2nd LENSES E-DIALOGUE WEBINAR:
SUSTAINABLE WATER MANAGEMENT IN SEMID-ARID AREAS

20 June 2023
h. 10:00 CET

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Agronomic management for soil water conservation

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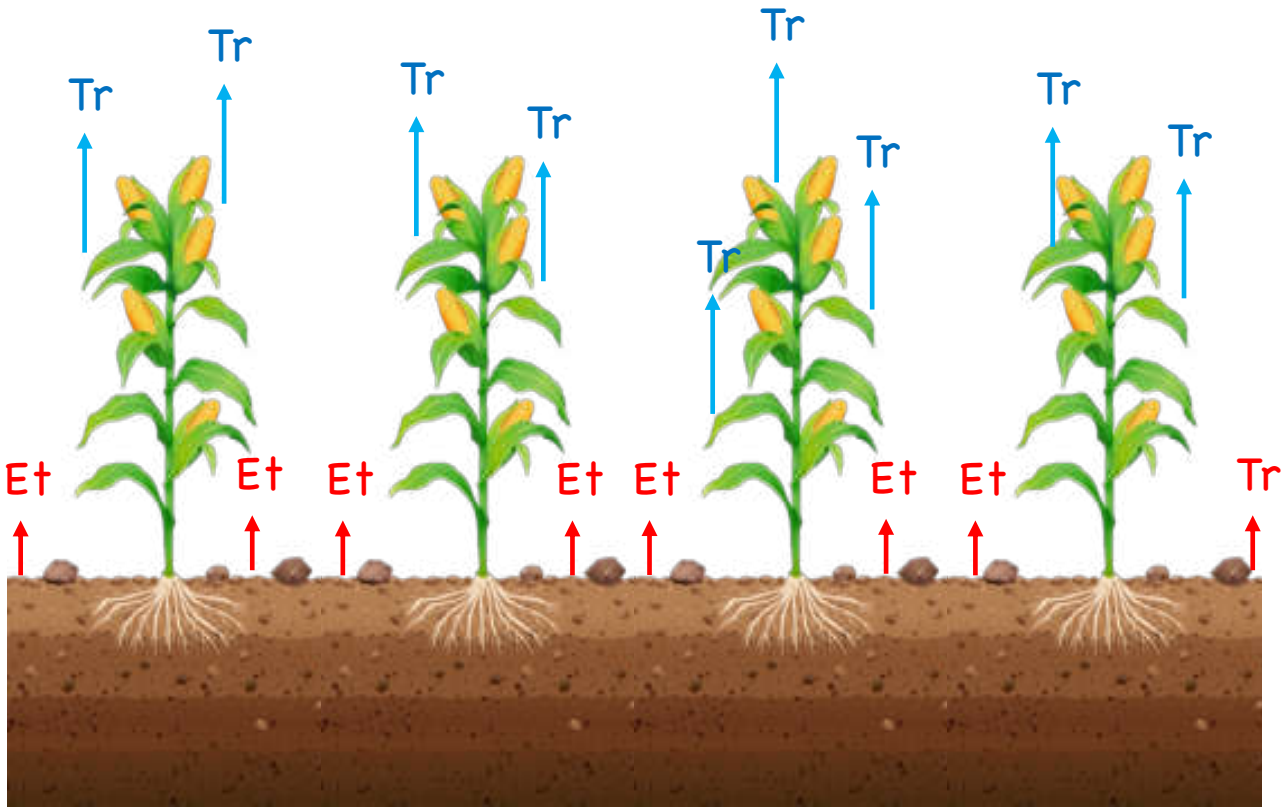
Soil water conservation

Agronomic management in rainfed systems aims at maximizing the soil water availability for transpiration during the crop cycle. On the other hand, soil evaporation and weeds transpiration should be limited. Water use efficiency can be obtained by:

