Leguminous green manure can drive the stabilisation of the increased soil organic carbon on dryland

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Content

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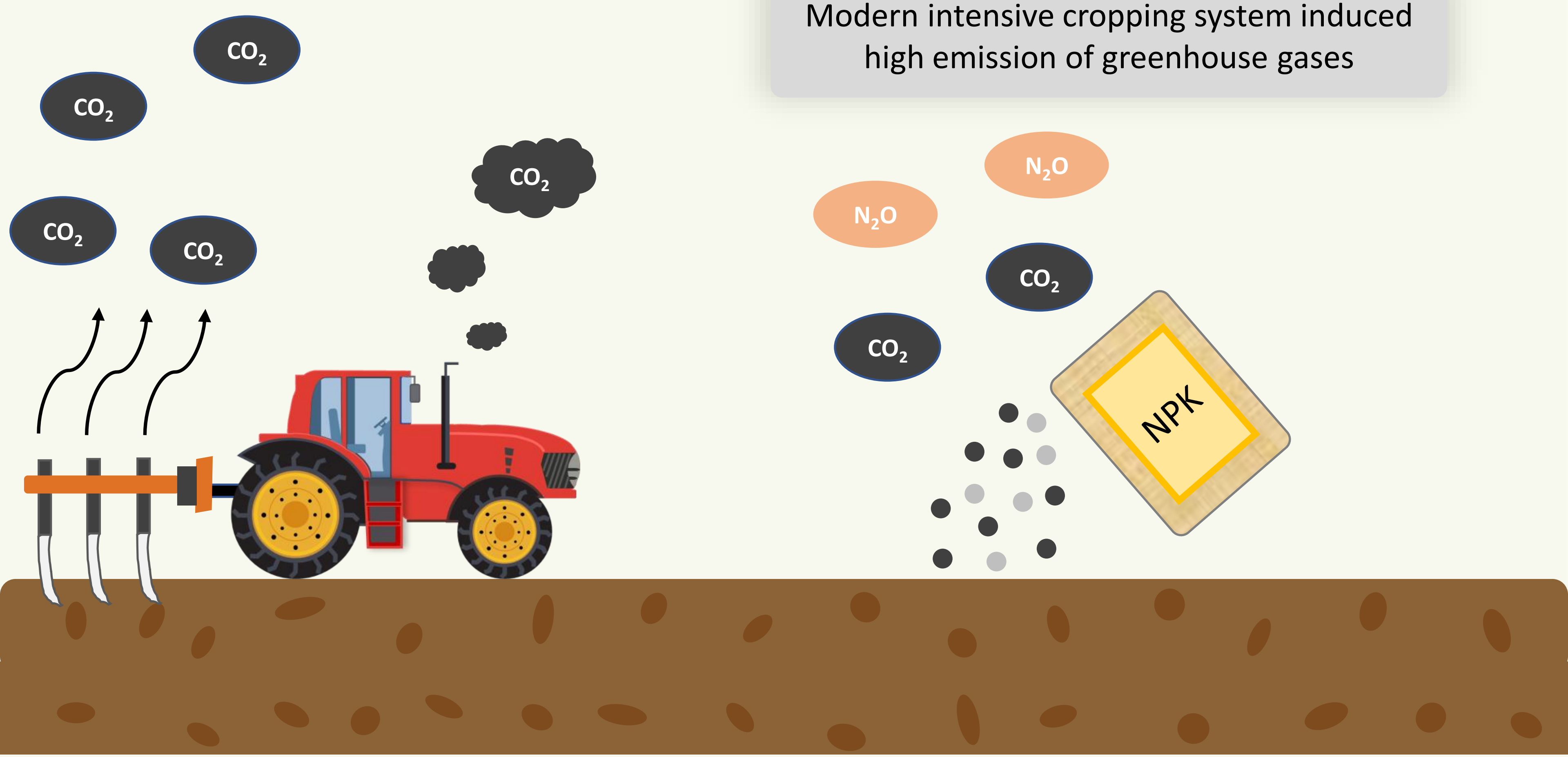
Background

Modern intensive cropping system induced high emission of greenhouse gases



Background

What's the connection between changing climate and crop yield?

