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## Yield gap analysis extended to marketable grain reveals the profitability of organic lentil-spring wheat intercrops

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*“Yield Gap Analysis Extended to Marketable Grain  
Reveals the Profitability of Organic Lentil-Spring  
Wheat Intercrops”*

*Viguier L, Bedoussac L, Journet E-P, Justes E*



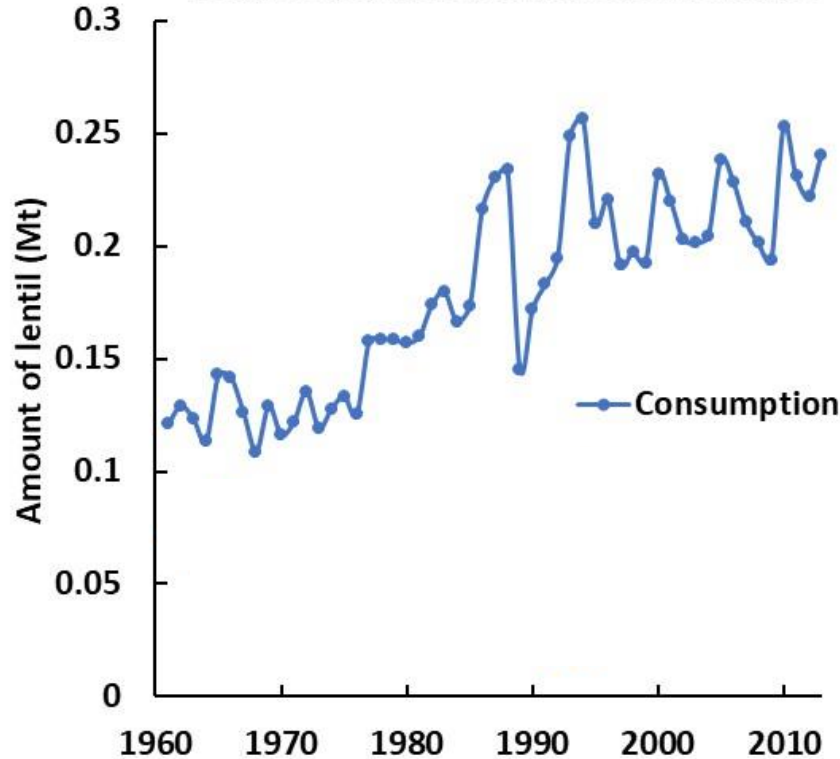
**VASCO Team**

Varieties and cropping systems for an agroecological production

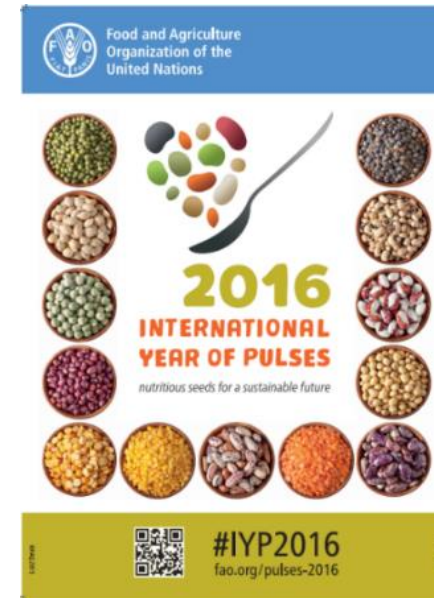
# Lentil in Europe

- [1] FAO, 2018
- [2] Nguyen, 2018
- [3] Watson et al. 2018
- [4] Ansari et al. 2015
- [5] Erskine et al. 2016
- [6] Magrini et al. 2016

