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Effect of conservation agriculture on soil quality under climate change

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- Sustainable food production is one of the major challenges of the twenty-first century in the era of global environmental problems:

Climate change

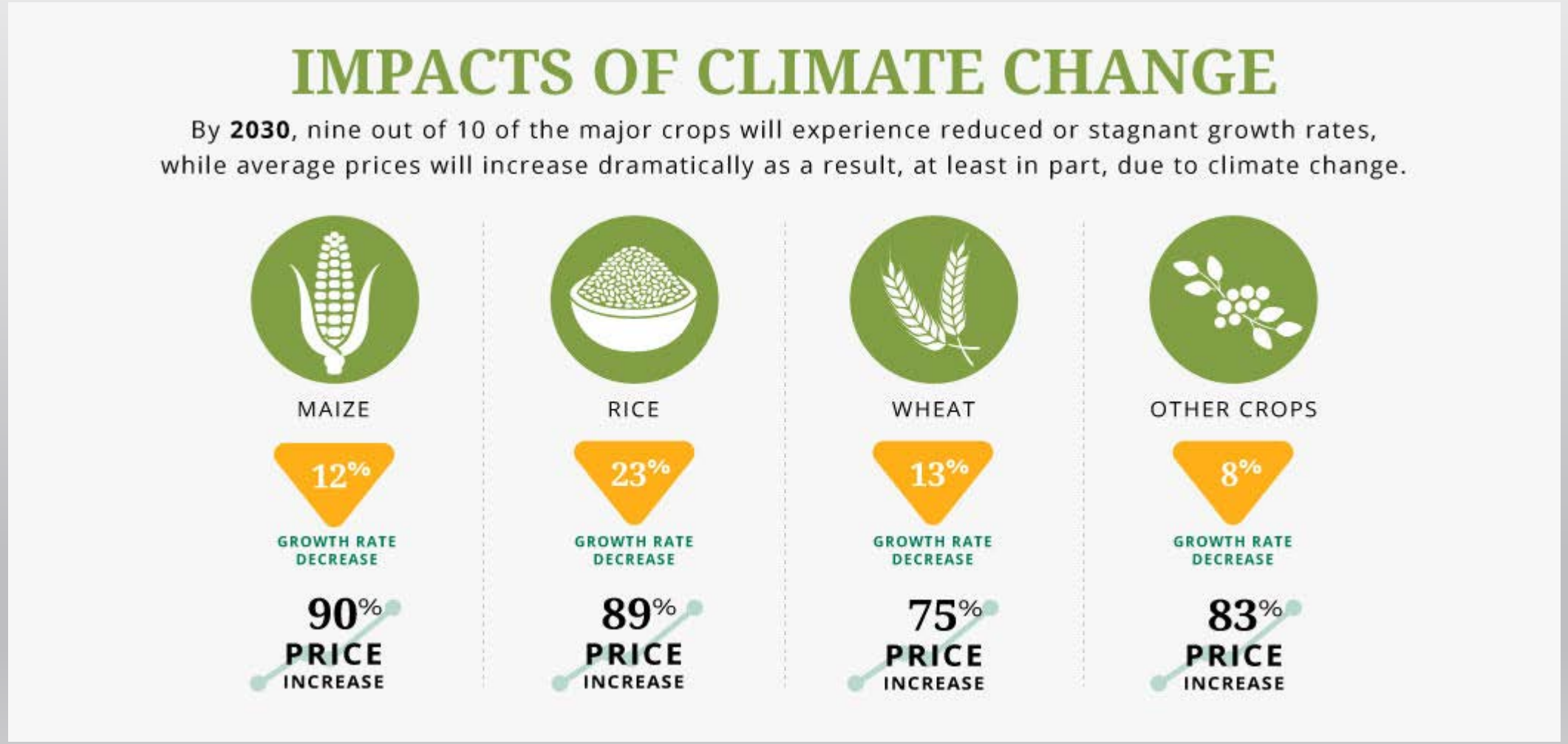
Increasing population

Natural resources degradation

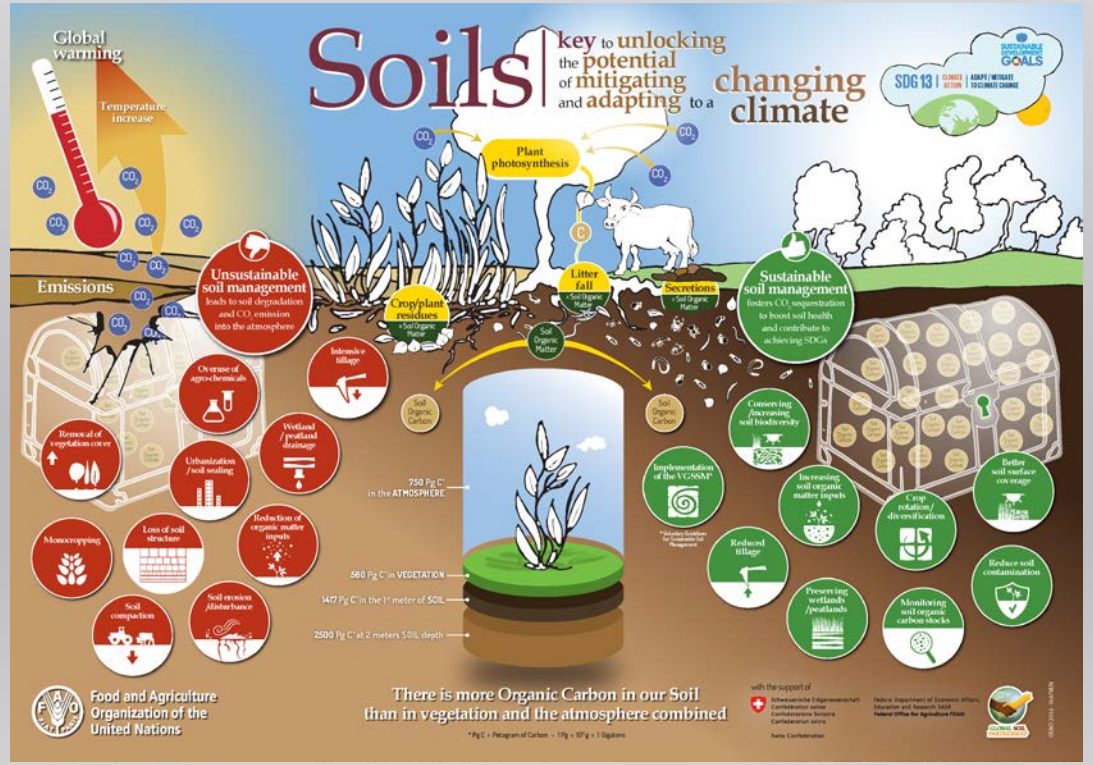
- Average global temperature is expected to increase through 0.5–2°C or higher and this increased temperature would affect agricultural production significantly
- Agriculture is among the highly sensitive systems influenced by change in weather and climate

