



LCA Food 2018



○ research group for environmental
life cycle & sustainability assessment

SOCLE: Soil Organic Carbon changes in LCA, which Evaluations to improve environmental assessments?

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- *Context:* ADEME SOCLE project 2014-2017



- *Scope:* Soil Organic Carbon & Climate Change in LCA
- *Objective:* Towards a consensual LCIA model...
 - Review/recommendations on how to model in LCA:
LULUC x agri. practices \Rightarrow Δ SOC \Rightarrow GHG
 - Feasibility/sensitivity for various agricultural contexts
- *Method review (Benoist et al. 2018)*

Methods tested

3 methods to assess the impact


Stock-difference approach
IPCC / ILCD

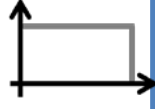
Müller-Wenk & Brandão 2010
UNEP-SETAC

Levasseur 2011, dynamic LCA
Not recommended




4 methods to allocate impacts over time

Uniform over 20 years
IPCC Tier 1


Uniform over another time period
Not recommended


Degressive over 20 years
ILCD


Degressive over another time period
ILCD


Accounting for the link C:N
IPCC

3 methods to assess the impact

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IPCC / ILCD
 LCI method

$$SOC = SOCSTD * FLU * FM_G * FI$$

$$\Psi_{CO_2, A \rightarrow B} = (SOC_A - SOC_B) * \frac{44}{12}$$

** temporal allocation rule*

Accounting for the link C:N
 IPCC

3 methods to assess the impact

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Dynamic LCA
 Not recommended

UNEP-SETAC

LCIA method within the land use framework

Δ Stock depends on the reference state
df = biogenic carbon stay in the air/ fossil one

$$CF_{occupation} = \frac{44}{12} \cdot \Delta Stock \cdot df \cdot \frac{1}{t_{occ}}$$

$$CF_{transformation} = \frac{44}{12} \cdot \Delta Stock \cdot df$$

* temporal allocation rule

3 methods to assess the impact

Stock-difference approach
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Levasseur 2011, dynamic LCA
Not recommended

Not recommended LCIA method

*GWP depends on the timing of emission
GWP are all integrated over a fixed 100 year
horizon starting at the moment of the first
emission/storage*

$$CF_{transformation} = \frac{\Delta C}{\Delta yr} * \frac{44}{12} * GWP_{dyn}$$

** temporal allocation rule*

○ Investigated agricultural products

- 3 temperate crops
wheat-maize-vine
+ meat-milk
- 2 tropical crops
soybean-sugar cane



○ Scenarios and sensitivity analyses

- Changes in land uses and practices
(at least 2 scenarios per crop)
- C stock data (IPCC, literature, +10%)
- Reference states (various)
- Regeneration times (+10%)

○ Results are in **CO_{2e}** and presented relative to :

