



Reduced herbicide use does not increase crop yield loss if compensated by alternative measures



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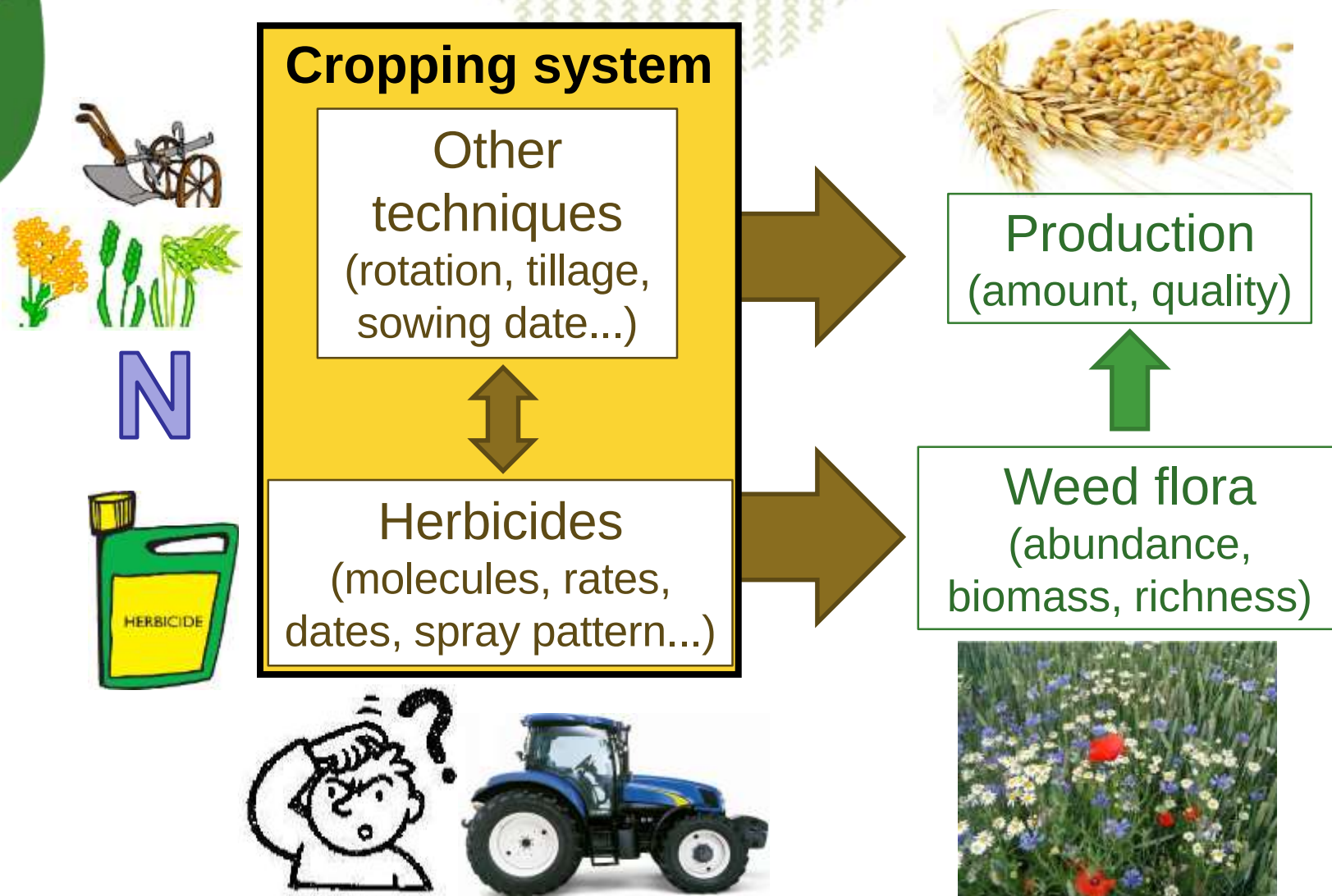
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