- In recent years, climate change impacts have been become the greatest threats to global food security

Agriculture is more vulnerable to climate change than any other sector. A warming climate could reduce crop yields by more than 25%, according to the World Bank



- In some parts of world, higher temperatures may lead to more vegetation growth and more carbon stored in the soil.
- higher temperatures could also increase decomposition and mineralization of the organic matter in the soil, reducing organic carbon content.



- soil moisture content is being affected by rising temperatures and changes in precipitation patterns.
- The increasing concentration of carbon dioxide in our atmosphere may cause the microbes in the soil to work faster to break down organic matter, potentially releasing even more carbon dioxide. The release of greenhouse gases from the soil.

Soul Of Infinite Life

What is soil?

5 basic function:

- sustaining plant and animal life
- regulating water
- filtering
- nutrient cycling
- supporting structures

- Healthy soil is essential for crop production (for human and livestock)
- Soil providing stable base to support plant roots, water and nutrient storage required for plant growth
- Industrial and modern agricultural practices lead to soil degradation

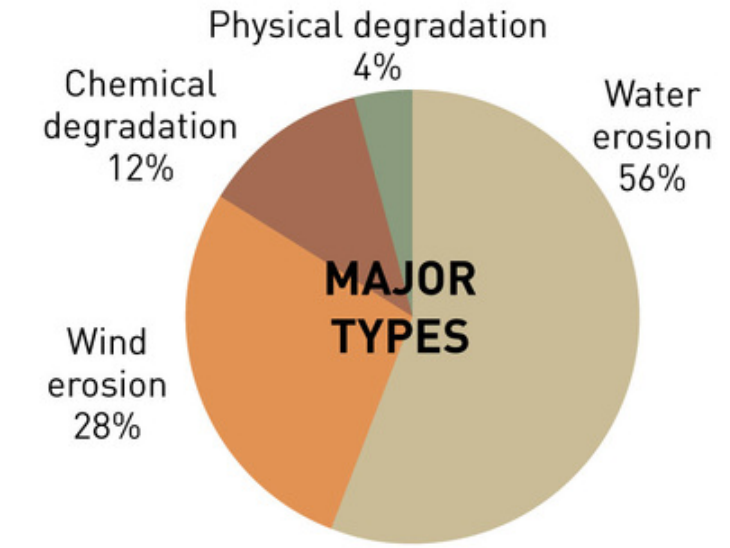
Soil degradation has multiple and complex impacts on the global environment through a series of direct and indirect processes that affect a large number of ecosystem functions and services, including climatic regulation, carbon sequestration, greenhouse gas emissions and increased biodiversity.

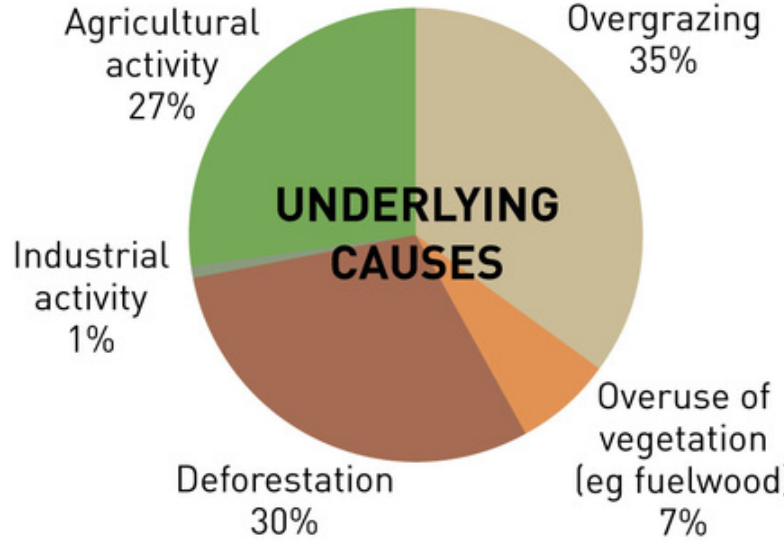
- Soil degradation is the decline in soil condition caused by its improper use or poor management, usually for agricultural, industrial or urban purposes.

- Soil degradation is a serious environmental problem.

- Soils are a fundamental natural resource, and are the basis for all terrestrial life. Avoiding soil degradation is crucial to our well-being.