Global yield decreased by **3.8 %**

Global yield decreased by **5.5 %**

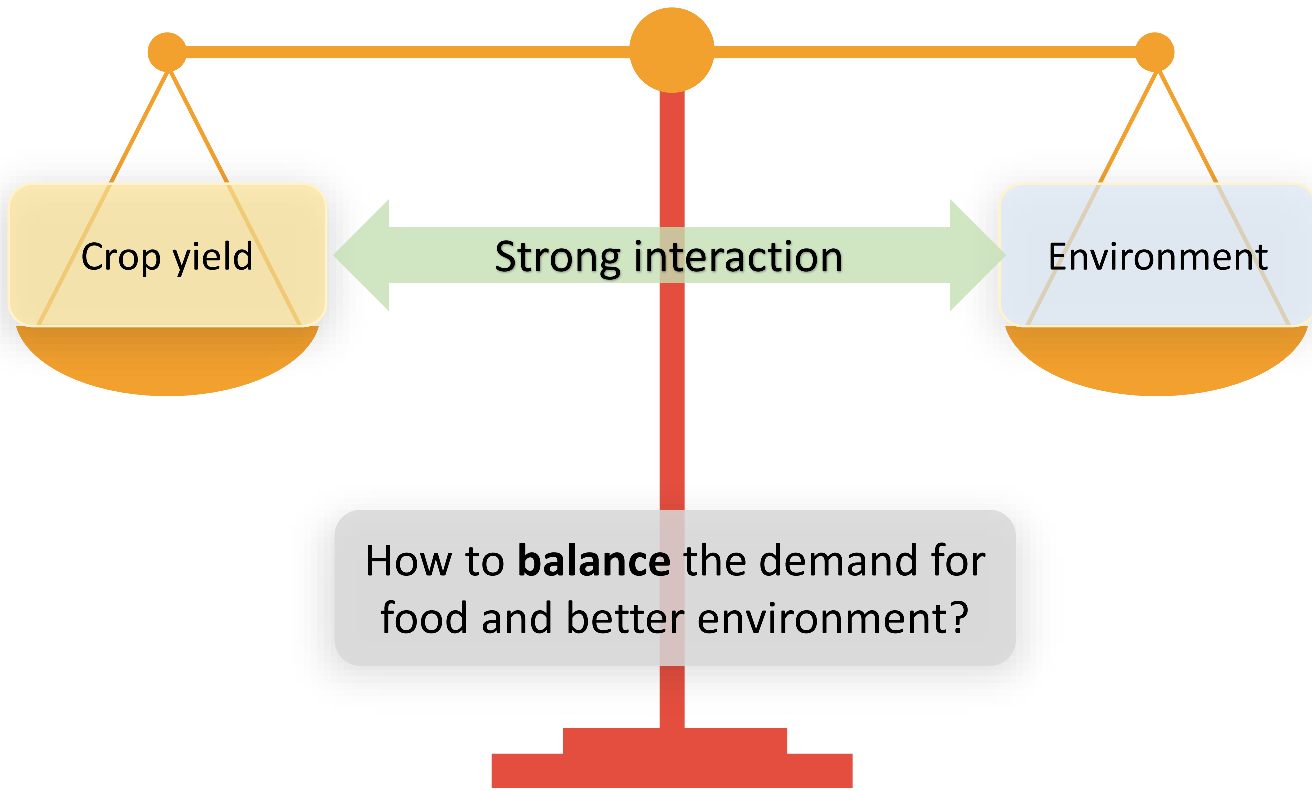
Maize yield

Wheat yield

Source: Internet

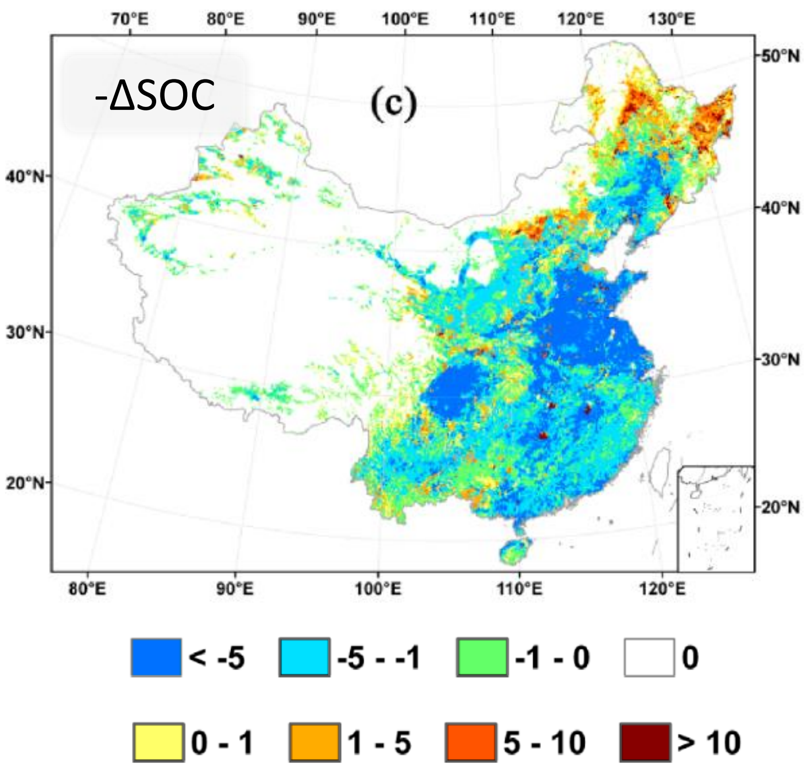
Lipper et al., 2014 ***Nature Climate Change***

Background

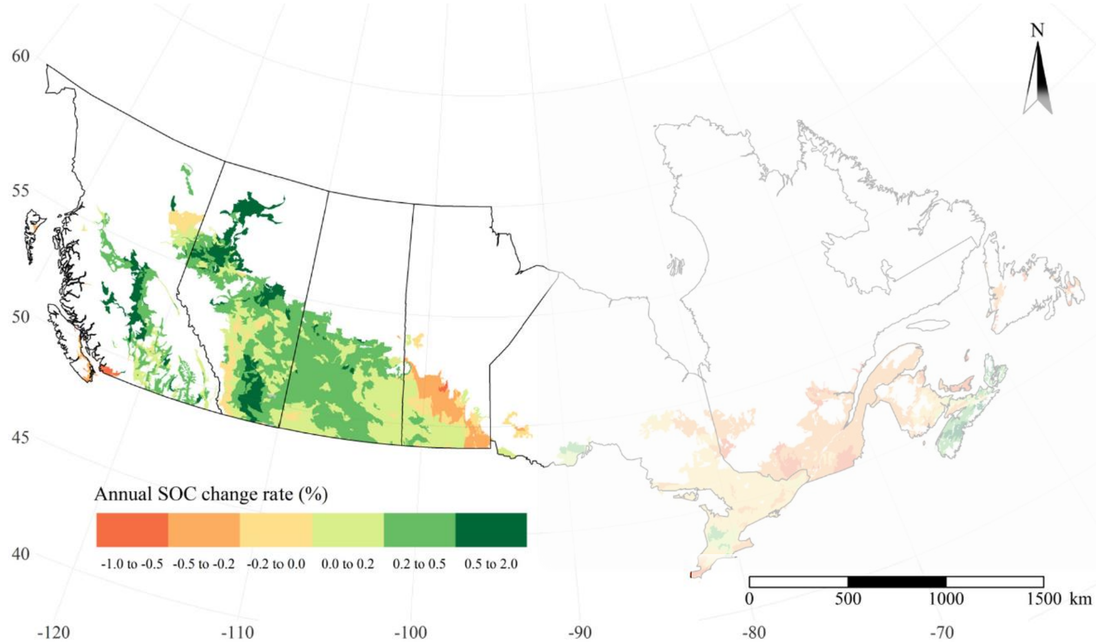

Crop yield
Strong interaction
Environment
How to **balance** the demand for food and better environment?

