# SEQUESTRATION AND CARBON CONSERVATION IN AGRICULTURE

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***Abstract****. Climate change and ensuring food security for an exponentially growing global human population are the greatest challenges in the future of agriculture. Improved soil management practices such as enhancing agro-ecosystem productivity, soil fertility, and carbon sequestration are crucial in tackling these environmental problems. The present synthesis assesses a range of current and potential future agricultural management practices that have an effect on soil organic carbon storage (SOC), and sequestration. Regarding the greenhouse effect, it should be emphasized that it is not only carbon as an independent element that is responsible, but carbon dioxide together with the other greenhouse gases (water vapor, methane, ozone, etc.). The incorporation of plant residues in the soil stimulates the activity of microorganisms, their degradation, their transformation into organic carbon in the soil, (SOC) with an important role in preserving soil fertility. Thus, to determine the amount of carbon dioxide that has been taken from the atmosphere and stored in biomass, the equivalence of atomic/molar mass is used. SOC stock boosting management measures such as fertilization, diverse crop rotations, cover cropping, and reduced tillage practices have been extensively discussed over the last 20 years. It is agreed among professionals that these beneficial practices must be maintained to help combat environmental issues in agriculture.*

***Keywords****: Carbon sequestration, emissions, agriculture, tillage*

## INTRODUCTION

Since 1880, the average temperature of the Earth's surface has increased by about 0.07°C (0.13°F) every decade, and by 0.74 ° C in the last century. That number may seem insignificant, but over time, it has become considerable. The main cause being an increase in CO2 as a result of human activity.

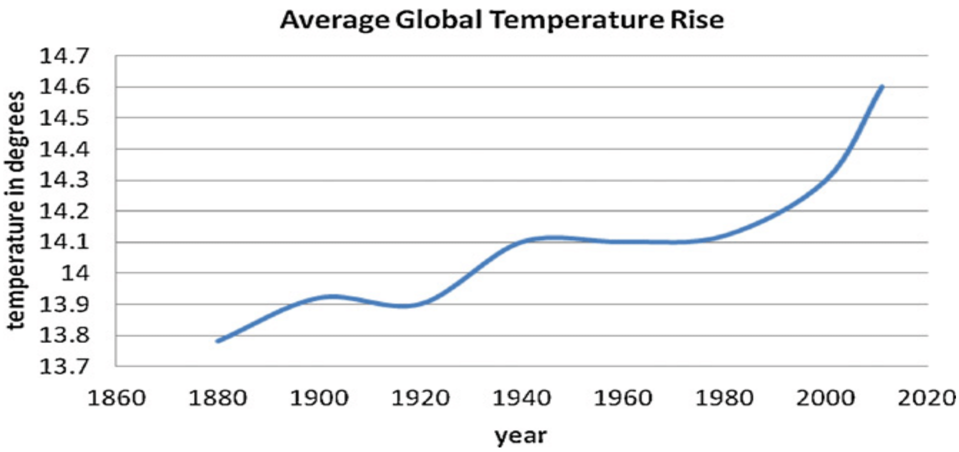



Fig. 1. Global temperature average

Carbon sequestration is an approach to mitigating global warming by capturing and transforming carbon dioxide (CO2). Global CO2 emissions from human activities reach 30 billion giga tons (Gt) per year, which corresponds to 8.1 Gt of carbon: 6.5 Gt from fossil fuel combustion, and 1.6 Gt from deforestation and agricultural practices.