Major types and causes of soil degradation





Source: FAO/UNEP

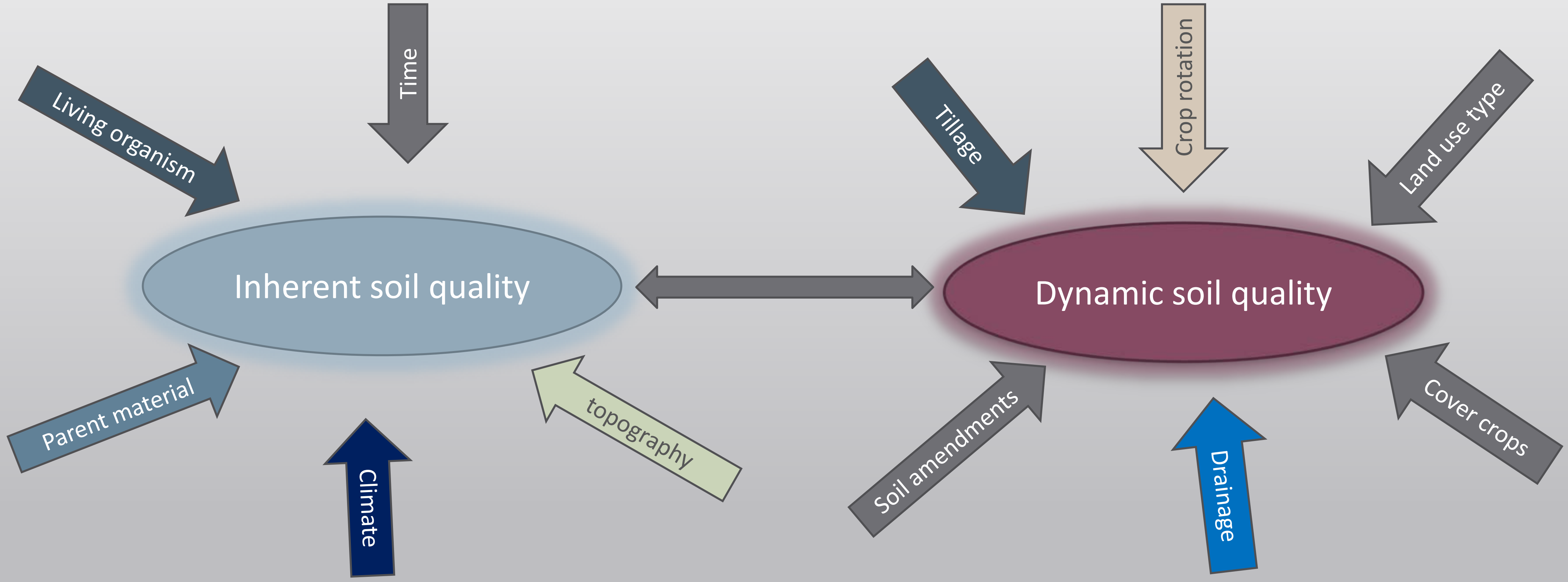
soil degradation is a decline in soil quality

SOIL QUALITY?

The capacity of specific kind of soil to function, whithin its natural or managed ecosystem boundaries, to sustain animal and plant productivity, maintain or enhance air and water quality and support human health and habitats.

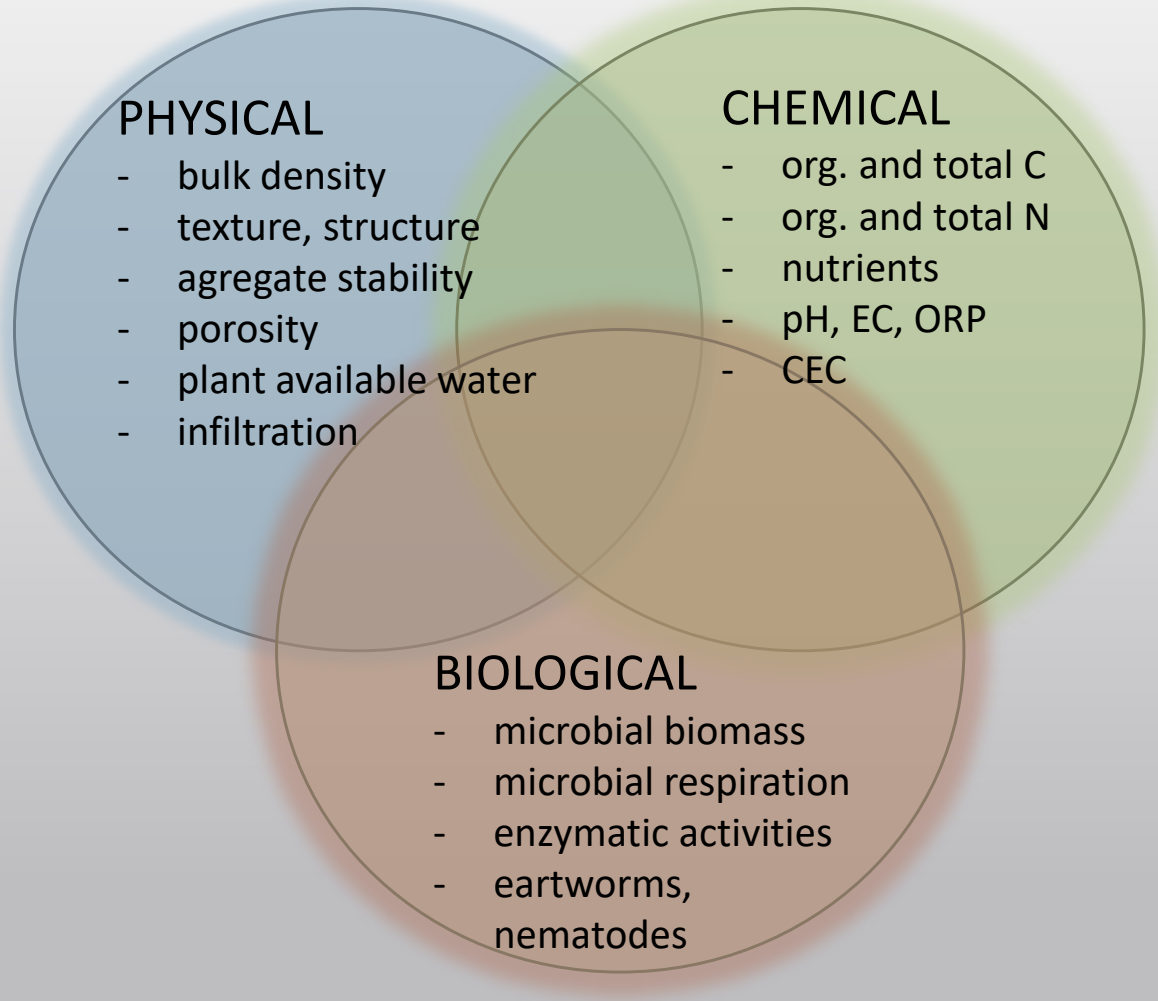
USDA (1994)

