Conservation Agriculture With & Without Trees
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What is Conservation Agriculture (CA)?

According to **FAO** *(2007)*

“CA is a concept for saving agricultural resources so as to achieve acceptable profits together with high and sustained levels of crop production while concurrently conserving the environment”

Redefined by **ICRAF** *(2014)*

CA is based **on optimizing yields and profits**, to achieve a **balance of agricultural, economic and environmental benefits**.

What does CA emphasize?

a) That Soil is a living body, essential to sustain life on earth.

b) The protection of the upper 0-20 cm of soil since it is the most active zone, but also the most vulnerable to erosion and degradation.
# Three Principles of Conservation Agriculture

<table>
<thead>
<tr>
<th>Principle</th>
<th>Practice</th>
<th>Biophysical Benefits</th>
<th>Farm Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum soil disturbance</td>
<td>Minimum tillage</td>
<td><strong>Improved soil physical properties</strong></td>
<td>• Reduced erosion</td>
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<tr>
<td></td>
<td>Zero-tillage</td>
<td>• Texture &amp; structure</td>
<td></td>
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<tr>
<td>Permanent soil cover</td>
<td>Live mulch</td>
<td>• Aeration</td>
<td>• Enhanced WH capacity</td>
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<td></td>
<td>Crop residue</td>
<td>• Soil moisture regime</td>
<td>• Enhanced soil fertility</td>
</tr>
<tr>
<td>Crop rotation / intercropping</td>
<td>Crop rotation</td>
<td><strong>Improved biological properties</strong></td>
<td>• Enhanced productivity</td>
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<td></td>
<td>Intercropping</td>
<td>• Microbial activities</td>
<td>• Enhanced Profitability</td>
</tr>
<tr>
<td></td>
<td>Both</td>
<td>• Organic matter (manure)</td>
<td></td>
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Adapted from FAO (2012)
Minimum Soil Disturbance
Why Ploughing Damages The Soil.

Conventional cultivation (e.g. using MB-Ploughs) leaves the soil bare, exposing it to:

- Erosion and evaporative water losses
- Accelerated decomposition of soil OM
- Destruction of soil structure.
- Extremely low yields
- High labor input esp. in Africa.

Source: [http://www.worldagroforestry.org](http://www.worldagroforestry.org)
Tractor-drawn minimum tillage

VS

Google share
Hoe Minimum-Tillage with Planting Basins, Zambia
Zai pits as a one-off disturbance of soil
Crop Rotation
Crop Rotation

- Legume: beans, peas, lima beans, potatoes
- Root: onions, garlic, turnips, beets, carrots, radishes
- Leaf: lettuce, greens, herbs, spinach, brassicas, corn
- Fruit: tomatoes, cucumbers, peppers, eggplant, squash, melons
Cover Cropping
Cover cropping using kales
Cover cropping using Velvet beans
Conservation Agriculture with trees (CAWT)
Conservation Agriculture With Trees

According to ICRAF (2014).

• CAWT is the inclusion of trees to support CA system
• Its done in order to combine the best of CA and the best of agroforestry - leading to a working model under different social, economic, biophysical, institutional and policy conditions.
Why is (CAWT) Important?

Problem: CO$_2$ levels are continuing to increase

Fact: A single young tree can absorb 11.8 Kgs of CO$_2$ per year

Solution: Increase the number of area of plants and trees to absorb CO$_2$
Benefits of Trees on Farm

Trees on farm provide the following benefits:

• Absorption and storage (sequestration) of vast amounts of carbon throughout their life.
• Windbreaks and shelter for crops,
• Erosion control via dissipation of rain drops
• Diversification of production (Fruits, timber etc)
• Maintenance of moisture levels while reducing carbon emissions.

(ICRAF 2014).
Other Benefits of CAWT

- Carbon sequestration
- Fodder
- Fruits
- Fuel wood
- Construction materials,
- Agricultural implements
- Biomass
- Nutrients
- Fencing
Soil Carbon: **CA Benefits**

- When bare soil is exposed between crops, carbon stored in the soil is lost to the atmosphere.
- By planting cover crops on croplands that have an off-season fallow period, farmers can expand the length of photosynthesis time.
- This practice increases the amount of carbon stored in the soil, while also improving soil quality and fertility.

Soil Carbon: **CAWT Benefits**

- Carbon storage through tree biomass.
- Soil improvement
- Enhanced soil structure and water infiltration and penetration through mulching and their rooting systems.
- Weed suppression through mulching and canopy cover.
- Nitrogen fixation and nutrient cycling through inclusion of deep rooted and leguminous trees and shrubs leading to improvement in crop yields
- Biodiversity conservation through leaves falling from the trees.
- Maintaining vegetative soil cover through mulching and upper canopy thus reducing soil erosion.
- Providing shelter belts against wind thereby controlling erosion.

