Univerza v Ljubljani
Biotehniška fakulteta

Slovenian Association for Conservation Agriculture (SZOK)

REGINA
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Soil regeneration following conservation agriculture principles

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International Conference

Regenerative agriculture. An innovative approach towards mitigation of climate change through multi-tier learning **(REGINA)**

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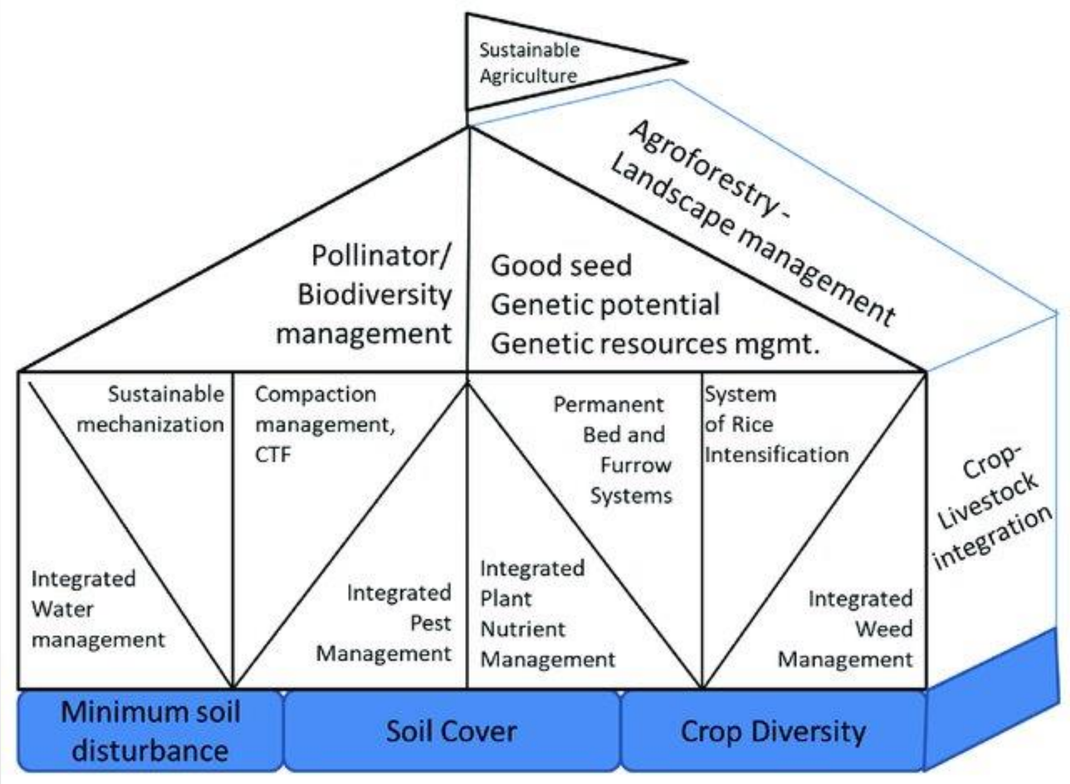
Three basic principles of conservation agriculture



"Conservation Agriculture" is carried out permanently on the same area.

Soil is a resilient system that, fortunately, slowly breaks down, but also takes a long time to regenerate.

The three interlinked **CA principles constitute the ecological foundation upon which sustainable agriculture** can be built with complementary good agricultural practices

(Friedrich, T. Conservation Agriculture as a means of achieving Sustainable Intensification of Crop Production. Agric. Dev. **2013**, 19, 7–11.)

term **"regenerative agriculture (RA)"** has recently found its way into scientific discourse

The **basis for RA are the three pillars of "conservation agriculture"**

"There is no regenerative agriculture without respect for the principles of conservation agriculture".

However, the concept of regenerative agriculture encompasses a broader horizon:

Regenerative agriculture is a way of managing agricultural landscape, where the main guideline is the regeneration or restoration of agricultural ecosystems in the direction of imitating natural processes, with an emphasis on the inclusion of different types of plants and livestock, as well as the improvement and restoration of soils in terms of their health, biological activity and the amount of organic matter. In doing so, farmers, as custodians of these ecosystems, do not follow a prescribed set of practices, but through observation, critical thinking and testing, they discover and apply sustainable practices that lead their specific agricultural ecosystem in the direction of maximum adaptability, robustness and resilience.