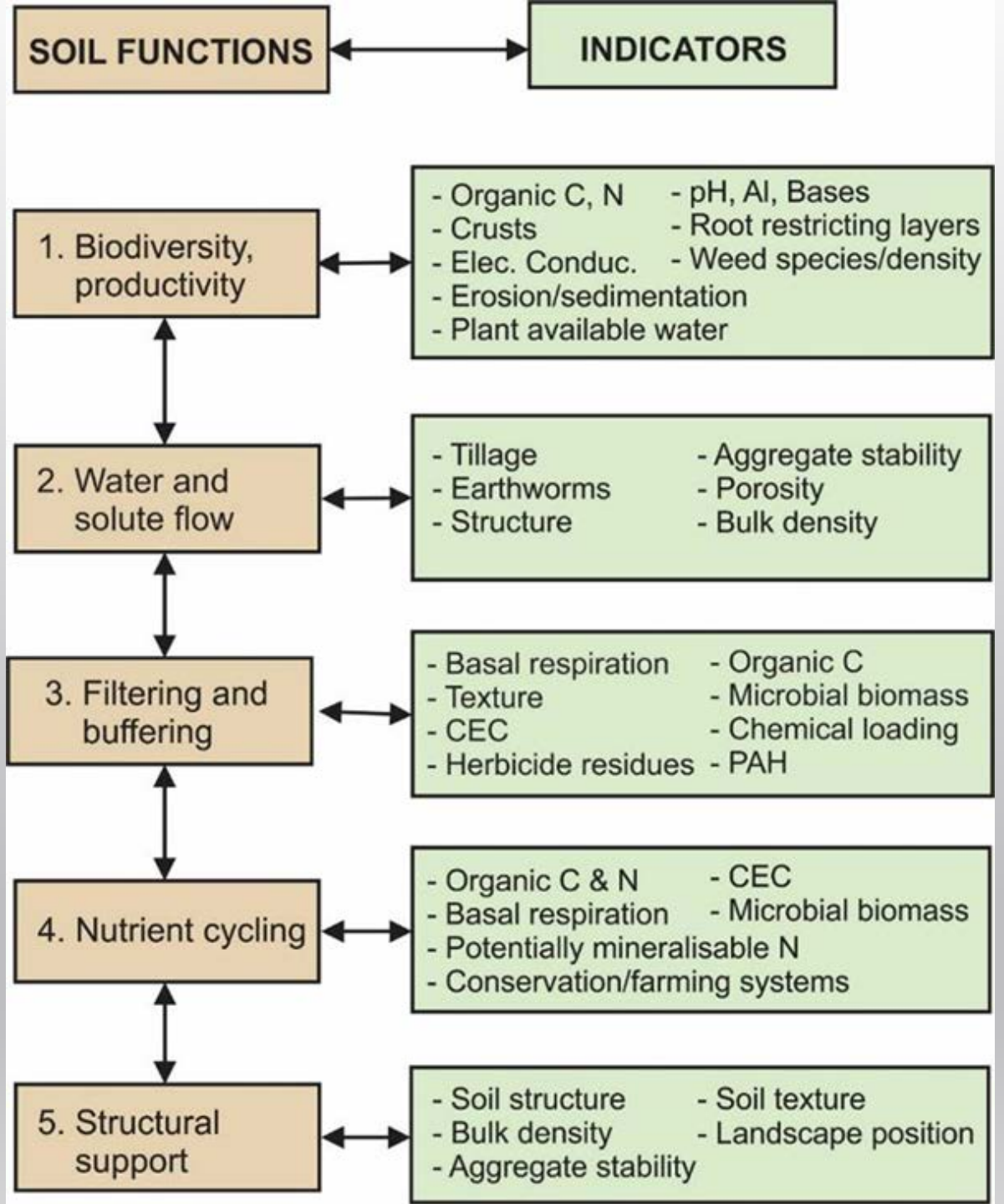
Factor effecting soil quality



SOIL QUALITY INDICATORS

- Soils have chemical, biological, and physical properties that interact in a complex way to give a soil its quality or capacity to function (genesis and classification).





- soil quality can not be measured directly
- Indicators of soil quality should give some measure of the capacity of the soil to function with respect to plant and biological productivity, environmental quality, and human and animal health.