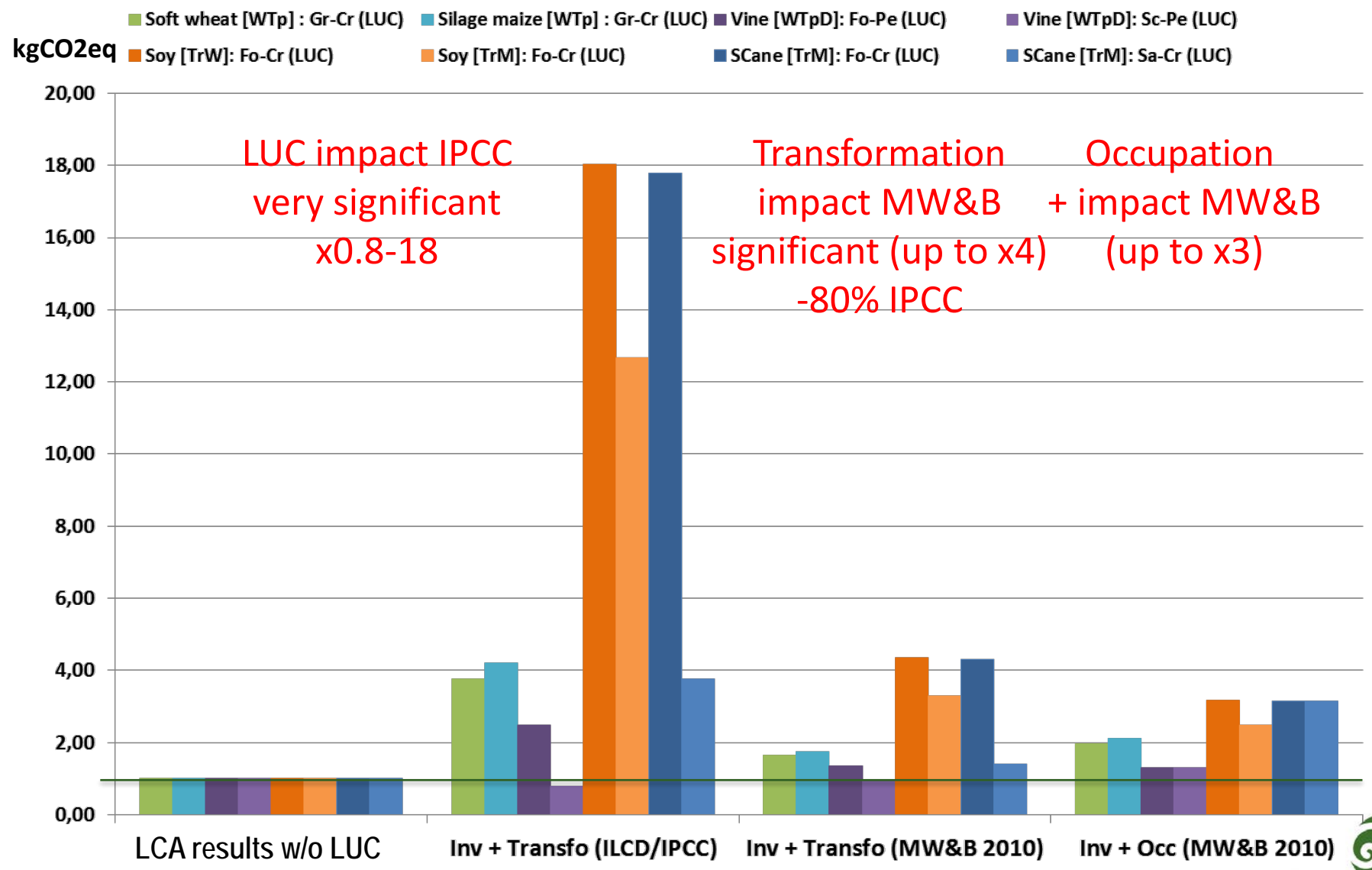
- The total impact without LULUC
- A baseline option with LULUC

○ Colour code

- Soft wheat [WTp] : Gr-Cr (LUC)
- Silage maize [WTp] : Gr-Cr (LUC)
- Vine [WTpD]: Fo-Pe (LUC)
- Vine [WTpD]: Sc-Pe (LUC)
- Soy [TrW]: Fo-Cr (LUC)
- Soy [TrM]: Fo-Cr (LUC)
- SCane [TrM]: Fo-Cr (LUC)
- SCane [TrM]: Sa-Cr (LUC)

- Soft wheat 1 [WTp] : Ti-NoTi (LMC)
- Silage maize 1 [WTp] : Ti-NoTi (LMC)
- Soft wheat 2 [WTp] : Ti-NoTi (LMC)
- Silage maize 2 [WTp] : Ti-NoTi (LMC)
- Vine [WTpD]: NoTi-Ti (LMC)
- Vine [WTpD]: Exp-NoExp (LMC)
- Vine [WTpD]: BaS- CoS (LMC)
- Milk1 [WTpM] : Ti-NoTi (LMC)
- Milk2 [WTpM] : Ti-NoTi (LMC)
- Beef [WTpM] : Ti-NoTi (LMC)
- Soy [TrW]: Ti-NoTi (LMC)
- Soy [TrM]: Ti-NoTi (LMC)
- SCane [TrM]: Burn-NoExp (LMC)
- SCane [TrM]: NoExp-Exp (LMC)