Concepts related to regenerative agriculture, which cannot be fully equated with it, include: "agroecology", "permaculture", "organic agriculture", "biodynamic agriculture", "holistic planned grazing", "agroforestry" and conservation tillage.

REQUIREMENTS FOR ACHIEVING THE POSITIVE OBJECTIVES OF CONSERVATION AGRICULTURE

- gather knowledge, experience and information on the entire cultivation system, in particular on weed control;
- carry out soil tests (balanced nutrient supply, adequate soil pH);
- avoid soils with poor drainage;
- level the surface of the soil;
- eliminate soil compaction, level landslides and rills;
- ground cover (plant residues, straw, intermediate crops);
- buy a seeder for direct sowing;
- to start on only one part of the estate's acreage and gather experience;
- use a balanced field rotation with green manure;
- be open-minded for developments and innovations.

Many important
BENEFITS OF CONSERVATION AGRICULTURE

- **Increasing soil organic matter and carbon sequestration**: Avoiding soil disturbance and retaining crop biomass promotes an increase in organic matter in agricultural soil.
- **Reduced greenhouse gas emissions**: Avoiding tillage, associated with better structural soil resilience, generally reduces greenhouse gas emissions.
- **Improving biodiversity**: Less soil disturbance, cover crops and mulch create an environment that promotes soil biodiversity, beneficial insects, reptiles, birds and small mammals. This can help with natural pest control and improve soil health.
- **Rational use of nutrients**: Increased bioavailability of nutrients and lower nutrient consumption per unit of crop – better utilization.
- **Less traffic and compacting of the soil** (less machine travels and greater walking strength of the soil). Even with these systems, compacted layers of soil sometimes develop, which need to be loosened periodically with appropriate tools (adapted looseners without mixing the soil layers).

Many important
BENEFITS OF CONSERVATION AGRICULTURE

Erosion reduction: In general, CA reduces soil erosion by up to 90%. Compared to conventional tillage, CA helps to maintain the structure of the soil and its ability to retain water and nutrients.

Improving surface water quality: By reducing erosion, runoff, and leaching of nutrients, CA can help improve water quality in nearby rivers and water bodies.

Water conservation: The water retention capacity of the soil is higher in CA fields.

Saving time for agricultural work: because farmers do not cultivate the land, they have more free time or have to hire fewer workers.

Economic sustainability: Although the transition to CA requires changes in practices, it can improve the resilience of agricultural systems in the long term and reduce costs associated with external inputs such as diesel, pesticides and fertilisers. The machinery on farms is smaller, so in the established CA system, investment costs are also lower.

Impact of the "no-till" system on soil organic carbon (Corg)

5 years after transition from the ploughing system to the "no-till" system
LTE"Mamino" (light Cambisol over gravel and sand alluvial of the Drava river)

TILLAGE	SOIL DEPTH (cm)	Organic C (t/ha)
PLOUGH	0-10	**17,6**
	10-20	20,0
	0-20	37,6
No-Till	0-10	**26,2***
	10-20	21,8
	0-20	48,0