✓ Optimizing crop transpiration

✗ Minimizing evaporation losses



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Yield gaps

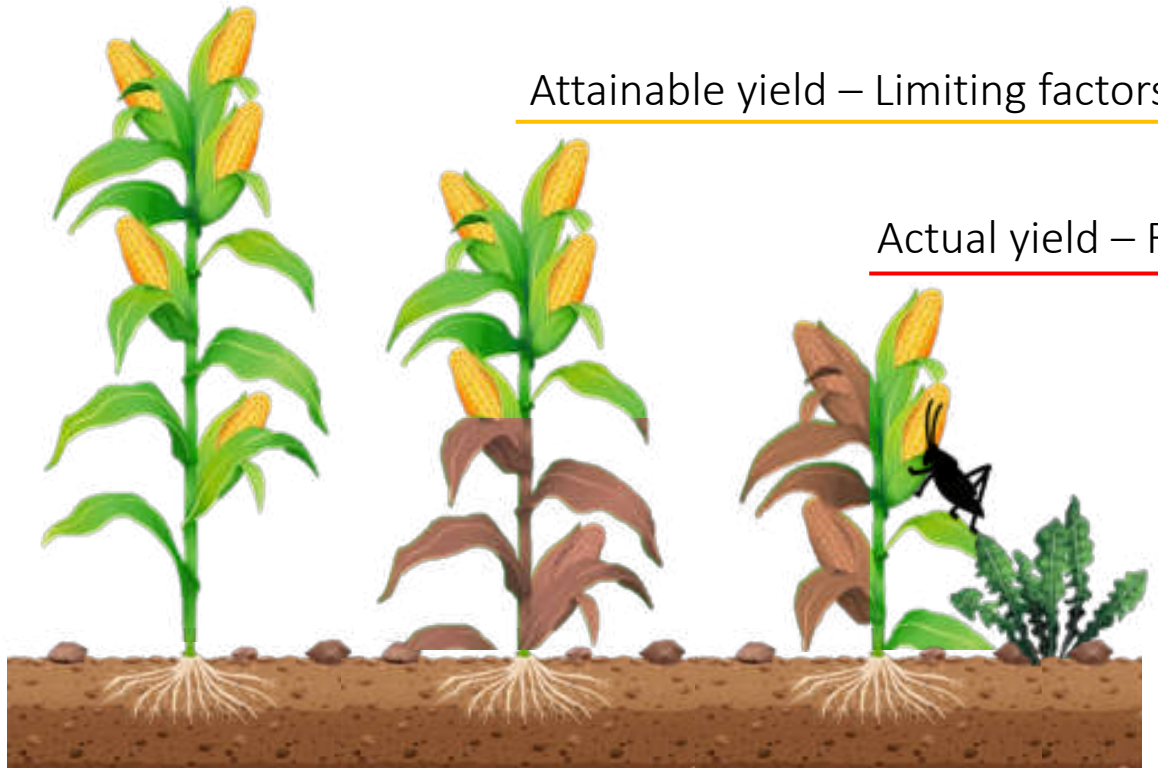
Potential yield – Determining factors (radiation, temperature, CO_2, soil, crop)

Attainable yield – Limiting factors (water)

Yield gap 1

Actual yield – Reducing factors (weeds, pests, diseases)

Yield gap 2



Benchmark irrigated sytems

Benchmark rainfed sytems

Attainable yield is typical of semiarid areas where water is the main limiting factor

Considering that the water transformation value is the highest compared to any other technical factor used in agriculture, the ***water use efficiency*** is determinant for the profitability and sustainability of agricultural systems