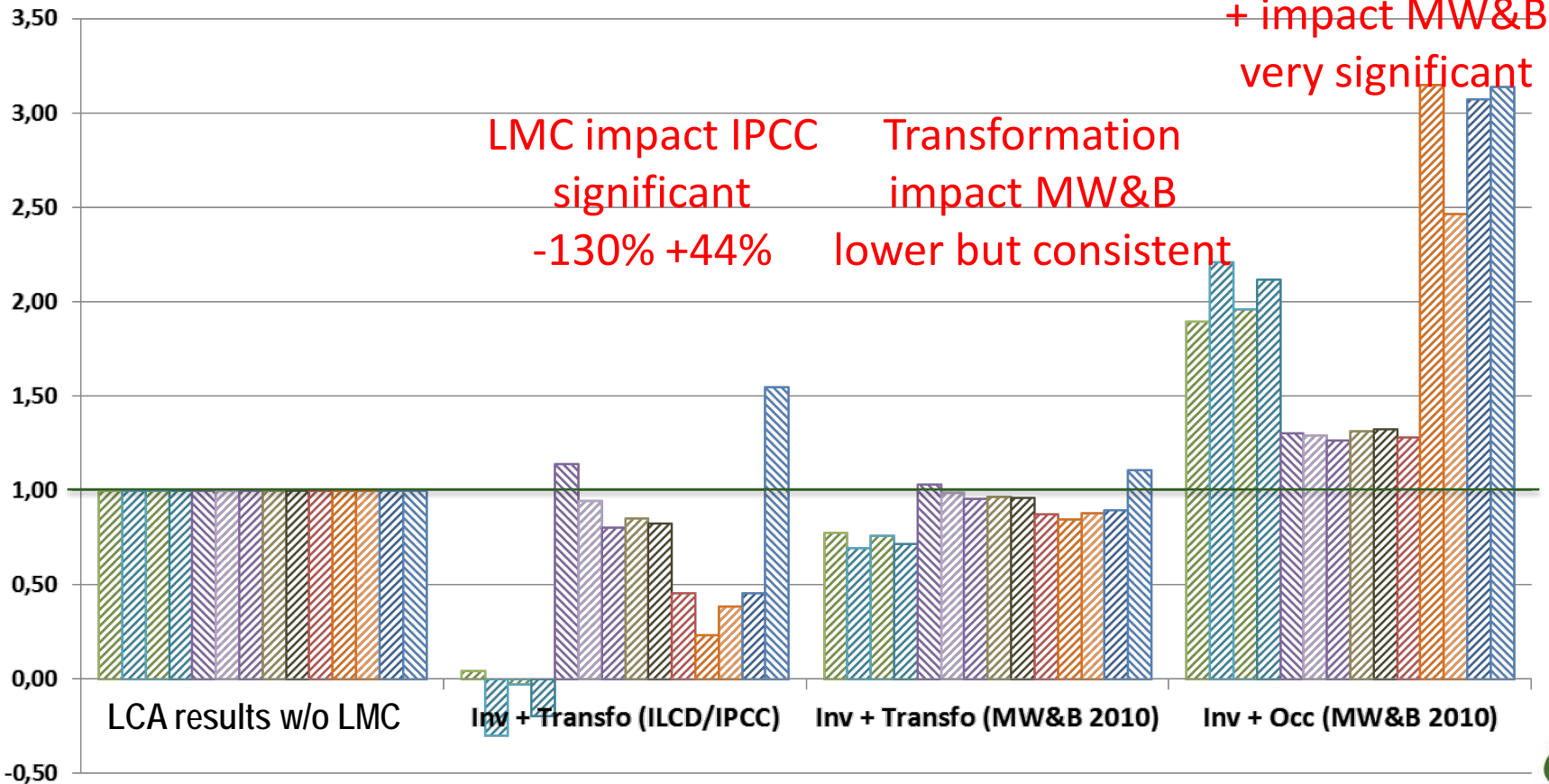
IPCC & MW&B: impacts of LUC



IPCC & MW&B & : impacts of LMC

- Soft wheat 1 [WTp] : Ti-NoTi (LMC)
- Silage maize 1 [WTp] : Ti-NoTi (LMC)
- Soft wheat 2 [WTp] : Ti-NoTi (LMC)
- Silage maize 2 [WTp] : Ti-NoTi (LMC)
- Vine [WTpD]: NoTi-Ti (LMC)
- Vine [WTpD]: Exp-NoExp (LMC)
- Vine [WTpD]: BaS- CoS (LMC)
- Milk1 [WTpM] : Ti-NoTi (LMC)
- Milk2 [WTpM] : Ti-NoTi (LMC)
- Beef [WTpM] : Ti-NoTi (LMC)
- Soy [TrW]: Ti-NoTi (LMC)
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kgCO₂eq



