Conservation Agriculture With & Without Trees

Eng. Alex R. Oduor & Eng. Maimbo Malesu

World Agroforestry Centre

Contents

- What is Conservation Agriculture (CA)?
- Three Principles of Conservation Agriculture
- Conservation Agriculture with trees (CAWT)
- Conservation Agriculture without trees (CA).
- Some Carbon & Tree facts

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"

Tabi Jobs, Google share

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

Principle	Practice	Biophysical Benefits	Farm Benefits
Minimum soil disturbance	Minimum tillage	Improved soil physical properties	
	Zero-tillage	• Texture & structure	• Reduced erosion
Permanent soil cover	Live mulch	• Aeration	• Enhanced WH capacity
	Crop residue	• Soil moisture regime	• Enhanced soil fertility
Crop rotation /intercropping	Crop rotation	Improved biological properties	• Enhanced productivity
	Intercropping	• Microbial activities	• Enhanced Profitability
	Both	• Organic matter (manure)	

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.

http://www.worldagroforestry.org

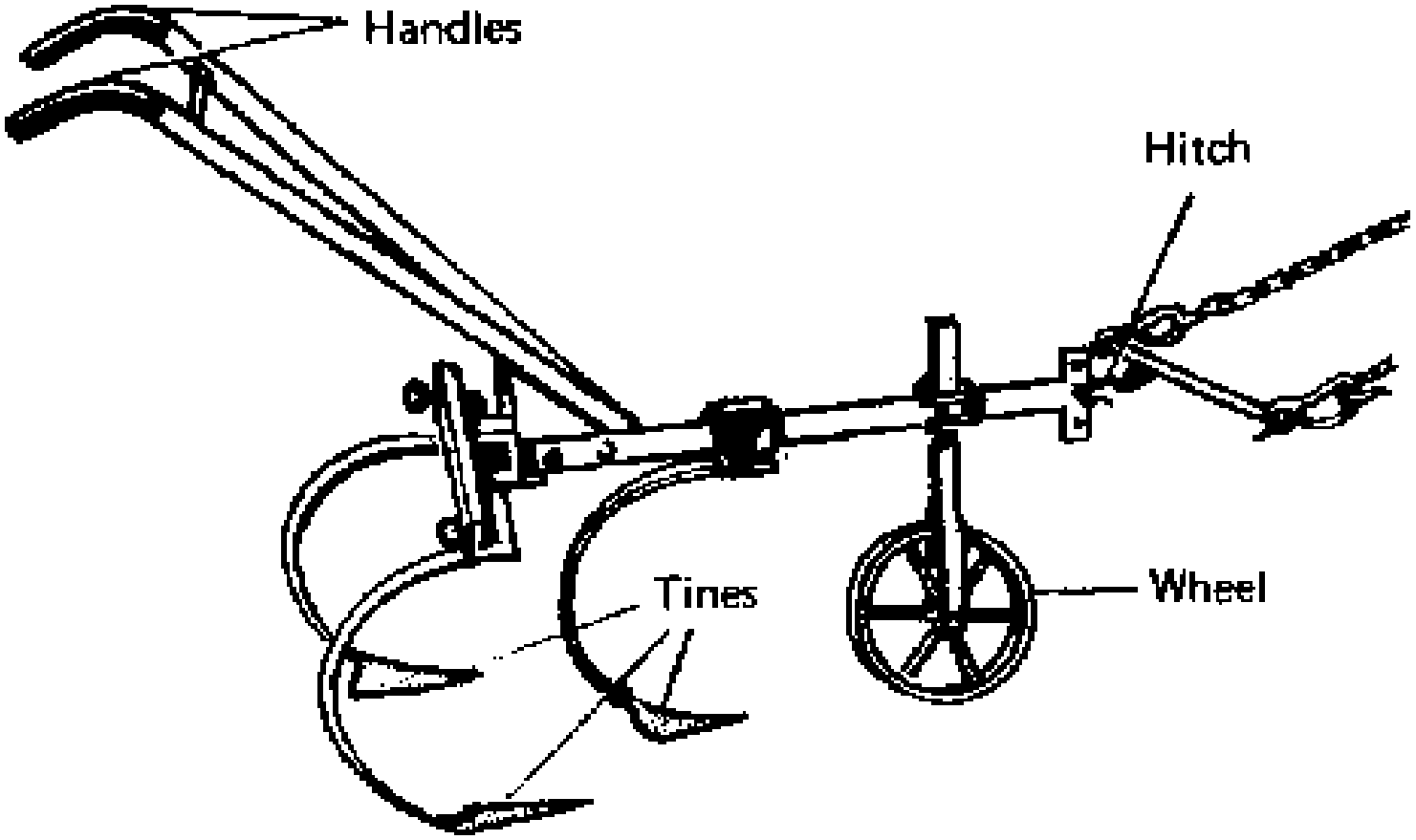
UN, Google Share

Tractor-drawn minimum tillage

Google share

VS

Animal-drawn tines



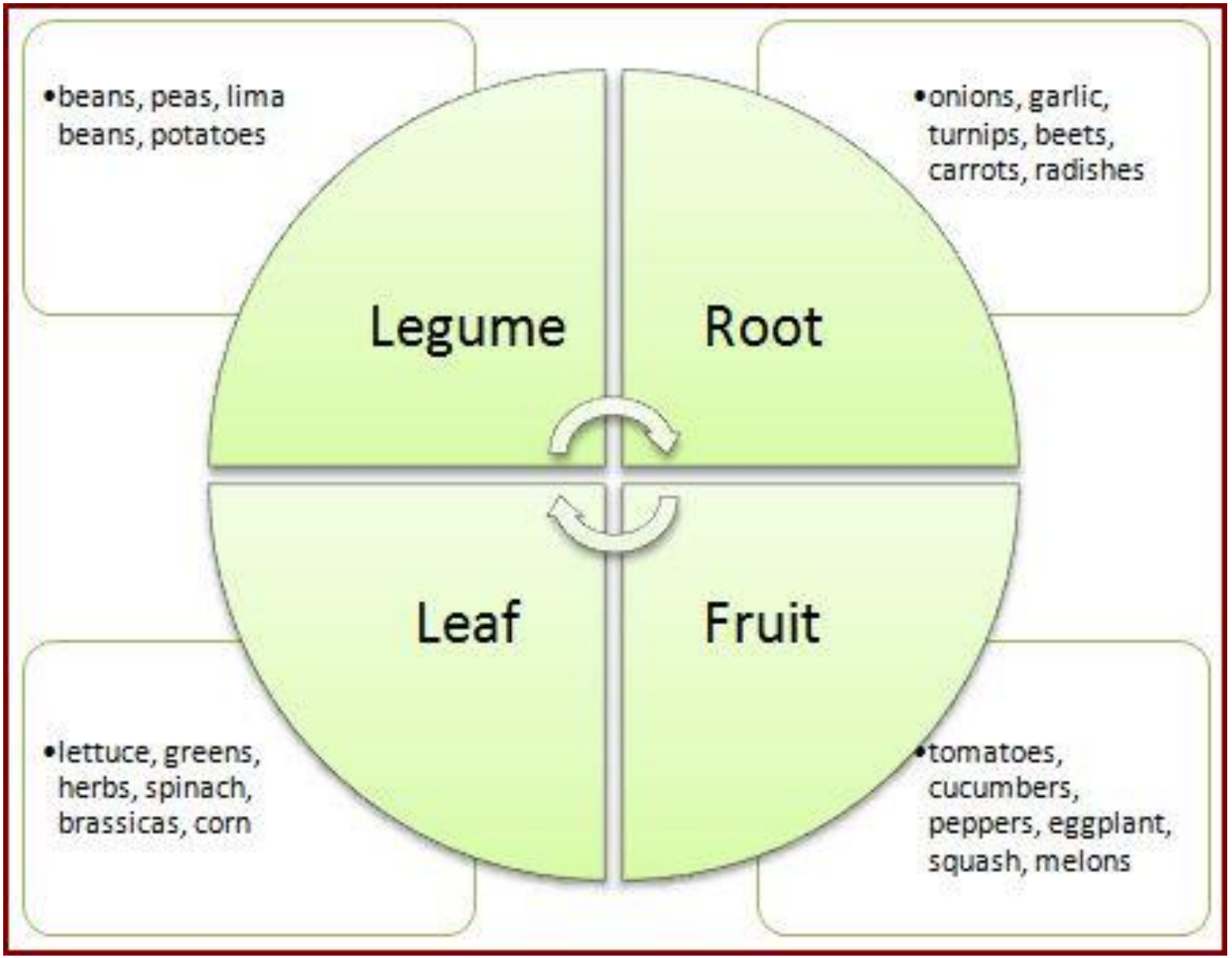
Animal-drawn cultivator

Hoe Minimum-Tillage with Planting Basins, Zambia

Zai pits as a one-off disturbance of soil

Crop Rotation

Crop Rotation

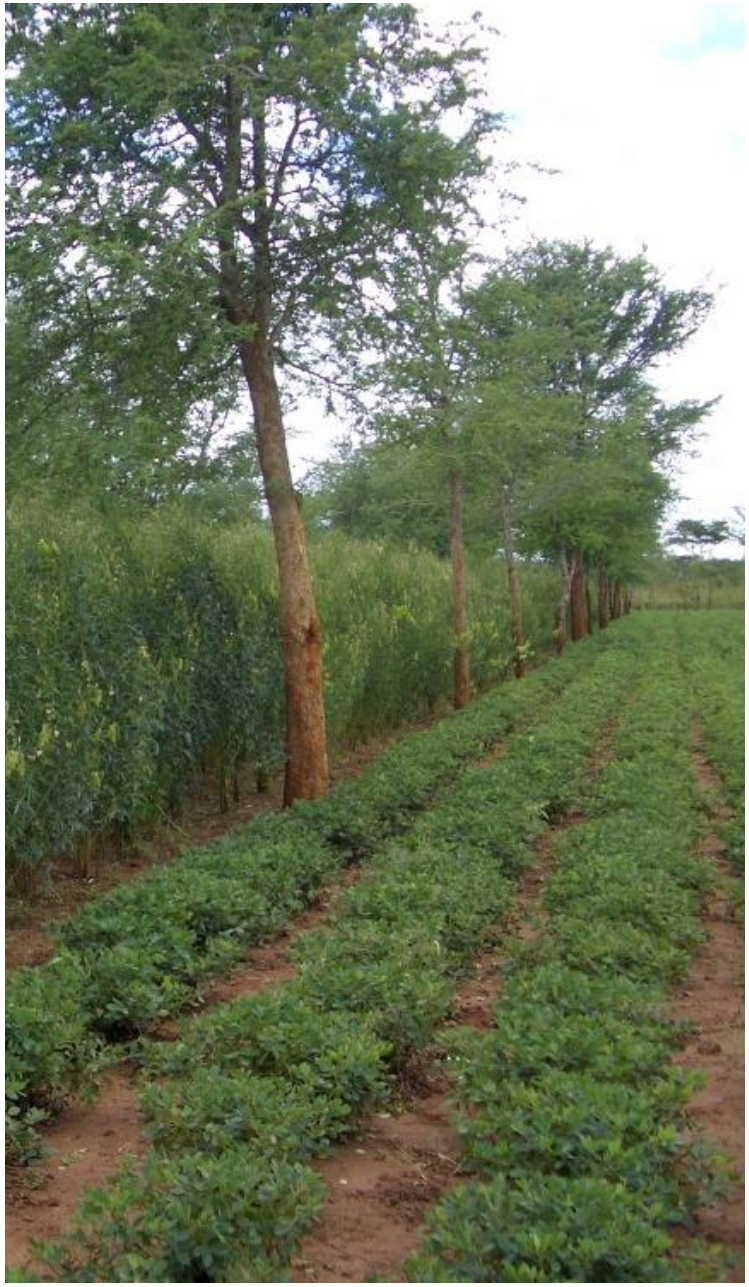


Cover Cropping

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.

ICRAF, Google slide share

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).

UPI.com, Google share

India, Google share

Other Benefits of CAWT