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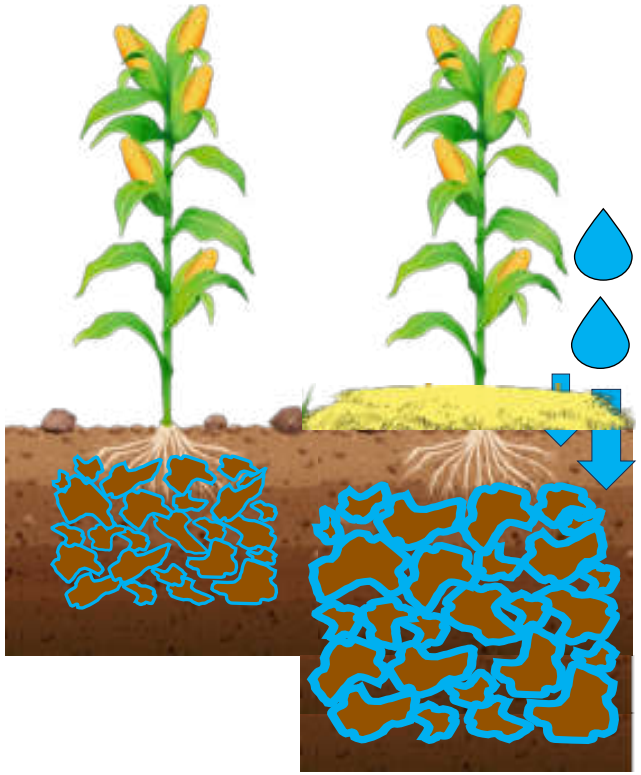
Increase of soil moisture

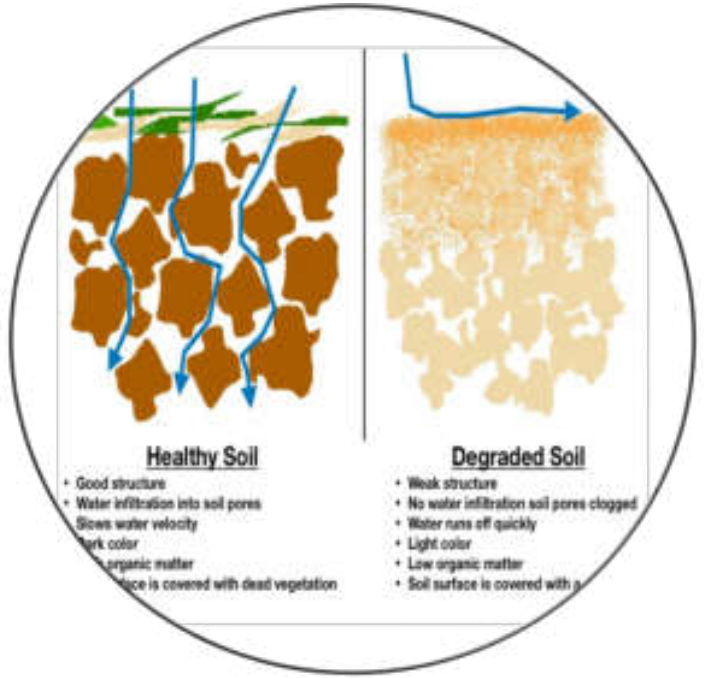
The increase of soil moisture can be obtained in different ways:



Runoff reduction

Increase of surface water infiltration

Increase of storage capacity
and water retention



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Increase of soil moisture

The improvement of soil properties relies on various factors such as **tillage**, **organic matter**, use of flocculant cations (Ca) while reducing deflocculant ones (Na).

Another crucial aspect is the adoption of cropping systems (**crop rotation, intercro**pping) involving plant species with strong, deep, and well-connected root systems, which effectively explore the soil's depths and enhance its structure for the benefit of subsequent crops.

Infiltration can also be increased through mulching with plant residues, which reduce the kinetic energy of raindrops hitting the soil; preserve the soil structure; reduce surface runoff, even by 50%.

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Increase of soil moisture

Deep tillage can be employed to increased the soil and water volume available to individual plants, and to enable deeper root growth

It has been observed that water accumulation in the soil, resulting from deep ploughing performed before the rainy season, is about **50 mm higher** compared to that resulting from minimum tillage or mulching, and even **100 mm higher** compared to that resulting from no tillage.

