No-till farming

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No-till farming (also called **zero tillage** or **direct planting** or **pasture cropping**) is a way of growing crops from year to year without disturbing the soil through tillage. No-till is an agricultural technique which increases the amount of water and organic matter (nutrients) in the soil and decreases erosion. It increases the amount and variety of life in and on the soil, including disease-causing organisms.

Young soybean plants thrive in the residue of a wheat crop. This form of no till farming provides good protection for the soil from erosion and helps retain moisture for the new crop.

Contents

Background

Tilling is used to remove weeds, shape the soil into rows for crop plants and furrows for irrigation. This leads to unfavorable effects, like soil compaction; loss of organic matter; degradation of soil aggregates; death or disruption of soil microbes and other organisms including mycorrhiza, arthropods, and earthworms;[1] and soil erosion where topsoil is blown or washed away. No-till farming avoids these effects by excluding the use of tillage. With this way of farming, crop residues or other organic amenities are retained on the soil surface and sowing/fertilizing is done with minimal soil disturbance. Continuous no-till needs to be managed very differently in order to keep or increase yield on the field. Residue, weeds, equipment, crop rotations, water, disease, pests, and fertilizer management are just some of the many details of farming that change when switching to no-till.

The idea of modern no-till started in the 1940s with Edward Faulkner, but it wasn't until the development of several chemicals after WWII that various researchers and farmers started to try out the idea. The first adopters of no-till include Klingman (North Carolina), Edward Faulkner, L.A. Porter (New Zealand), Harry and Lawrence Young (Herndon, Kentucky), the Instituto de Pesquisas Agropecuarias Meridional (1971 in Brazil) with Herbert Bartz.[2]

Issues

Profit, economics, yield

Studies have found that no-till farming can be more profitable[3][4] if performed correctly.[5]

Less tillage of the soil reduces labour,[6] fuel,[7] irrigation[8] and machinery costs.[4] No-till can increase yield because of higher water infiltration and storage capacity, and less erosion.[5] Another benefit of no-till is that because of the higher water content, instead of leaving a field fallow it can make economic sense to plant another crop instead.[9]

As sustainable agriculture becomes more popular, monetary grants and awards are becoming readily available to farmers who practice conservation tillage. Some large energy corporations which are among the greatest generators of fossil-fuel-related pollution may purchase carbon credits, which can encourage farmers to engage in conservation tillage.[10][11] Under such schemes, the farmers' land is legally redefined as a carbon sink for the power generators' emissions. This helps the farmer in several ways[*citation needed*], and it helps the energy companies meet regulatory demands for reduction of pollution, specifically carbon emissions.

No-till farming can increase organic (carbon based)[5] matter in the soil, which is a form of carbon sequestration. However, there is debate over whether this increased sequestration detected in scientific studies of no-till agriculture is actually occurring, or is due to flawed testing methods or other factors.[12] Regardless of this debate, there are still many other good reasons to use no-till, e.g. reduction in fossil fuel use, no erosion, soil quality.

Environmental

Carbon (air and soil) and other greenhouse gases

No-till has carbon sequestration potential through storage of soil organic matter in the soil of crop fields.[13] Tilled by machinery, the soil layers invert, air mixes in, and soil microbial activity dramatically increases over baseline levels. The result is that soil organic matter is broken down much more rapidly, and carbon is lost from the soil into the atmosphere. This, in addition to the emissions from the farm equipment itself, increases carbon dioxide levels in the atmosphere.

Cropland soils are ideal for use as a carbon sink, since they have been depleted of carbon in most areas. It is estimated that 78 billion metric tonnes of carbon that was trapped in the soil has been released[14] because of tillage. Conventional farming practices that rely on tillage have removed carbon from the soil ecosystem by removing crop residues such as left over corn stalks, and through the addition of chemical fertilizers which have the above mentioned effects on soil microbes.

By eliminating tillage, crop residues decompose where they lie, and by growing winter cover crops, carbon loss can be slowed and eventually reversed.

In addition to keeping carbon in the soil, no-till farming reduces nitrous oxide (N_2O) emissions by 40-70%, depending on rotation.[15][16] Nitrous oxide is a potent greenhouse gas that stays in the atmosphere for 120 years.[17]

Soil and water

No-till improves soil quality (soil function), carbon, organic matter, aggregates,[18] protecting the soil from erosion,[19] evaporation of water,[8] and structural breakdown. A reduction in tillage passes helps prevent the compaction of soil.