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

Fruits from trees in the market

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.

Nature4Climate 2018

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.

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 ($MtCO_2e$/year).
- This is comparable to the emissions from ***79 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 ($MtCO_2e$/year).
- This is comparable to the emissions from ***94 million passenger vehicles per year***.

https://nature4climate.org/science/n4c-pathways/grasslands-and-agricultural-lands/conservation-agriculture/

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.

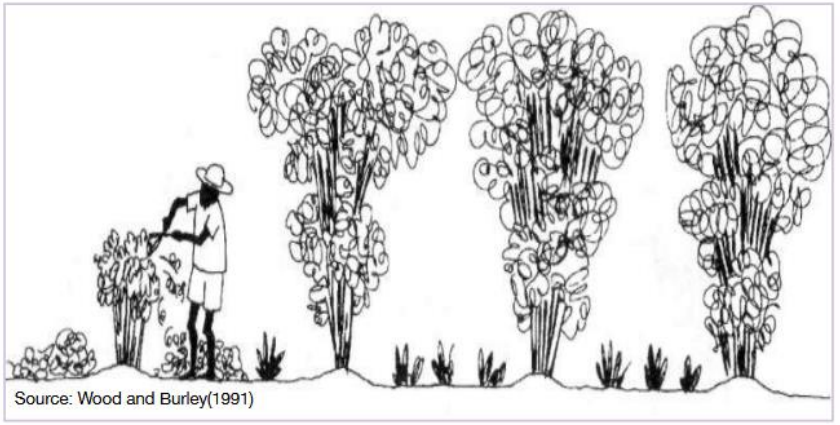
https://nature4climate.org/science/n4c-pathways/grasslands-and-agricultural-lands/integration-of-trees-in-croplands/