Background

Zhang et al., 2014, ES&T

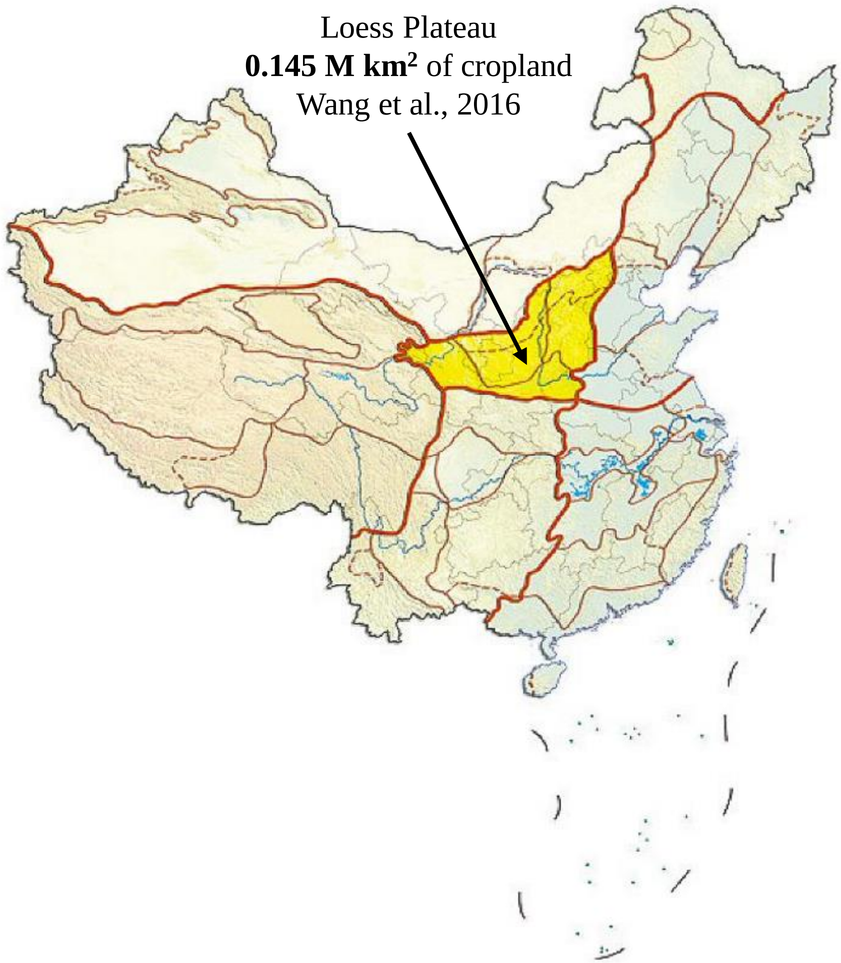


Fan et al., 2019, Geoderma

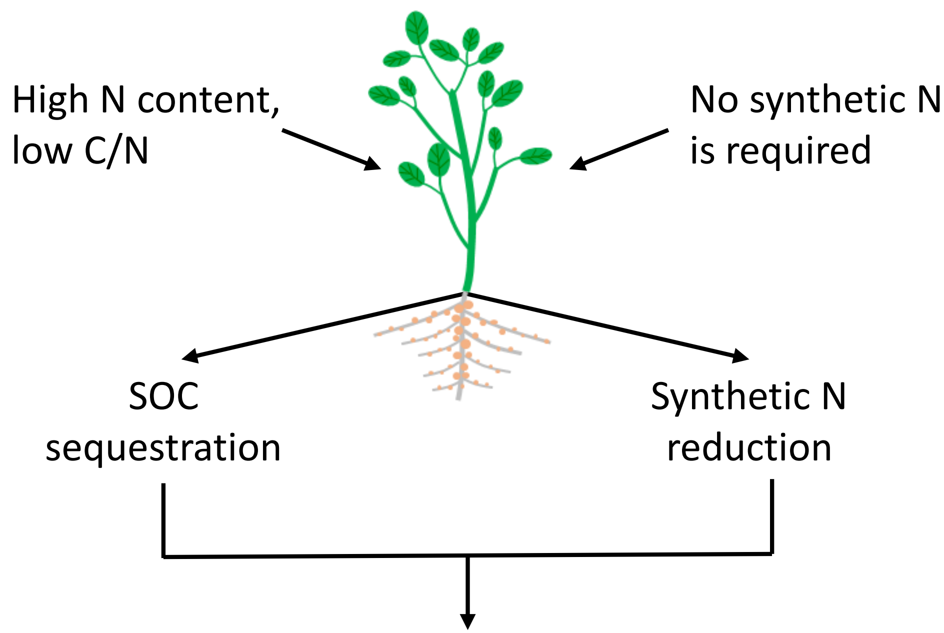


The cropland SOC in both China and Canada is increased through better field management

Background



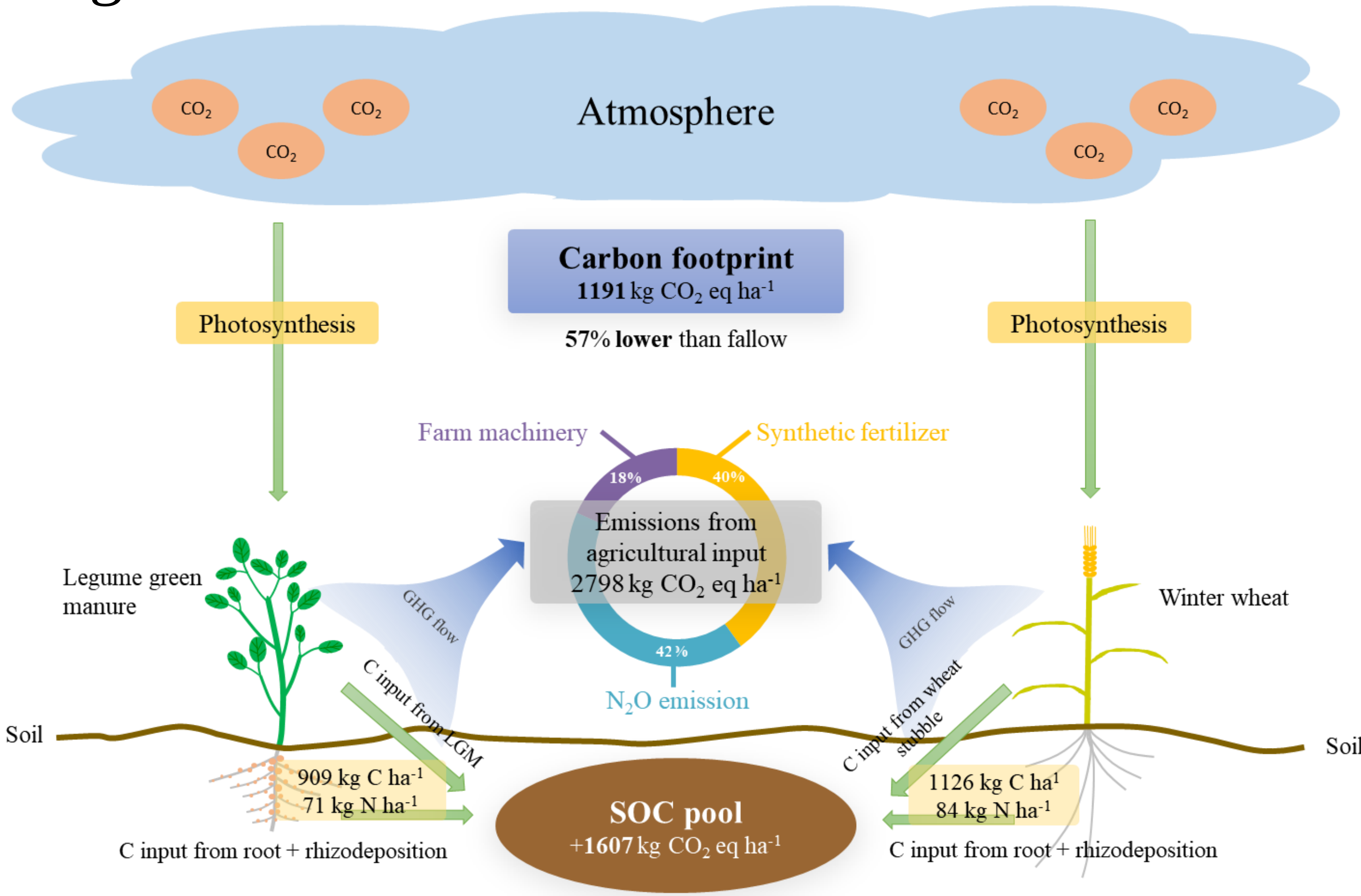
- Summer fallow-winter wheat rotation is widely applied;
- Low soil fertility and high synthetic N rate;
- Rich heat and precipitation in summer



- Maintain productivity of the cropland soils;
- Mitigate the environmental impacts due to crop production;
- Propel **sustainable** development of agriculture.