Lentil consumption and production in EU



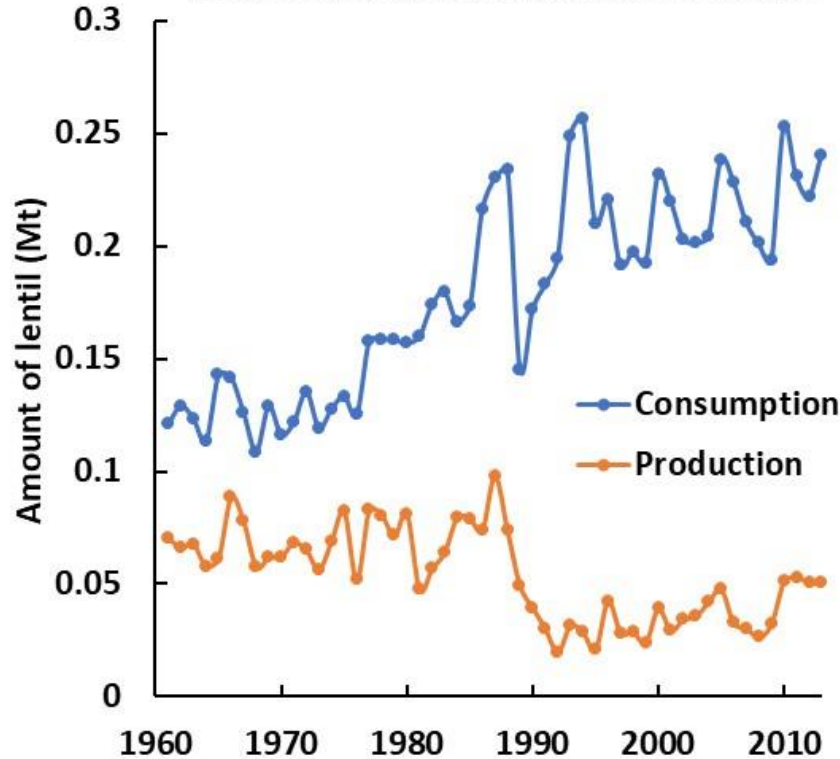
- Growing consumption [1]
- Enhanced communication:
  - Nutritional advantages [2, 3, 4, 5]
  - Environmental benefits [4, 5]
- Dietary transition favorable [6]



# Lentil in Europe

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Lentil consumption and production in EU



- Growing consumption [1]
- Enhanced communication:
  - Nutritional advantages [2, 3, 4, 5]
  - Environmental benefits [4, 5]
- Dietary transition favorable [6]
- Consumption > Production
  - ➔ Regional deficit [1]
  - ➔ Market opportunity



# Why such a deficit in lentil production ?

- [1] Peoples et al. 2002
- [2] Angus et al. 2015
- [3] Wang et al. 2013
- [4] Laserna-Ruiz et al. 2012
- [5] Carr et al. 1995

- Despite economic and agronomic advantages:
  - High selling price
  - No need for N fertilization [1]
  - Diversification of rotations [2]
- Low and unstable productivity → 3 major yield-reducing factors



**Weeds**

Up to **100% losses** [3]



**Bruchids**

Up to **50% losses** [4]



**Lodging**

Up to **100% losses** [5]





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**Can intercrops (IC) lower these reducing factors compared to sole crops (SC) ?**



# Field experiments 2015 and 2016

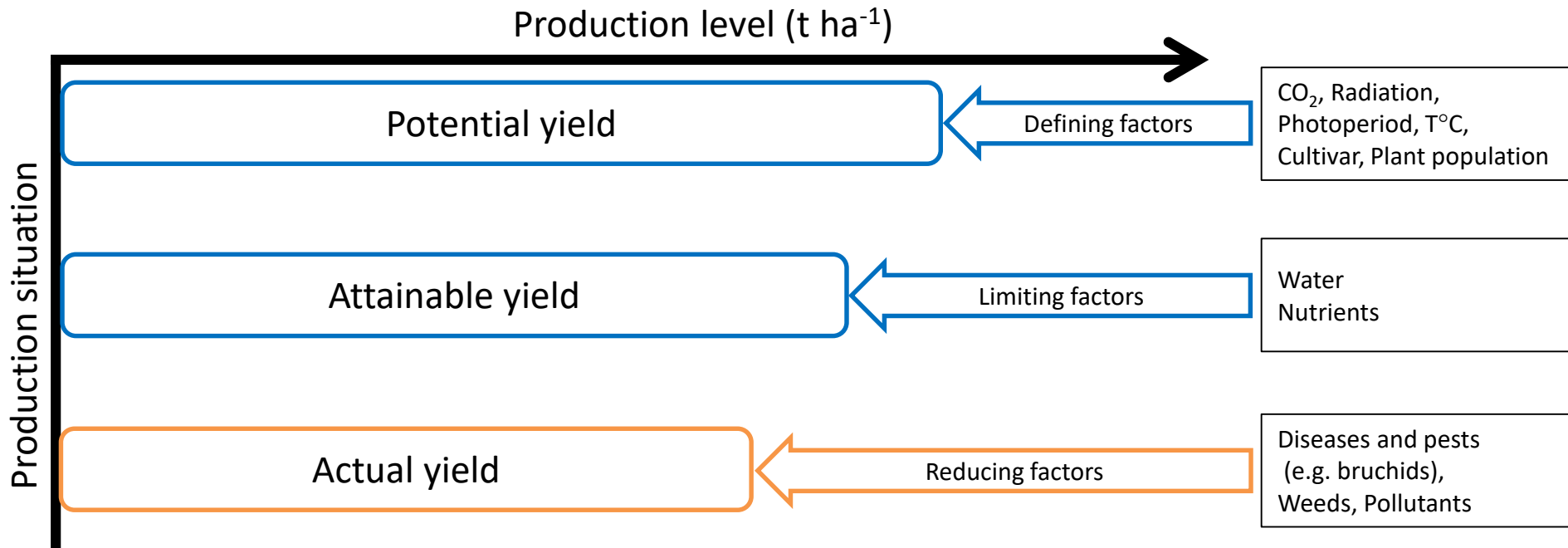


- INRA Auzeville (SW France)
- Experimental plots, no inputs
- Low N mineral content at sowing ( $30 \text{ kg N ha}^{-1}$ )
- 4 lentil and 2 spring-wheat cultivars
- 100% lentil + 17% wheat in intercrop
- Both crops sown and harvested simultaneously