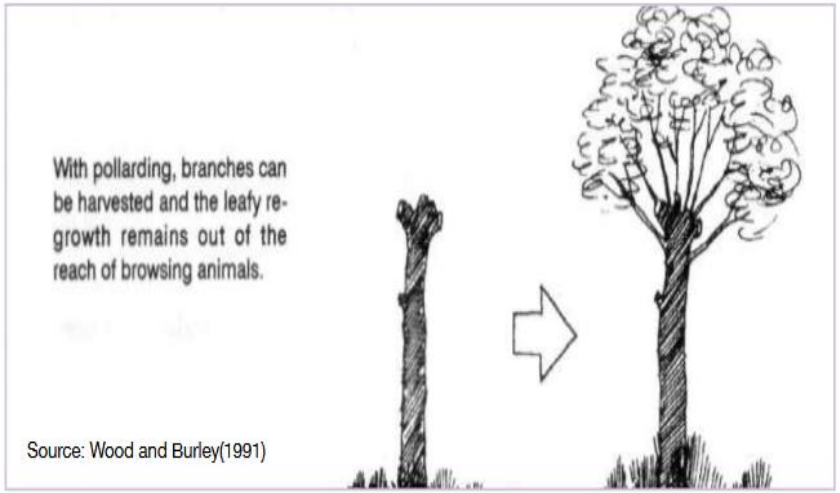
How is CA Implemented? Key Feature:

- No burning of crop residue.
- No ploughing, disking 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)



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.

Animals feeding on crop residues

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.

Nature4Climate 2018

In Conclusion

Some carbon and tree facts

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

Further Learning Resources (1)

- Brenna S., Acutis M., Tabaglio V., and Grandi M. (2018) Conservation Agriculture as a driver for Carbon Credit market. Available online: www.researchgate.net [accessed Nov 04 2018].
- FAO (2001) The economics of conservation agriculture. Availabe online: http://www.fao.org/docrep/004/y2781e/y2781e04.htm [accessed Nov 03 2018].
- Cheesman, S., Thierfelder, C., Neal S., Girma E, Kassie, T., Frossard, E. (2016) Soil carbon stocks in conservation agriculture systems of Southern Africa. Soil and Tillage Research. Volume 156: 99-109 Available online: https://www.researchgate.net/publication/283256024_Soil_carbon_stocks_in_conservation_agriculture_systems_of_Southern_Africa [accessed Nov 03 2018].
- Conservation Agriculture (2018) Grasslands & Agricultural Lands. Nature for Climate. Available online: https://nature4climate.org/science/n4c-pathways/grasslands-and-agricultural-lands/conservation-agriculture/ [accessed Nov 03 2018].
- FAO (2012) Soil Organic Carbon Accumulation and Greenhouse Gas Emission Reductions from Conservation Agriculture: A literature review. By Corsi, S., Friedrich, T., Kassam, A., Pisante, M., de Moraes Sà, J. Integrated Crop Management. Vol.16-2012. FAO. Available online: http://www.fao.org/3/a-i2672e.pdf [accessed Nov 03 2018].
- FAO, (2013) Climate-Smart Agriculture (CSA).Available online: http://www.fao.org/docrep/018/i3325e/i3325e.pdf [accessed Nov 12 2018].
- FAO (2014) Conservation agriculture (CA). Available online: http://www.fao.org/ag/ca/ [accessed Nov 12 2018].

Further Learning Resources (2)

FAO (2018) How to practice Conservation Agriculture? Available online: http://www.fao.org/agriculture/crops/thematic-sitemap/theme/spi/scpi-home/managing-ecosystems/conservation-agriculture/ca-how/en/ [accessed Nov 03 2018].

FAO (2018) How to practice Conservation Agriculture? Available online: http://www.fao.org/agriculture/crops/thematic-sitemap/theme/spi/scpi-home/managing-ecosystems/conservation-agriculture/ca-how/en/ [accessed Nov 03 2018].

Garnett, T., and Godfray, C. (2012) Sustainable intensification in agriculture. Oxford, UK. Available online: http://www.fcrn.org.uk/sites/default/files/SI_report_final.pdf [accessed Nov 12 2018].