However, **when meteorological inputs are limited, minimum tillage can yields better results** compared to deep tillage.

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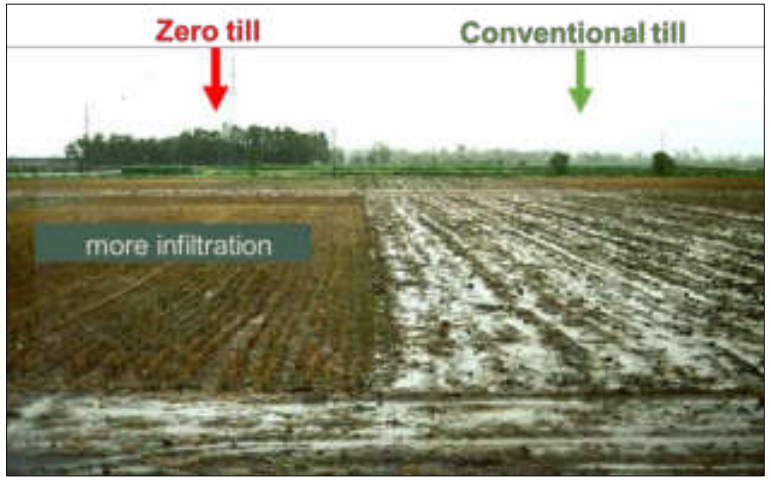
Increase of soil moisture

MINIMUM TILLAGE

- Erosion reduction
- OM mineralization reduction
- Increased soil biodiversity
- C sequestration
- Enhanced water infiltration



Tillage	Runoff	Erosion
Ploughing + harrowing	100%	100%
Minimum tillage	74,9%	30,3%
No tillage	61,1%	13,1%

Tillage	Infiltration (mm/min)	Soil cover (%)
No tillage	2.7	48
Subsoiler plough	1.3	27
Plough	0.8	12

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Increase of soil moisture

Eyebrow terraces in Tana-Beles Watershed – Ahmara State Ethiopia

Eyebrow terraces in Tana-Beles Watershed – Ahmara State Ethiopia

Eyebrow terraces in Umbria - Italy

Eyebrow terracing in Santiago Island, Cape Verde

Land settings are crucial in arid regions to retain rainfall water and increase infiltration

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Increase of soil moisture

MICRO-CATCHMENT
For water harvesting

The micro-catchments guide runoff into their centre where it accumulates

half moons for water harvesting - Niger

Planting pit – Mali

Planting pit – Burkina faso

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Reduction of soil water losses

Once water reserves are stored in the soil, it is necessary to limit water losses

1. Addressing **climatic factors** to reduce direct evaporation and excessive transpiration through mulching, windbreaks, and shading

2. **Managing the soil** to limit direct evaporation by reducing the influx of liquid water to the soil surface through appropriate tillage practices

3. **Managing vegetation** cover to reduce transpiration by lowering the Leaf Area Index (LAI), controlling weeds, and increasing stomatal resistance through the use of antitranspirants.

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Reduction of soil water losses

SHALLOW TILLAGE

Performed at a depth of 5-10 cm, both prior to sowing (weed removal) and during crop growth (hoeing), shallow cultivations are particularly effective in weed control, reducing evaporation, and promoting the penetration of rainfall. Specifically, they serve the following purposes:

1. **Breaking the capillary** continuity that allows water to rise from deeper layers and evaporate into the atmosphere

2. Promptly drying the cultivated soil layer, which subsequently acts as a mulch layer, **reducing thermal flux** (dry soil mulch)

3. **Covering any cracks** that form on the surface as the soil dries out (increase the evaporative surface area)

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Reduction of soil water losses

Hoeing

Harrowing

Milling

Reduction
30 to 70%

«A good soil cultivation is equivalent to irrigation»