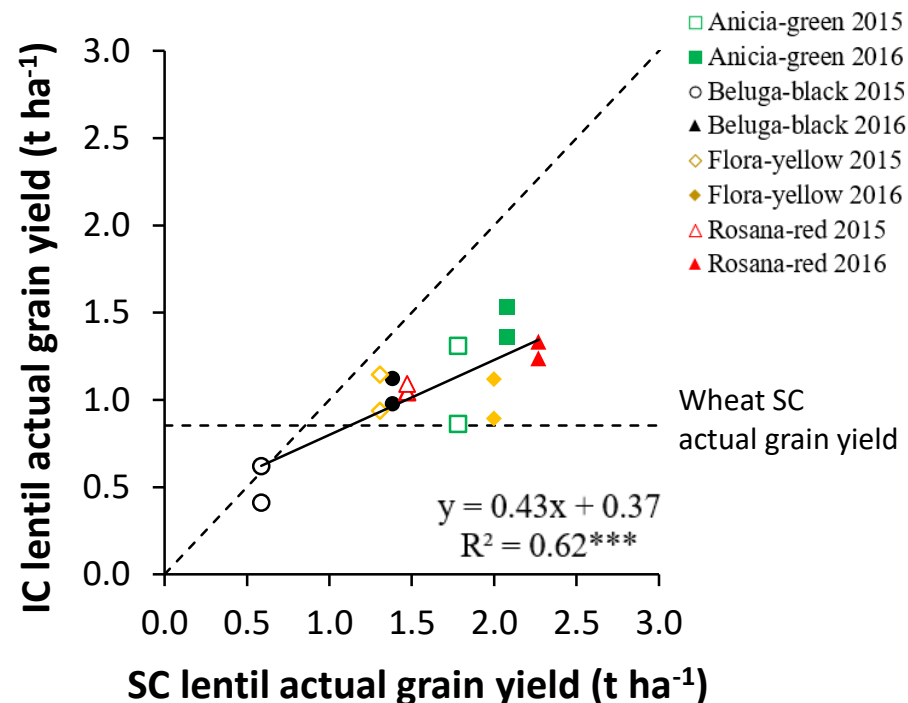
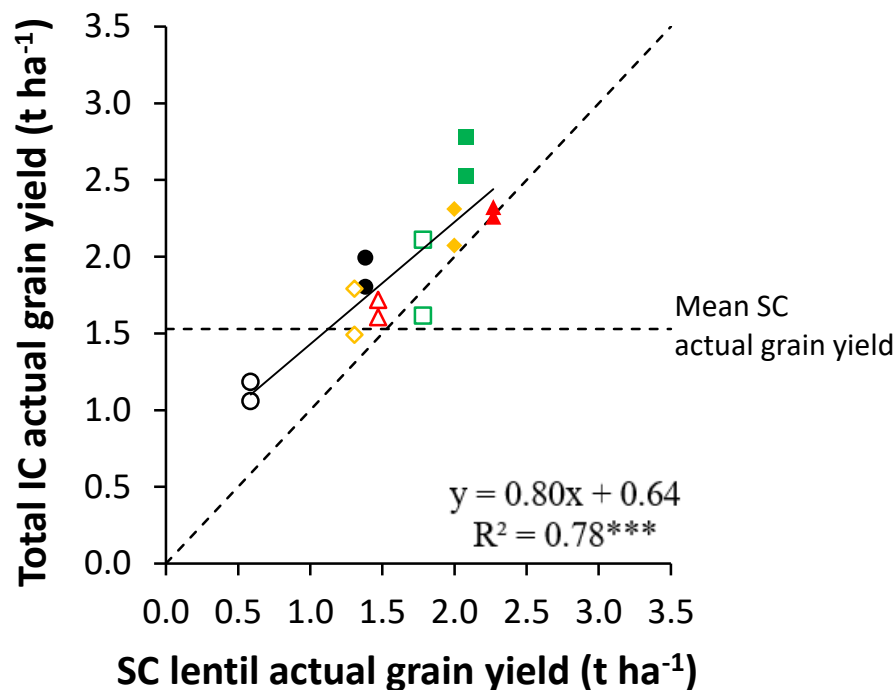
# Yield gap concept