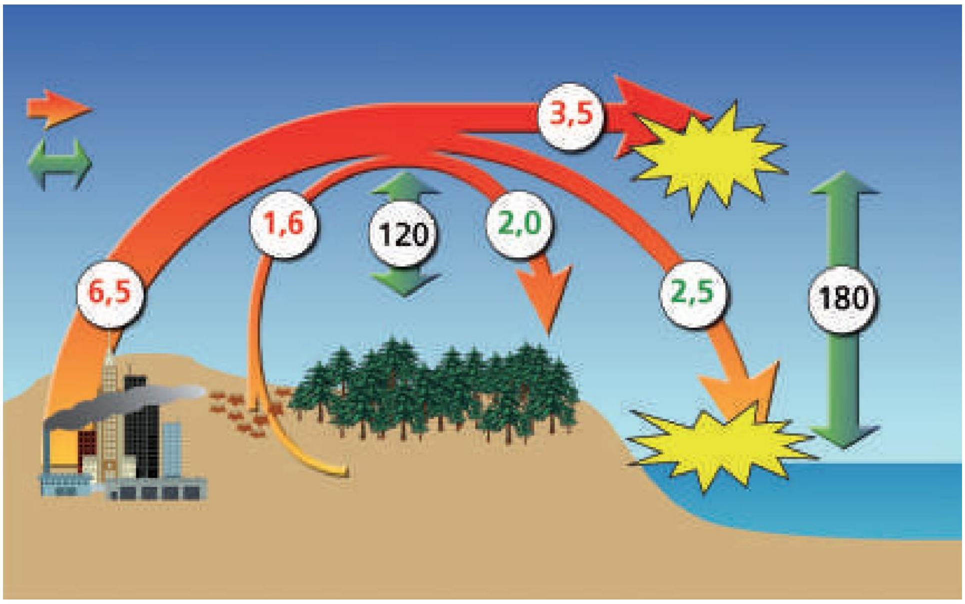



Fig. 2. Carbon sequestration

The objective is to enhance ecosystem services in terms of water quality, nutrient cycling, biodiversity, increase in NPP, and offsetting emissions.

Agriculture is one of the sectors most affected by climate change, but is one of the segments that can make the biggest difference in reducing carbon in the atmosphere. The $CO_2$ from the atmosphere is stored it in the soil through plant photosynthesis. Earth's soils store twice as much carbon as the atmosphere.

Historic changes in land use - in particular the conversion of grasslands and forests to arable land - as well as crop management practices, have led to a significant decrease in soil organic carbon (SOC) stocks. This leads to increased carbon dioxide (CO2) emissions in the atmosphere.

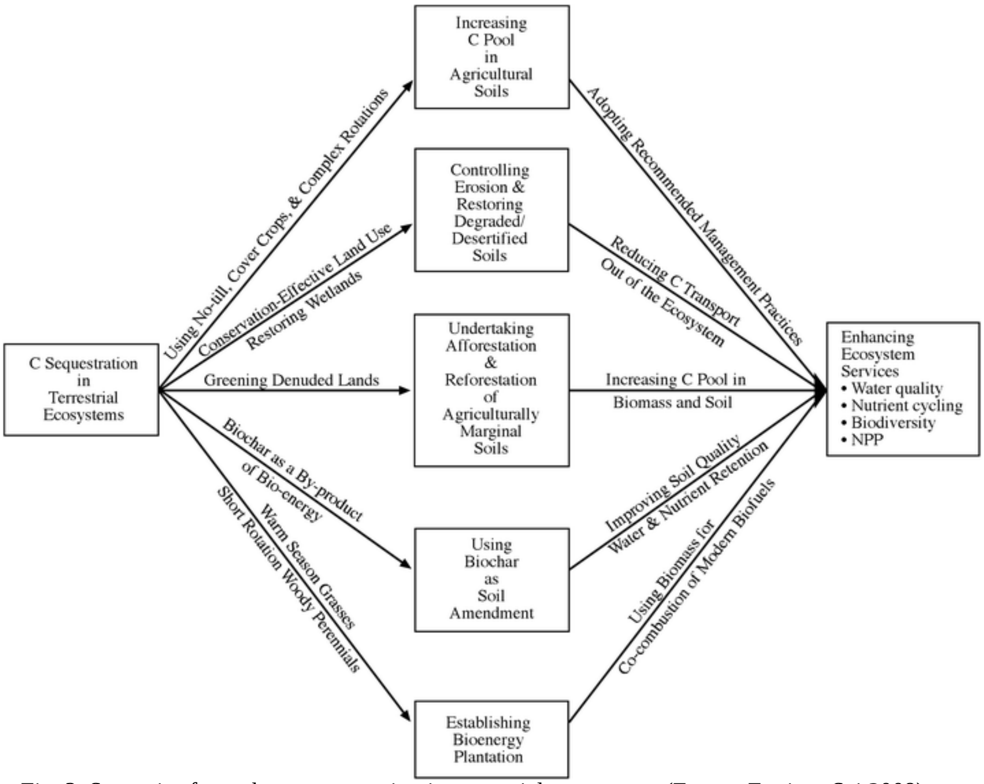
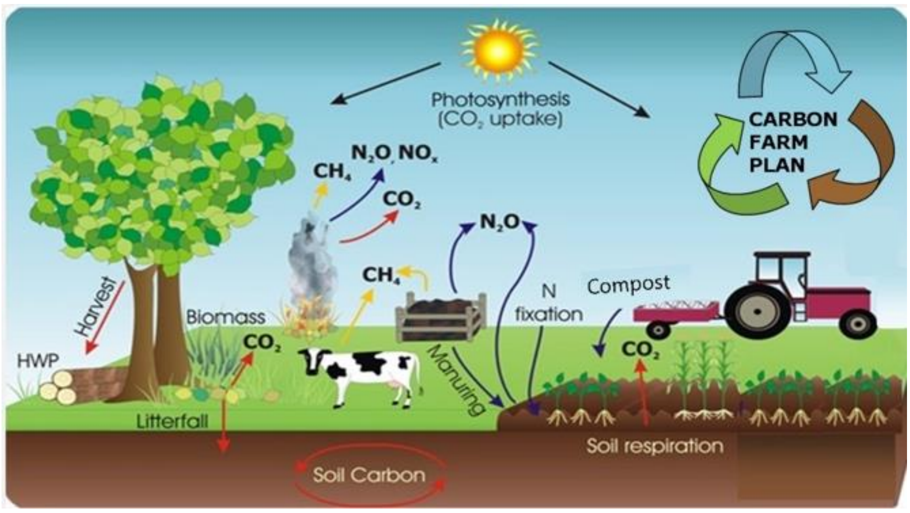