CONSERVATION AGRICULTURE (CA)

- ✓ a concept for resource-saving agriculture crop production which is based on enhancing natural and biological process above and below the ground
- ✓ CA has emerged as an alternative strategy for conserving natural resource

Conservation agriculture

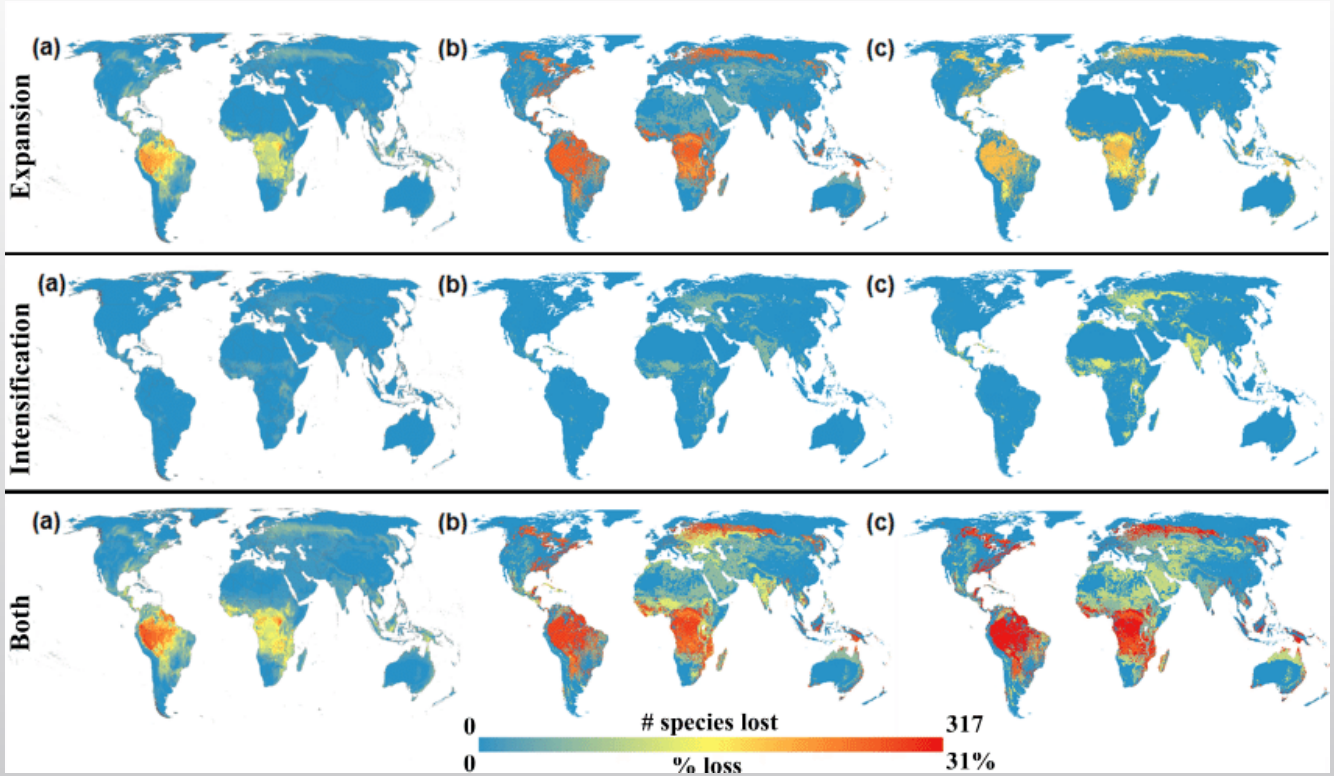
CA affects many soil quality aspects:

- erosion (by water and wind),
- biogenity (organisms),
- organic matter (SOM),
- water content (storage, infiltration),
- compaction (anthropogenic or natural causes),
- nutrient status,
- pest and diseases (potential risk),
- weed infestation, in word physical,
- other physical, chemical and biological aspects.

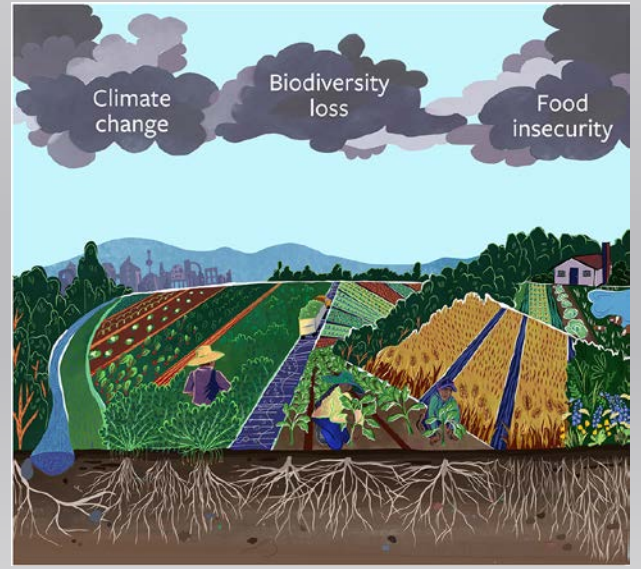
- With application of proper crop management can decrease negative influence of climate changes
- CA need to be adapted and implemented according every single production area – agroecological conditions
- With application of crop management closer to CA principles, we can expect less damages and potential problems and risks

Issues	Conservation agriculture	Traditional agriculture
Tillage	Minimum soil disturbance	Disturbs the soil
Soil cover	Soil surface permanently covered	Leaves naked surface
Erosion	Minimum	Maximum
Soil physical health	Good	Poor
Soil compaction	Potential problem in initial stage!!! **can solve by using mulch and promotion of bio-tillage or some conservation tillage eq. subsoiling**	Reduces compaction by tillage operation
Soil biological health	Enhancing biodiversity	Poor biodiversity
Water infiltration	Best water infiltration	Lowest water infiltration
SOM	Build up SOM	Oxidizes SOM and causes its lost
Soil temperature	Moderate	Variable
Production cost	Low	high

- Introducing soil to agricultural production, agricultural biodiversity decreases, especially in conventional agriculture (soil disturbed by ploughing, application of agrochemicals, etc.).