(adapted from Evans 1993 and Van Ittersum et al. 2013)





# Effect of intercrops (IC) on actual grain yields



- Anicia-green 2015
- Anicia-green 2016
- Beluga-black 2015
- ▲ Beluga-black 2016
- ◇ Flora-yellow 2015
- ◆ Flora-yellow 2016
- △ Rosana-red 2015
- ▲ Rosana-red 2016

- Total IC actual grain yield > lentil SC  
→ **Complementary use of resources, notably N**
- Lentil IC actual grain yield < lentil SC  
→ **Strong competition of wheat over lentil**
- **Effect on actual gross margins ?**



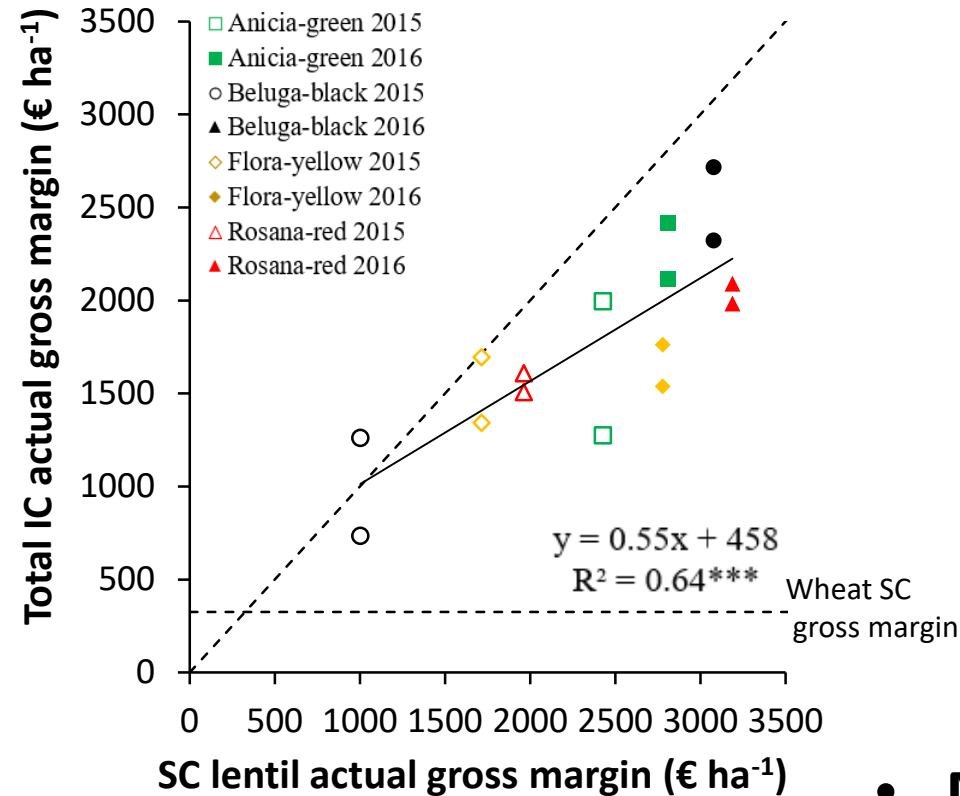
# Effect of intercrops (IC) on actual gross margins