MULCHING

Compared with non-mulching treatment, plastic film mulching increased maize transpiration by about 18% and reduced soil evaporation by 44% (Chen Z. et al., 2019) (average 2016-2017)

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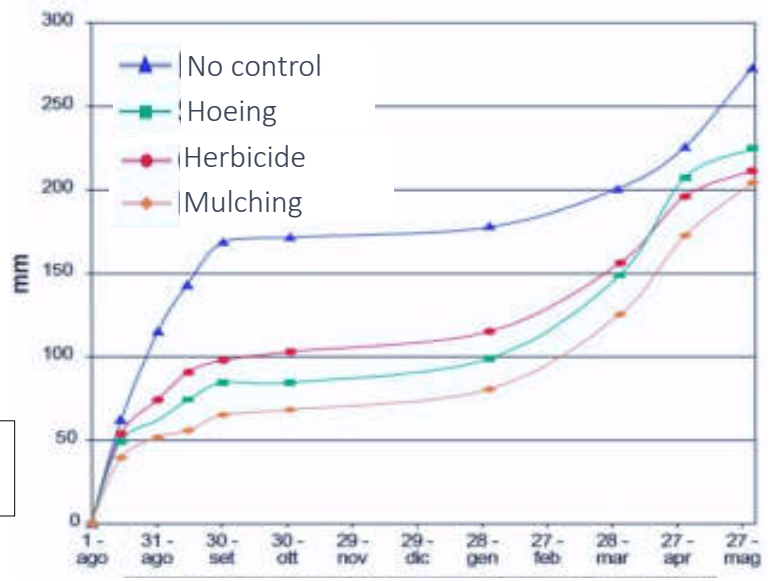
Reduction of soil water losses

WEED MANAGEMENT

Weeds are a transpiring plant mass that significantly depletes soil water reserves. In arid farming, the most effective methods for weed control are represented by preparatory and complementary cultivation practices.

Crop water requirements reduced by 40-50 mm



WINDBREAKS

Windbreaks, whether living or non-living, are helpful measures to reduce the effects of air movement on the evapotranspiration process, as they contribute to reducing the saturation deficit of water vapor in the boundary layer between the canopy and the atmosphere.

SHADING

Shading, achieved using shade nets or hail nets, widely used in overhead trellis systems for table grape vineyards, reduces the intercepted solar energy by the vegetation and soil, thereby significantly attenuating the evapotranspiration flux of the crop.

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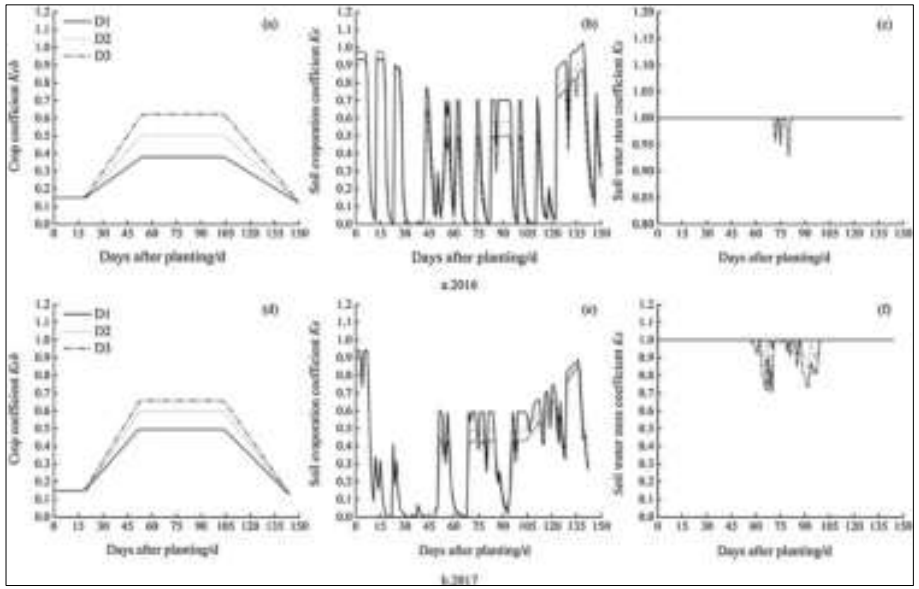
Reduction of soil water losses

SOWING TIMING AND DENSITY

Sowing or transplanting should consider the need to provide suitable soil conditions for the crop establishment and align the production cycle with the most suitable climatic period, ensuring adequate precipitation and reduced evapotranspiration.

