



Potential of soybean for relay cropping systems: what we know and what we don't?

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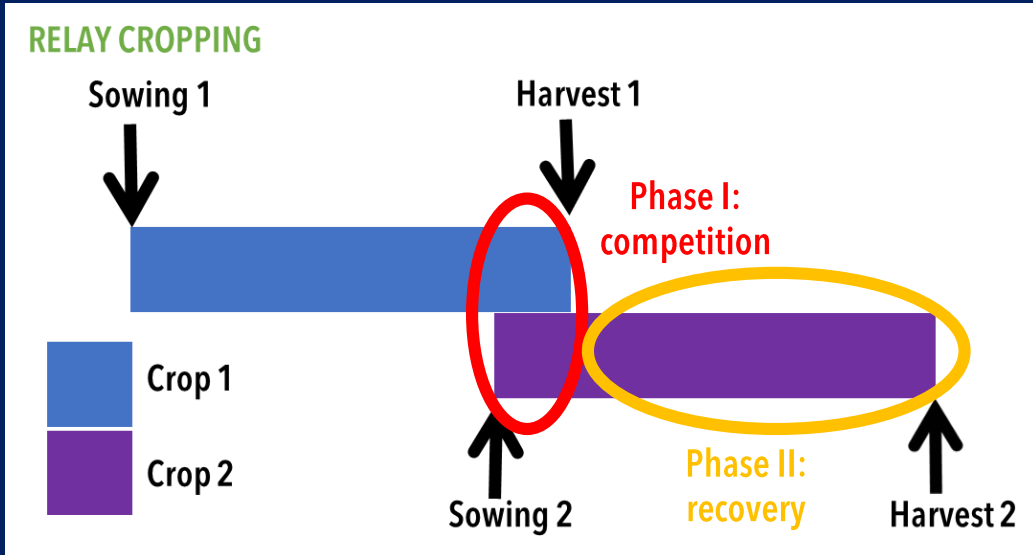
Session: C1 - Yield and seed composition response to environment



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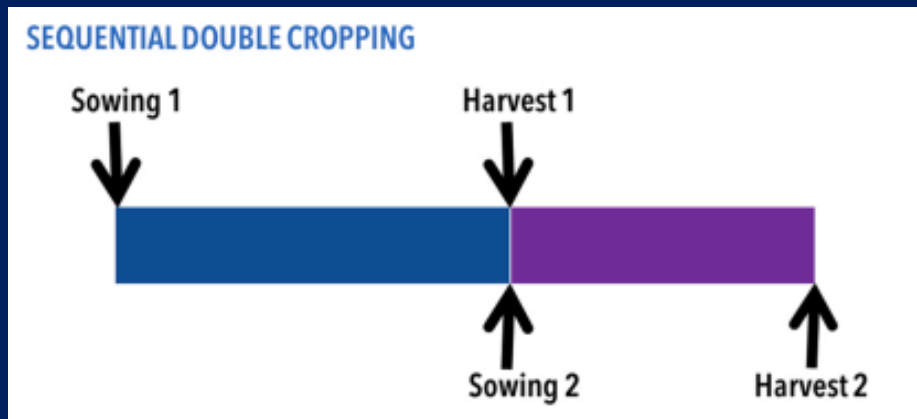


What is relay cropping?



Adapted from Brun and Levèque, 2020

Crop 1: primary crop
Crop 2: relay crop



Why relay cropping gains increasing attention?

- Reduced profitability of conventional cereal-based cropping systems (Maresma *et al.*, 2019),
- Unfavorable weather for sequential double cropping (Liu *et al.*, 2019; Soba *et al.*, 2022):
 - ✓ Heat/drought stresses, especially under rainfed conditions,
 - ✓ Insufficient thermal time to reach grain maturity,
 - ✓ Limited field access for grain harvest (e.g. early autumn rainfall).
- Lengthening of the growing season across higher latitudes under climate change (Mueller *et al.*, 2015).