Fig. 3. Strategies for carbon sequestration in terrestrial ecosystems.(Energy Environ Sci 2008)



When a soil is converted from natural soil, such as forests, meadows, steppes and savannas, to arable land, the organic carbon content of the soil is reduced by about 30-40%. This loss is due to the removal of carbon-containing plant material caused by harvesting.

## MATERIAL AND METHODS

Methods in reducing carbon emissions in agriculture can be grouped into two categories:

- reduction of emissions - minimum soil works
- Improving carbon sequestration based on the retention of plant residues from previous crops, the introduction of legumes into crop rotation, green manure, intercropping, proper crop rotation, etc

Regarding the greenhouse effect, it should be emphasized that it is not only carbon as an independent element that is responsible, but carbon dioxide together with the other greenhouse gases (water vapor, methane, ozone, etc.). Thus, to determine the amount of carbon dioxide that has been taken from the atmosphere and stored in biomass, the equivalence of atomic/molar mass is used.

Carbon has an atomic mass of 12.0107 g / mol, being 3.6642 times lighter than carbon dioxide, which has a molar mass of 44.010 g / mol. As a result, in order to store one gram of carbon in biomass, the plants must take in 3.6642 grams of carbon dioxide from the atmosphere, according to the relation:

$$MCO_2 = MC \times 3,6642$$

Where as $MCO_2$ represents the amount of $CO_2$ absorbed to store an amount of $MCO_2$ carbon.

$C = 1 / 3,6642 = 0,273$

## RESULTS AND DISCUSSION

### Reducing emissions through minimum soil work

The carbon footprint, also called the $CO_2$ footprint, is the total greenhouse gas emissions that an organization, event, product, or person produces over a period of time.

One liter of diesel with a density of 0.85 kg / liter leads to 2.6 kg $CO_2$ emissions

Through the classic system of soil works we consume 78 l diesel / ha = 203 kg $CO_2$ / ha.

If we use the system of minimum soil works, the consumption is reduced to 40 l = 104 kg $CO_2$.

If we use the "No Tillage" system, the consumption is reduced to 20 l / ha, ie a maximum of 52 kg $CO_2$ / ha.

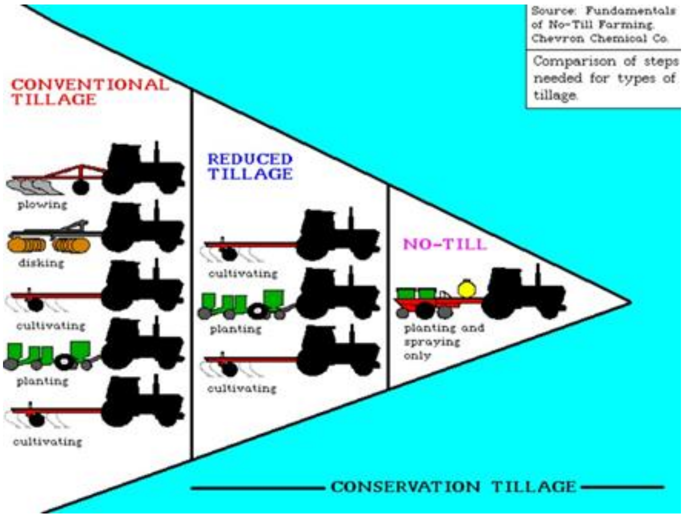



Fig. 4. Comparation between no-tilagem reduced tillage and conventional tillage

*Table 1*

Comparative wheat productions in Classic and No Till system

| Crop System | Fertilization | Production | % | Difference Kg/ha |
|---|---|---|---|---|
| Classic | $N_0$ $P_0$ $K_0$ | 4644 | 111 | 448 |
| | $N_{80}$ $P_{80}$ $K_{80}$ | 4685 | 112 | 489 |
| | $N_{160}$ $P_{80}$ $K_{80}$ | 4783 | 114 | 587 |
| No-till | $N_0$ $P_0$ $K_0$ | 4489 | 107 | 293 |
| | $N_{80}$ $P_{80}$ $K_{80}$ | 4600 | 110 | 404 |
| | $N_{160}$ $P_{80}$ $K_{80}$ | 4659 | 111 | 463 |

**Incorporation of Plant Residues**

For crops where the final product is formed or produced in the form of dry matter (straw, corn for grain, sunflower, tobacco, hay), the mass of vegetable residues is 1.3 - 5.8 times higher than the main production.