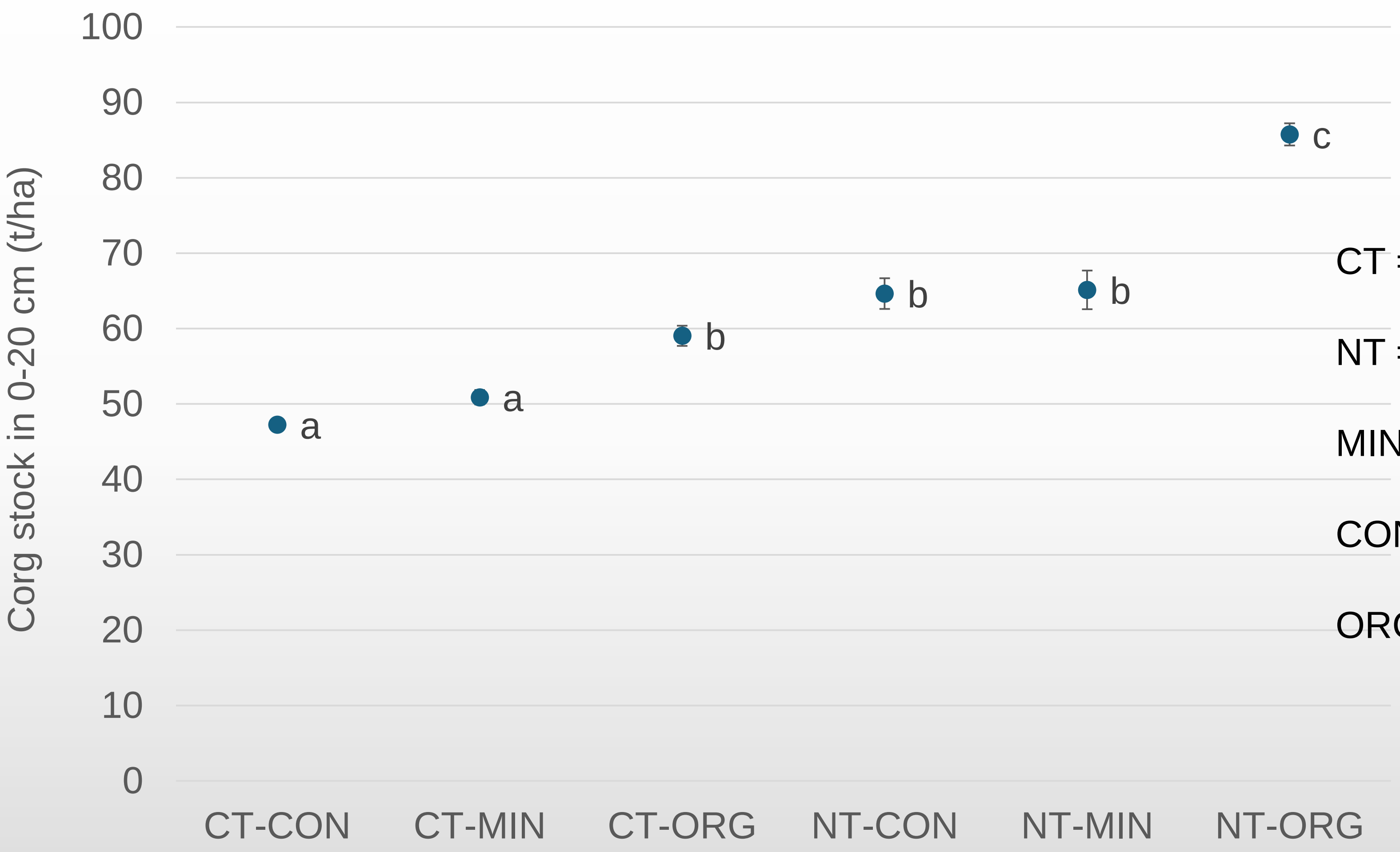
In the soil layer of soil 0-10 cm **at NT in 5 years 7 to 10 t of organic C/ha more** than in ploughing.

This difference is very large, as it means an accumulation of as much as **1400 to 2000 kg of Corg/ha every year**.

Possible causes of Corg accumulation on NT vs. plough:

- Lower oxidation of organic matter due to less intensive soil cultivation
- the incorporation of organic matter into soil aggregates becomes inaccessible to microbes (formation of stable humus)
- more weeds and therefore more organic matter excreted into the soil (exudates) during the year and more residues after harvest;
- ca. 30 to 40% of organic matter generated by photosynthesis is excreted into the rhizosphere during the growing season. Recent studies show that exudates are decisive for the formation of stable humus, even more important than plant residues or roots.