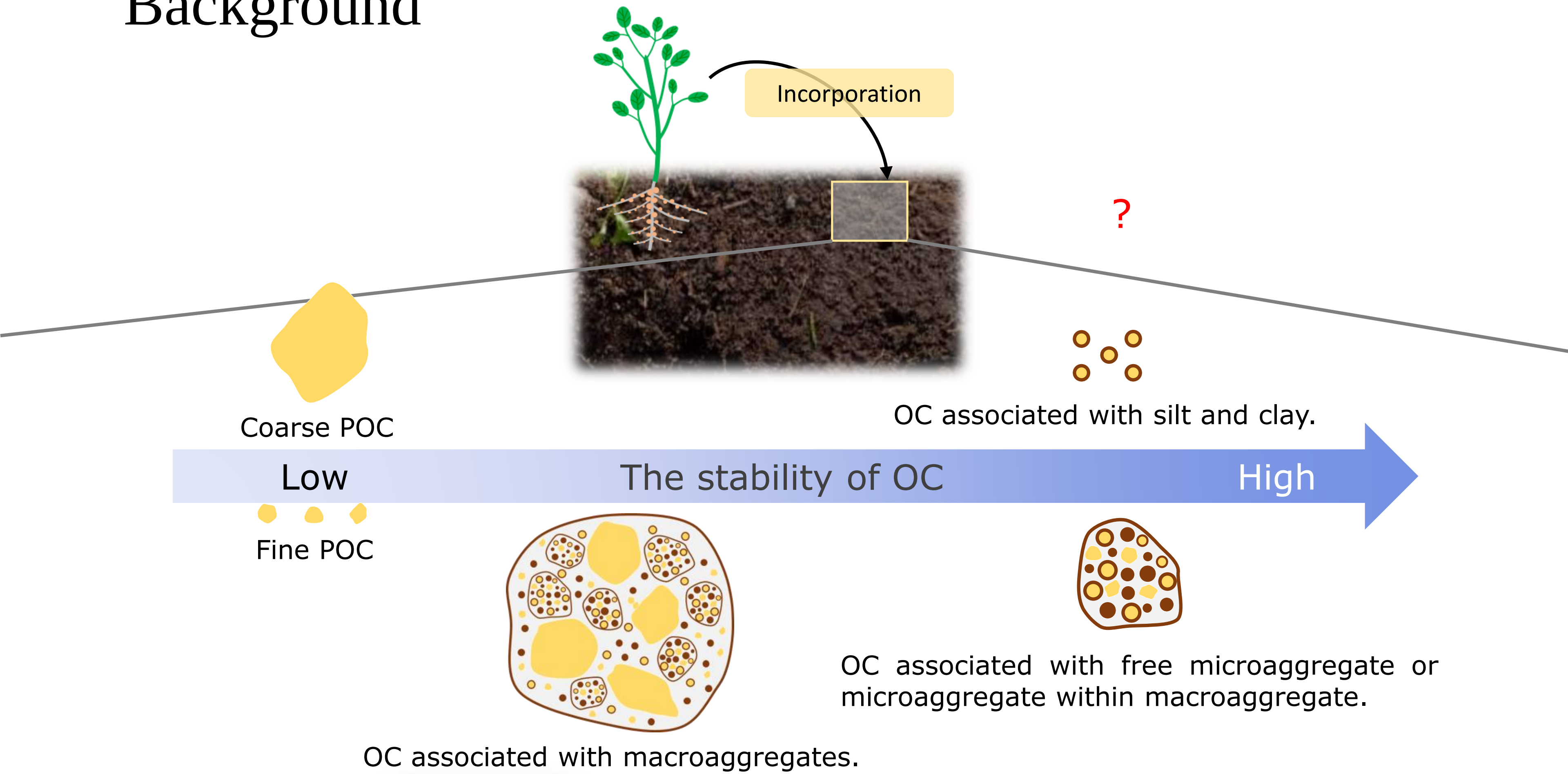
Source: Chinese National Geography

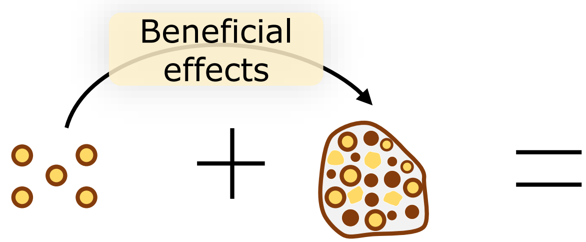
Background



Yao, Z., et al. (2017). "Coupling life-cycle assessment and the RothC model to estimate the carbon footprint of green manure-based wheat production in China." Science of The Total Environment **607**: 433-442.

Background





The OC associated with silt+clay and microaggregate are considered as **physicochemically protected** C.

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Experimental design

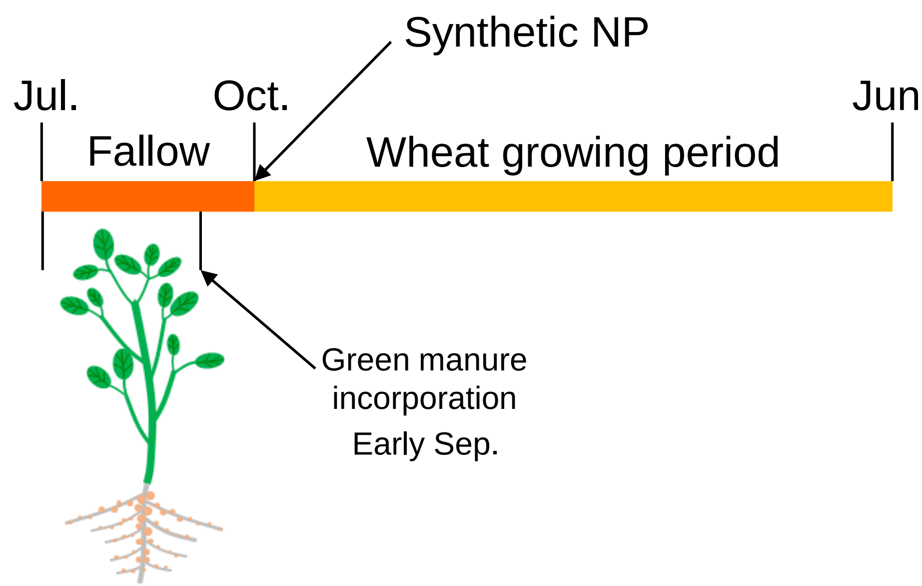
No synthetic fertilizer for LGM while synthetic N and P are applied as basal fertilizers before wheat seeding

Split-plot design

Sub treatments

0	0	0	0
108	108	108	108
135	135	135	135
162	162	162	162
kg N/ha	kg N/ha	kg N/ha	kg N/ha
Mung bean *Vigna radiata* (Linn.)Wilczek	Huai bean *Glycine soja* Sieb. et Zucc	Fallow	Soybean *G.* max (L.) Merr.