- Total IC gross margin < lentil SC

→ IC are less profitable than lentil SC

→ Lentil determines IC gross margins

➤ Lentil price = 4 × wheat price

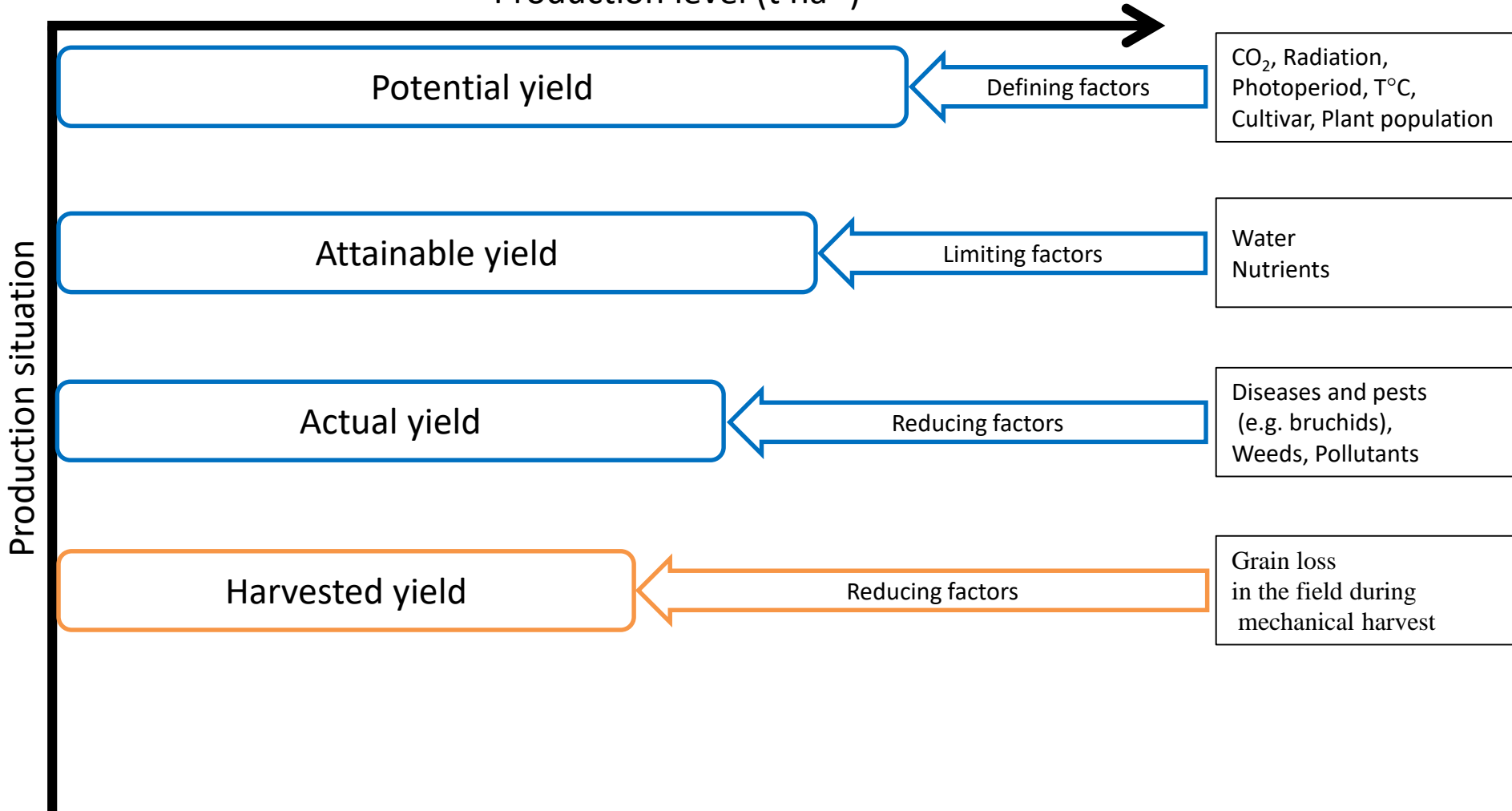


- Mechanical harvest efficiency ?

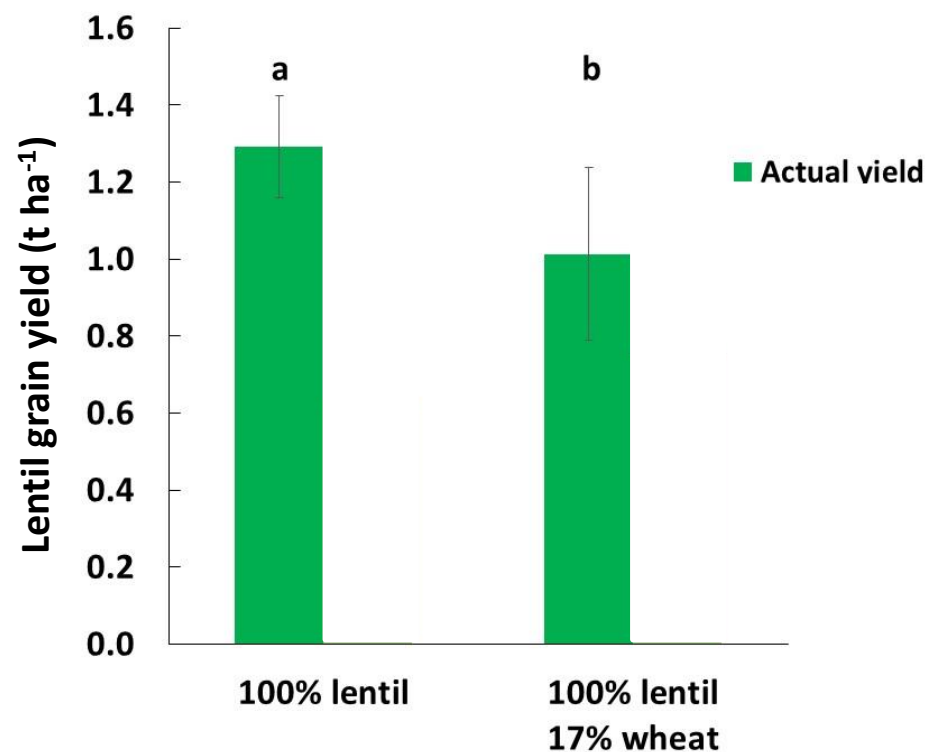


# Yield gap concept (adaptation Viguiet et al. 2018)

Production level (t ha<sup>-1</sup>)