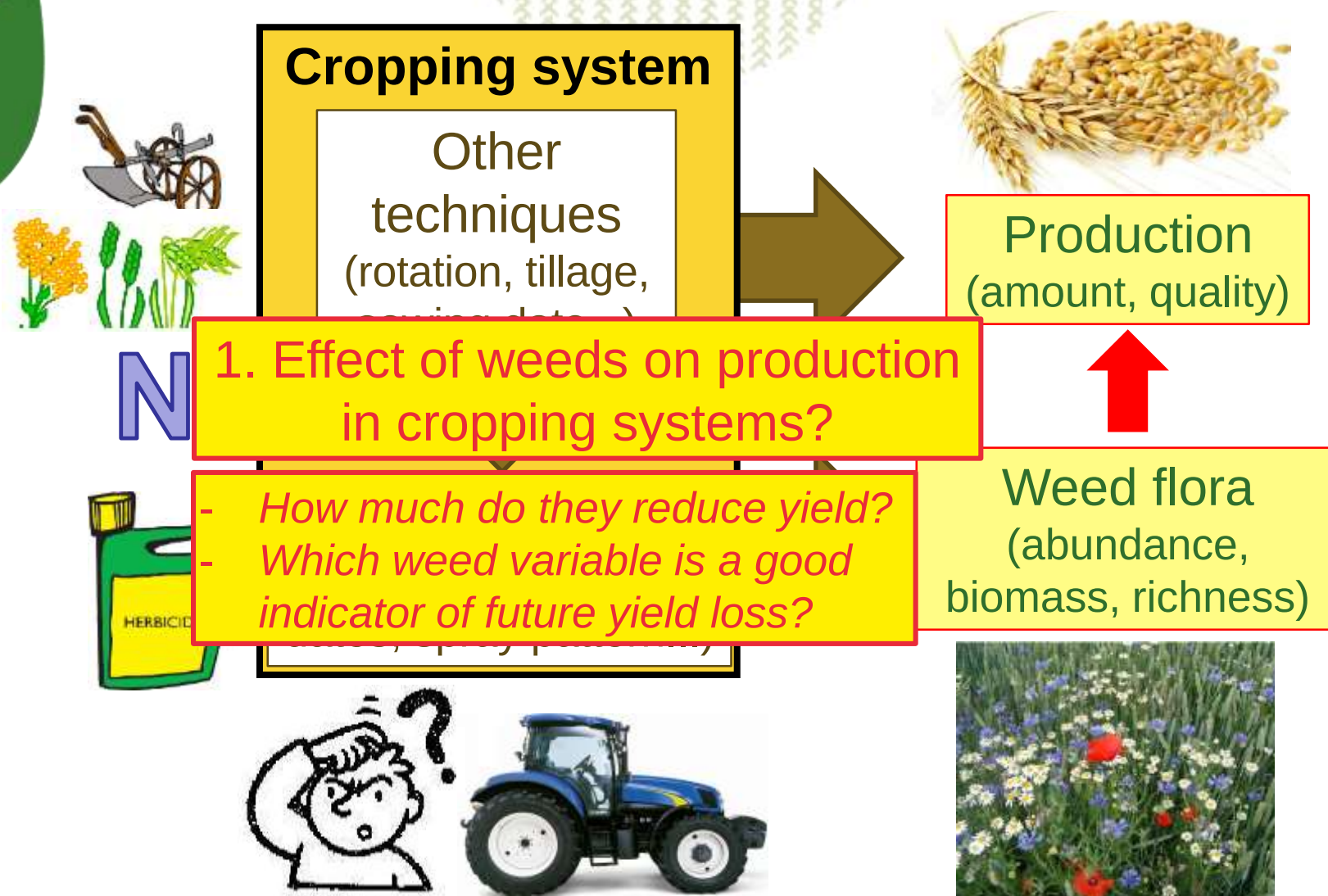
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