"We might say that the earth has the spirit of growth; that its flesh is the soil." Leonardo daVinci

Agriculture Resiliency

Conservation Agriculture

Snohomish Conservation District

working together for better ground since 1941

CONSERVATION AGRICULTURE

We are fortunate in the Puget Sound region of Washington to have nearly level alluvial floodplains along our major river valleys that have provided us with deep rich soils. It is upon these soils that most of our agriculture has developed. With sufficient drainage infrastructure, a mild Pacific climate, and little erosion, these soils have held up well to many forms of agricultural production.

Today, we are facing many changes across our landscape - increasing development pressures, more impervious surfaces, changes in our hydrologic cycles and in our climate. All of these impacts have challenged farmers to find innovative ways to adapt to maintain healthy, productive, and resilient agricultural systems. Conservation Agriculture (CA) is a technique that can be used to adapt to these changes and create a more agricultural resilient system with healthy soils.

What is Conservation Agriculture?

Conservation Agriculture allows us to realize multiple benefits to our landscape – soil resilience, agricultural productivity, and clean water - through a set of soil management practices designed to simulate a sustainable system (Shaxson et al, 2008).

There are three core principles of CA:

1. Minimize soil disturbance (no-till or conservation-till methods)
2. Maintenance of soil cover throughout the year (cover crops, mulches, residue)
3. Managing crop rotations to combat pests and pathogens

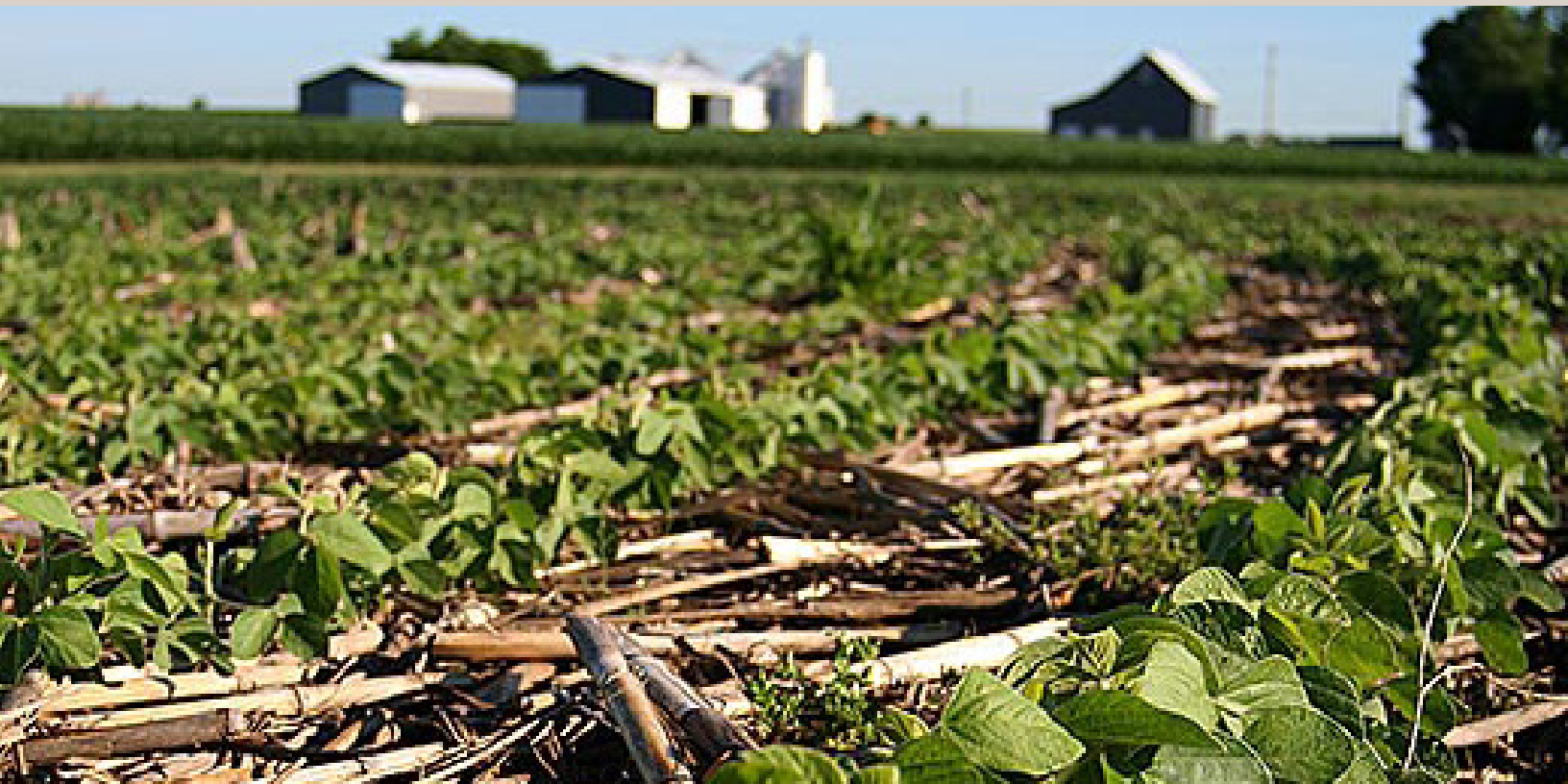
No or conservation-till methods protect soil structure, soil composition, and biodiversity. Soil cover methods such as cover crops provide organic inputs, protect against soil erosion, and increase soil biological processes and nutrient availability to crops. Crop rotations guard against pests and pathogens with minimal use of pesticides The UN Food and Agriculture Organization recently added a fourth principle – reduced traffic over soils – to protect soil structure.