	Evaporation	Transpiration
60000 plants/ha	265,6	234,3
75000 plants/ha	241,5	286,2
90000 plants/ha	225,1	328,0

The maize transpiration increased with the increase of planting density, and the maize evaporation decreased (Chen Z. et al, 2019)



Comparisons of basal crop coefficient, soil evaporation coefficient, and soil water stress coefficient of maize between mulching and non-mulching

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Reduction of soil water losses

FERTILIZATION

In rainfed farming, the quantity of nutrients to be applied needs to be balanced. On one hand, it should not limit the productive potential, and on the other hand, it should not significantly decrease the osmotic potential of the circulating solution or create imbalances between vegetative and reproductive parts of the plant.

The use of amendments and **organic matter** is always advisable due to their positive effects on the physical characteristics of the soil, such as water retention capacity, as well as their chemical properties, such as pH and ion exchange capacity, which ensure the potential availability of nutrients for the crop over time.

ORGANIC MATTER

- Soil structure
- Water retention
- Porosity
- Nutrition
- Microflora/fauna
- CEC
- Carbon stock

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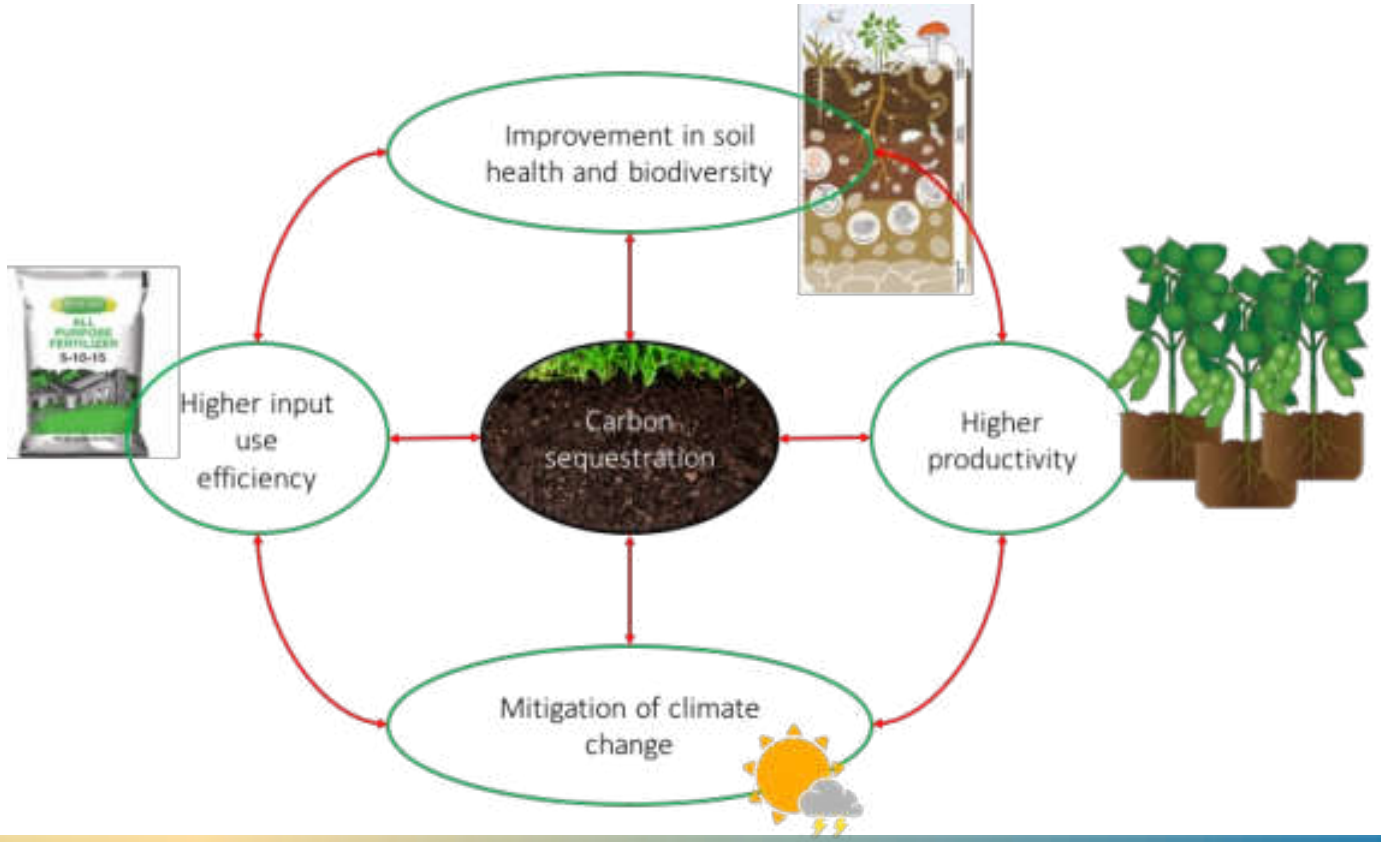
Potential global contribution of response options to mitigation, adaptation, combating desertification and land degradation, and enhancing food security