Recently, researchers at the Agricultural Research Service of the United States Department of Agriculture found that no-till farming makes soil much more stable than plowed soil. Their conclusions draw from over 19 years of collaborated tillage studies. No-till stores more carbon in the soil and carbon in the form of organic matter is a key factor in holding soil particles together. The first inch of no-till soil is two to seven times less vulnerable than that of plowed soil. The practice of no-till farming is especially beneficial to Great Plains farmers because of its resistance to erosion.[20]

Crop residues left intact help both natural precipitation and irrigation water infiltrate the soil where it can be used. The crop residue left on the soil surface also limits evaporation, conserving water for plant growth. Soil compaction and no tillage-pan, soil absorbs more water and plants are able to grow their roots deeper into the soil and suck up more water.

Tilling a field reduces the amount of water, via evaporation, around 1/3 to 3/4 inches (0.85 to 1.9 cm) per pass.[8] By no-tilling, this water stays in the soil, available to the plants.

Soil biota, wildlife, etc.

In no-till farming the soil is left intact and crop residue is left on the field. Therefore, soil layers, and in turn soil biota, are conserved in their natural state. No-tilled fields often have more beneficial insects and annelids,[21] a higher microbial content, and a greater amount of soil organic material. Since there is no ploughing there is less airborne dust.

No-till increases the amount and variety of wildlife.[22] This is the result of improved cover, reduced traffic and the reduced chance of destroying ground nesting birds and animals (plowing destroys all of them).

Albedo

Tillage lowers the albedo of croplands. The potential for global cooling as a result of increased Albedo in no till croplands is similar in magnitude to the biogeochemical (carbon sequestration) potential.[23]

Historical artifacts

Tilling regularly damages ancient structures under the soil such as long barrows. In the UK, half of the long barrows in Gloucestershire and almost all the burial mounds in Essex have been damaged. According to English Heritage modern tillage techniques have done as much damage in the last six decades as traditional tilling did in the previous six centuries. By using no-till methods these structures can be preserved and can be properly investigated instead of being destroyed.[24]

Prior to no-till farming's rise in popularity, the annual tilling of the soil often exposed arrowheads and other artifacts. Other artifacts include bullets, medals, and buttons, coins and other metal items from destroyed houses and barns.

Cost

Equipment

No-till requires specialized seeding equipment designed to plant seeds into undisturbed crop residues and soil. Purchasing new equipment (seed drills for example) is expensive and while the cost could be offset by selling off plows, etc. doing so is not usually done until the farmer decides to switch completely over (after trying it out for a few years). This results in more money being invested into equipment in the short term (until old equipment is sold off).[25]

Drainage

If a soil has poor drainage, it may need drainage tiles or other devices in order to help with the removal of excess water under no-till. Farmers should remember that water infiltration will improve after several years of a field being in no-till, so they may want to wait until 5–8 years have passed to see if the problems persists before deciding to invest in such an expensive system.

Gullies

Gullies can be a problem in the long-term. While much less soil is displaced by using no-till, any drainage gulleys that do form will get deeper each year since they aren't being smoothed out by plowing.[26] This may necessitate either sod drainways, waterways, permanent drainways, cover crops, etc.

Must be managed differently

See management section.

Increased chemical use

One of the purposes of tilling is to remove weeds. No-till farming does change weed composition drastically. Faster growing weeds may no longer be a problem in the face of increased competition, but shrubs and trees may begin to grow eventually.

Some farmers attack this problem with a “burn-down” herbicide such as glyphosate in lieu of tillage for seedbed preparation and because of this, no-till is often associated with increased chemical use in comparison to traditional tillage based methods of crop production. However, there are many agroecological alternatives to increased chemical use, such as winter cover crops and the mulch cover they provide, solarization or flaming.

Management

No-till requires some different skills in order to do it successfully. As with any production system, if no-till isn't done correctly, yields can drop. A combination of technique, equipment, pesticides, crop rotation, fertilization, and irrigation have to be used for local conditions.