Main treatments



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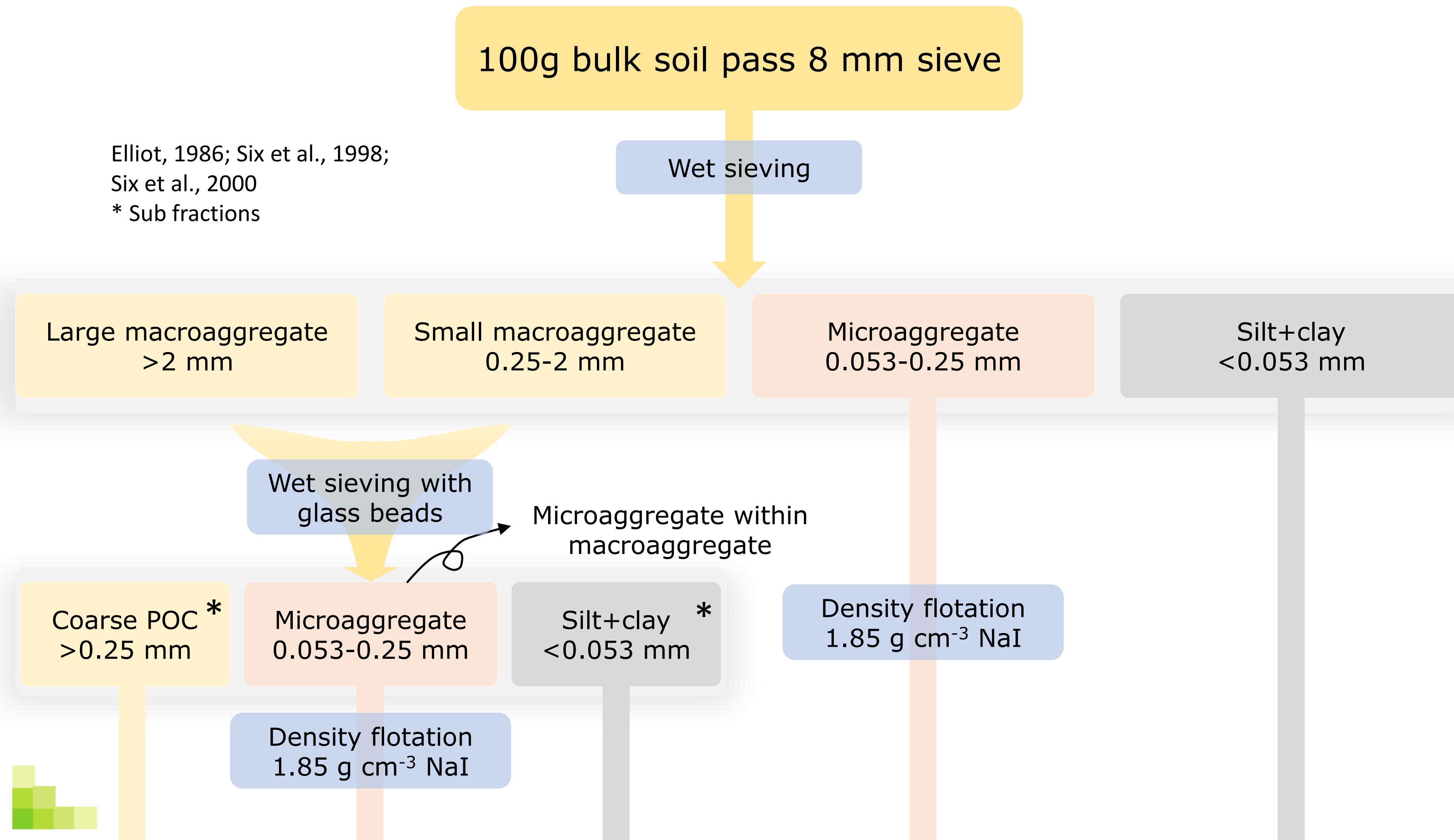
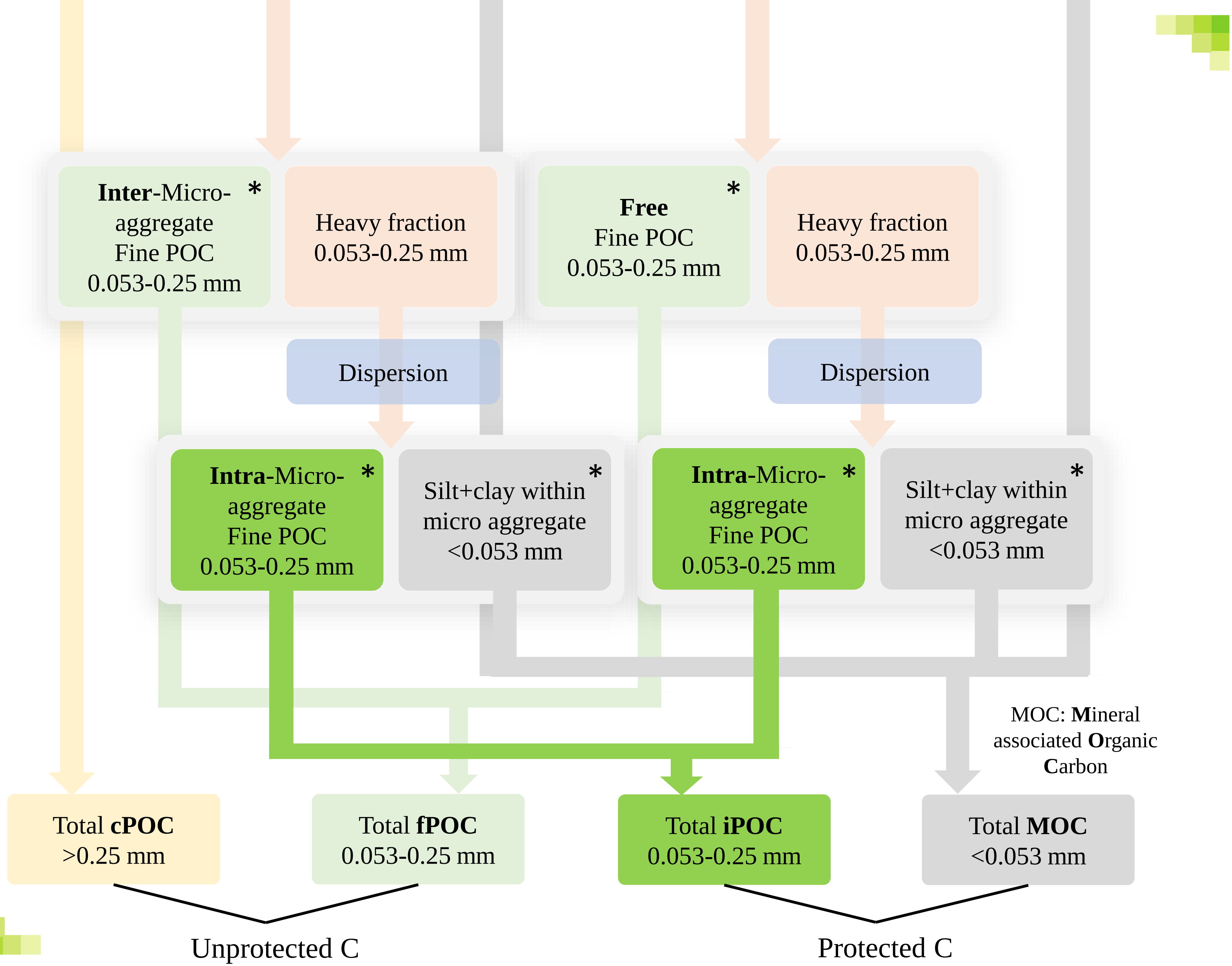
Experimental design

Elliot, 1986; Six et al., 1998;
Six et al., 2000
* Sub fractions





Inter-Micro-aggregate Fine POC 0.053-0.25 mm *
Heavy fraction 0.053-0.25 mm
Free Fine POC 0.053-0.25 mm *
Heavy fraction 0.053-0.25 mm
Dispersion
Dispersion
Intra-Micro-aggregate Fine POC 0.053-0.25 mm *
Silt+clay within micro aggregate <0.053 mm *
Intra-Micro-aggregate Fine POC 0.053-0.25 mm *
Silt+clay within micro aggregate <0.053 mm *
MOC: Mineral associated Organic Carbon
Total cPOC >0.25 mm
Total fPOC 0.053-0.25 mm
Total iPOC 0.053-0.25 mm
Total MOC <0.053 mm
Unprotected C
Protected C