*Nature4Climate* 2018

Garrity 2010
Tangible Benefits for the farmer from adopting CA

- 96% less soil erosion.
- 66% less fuel use.
- Maintenance or improvement of the organic matter and its role enhanced.
- Higher water use efficiency.
- Increase in soil fertility and soil understood as a living entity
- Reverse negative trends
- Lower production costs.
- Higher production stability and higher yield potential.
- Increased cropped area.
**Numbers**

**CA without trees:**

- About 350 M ha – upto 25% of the world’s cropland – could be planted with cover crops.

- Practicing CA could sequester up to 372 M Tons of CO$_2$ equivalent per year (MtCO$_2$e/year).

- This is comparable to the emissions from $79 \text{ M passenger vehicles per year}$.

**CA with trees:**

- Trees could be planted in croplands across 608 M ha globally – an area over half the size of the USA.

- It is estimated that holding warming to below 2 degrees C would need the application of agroforestry systems across 322 M ha, an area about the size of India.

- Planting trees in agricultural lands could store 439 M tons of CO$_2$ equivalent per year (MtCO$_2$e/year).

- This is comparable to the emissions from $94 \text{ million passenger vehicles per year}$.

Conservation Agriculture (CA)
Where Has CA Been Practiced?

- USA, Europe, Africa, Latin America, Australia.
- Successful programs in Ethiopia, Indonesia, Senegal and Timor-Leste.
- In Latin America, CA has revolutionized farming systems within the last decade.
- It is now being seen as a possible solution to Sub-Saharan Africa too.

How is CA Implemented? Key Feature:

- No burning of crop residue.
- No ploughing, diskimg or soil cultivation
- Direct seeding or planting (Zero-Tillage)
- Crop & cover crop to stay on the surface
- Mulching from permanent crop and weed residue.
- Controlled grazing
- Application of lime & minimal fertilizers on soil surface.
- Use specialized equipment for seeding & fertilizer application
How Is CAWT Implemented?

- Nursery establishment & management
- Field preparation and transplanting
- Watering/Irrigating
- Controlling weeds
- Mulching
- Gapping
- Thinning
- Pruning
- Coppicing
- Pollarding
- Laser leveling (CIMMYT 2015)

Source: Wood and Burley (1991)

Joseph Mutua, Jonathan Muriuki, Peter Gachie, Mieke Bourne and Jude Capis 2014
Conservation Agriculture with Livestock

- Establishment of permanent forage plots for direct grazing or cut-and-carry.
- Permission of controlled grazing time in a given area, e.g. 15 days per month.
- Reduction of herd size by culling to destock some animals and ensure the right density.
- Temporary displacement of animals to other areas especially among pastoralist communities.
- Contour grass strips and palatable leguminous trees esp. on steep lands.
- Carrying and spreading bushy vegetation to make a mulch.
- Zero grazing to allow for precise amounts of feeds and nutrients.
Main Challenges for CAWT:
Disseminating knowledge to farmers about

• **What type** of cover crop or crop mixture to plant,
• **When** to plant,
• **How deeply** to plant and,
• **What new equipment** might be necessary.
• More research **to map the regions** where various tree-planting practices are likely to have net economic benefits.
In Conclusion
Some carbon and tree facts

<table>
<thead>
<tr>
<th>Carbon facts</th>
<th>Tree Facts</th>
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<tbody>
<tr>
<td>CO2 concentrations have risen by 25% - over 39% in the last century</td>
<td>A single tree can annually absorb up to 19 kg of CO2</td>
</tr>
<tr>
<td>CO2 is fixed in trees and vegetation through photosynthesis</td>
<td>Trees are natural pollution filters when they absorb pollutants through leaf stomates</td>
</tr>
<tr>
<td>CO2 makes plants more resistant to extreme weather</td>
<td>Trees lower temperatures by transpiring water</td>
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<tr>
<td>CO2 makes trees healthier &amp; easier to manage</td>
<td>Trees reduce heat sinks which are 6 - 9 Degrees F warmer than surrounding areas.</td>
</tr>
<tr>
<td>100 Metric tons of CO2 can accumulate in an acre of forest over time.</td>
<td>Trees reduce erosion and recharge groundwater</td>
</tr>
<tr>
<td>Each person generates approx. 2.3 Tons of CO2 annually</td>
<td>An acre of trees absorbs enough CO2 annually equal to amount produced by driving a car for 42,000 km.</td>
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</tbody>
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Further Learning Resources (1)

Further Learning Resources (2)


• Thank you for your interest