Benefits

There are two interconnected benefits that make CA different from conventional agriculture:

1. There is a constant net increase of soil organic matter, rather than a decrease, and
2. There is a consistent improvement in soil moisture retention minimizing the effects of drought on crops.

While each principle has its own benefits as introduced below, all benefits of CA are realized through the interconnection of the three core principles functioning together to create an agro-ecosystem (Cornell University, 2018).



1. Conservation Tillage or No-till

Conservation tillage and no-till practices take advantage of biological systems to perform the work of mechanical tillage - saving time, money, and avoiding soil degradation. When soil is mechanically tilled, soil pore, root, and mycorrhizal hyphae networks (important for phosphorus availability) are destroyed. No till methods make use of deep-rooted cover crops, crop residues, and biological organisms such as earthworms to till soils and relieve compaction. Literature reviews have shown that soil microbes increase rapidly in only a few years after reduced or no-till practices are adopted. This increase in biological processes has the added benefits of building resilience against soil compaction, increasing nutrient cycling and availability for crops, increasing water infiltration, and increasing water holding capacity (Shaxson et al., 2007). Pathogen control has also been associated with soil microbial increases (Hobbs et al., 2007).

Mechanical tillage of wet soil can also increase soil compaction below the tillage zone creating what are known as tillage or plow pans. Once these pans are created, water cannot infiltrate as effectively which can lead to ponding in wet months (NRCS, 2011). Reducing tillage can prevent plow pans, allow water to infiltrate more deeply into soil, reduce ponding, and maintain soil moisture later into the season. Farmers may find that sub-soiling or chiseling will be needed to address deep compaction layers before reduced or no-till techniques are adopted.

2. Soil Cover / Cover Crops

Organic soil cover in the form of cover crops and associated cover crop residue shows a wide range of benefits to soils including increases in organic matter and biological activity, increased water holding capacity and infiltration, and pathogen control. In a literature review conducted by Kumar and Goh (2000), studies showed that crop residues provided a significant benefit to crop production due to the positive effects on all three aspects of soil health - physical, chemical and biological functions. Studies demonstrate that mulches such as crop residue, increase soil moisture by moderating soil temperatures and reducing evaporation. At the same time, mulches and crop residues increase soil organic matter, promoting greater biological activity and in turn improving nitrogen availability (Hobbs et al., 2007).