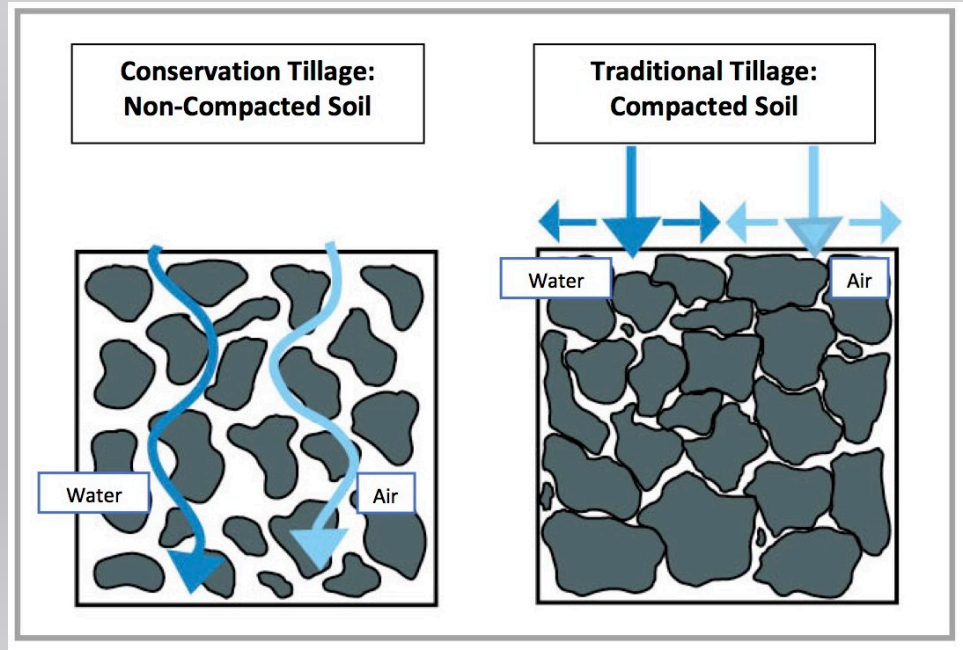
(Source: Kehoe, Laura & Romero-Muñoz, Alfredo & Polaina, Ester & Estes, Lyndon & Kreft, Holger & Kuemmerle, Tobias. (2017). Biodiversity at risk under future cropland expansion and intensification. Nature Ecology and Evolution. 1. 10.1038/s41559-017-0234-3.)



- Adopting the CA principles agricultural activity can significantly reduce the negative impact on biodiversity and natural biological processes in the soil

Conservation tillage is any method of soil cultivation that leaves the previous year's crop residue (such as corn stalks or wheat stubble) on fields before and after planting the next crop to reduce soil erosion and runoff, as well as other benefits such as carbon sequestration

With this technique, at least 30% (up to 100%) of the soil surface is covered with crop residue/organic residue following planting



BENEFITS OF CONSERVATION TILLAGE

RESOURCES: TIME & MONEY

DECREASED labor time

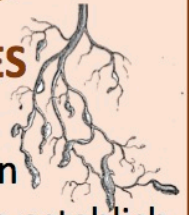
MORE family time

FEWER passes & **LESS** equipment wear & tear: **Average** - $5 per acre savings[1]

REDUCED fuel costs: **Average** - 3.5 gallons per acre savings[1]

SOIL HEALTH

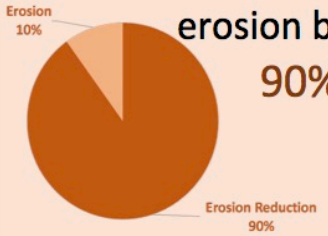
IMPROVES soil aggregation for roots to establish



INCREASES organic matter

FEEDING the biology

REDUCED soil erosion by 90%[1]



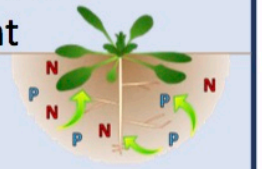
WATER

IMPROVES water availability

REDUCES sediment loading

IMPROVING water clarity

REDUCES nutrient runoff



REDUCING algal blooms & dead zones

[1] Values cited from "Top 10 Conservation Tillage Benefits," Conservation Technology Information Center at Purdue University (2017)

Research Projects

Assessment of conservation soil tillage as advanced methods for crop production and prevention of soil degradation