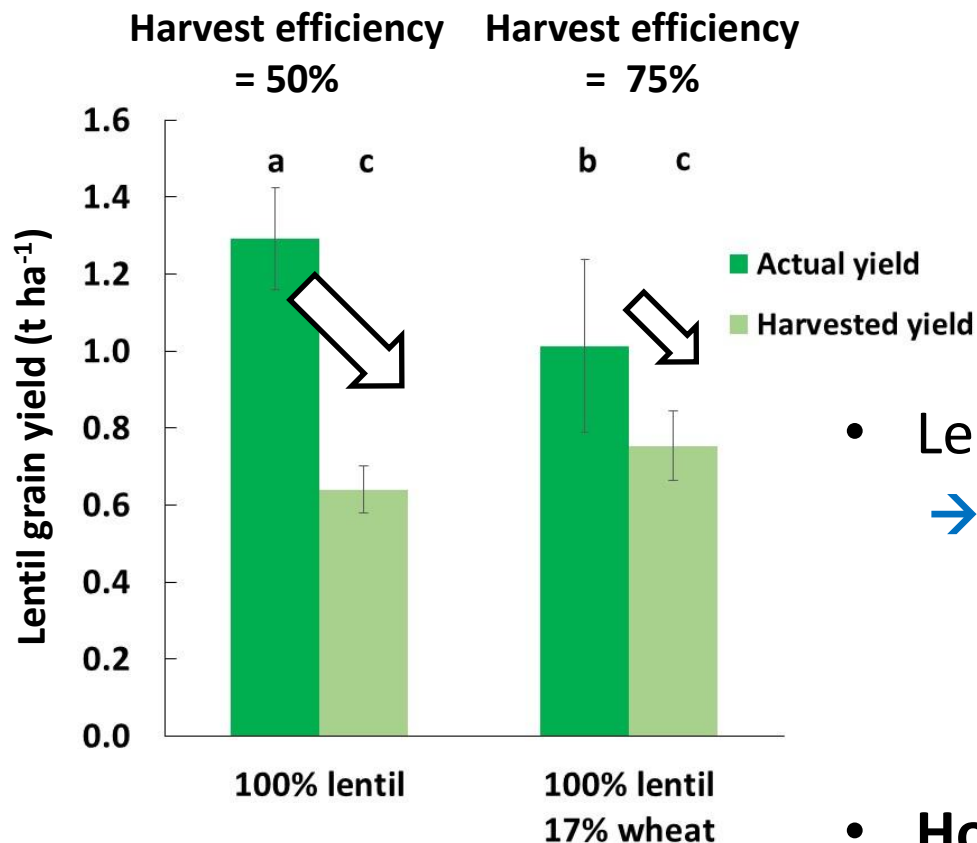
# Effect of intercrops (IC) on lentil harvest efficiency



# Effect of intercrops (IC) on lentil harvest efficiency



Mechanical harvest at INRA in 2016



- Lentil IC harvested yield = lentil SC  
→ Importance of considering harvest losses
- How to explain harvest efficiency ?