Panel A shows response options that can be implemented without or with limited competition for land, including some that have the potential to reduce the demand for land. Co-benefits and adverse side effects are shown quantitatively based on the high end of the range of potentials assessed. Magnitudes of contributions are categorised using thresholds for positive or negative impacts. Letters within the cells indicate confidence in the magnitude of the impact relative to the thresholds used (see legend). Confidence in the direction of change is generally higher.

Options shown are those for which data are available to assess global potential for three or more land challenges.
The magnitudes are assessed independently for each option and are not additive.

Last but not least…

According to the IPCC (Special Report on Climate Change and Land), increasing SOC content is one of the most effective options for climate change adaptation and mitigation, combating desertification, soil degradation, and ensuring food security.



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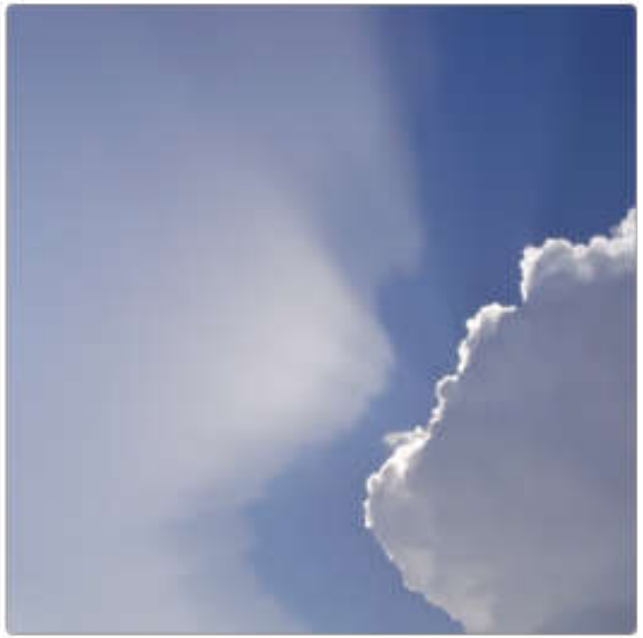
THANKS FOR YOUR ATTENTION!



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