Results

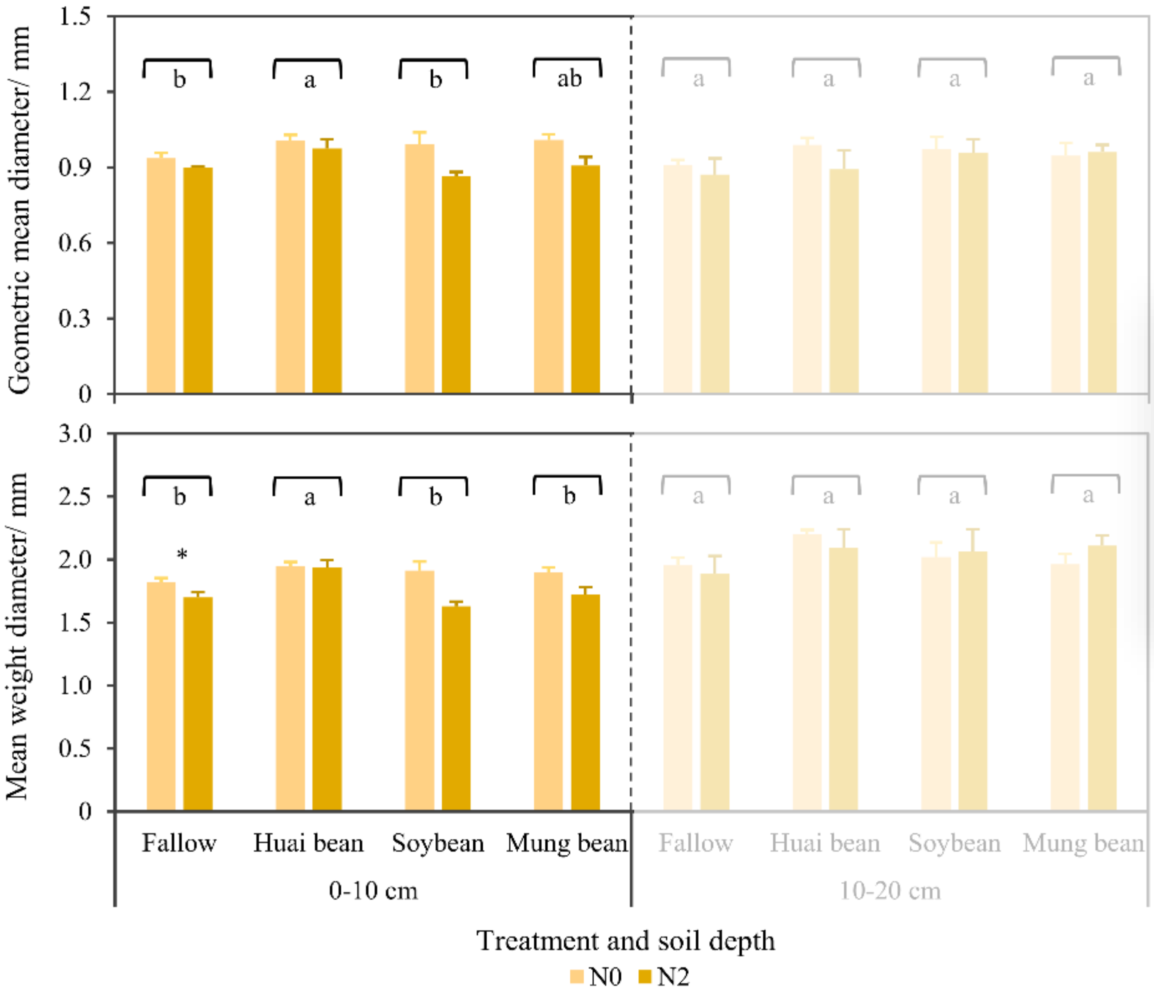


Fig. 1 Geometric mean diameter and mean weight diameter of the soil at the 0-10 and 10-20 cm soil layers.

- The LGM only affected the soil particle mass distribution at the 0-10 cm soil.
- Huai bean was efficient in increasing the GMD and MWD.

Results

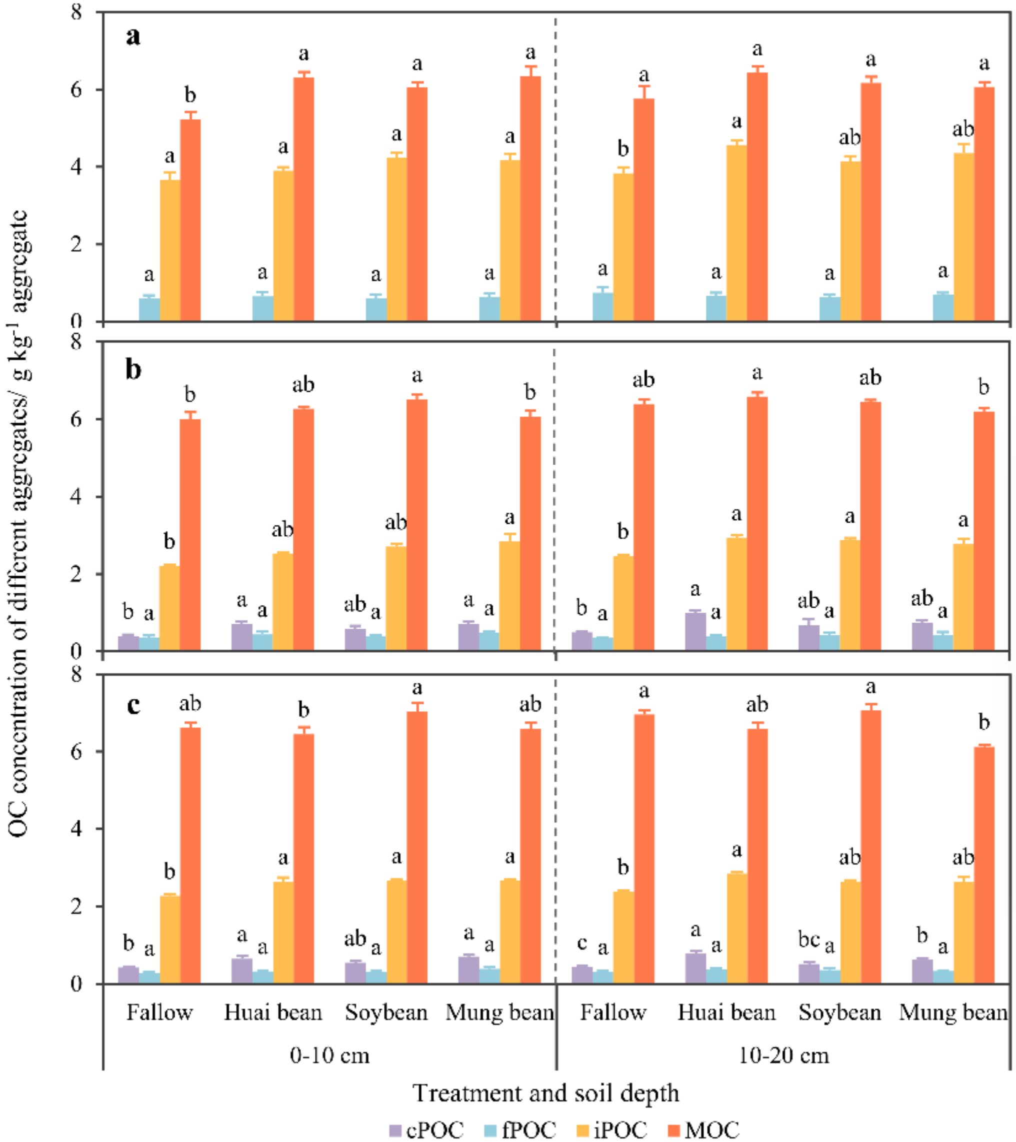


Fig. 2 Organic carbon concentration of cPOC, fPOC, iPOC and MOC for free microaggregate (a), small macroaggregate (b) and large macroaggregate (c) at the 0-10 and 10-20 cm soil layers.