While many use tillage as a way to dry wet soil in the spring, cover crops can also be effective at drying soils for earlier planting through a number of mechanisms. Winter cover crops such as winter wheat or rye can be planted so as these cover crops put on growth in spring they utilize water in the soil profile and help to dry surface soils for timely seedbed establishment. Cash crops are then directly seeded into cover crop residues. This increase in biological organisms improves soil structure, creating more pore spaces for water to drain thus improving infiltration. Cover crops with large tap-roots, such as certain radishes or turnips, can begin to break up tillage compaction and create large holes within the soil profile as they rot for downward water movement. Crop residues break down more quickly under a canopy of cover crops and the roots of cover crops will help stabilize the soil and improve water infiltration deeper into the soil, allowing soils to drain more effectively (NRCS, 2011).

Cover crops and residues can also help with weed and pest suppression. Cereal cover crops, when cut or rolled flat, have properties that chemically suppress the growth of many weeds (Jung et al., 2004). Crop residues help to reduce weed infestation through competition for space, light, and moisture. An increase in microorganisms due to residue has also shown to suppress weeds through biological activities of competition and predation (Hobbs et al., 2007). Increased numbers of beneficial insects found in high residue fields lead to lower pressures by insect pests.

3. Crop Rotations

Crop rotations protect against pest and disease problems by interrupting the life cycle of certain bacteria, fungi, insect, and weed pests. With an increased diversity of crops, an increase in beneficial soil biota results - to include predatory wasps, spiders, mites, springtails, nematodes, bacteria, and fungi. Crop rotations have shown to increase yields by around 10% in rotational systems as compared to monoculture, non-rotational systems, largely due to natural pest control (Cornell University, 2015).

The more diverse the crop rotations, the more nutrient cycling and pest suppression seems to take place. Adding legumes into the mix can increase nutrient cycling significantly. Also, creating different root residues at different depths in the soil profile from a variety of crops can improve soil biology and the associated resilience to pests (Shaxson et al., 2007).

When the above three management techniques are combined into a fully operational CA system, labor inputs and costs tend to decrease. With the reductions or elimination of tillage, valuable labor is saved during planting season. Lands under no-till tend to involve less weeding and pest control management after the establishment of permanent soil cover and crop rotations. Increasing organic matter, soil structure, and soil biota increases nutrient cycling and supply within the soil profile. CA builds up soil fertility over time leading to fewer fertilizer inputs to realize maximized yields (Cornell University, 2015). Significant reductions in fuel are also realized (Hobbs et al., 2008).

How to Begin

CA is applicable to all scales of agriculture from small manual plots to large mechanized operations. There are several considerations to be made when moving towards adoption of CA methods in order to maximize the above benefits as quickly as possible. Considering climate, soil types, topography and current on-farm conditions will help guide how you design an effective system for your farm. Developing a plan for a suite of practices that match farm goals and resources such as equipment and labor will make transitioning towards CA easier. Resource planners from the Snohomish Conservation District can assist you with all of these considerations and help you explore practices that you are interested in adopting.

In addition to Snohomish Conservation District staff, you may find that articles, websites, and local farmers who have adopted similar methods are a good place to start researching what will work best on your farm. The "Find Out More" section below is a good place to start. The first several years of transition may take some adaptive management while you find a system that works for your land, resources, management, and economic considerations. You may choose to start small with one or two fields as you adjust to the different management techniques and observe how your land responds.

Find Out More

For more information on conservation agriculture contact the Snohomish Conservation District at (425) 335-5634.

Cornell University College of Agriculture and Life Sciences has a wonderful page of frequently asked questions about conservation agriculture that addresses many of the concerns that farmers have when considering new practices.

- http://conservationagriculture.mannlib.cornell.edu/pages/aboutca/faq.html#9

Page on equipment for Conservation Agricultural systems

- http://conservationagriculture.mannlib.cornell.edu/pages/resources/equipment.html

Articles on reduced tillage and cover crops in the Maritime Pacific Northwest

- https://snocd.org/reduced-tillage
- https://snocd.org/cover-crops-intro

Articles on the economics of Conservation Agriculture

- https://snocd.org/economics-conserve-ag
- https://snocd.org/conservation-ag

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