Cover crops

Cover crops are used occasionally in no-till to help control weeds and increase nutrients in the soil (by using legumes)[27] or by using plants with long roots to pull mobile nutrients back up to the surface from lower layers of the soil. Farmers experimenting with organic no-till use cover crops instead of tillage for controlling weeds, and are developing various methods to kill the cover crops (rollers, crimper, choppers, etc.)[28] so that the newly planted crops can get enough light, water, nutrients, etc.[29][30]

Disease, pathogens, insects and the use of crop rotations

With no-till, residue from the previous years crops lie on the surface of the field, cooling it and increasing the moisture. This can cause increased or decreased or variations of diseases that occur,[31] but not necessarily at a higher or lower rate than conventional tillage.[32] In order to help eliminate weed, pest and disease problems, Crop rotations are used. By rotating the crops on a multi-year cycle, pests and diseases will decrease since the pests will no longer have a food supply to support their numbers.

Organic no-till technique: The cardboard method

Some farmers who prefer to pursue a chemical-free management practice often rely on the use of normal, non-dyed corrugated cardboard for use on seed-beds and vegetable areas. Used correctly, cardboard placed on a specific area can A) keep important fungal hyphae and microorganisms in the soil intact B) prevent recurring weeds from popping up C) increase residual nitrogen and plant nutrients by top-composting plant residues and D) create valuable topsoil that is well suited for next years seeds or transplants. The plant residues (left over plant matter originating from cover crops, grass clippings, original plant life etc.) will rot while underneath the cardboard so long as it remains sufficiently moist. This rotting attracts worms and other beneficial microorganisms to the site of decomposition, and over a series of a few seasons (usually Spring-->Fall or Fall-->Spring) and up to a few years, will create a layer of rich topsoil. Plants can then be direct seeded into the soil come spring, or holes can be cut into the cardboard to allow for transplantation. Using this method in conjunction with other sustainable practices such as composting/vermicompost, cover crops and rotations are often considered beneficial to both land and those who take from it.

Water issues

No-till dramatically reduces the amount of erosion in a field. While much less soil is displaced, any gullies that do form will get deeper each year instead of being smoothed out by regular plowing. This may necessitate either sod drainways, waterways, permanent drainways, cover crops, etc.[33]

A problem that occurs in some fields is water saturation in soils. Switching to no-till will help the drainage issue because of the qualities of soil under continuous no-till include a higher water infiltration rate,.[34] So, you might want to see how a field with saturated soil behaves under no-till before deciding whether or not to purchase tiling for the area.

Equipment

It is very important to have planting equipment that can properly penetrate through the residue, into the soil and prepare a good seedbed.[35] Switching to no-till reduces the maximum amount of power needed from farm tractors, which means that a farmer can farm under no-till with a smaller tractor than if he/she was tilling.[36] Using a smaller, lighter tractor has the added benefit of reducing compaction.

Soil temperature

Another problem that growers face is that in the spring the soil will take longer to warm and dry, which may delay planting to a less ideal future date. One reason why the soil is slower to warm is that the field absorbs less solar energy as the residue covering the soil is a much lighter color than the black soil which would be exposed in conventional tillage. This can be managed by using row cleaners on a planter.[37] Since the soil can be cooler, harvest can occur a few days later than a conventionally tilled field. Note: A cooler soil is also a benefit because water doesn't evaporate as fast.

Residue

On some crops, like continuous no-till corn, the thickness of the residue on the surface of the field can become a problem without proper preparation and/or equipment.

Fertilizer

One of the most common yield reducers is nitrogen being immobilized in the crop residue, which can take a few months to several years to decompose, depending on the crop's C to N ratio and the local environment.[38] Fertilizer needs to be applied at a higher rate during the transition period while the soil rebuilds its organic matter. The nutrients in the organic matter will be eventually released back into the soil, so this is only a concern during the transition time frame (4–5 years for Kansas, USA). An innovative solution to this problem is to integrate animal husbandry in various ways to aid in the decomposition cycle.[39]

Misconceptions

Need to fluff the soil

Although no-till farming often causes a slight increase in soil bulk density, periodic tilling is not needed to “fluff” the soil back up. No-till farming mimics the natural conditions under which most soils formed more closely than any other method of farming, in that the soil is left undisturbed except to place seeds in a position to germinate.

External links

- No-Till Farmer Website (http://www.no-tillfarmer.com)

Similar terms

No-till farming is not equivalent to conservation tillage or strip tillage. Conservation tillage is a group of practices that reduce the amount of tillage needed. No-till and strip tillage are both forms of conservation tillage. No-till is the practice of never tilling a field. Tilling every other year is called rotational tillage.

See also

- Conventional tillage
- Masanobu Fukuoka, one of the pioneers of no-till grain cultivation
- Natural farming
- No-dig gardening
- Permaculture
- Strip-till

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