- The OC concentration of iPOC in microaggregate was the highest.
- LGM increased the OC concentration of iPOC and MOC in different soil layers.
- For all aggregates, the OC concentration of fPOC was not increased due to the incorporation of LGM

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Results

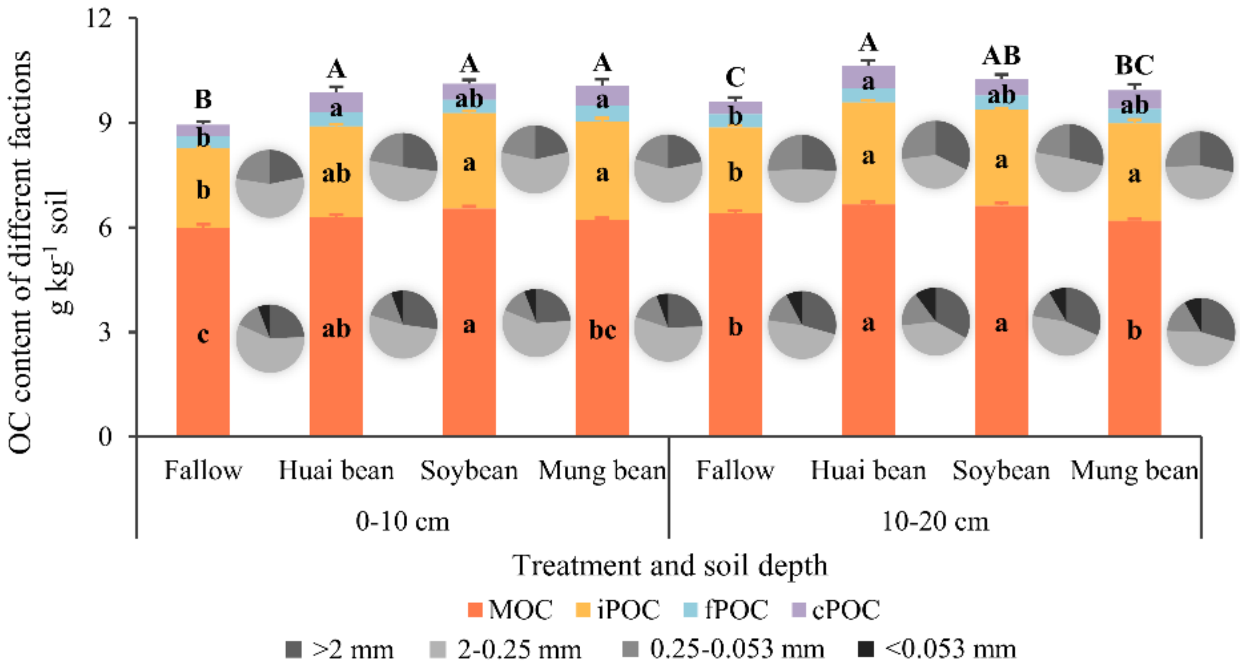

Fig. 3 Total OC content of different fractions at the 0-10 and 10-20 cm soil layers and the contribution of different soil particles to MOC and iPOC (pie chart).

- LGM increased the OC content of iPOC and MOC in the bulk soil.
- LGM also tended to increase fPOC+cPOC in the bulk soil.
- All aggregates made important contributions to iPOC and MOC while small macroaggregate was the main contributor.

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Results

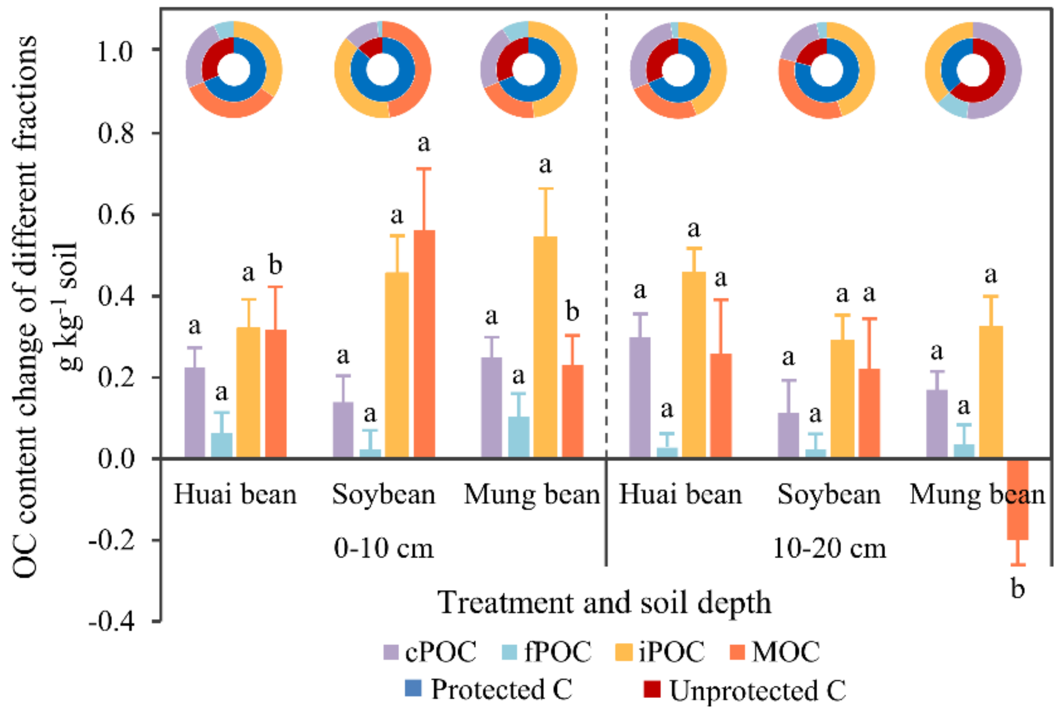


Fig. 4 Total OC content changes of different fractions and their contribution to the total changes of the SOC in the bulk soil (sunburst chart) at the 0-10 and 10-20 cm soil layers due to including LGM in the cropping system.

- Protected C (iPOC+MOC) accounted for 69-86% of the increase of the SOC.
- The contribution of both iPOC and MOC was important to the increased SOC.

