Conventional Tillage examples include mould-board ploughs that invent or "turn over" soils, rotary hoes and roto-tiller tillage tools that pulverise soils, and cause intensive soil disturbance and bare soil surfaces.

In contrast, Conservation Agriculture practices such as no-tillage aim to produce ultra low soil disturbance. The use of ‘roller-crimper’ methods or herbicide aim to retain crop residues as an ‘anchored mulch’ instead of ‘turning’ in or burial. Other soil conservation methods include sowing & growing green manures and cover crops. These methods aim all to accumulate & maintain soil organic matter, to avoid, remedy or mitigate soil erosion and surface runoff nutrient losses, & potential degradation surface water.

The majority of scientific and amateur gardening trials and agricultural research in methods to apply biochar has been focussed on mixing biochar with composts, surface spreading methods with subsequent conventional tillage methods to "turn in", bury and mix biochar into soils.

"Deep'form application of biochar research by Paul Blackwell et al, (2009) in Western Australia, & no-tillage direct seed drill research by New Zealanders Don Graves et al (2013), are rare exceptions to a paucity of research into biochar application methods designed to protect soil structure, by placement biochar in close proximity to rhizosphere soils where it can be easily accessed by plant roots & mycorrhizal fungi

Other proposed methods for using minimum tillage technologies to apply biochar into soils adjacent to plant roots include "Baker Boot" seed drill, ‘Aqua-fill’ seed drill, ‘double-disc’, triple disc, ‘U’-shaped seed drills, ‘Keyline’ aka ‘Yeomans’ plow, mole ploughs, chisel ploughs, slurry injectors, poultry litter 'sub-surfacer' and sub-soilers. Small scale equivalents include "no-dig" soil cores and seedling transplanting methods, and 'seed-balls'.

Biochar research has examined the effectiveness of biochar as a water absorbent and nutrient adsorbent ingredient for making plant propagation potting media, and as an alternative to expanded clay products Vermiculite and Perlite as a carrier media for mycorrhizal fungi to inoculate plant roots of nursery seedings.

Optimal biochar placement in plant root soil zones, (rhizosphere soils) Biochar placement adjacent to plant root zones enables plant roots, rhizobacteria and mycorrhizal fungi close access to nutrients attached to biochar surfaces, and soil water and soil micro-organisms contained within biochar.

Additionally beneficial effects can occur from plant root exudates rich in nutrients & Carbon that can induce "hot-spots" of soil bio-diversity and biologically available energy within soil aggregates, rhizospheres and biochar.

**Conventional seed drill**
- No-till seed drill used to create a "U" shaped seed bed that is produced by a no-till seed drill, a "double-disc", or "aerial" drilled into the soil structure, or a vertical slot shaped slot formed by a single disc, i.e., the seedbed shape results from the combination of "U" shaped soilspacer and a vertical drill. Finally, the seedbed is closed by a pair of offset angulated elements, where following bailed the soil opener.

**No-till trial application of a biochar slurry (10:50:1 v/v biochar/water) Biochar slurry was mixed at a rate of 1 litre per metre, at a depth of 5mm into 1 treated spacer, & subsequently shown horizontally in the paired spacers, & 20cm deep into the vertical drill. Graves et al (2013)\[7\]

**Baker Boot**
- The Baker Boot employs a ‘shovel’ and a 'compactor' wheel mechanism that are able to penetrate soil to depths of 100s of mm, leaving a shaped seedbed, formed by a ‘double-disc’ seed drill, “U” shaped seedbed, formed by a hoe seed drill, “V” shaped seedbed, formed by a Baker Boot seed drill, “X” shaped Cross-Star® seedbed designed to maximize plant seeds and commonly used PK fertilizers, thereby protecting emerging plant seedlings from "burning" by overly volatile nutrients. Diagrams courtesy of Dr. John Baker.

**Arbuscular mycorrhizal fungi (AMF) aka Endomycorrhizal fungi**
- Characteristic small fungal 'row-like' arbuscules located within plant root central cells.

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**Arbuscular mycorrhizal fungi & Phlox sphaleropetalus seedlings**
- "Conventional" plants grow adjacent to AMF / ECM partners and their fruiting bodies, or in soils with low levels of plant available phosphates that may produce root exudates that act as signals and attract mycorrhizal fungi to form fungal / plant partnerships. AMF are obligate biotrophs, i.e. they obtain nutrients from dead organic matter, and can live only in the presence of suitable living plant root hosts. AMF fungi are asexual and do not produce fungal fruiting bodies, nor produce of 100s of 10,000s of fungal spores.

**Environmental and Human Derived Effects on Mycorrhizal Symbioses**
- Plants growing in drought-prone climates, and in soils with low levels of plant available phosphates may produce root exudates that act as signals and attract mycorrhizal fungi to form fungal / plant partnerships. AMF are obligate biotrophs, i.e. they obtain nutrients from dead organic matter, and can live only in the presence of suitable living plant root hosts. AMF fungi are asexual and do not produce fungal fruiting bodies, nor produce of 100s of 10,000s of fungal spores.

**What good are mycorrhizal fungi?**
- Mycorrhizal symbioses (partnerships) between plant roots and extensive networks of fine filamentous mycelia (aka hyphae) of mycorrhizal fungi soil fungi, provide 'host' plants with increased access to nutrients and water contained in an enlarged soil volume when compared to plants roots alone.

Thus mycorrhizal symbioses provide plants with improved plant drought tolerance, and increased availability to soil nutrients including phosphates. Adenosine Triphosphate (ATP) is a co-enzyme required for transport of chemical energy in cell metabolism, including photosynthesis. In this manner, mycorrhizal symbiosis enables improved rates of plant photosynthesis, increased carbon energy available for soil organic matter, productivity and growth of plant, fungal and soil bacteria partners.

- A in a manner analogous to "pro-biotic" effects of diverse mixtures of so-called 'beneficial' bacteria and micro-biomes in an animal's gut, mycorrhizal symbioses of plant roots can also assist plants to be protected from opportunistic soil pathogens that can cause plant diseases.

- Some fungi are detrimental plant parasites, pathogens or decomposer (saprotrophic) organisms. However, most plant roots (>90%) form mycorrhizal symbioses or 'partnerships' between plant roots and mycorrhizal soil fungi, and a mycorrhizal symbiosis (partnership) is a mutualistic relationship between plant and fungus.

- Arbuscular mycorrhizal fungi (AMF) are obligate biotrophs, i.e. AMF cannot access nutrients from dead organic matter, and can live only in the presence of suitable living plant root hosts. AMF fungi are asexual and do not produce fungal fruiting bodies, nor produce of 100s of 10,000s of fungal spores.

- In contrast, Ecto-mycorrhizal (EM) or Ericoid mycorrhizal (ErM) fungi, Basidimycocyte and Ascomycete fungi, produce fruiting bodies, aboveground mushrooms and toadstools, or subterranean truffles that contain very many mycorrhizal fungal / plant partnerships (symbioses). However, most plant roots (>90%) form mycorrhizal symbioses or 'partnerships' between plant roots and mycorrhizal soil fungi, and a mycorrhizal symbiosis (partnership) is a mutualistic relationship between plant and fungus.

- Ecto and EM fungi obtain most Carbon energy from symbiotic plant photosynthesis, mycorrhizal fungal partners and their fruiting bodies.

- Ecto-Mycorrhizal fungi / Mycorrhizal Fungi / Phlox sphaleropetalus seedlings
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