# Effect of intercrops (IC) on lentil harvest efficiency



Intercrop lentil at harvest

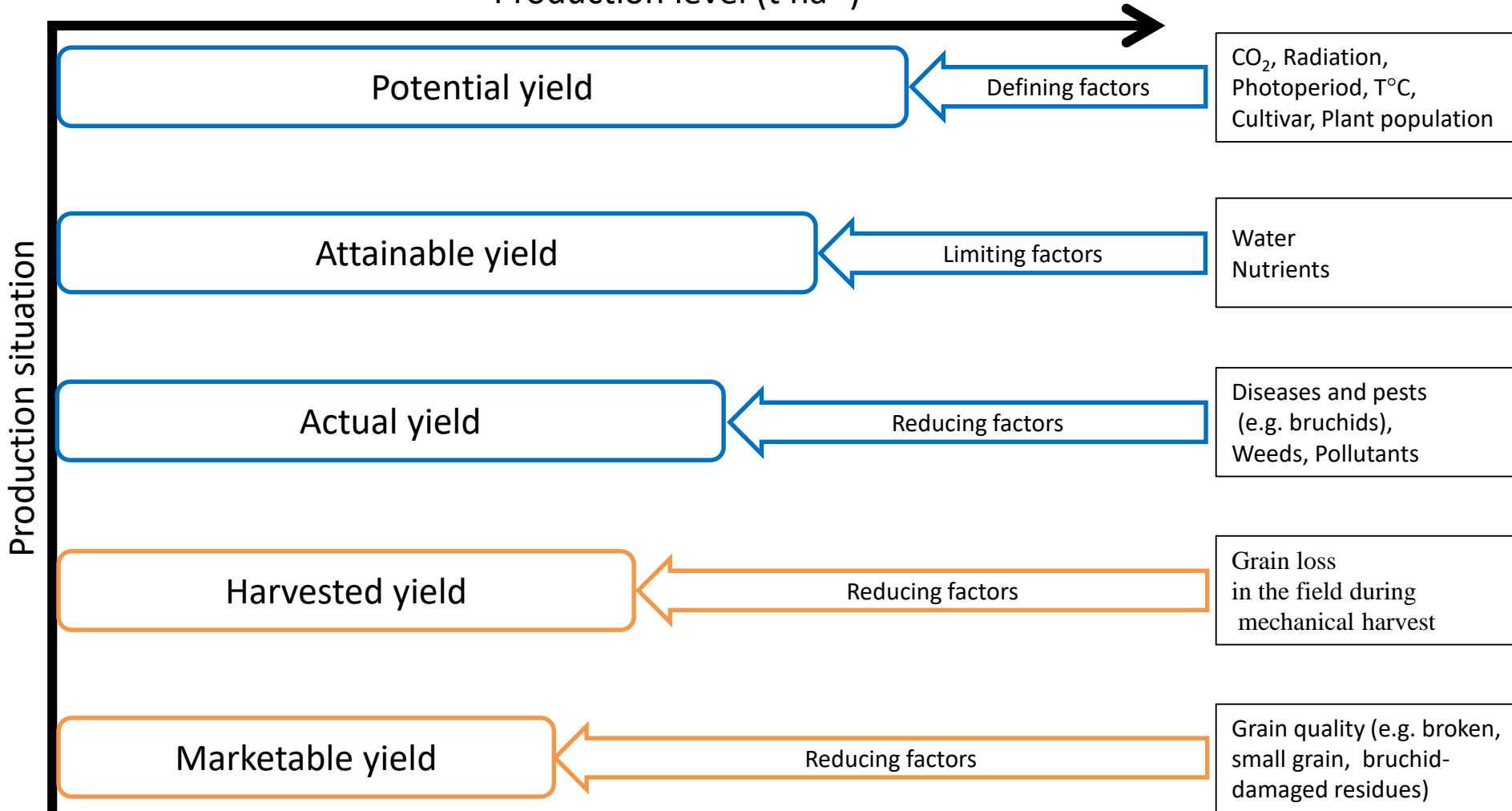


Sole crop lentil at harvest

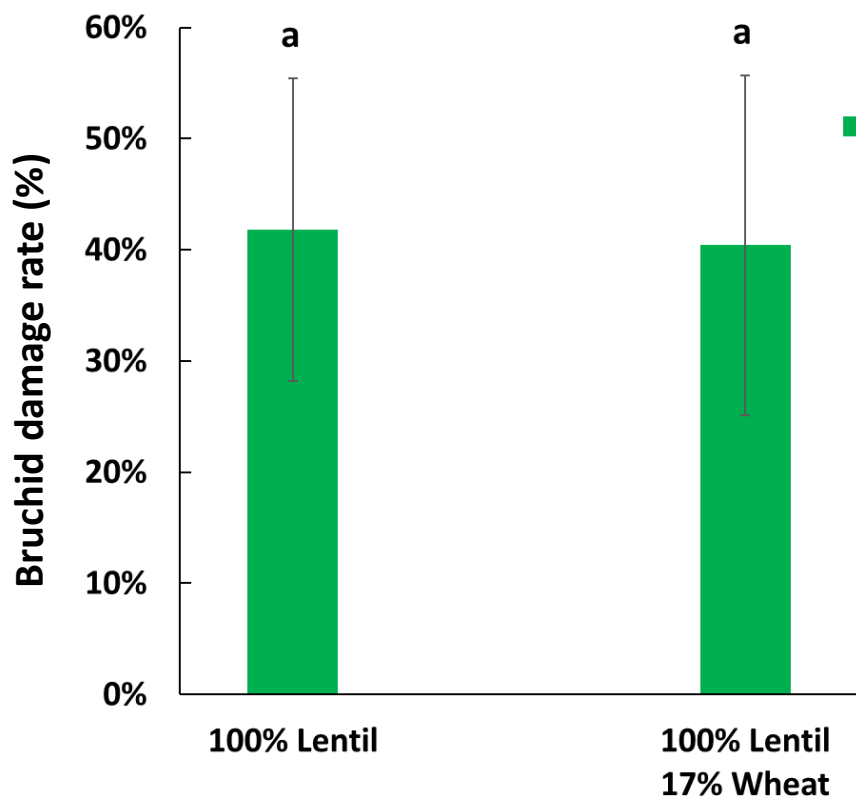
- Lentil IC lowest pod height > lentil SC  
→ Stake effect from wheat