C_{org} stocks in gley clay-loam soil in Ljubljana after 24 years of LTE „TillComp“



CT = ploughing

NT = no-till

MIN = mineral fertilizers

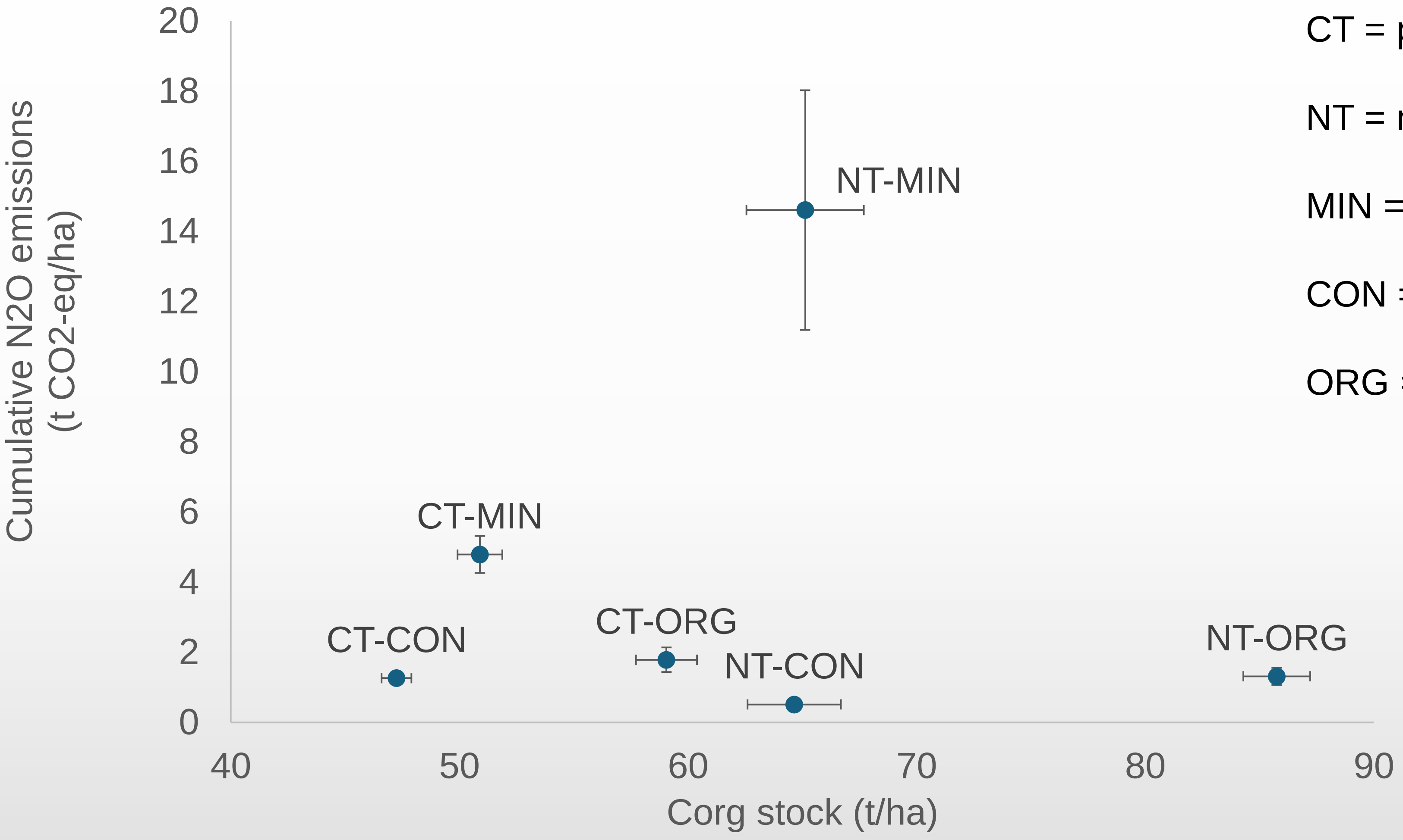
CON = zero fertilizers

ORG = compost

Difference between no-till *vs* ploughing is 15 – 26 t Corg/ha

= **625 – 1083 kg Corg/ha per year!**

Trade-offs between C_{org} stocks and N_2O emissions



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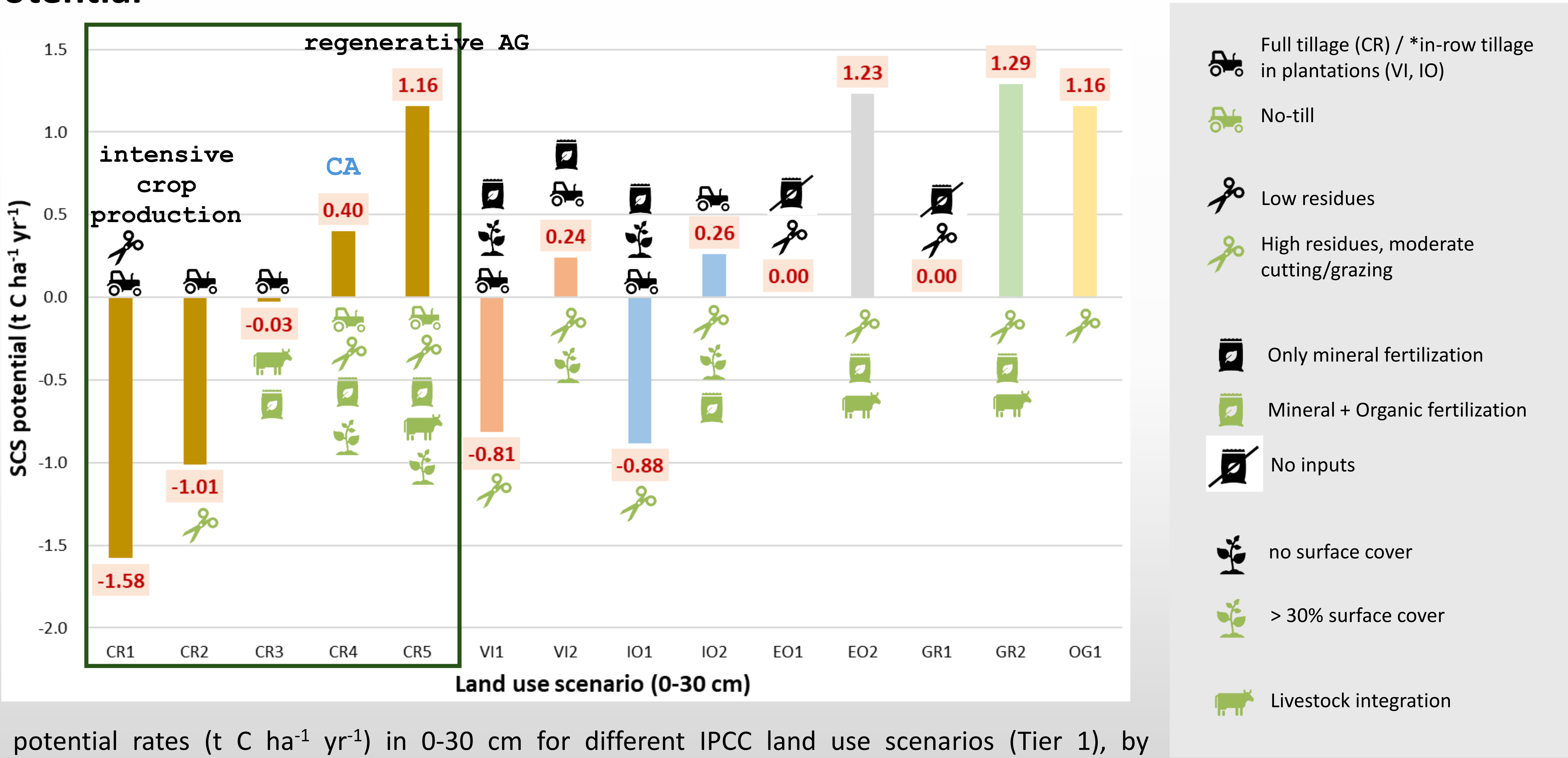
Relationship between cumulative N_2O emissions and C_{org} stocks after **24 years** of implementation of tillage and fertilisation routines

Agricultural land use model scenarios in Slovenia and Carbon Sequestration rate potential



SCS potential rates (t C ha^{-1} yr^{-1}) in 0-30 cm for different IPCC land use scenarios (Tier 1), by assumption that agricultural land use category does not change in 20 years.

Thought for conclusion

- Conservation/regenerative agriculture is a basis for a sustainable agriculture,
- …but only, when it is performed as an integrative system, holistically and over long-term.
- …it is a dynamic system which needs permanent learning of a farmer (that is whay Regina learning platform is very important).

Thank you for attention

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