Alternative to SDC across central Illinois, USA, "the northern limit" for SDC (Brown and Graffis, 1976; Chan *et al.*, 1980)

An important measure (Tanveer *et al.*, 2017; Gesch *et al.*, 2023):

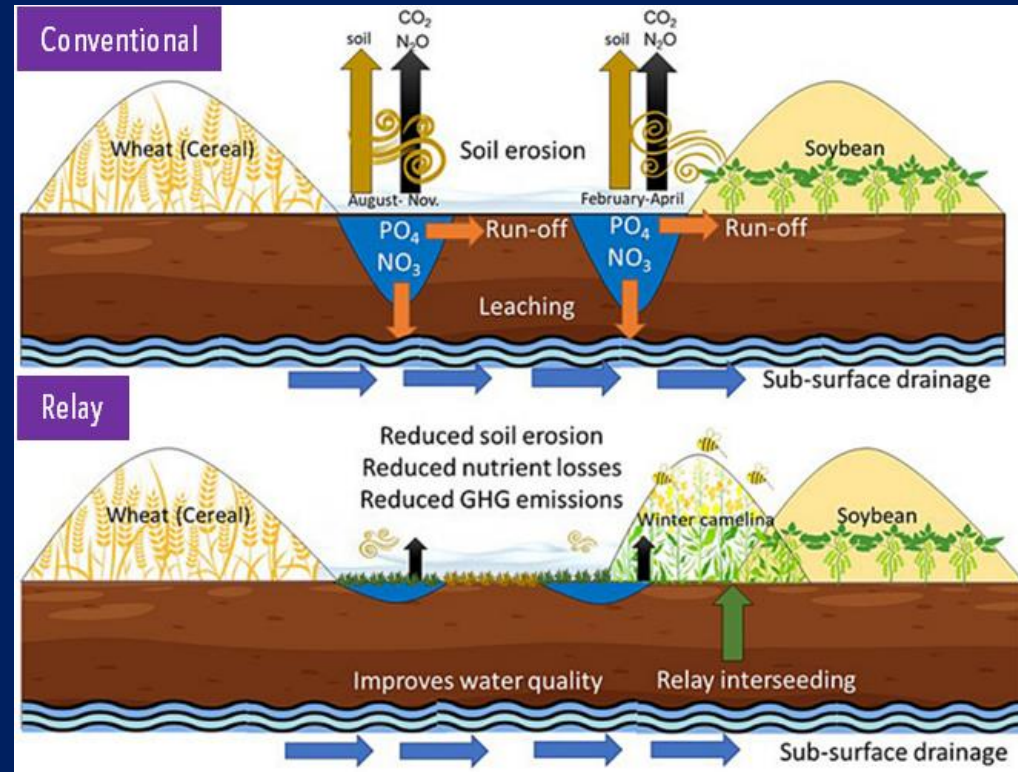
- ✓ Climate change adaptation and mitigation
- ✓ Spatio-temporal diversification

Relay cropping: a trade-off between food security and environmental sustainability

Numerous benefits compared to conventional system (Tanveer *et al.*, 2017)