Results

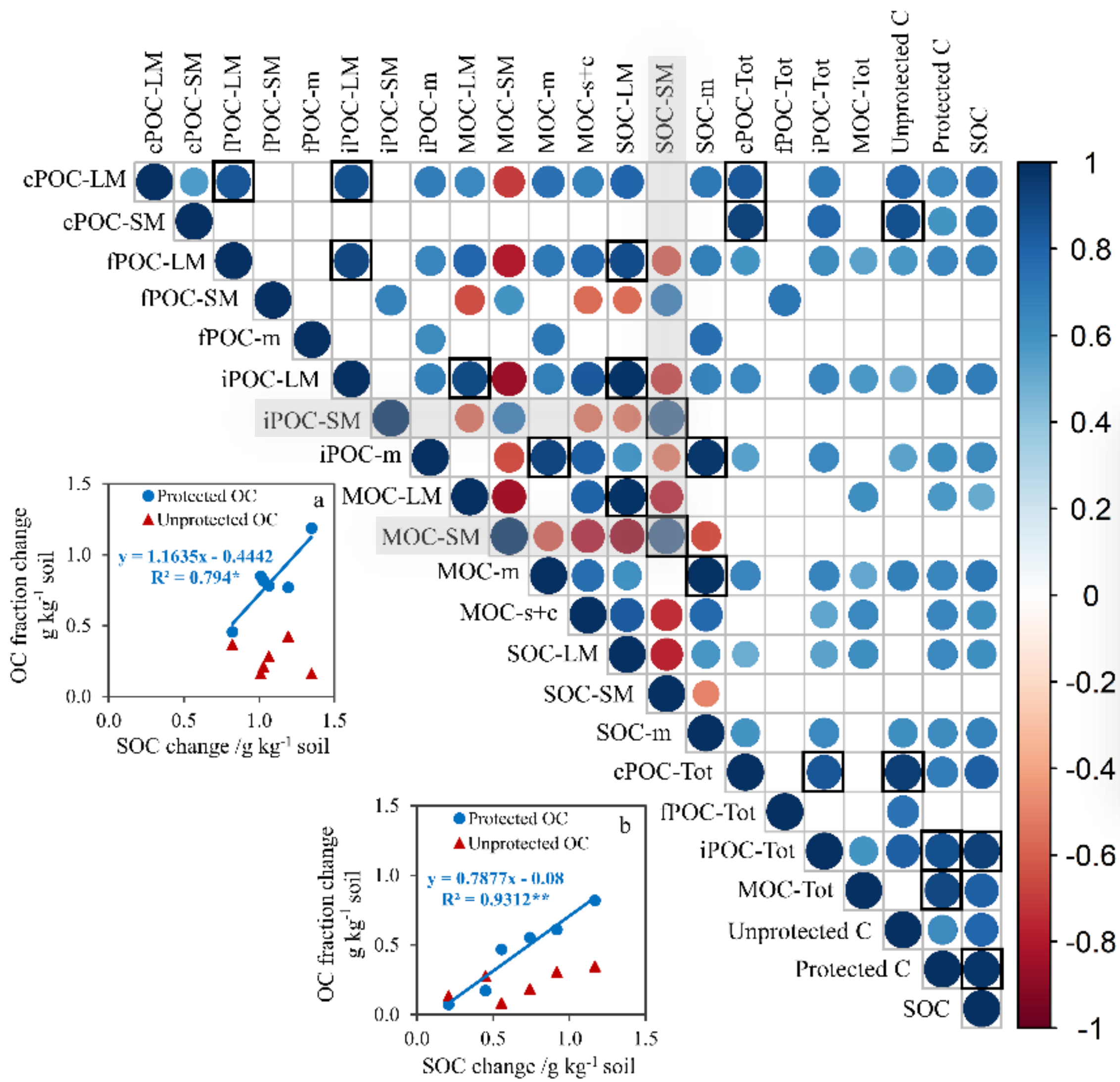
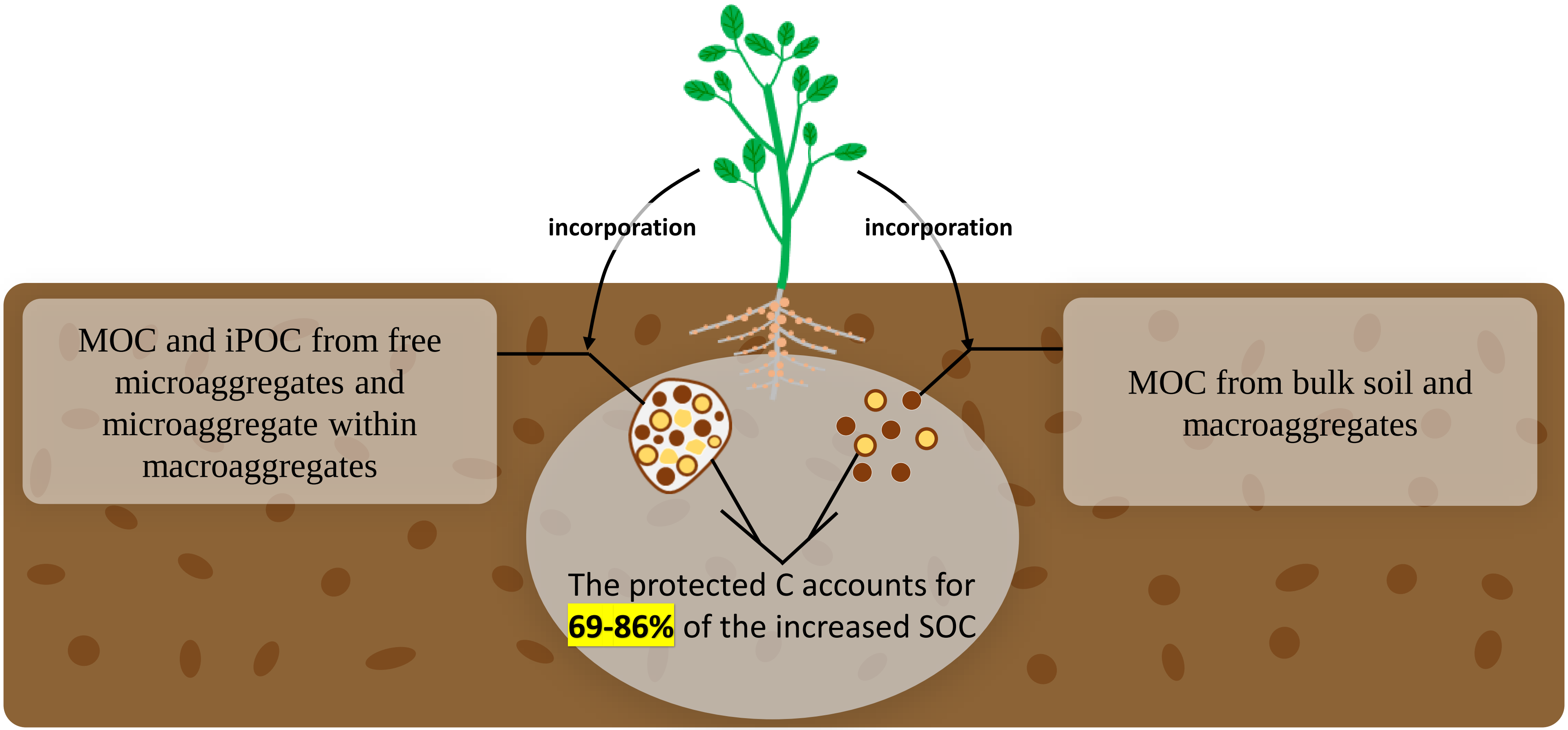


Fig. 5 Correlation matrix of OC content among different fractions and the correlation between the content change of SOC and protected/unprotected OC at the 0-10 (a) and 10-20 cm soil (b).

- The SOC of the aggregates were closely related to the corresponding OC content of iPOC and MOC.
- The changes of protected C were significantly correlated with the changes of SOC in the bulk soil.

Summary



incorporation
incorporation
MOC and iPOC from free microaggregates and microaggregate within macroaggregates
MOC from bulk soil and macroaggregates
The protected C accounts for 69-86% of the increased SOC

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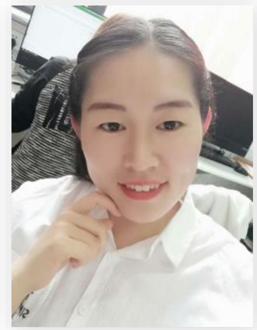

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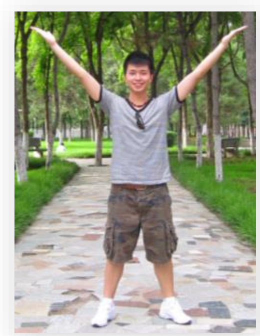

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