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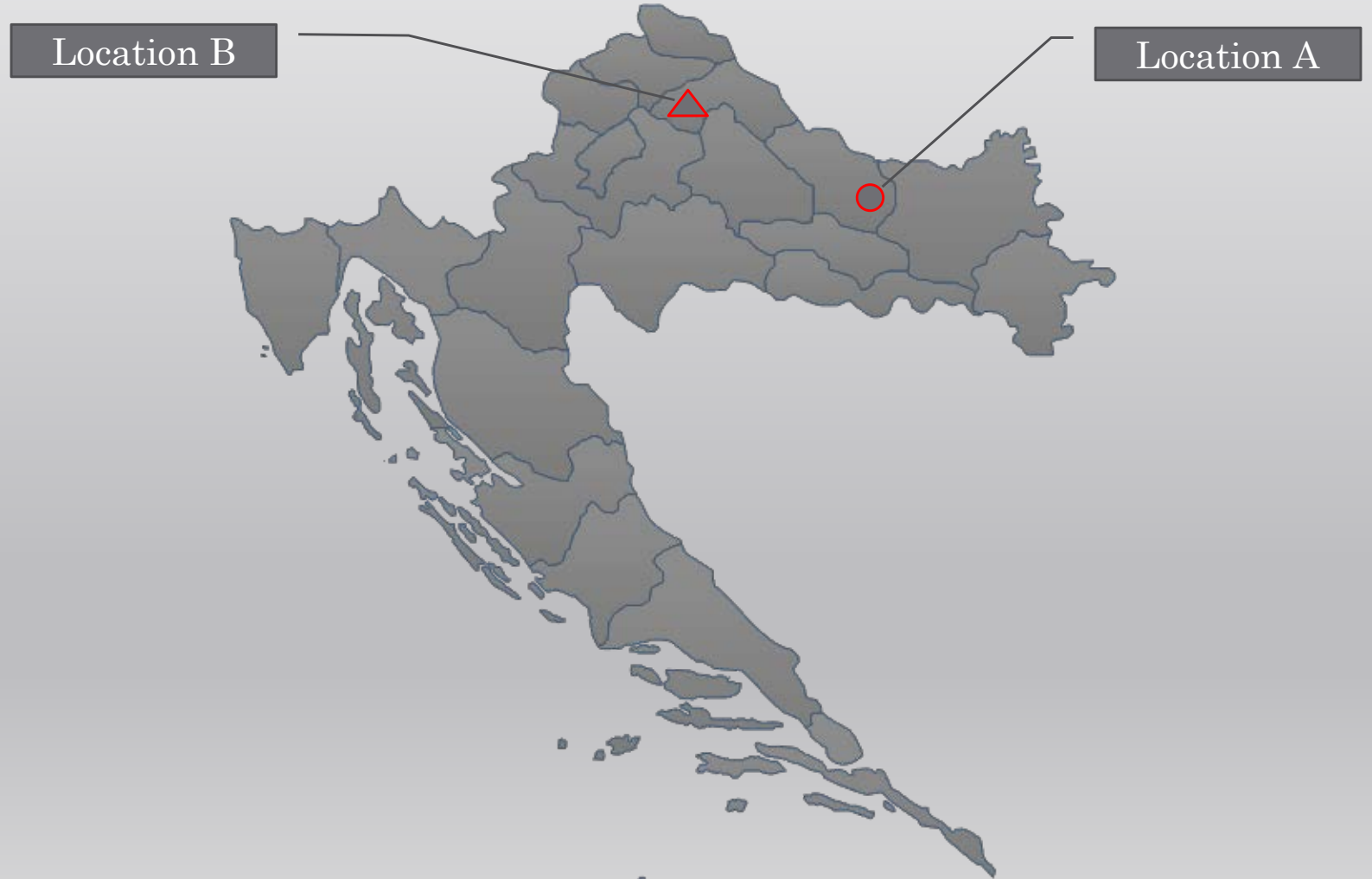
http://www.activesoil.eu/index.php/en/

The aim of these studies is to determine the level of degradation of selected components of the physical, chemical and biological soil complexes by comparison of conventional and conservation soil tillage systems. Also, defining positive measures and procedures for stopping, preventing and mitigating anthropogenic and natural degradation processes in the soil at different agroecological research sites will be of great pertinence to environmental protection, agricultural producers, scientific and professional community, decision-makers, and will certainly serve as a basis for further scientific research.

The experimental part of the study was conducted at stationary experimental fields, in two (2) locations:

- Location A: Virovitica-Podravina County (Čačinci place – Owned by PG "Knežević")

- Location B: Koprivnica-Križevci County (place Križevci–trial site of Križevci College of Agriculture–KCA)



Experimental site

ACTIVEsoil

HRZZ Hrvatska zaklada za znanost

HRZZ project:
"Assessment of conservation soil tillage as advanced methods for crop production and prevention of soil degradation"
ACTIVEsoil: IP-2020-02-2647

Treatment A Soil tillage)	
A1-ST	Conventional/standard tillage
A2-CTD	Conservation System Deep
A3-CTS	Conservation System Shallow

Treatment B liming	
B1-CN	Bez kalcizacije
B2-CY	with liming

Tretman C (fertilization/conditioners)	
I-C1-FR	according recommendation
II-C2-FD	decreased by 50%
III-C3-GFR	according recommendation + GeO2
IV-C4-GFD	decreased by 50% + GeO2

Objectives

- to determine the level and time dynamics of changes in physical, chemical and biological parameters that indicate soil degradation by mutual comparison of the researched systems of plant production
- to determine the impact of plant production on biodiversity (earthworms in the soil, weeds, aflatoxin contamination potential in soil and on crops),
- to determine and analyses the intensity of changes in plant-breeding parameters of research (phenological observations, biometric components, yields and yield components) considering the system of plant production,
- analysis of collected agrometeorological and agroclimatic elements, evaluation of the level of their impact on the investigated parameters and development of future projections/simulations based on research results,
- to developed a low-cost sensory system for measuring biological activity through CO_2 production and measuring N_2O emissions on agricultural soils,
- to analyses and evaluate each system of plant production from an economic point of view and to develop future projections of economic trends,
- to develop a system of recommendations to prevent soil degradation for the researched agroecological region, which will be based on the principles of sustainable soil management and will be used for choosing of an optimal system of plant production,
- to prepare and propose recommendations to the Ministries and other state bodies to supplement and elaborate regulations in the field of sustainable land management with regard to the effects of climate change and to point-out the importance of systematic soil monitoring.