Joseph Mutua, Jonathan Muriuki, Peter Gachie, Mieke Bourne and Jude Capis (2014) **Conservation Agriculture With Trees:** Principles and Practice. A simplified guide for Extension Staff and Farmers (2014) Available online: http://www.worldagroforestry.org/downloads/Publications/PDFS/TM17693.pdf

Marsh, L., Zoumenou, V., Cotton, C., Hashem, F.(2017) Organic farming: knowledge, practices, and views of limited resource farmers and non-farmers on the Delmarva Peninsula. Available online: https://link.springer.com/article/10.1007/s13165-016-0150-x [accessed Nov 12 2018].

Mutua, J., Muriuki, J., Gachie, P., Bourne, M. and Capis, J. (2014) Conservation Agriculture With Trees: Principles and Practice: A simplified guide for Extension Staff and Farmers. Technical Manual No. 21. World Agroforestry Centre, (ICRAF) Nairobi, Kenya. Available online: http://www.worldagroforestry.org/downloads/Publications/PDFS/TM17693.pdf [accessed Nov 12 2018].

Nature4Climate (2018) Trees in cropland. Available online: https://nature4climate.org/science/n4c-pathways/grasslands-and-agricultural-lands/integration-of-trees-in-croplands/ [accessed Nov 03 2018].

Neubert, S. (2016) More organic farming in sub-Saharan Africa. Available online: https://www.dandc.eu/en/article/despite-obstacles-organic-farming-makes-more-sense-sub-saharan-africa-conventional [accessed Nov 12 2018].

*Sedjo, Roger; Sohngen, Brent (2012). "Carbon Sequestration in Forests and Soils". Annual Review of Resource Economics. **4**: 127–144. doi:10.1146/annurev-resource-083110-115941.*

Srinivasarao C., Lal R., Kundu S., Thakur P. (2015) Conservation Agriculture and Soil Carbon Sequestration. In: Farooq M., Siddique K. (eds) Conservation Agriculture. Springer, Cham. https://link.springer.com/chapter/10.1007/978-3-319-11620-4_19 [accessed Nov 03 2018].

WWFGlobal (2012) African Ecological Footprint Report. Available online: http://www.panda.org/lpr/africa2012 [accessed Nov 12 2018].

Garnett, T., and Godfray, C. (2012) Sustainable intensification in agriculture. Oxford, UK. Available online: http://www.fcrn.org.uk/sites/default/files/SI_report_final.pdf [accessed Nov 12 2018].

Marsh, L., Zoumenou, V., Cotton, C., Hashem, F.(2017) Organic farming: knowledge, practices, and views of limited resource farmers and non-farmers on the Delmarva Peninsula. Available online: https://link.springer.com/article/10.1007/s13165-016-0150-x [accessed Nov 12 2018].

Mutua, J., Muriuki, J., Gachie, P., Bourne, M. and Capis, J. (2014) Conservation Agriculture With Trees: Principles and Practice: A simplified guide for Extension Staff and Farmers. Technical Manual No. 21. World Agroforestry Centre, (ICRAF) Nairobi, Kenya. Available online: http://www.worldagroforestry.org/downloads/Publications/PDFS/TM17693.pdf [accessed Nov 12 2018].

Nature4Climate (2018) Trees in cropland. Available online: https://nature4climate.org/science/n4c-pathways/grasslands-and-agricultural-lands/integration-of-trees-in-croplands/ [accessed Nov 03 2018].

Neubert, S. (2016) More organic farming in sub-Saharan Africa. Available online: https://www.dandc.eu/en/article/despite-obstacles-organic-farming-makes-more-sense-sub-saharan-africa-conventional [accessed Nov 12 2018].

*Sedjo, Roger; Sohngen, Brent (2012). "Carbon Sequestration in Forests and Soils". Annual Review of Resource Economics. **4**: 127–144. doi:10.1146/annurev-resource-083110-115941.*

Srinivasarao C., Lal R., Kundu S., Thakur P. (2015) Conservation Agriculture and Soil Carbon Sequestration. In: Farooq M., Siddique K. (eds) Conservation Agriculture. Springer, Cham. https://link.springer.com/chapter/10.1007/978-3-319-11620-4_19 [accessed Nov 03 2018].

WWFGlobal (2012) African Ecological Footprint Report. Available online: http://www.panda.org/lpr/africa2012 [accessed Nov 12 2018].

- **Thank you for your interest**

NUS Blog, Google share