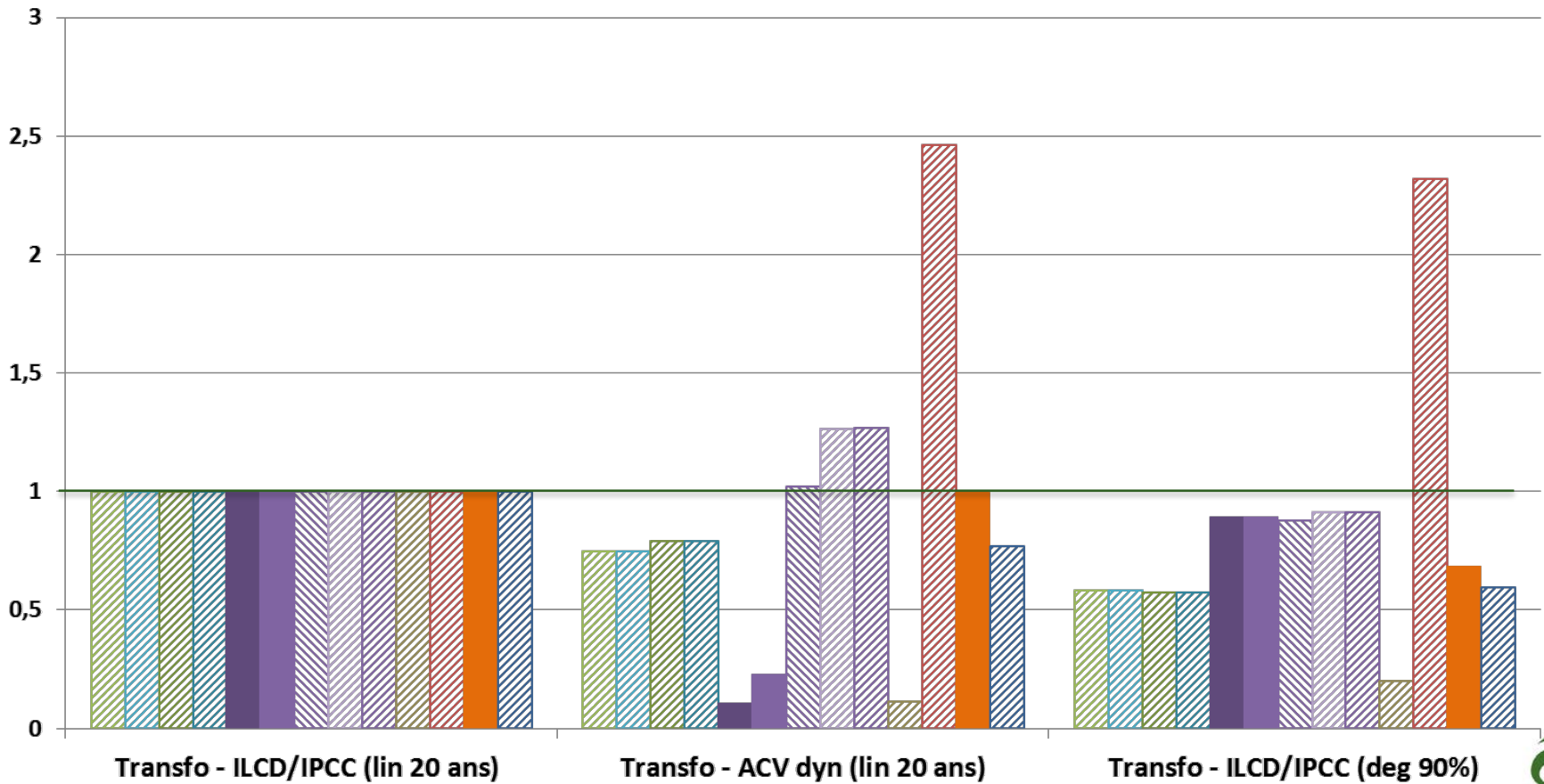
LMC impact IPCC
significant
-130% +44%

Transformation
impact MW&B
lower but consistent

Occupation
+ impact MW&B
very significant

Dynamic LCA & temporal allocation

- ▨ Soft wheat 1 [Wtp] : Ti-NoTi (LMC)
- ▨ Silage maïze 1 [Wtp] : Ti-NoTi (LMC)
- ▨ Soft wheat 2 [Wtp] : Ti-NoTi (LMC)
- ▨ Silage maïze 2 [Wtp] : Ti-NoTi (LMC)
- ▨ Vine [WtpD]: Fo-Pe (LUC)
- ▨ Vine [WtpD]: Sc-Pe (LUC)
- ▨ Vine [WtpD]: NoTi-Ti (LMC)
- ▨ Vine [WtpD]: Exp-NoExp (LMC)
- ▨ Vine [WtpD]: BaS- CoS (LMC)
- ▨ Milk1 [WtpM] : Ti-NoTi (LMC)
- ▨ Beef [WtpM] : Ti-NoTi (LMC)
- ▨ Soy [TrW]: Fo-Cr (LUC)
- ▨ SCane [TrM]: Burn-NoExp (LMC)



○ Results of case studies

- LUC & LMC influence climate change impact
- Occupation & transformation MW&B are both significant
- The method choice influences LUC results
- All tested methods are sensitive to practices
- Accounting of C:N is not negligible (up to +15%)

- Results of case studies
 - C stocks = very sensitive parameters (up to x 8)
 - Reference states are critical & not easy to find data
 - Regeneration time is influential & very difficult to assess!
- Recommendations
 - Field data when possible (consistency!)
 - Sensitivity analysis on key factors
 - IPCC Tier 1/degressive at minima, +MW&B
- Perspectives
 - Testing the trade-offs with field data