The expected planned results arise as a logical result of the well-defined research goals, which outline the most significant

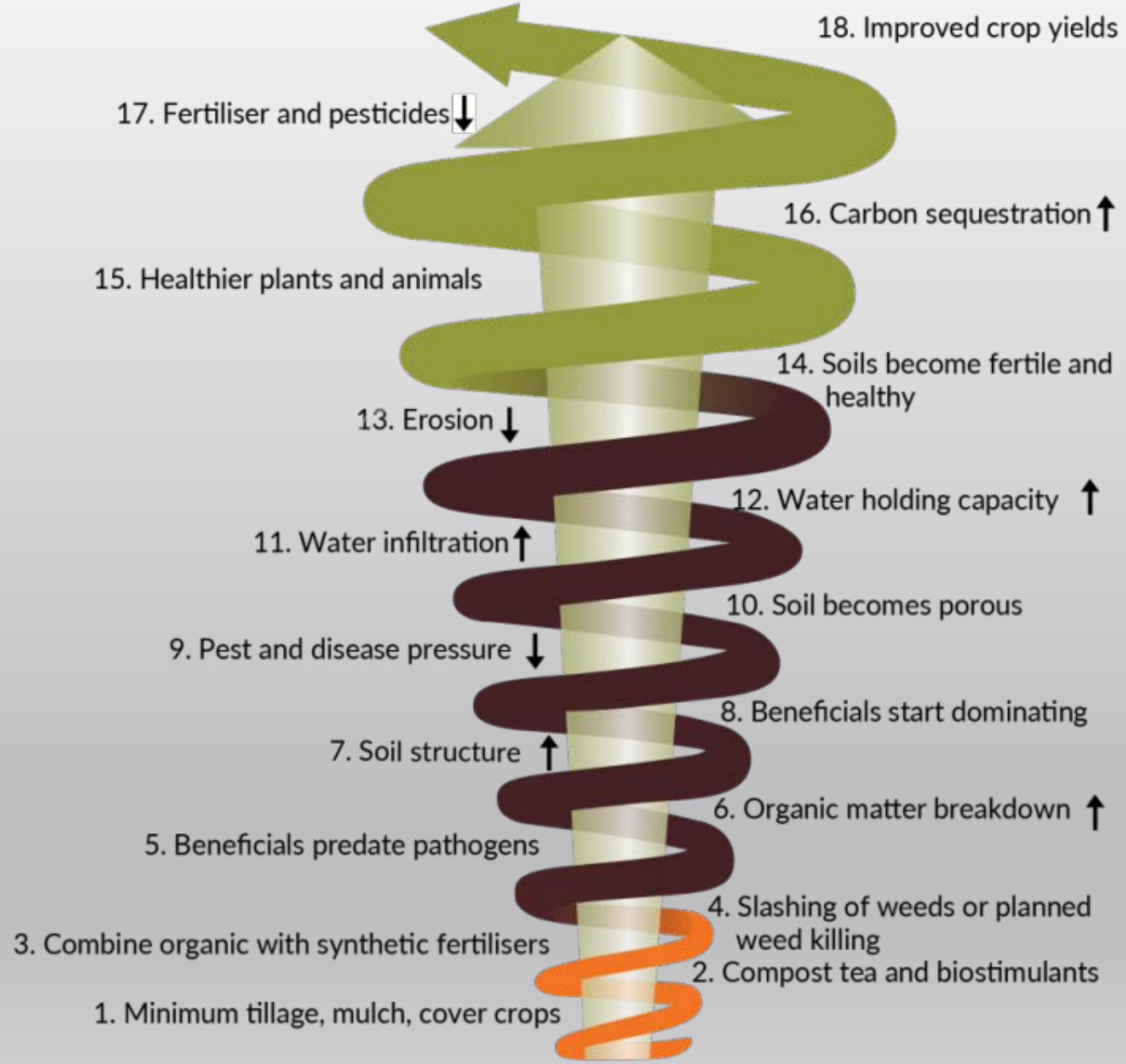
- the integration and consolidation of the postulates of conservation agriculture with application in different agroecological conditions and for different cultures
- the development of an optimal plant production system, taking into account all the investigated indicators
- progress in the development of agro-climatic projection models,
- progress in development of methodology for tracking economic indicators specific to conservation systems and projections for the future,
- better insight into the degradation processes in the soil and the way they are mitigated,
- optimization of sampling methods and measurements of biotic and ecological potentials of arable land as a tool for monitoring the success of conservation systems of plant production,
- contribution to reducing the negative effects of climate change (accumulation and conservation of water in the soil, reduction of CO_2 and N_2O as greenhouse gases),
- interpretation and significance of CO_2 and N_2O emissions on agricultural soils, elaborated in conceptually different ways for soil quality assessment and impact assessment of global climate change,
- encouraging and developing agro-biodiversity,
- better understanding of the complexity of climate-soil-plant relationship,
- better elaborated rules on sustainable land management and treatment in plant production.

Conclusion


1. Intensive tillage
2. Soil organic matter ↓
3. Aggregates break down
4. Monoculture
5. Microbial diversity ↓
6. Synthetic fertilisers added
7. Weed killer, no mulch
8. Soil carbon oxidised
9. Pathogens starts ↑
10. Soil structure collapses
11. Pests and disease ↑
12. Surface crust forms
13. Low water infiltration
14. Run off and erosion ↑
15. Low soil fertility
16. Reduced crop yields
17. More fertiliser needed
18. Creating more problems
Low profitability and resilience

Conclusion

Higher Profitability, Resilience and Continuous Soil Regeneration




THANK YOU FOR YOUR ATTENTION