# Yield gap concept (adaptation Viguiet et al. 2018)

Production level (t ha<sup>-1</sup>)



# Effect of intercrops (IC) on bruchid damage rate

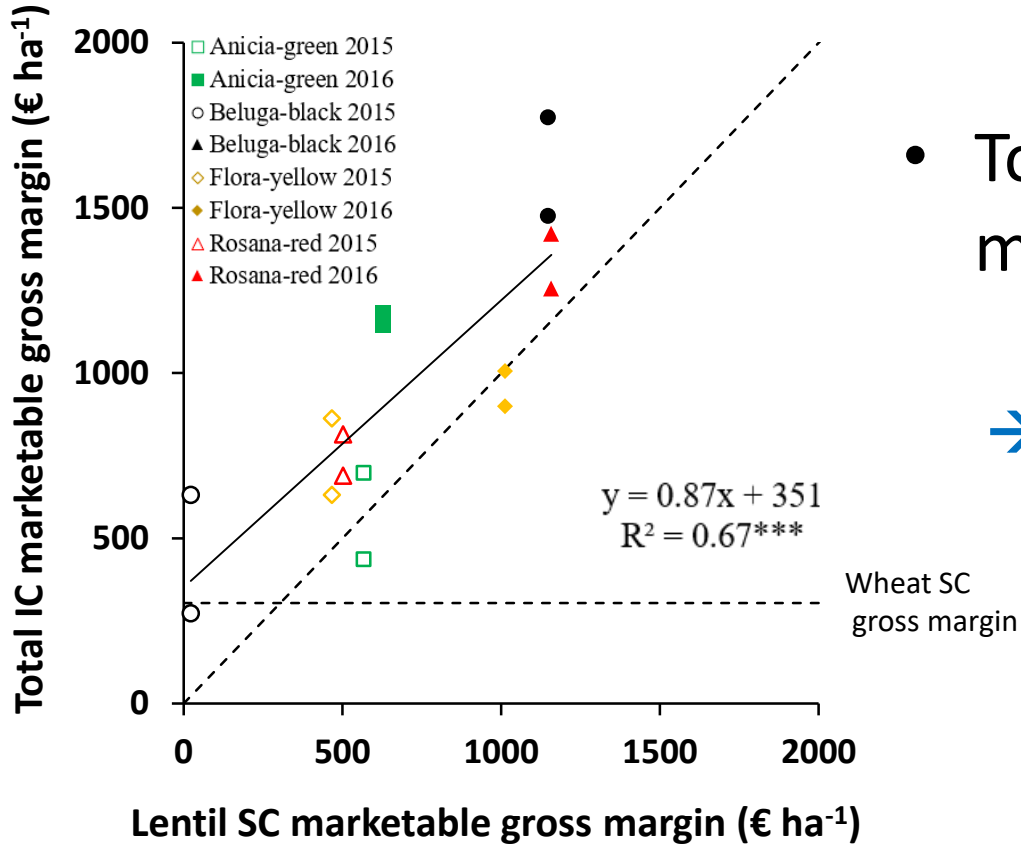


■ Lentil

- No effect of IC on bruchids  
→ IC not a lever to lower bruchids
- Important impact of bruchids
- Effect of year and lentil cultivar  
→ Trial not designed for such study



# Effect of intercrops (IC) on marketable gross margins



- Total IC marketable gross margin > lentil SC

→ IC is an insurance and a bonus



# Conclusions

- Intercropping lentil with wheat
  - **Lowers lentil lodging**
  - **Has no effect on bruchid damages**
- Economic analysis
  - **Should consider marketable yield**
  - **Indicates lentil crop is currently far from optimum**





# Thanks for your attention

- For more information:  
→ **Agron. Sustain. Dev. (2018)**

Agronomy for Sustainable Development (2018) 38:39  
<https://doi.org/10.1007/s13593-018-0515-5>

RESEARCH ARTICLE



Yield gap analysis extended to marketable grain reveals the profitability of organic lentil-spring wheat intercrops

Viguière Loïc<sup>1,2</sup> · Bedoussac Laurent<sup>3</sup>  · Joumet Etienne-Pascal<sup>1,4</sup> · Justes Eric<sup>1,5</sup>

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