hyphae of arbuscular mycorrhizal fungi grow beyond nutrient depleted zones found around roots and root hairs. Hyphae form a frame for soil particles to collect into aggregates which are coated with glomalin.

How does Glomalin work?

Glomalin is extremely “tough”. It is resistant to microbial decay (lasting at least 10 to 50 years) and does not dissolve easily in water. **Glomalin** is soluble at high temperatures (121 ^{o}C or 250 ^{o}F). These properties make **glomalin** a good protector of hyphae and soil aggregates.

The unusual extraction conditions remove high quantities of the rich organic material (i.e. **glomalin**) leaving soil a mineral grey color (Fig. 2). **Glomalin** accounts for a large amount (about 15 to 20%) of the organic carbon in undisturbed soils.

Fig. 2. Glomalin is extracted from soil with high heat. After removal of glomalin, soil is transformed from a rich brown color to a grey mineral color.

When a hypha stops transporting nutrients, we think **glomalin** sloughs off onto surrounding soil particles. Hundreds of meters of hyphae can grow throughout a small sample of soil resulting in the production of large amounts of **glomalin.** High **glomalin** concentrations are related to the formation and stabilization of aggregates in undisturbed and no-till systems compared to nearby conventionally tilled sites.

Glomalin and Soil Aggregation

Soil aggregation is a complex process that glues together of soil particles (minerals, organic matter, etc.) together into pellets. These pellets are rich in nutrients and resist erosion.

Hyphae act as a frame upon which soil particles may collect while **glomalin** glues them together and protects them (Figs. 1 and 3). This is similar to walls in a house, where boards (i.e. hyphae) are used to frame-up the wall, insulation (i.e. soil particles) fills in spaces between boards, wall board (i.e. microbial glues, like **glomalin** and fungal and bacterial polysaccharides) help keep everything in place, and finally it is all coated with a protective layer of paint (i.e. **glomalin**).

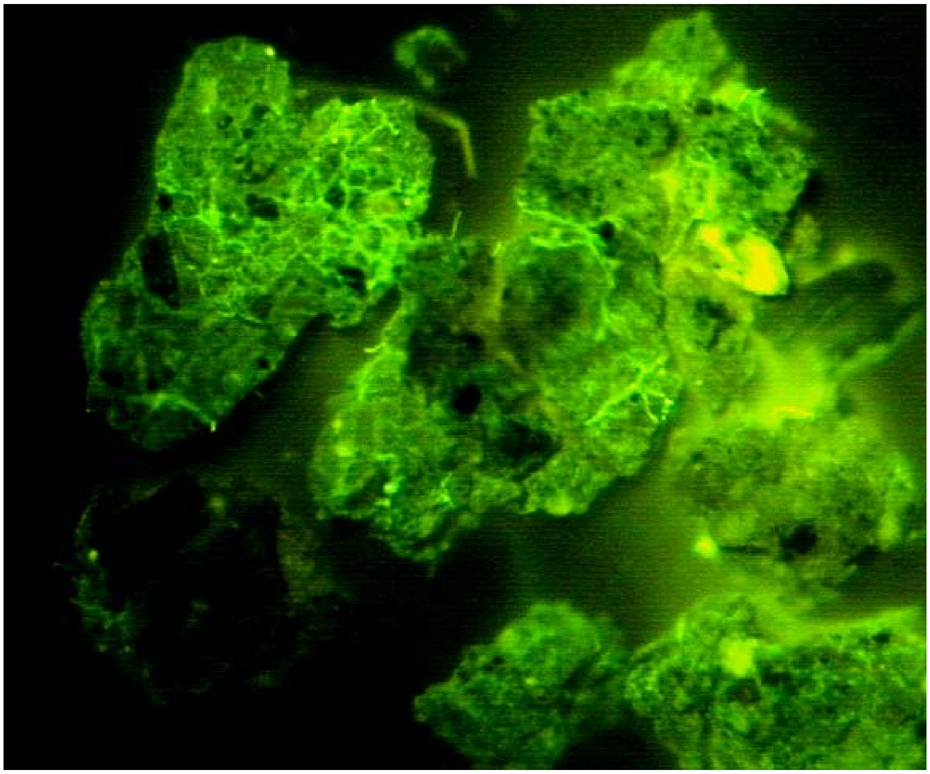


Fig. 3. Glomalin is naturally brown. A laboratory procedure reveals glomalin on hyphae and soil aggregates as the bright green material shown here.

Sticking soil particles together (i.e. aggregate formation) is just one part of the process and one role for **glomalin** and other microbial polysaccharides. **Glomalin** is an important molecule in aggregate stabilization. When aggregates are not stabilized, they break apart with rainfall. Organic matter and nutrients within disrupted aggregates may be lost to rain and wind erosion. The chemistry of **glomalin** makes it an ideal stabilizing coat.

The Glomalin Advantage

Properties

* Formed by Arbuscular Mycorrhizal Fungi
  - Beneficial to most crop plants
  - Found in all soils
* Produced in large amounts
* Extremely “tough”
  - Does not dissolve in water
  - Resistant to decay

Function

* Protect hyphae from nutrient loss
* Glue together soil aggregates
* Stabilize aggregates
  - Reduces wind and water erosion
  - Increases water infiltration
  - Increases water retention near roots
  - Improves nutrient cycling
  - Improves root penetration by reducing compaction
* Soil carbon and/or nitrogen storage

Management

* Minimum or no-till to reduce disruption of hyphal network
* Reduced inputs, minimum P
* Cover crops to maintain living roots
* Nonmycorrhizal crops (canola, cabbage, broccoli, cauliflower) equal no glomalin production

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