Higher economic profitability

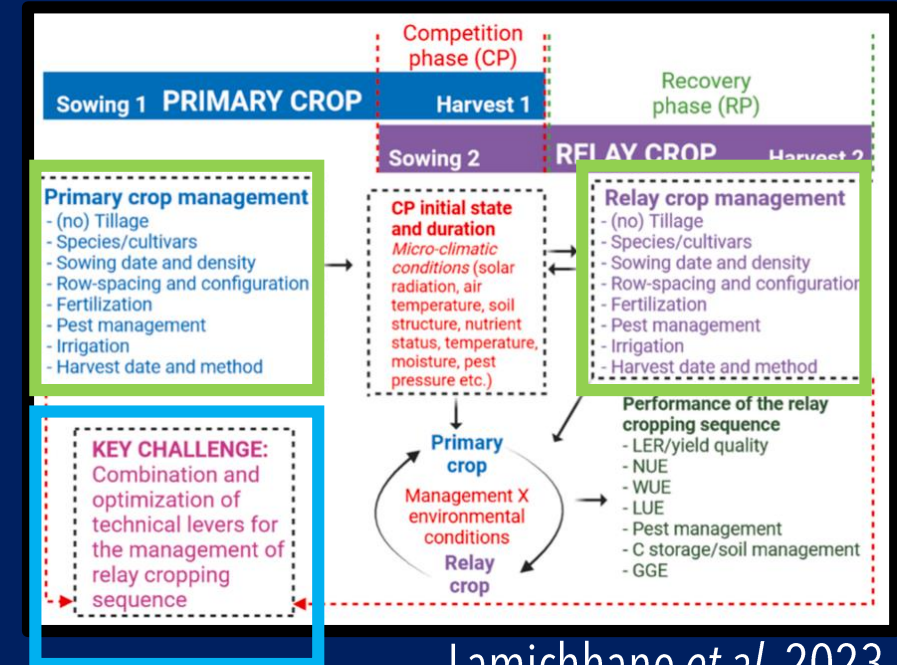


Higher environmental sustainability (Gesch *et al.* 2023)

But relay cropping has also drawbacks



- Difficulty to manage the two crops in general and "the competition phase" in particular,
- A lot of need for anticipation and organization even before sowing the primary crop,
- High labor costs vs. low or unsecured harvest.



Lower competitiveness of relay cropping compared to conventional or sequential double cropping: **main cause of poor adoption?**

Ideal characteristics of species for relay cropping

Primary crop

- Plasticity (no rigid structure)
- Early maturing
- Short strawed
- Upright growth habit (no spreading)



Relay crop

- Wide range of maturity groups
- Shade tolerance
- Low sensitivity to phytotoxicity
- Slow growth habit during the competition phase
- Drought tolerance
- Resistance to mechanical crushing



Soybean fulfils most of the characteristics of the relay crop!!!

Soybean as a relay crop for relay cropping: **knowns** and **unknowns**

- Ideal primary crops for soybean: small-grain cereals (wheat, oat, barley, triticale & rye) + other primary crops: maize, rice, winter camelina, oilseed rape & sorghum



- Optimal sowing dates & densities



- Traits and/or indicators:

- ✓ Stand establishment (e.g. emergence vigor, drought tolerance)
- ✓ Competition phase (e.g. slow growth rate)
- ✓ Post-competition phase (e.g. high growth rate)



Soybean as a relay crop for relay cropping: **knowns** and **unknowns**

- Primary/relay crop row numbers, spacing & orientation

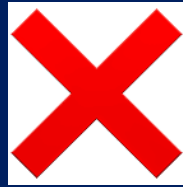


4:2 configuration



2:1 configuration

- Optimal quantity/timing of fertilization & irrigation



- Optimal equipments (adaptations) for harvest



Conclusions and perspectives

- Need to identify key factors affecting relay cropping adoption,
- Public policy supporting farmers during the transition period (incentives?),
- More research to fill the current knowledge gaps:
 - ✓ Specific genotypes for relay cropping?
 - ✓ Relay crop modeling and development of decision support systems,
 - ✓ Technological innovation for an improved management of relay cropping,
 - ✓ A multi-criteria assessment comparing relay vs. conventional vs. sequential double cropping system across contrasted environmental conditions.

For more detailed information

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Relay cropping for sustainable intensification of agriculture across temperate regions: Crop management challenges and future research priorities

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Poster: subsection C1 (Debaeke *et al.*), key results on wheat-soybean relay cropping in Southwest France

INRAE **Relay-cropping of soybean cultivars into wheat for ecological intensification of agriculture**

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IDEOTYPAGE ET PHENOTYPAGE POUR L'ADAPTION DES CULTURES EN RELAI ET EN DEROBE

Thank you all for your attention!