The distribution of plant residues on the soil layer of 0-10 cm differs depending on the tillage system:

- in the conventional system, 17%;
- in the system of minimum works, 75%.
- in the direct seeding system, without plowing, 90%.

*Table 2*

Nutrient intake from plant residues, (kg /t)

| **Plant Residues** | **N** | **$P_20_5$** | **$K_20$** | **S** | **CaO** | **MgO** |
|---|---|---|---|---|---|---|
| Wheat Straw (kg / t) | 5,0 | 2,1 | 9,5 | 0,3 | 4,2 | 2,1 |
| Corn Cobs (kg / t) | 7,0 | 3,5 | 2,9 | 0,3 | 7,0 | 3,5 |

**Carbon Storage from Incorporating Plant Residues**

The incorporation of plant residues in the soil stimulates the activity of microorganisms, their degradation, their transformation into organic carbon in the soil, (SOC) with an important role in preserving soil fertility.

1 t straw holds - 220 kg CO2 = 60 kg C
1 t corn cobs / sunflower stalks - 230 kg CO2 = 60 kg C
1 to humus = 400 kg C = 1468 kg CO2

*Table 3*

The amount of SOC obtained from plant residues

| Crop | Vegetable mass used | Humus kg/ha | Kg CO2 |
|---|---|---|---|
| Autumn Wheat | Roots - stalk<br>Straw | 600<br>1000 | 880<br>1468 |
| Corn | Roots - stalk<br>Stem - leaves | 800<br>1000 | 1174<br>1468 |
| Rapeseed | Stem - leaves | 2000 | 2936 |
| Sugar beet | Leaves - roots | 1200 | 1761 |

**Fixation by photosynthesis of the initial carbon in the form of $CO_2$, at the level of crops**

Carbon fixation by photosynthesis differs depending on the crop and the area. CO2 absorbed by plants is not fully sequestered because a large percentage,(which in the case of trees is 40-50%,) is returned to the atmosphere through the phenomenon of soil photosynthesis respiration, and to their biological decomposers, specific to the soil.

Although accumulations in photosynthesis occur only during the day, they are generally higher than the loss through respiration (which occurs without interruption). The balance being positive, in favor of accumulations (Pallardy, 2008). 20-40% from the carbon that the plant brings through photosynthesis, it is transferred to the rhizosphere (Walker, 2016).

To calculate the amount of carbon fixed in the air by a crop, biomass production is taken into account.

For example, in the case of wheat cultivation, at a production of 14 tons of aerial biomass, there are 6.5 tons of grain + 7.5 tons of straw. Underground there are 3.6 t (roots).

The amount of straw is equal to the grain harvest multiplied by the coefficient 0.59 - 0.65, depending on whether the harvest is higher or lower than 4 tons / ha.

Grain production is exported from agricultural land, so this amount of carbon will be reintroduced into the circuit through consumption.

**CONCLUSIONS**

Soil is a very large reservoir for carbon storage. Keeping carbon in the soil as much as possible becomes crucial both for reasons of soil fertility and to mitigate the greenhouse effect.

This is possible by adopting conservative measures:

- reducing $CO_2$ emissions through minimal soil work
- reducing high pollution inputs, such as nitrogen fertilizers and replacing them with plants that bring nitrogen through symbiosis (legumes).

- incorporation of various organic materials of plant and animal origin: manure, peat, compost, vermicompost, vegetable waste, etc.
- species diversification through different alternations, rotations and crop associations

Carbon management is necessary to solve a range of issues related to soil, water management, land productivity, biofuel and climate change. A reduction of EU greenhouse gas emissions in the EU by at least 40% by 2030 (compared to 1990 levels), is one of the targets approved by the European Council as part of the 2030 climate and energy policy framework. The EU ETS will be the main tool for achieving this goal.

The EU ETS Emissions Trading System (EU ETS Emissions Trading System) was launched in 2005 to promote the reduction of greenhouse gas emissions in a cost-effective and cost-effective way.

1 CER - Certified Emission Reduction (certificates from CDM emission reduction projects - Clean Development Mechanism) = 1 ton CO2

Carbon certificates should not be confused with green certificates, which refer to certificates obtained as a result of renewable or green energy production.

Romanian farmers who have begun to adapt their tillage and cultivation techniques, making the transition to sustainable agriculture, could increase their incomes by selling carbon certificates on the international market.

They can earn an additional 45-105 euro / ha / year, by capturing 3-7 tons of $CO_2$ / ha / year in the soil, implementing the measures of conservative agriculture.

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