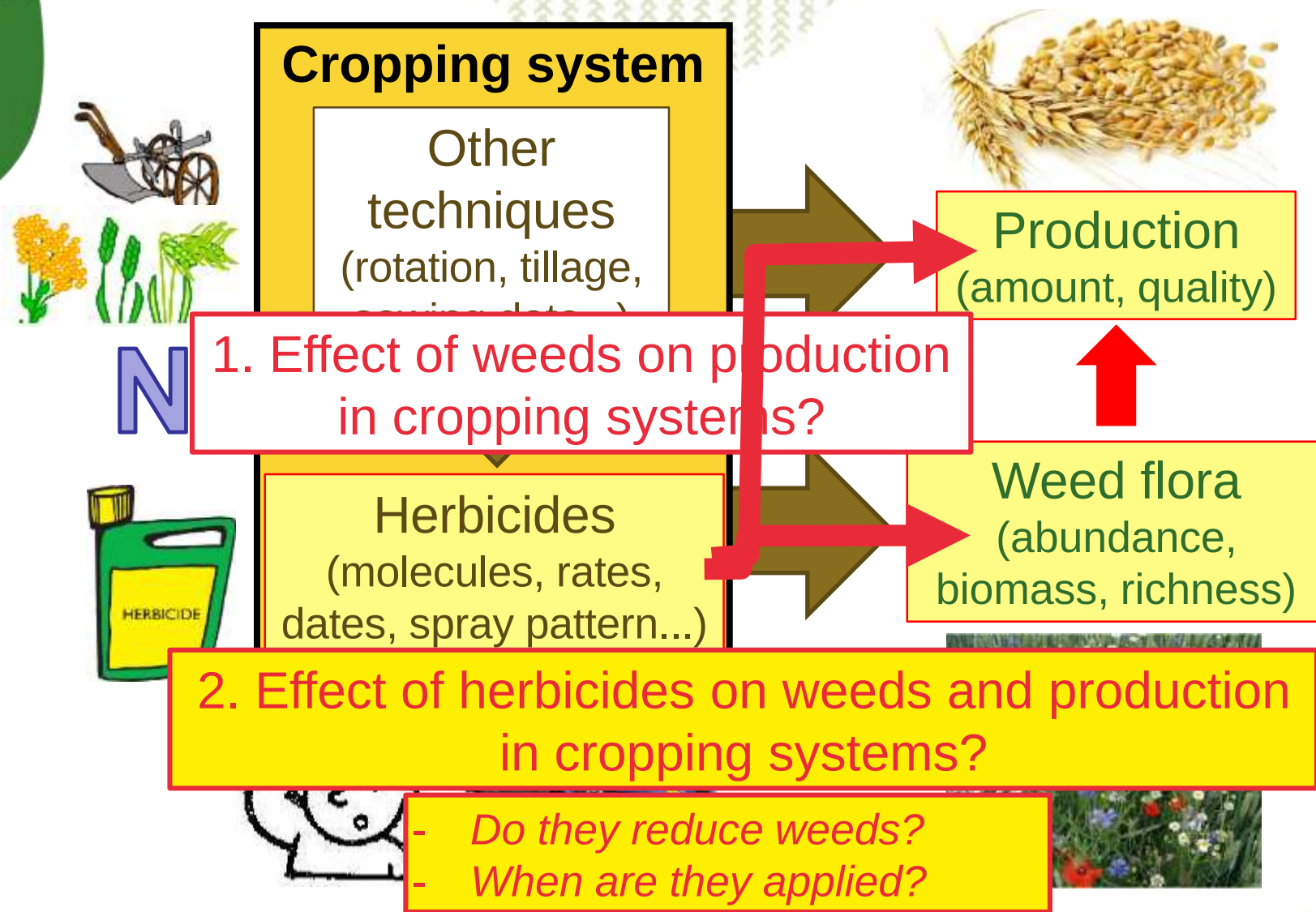
Context and objectives



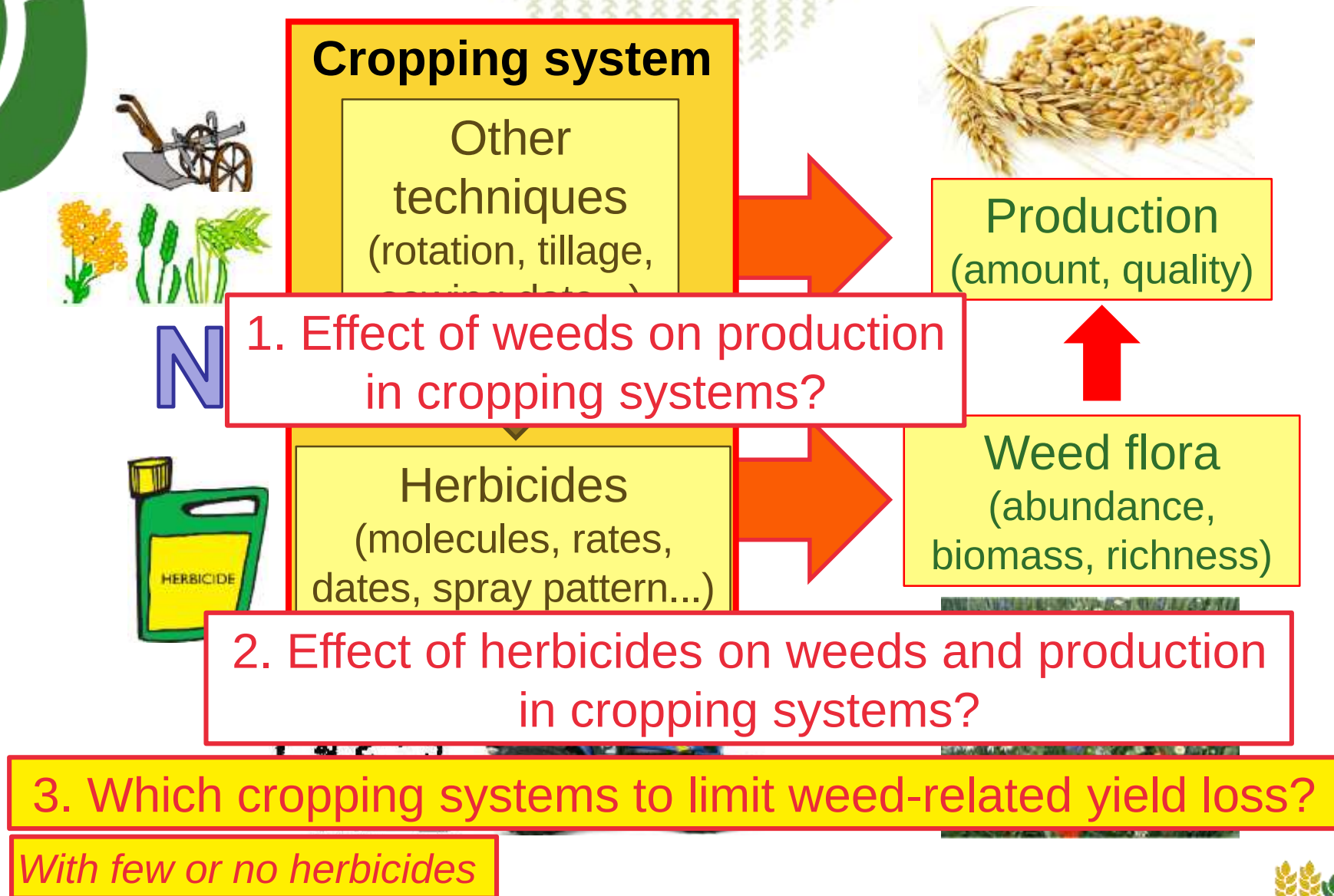
Context and objectives



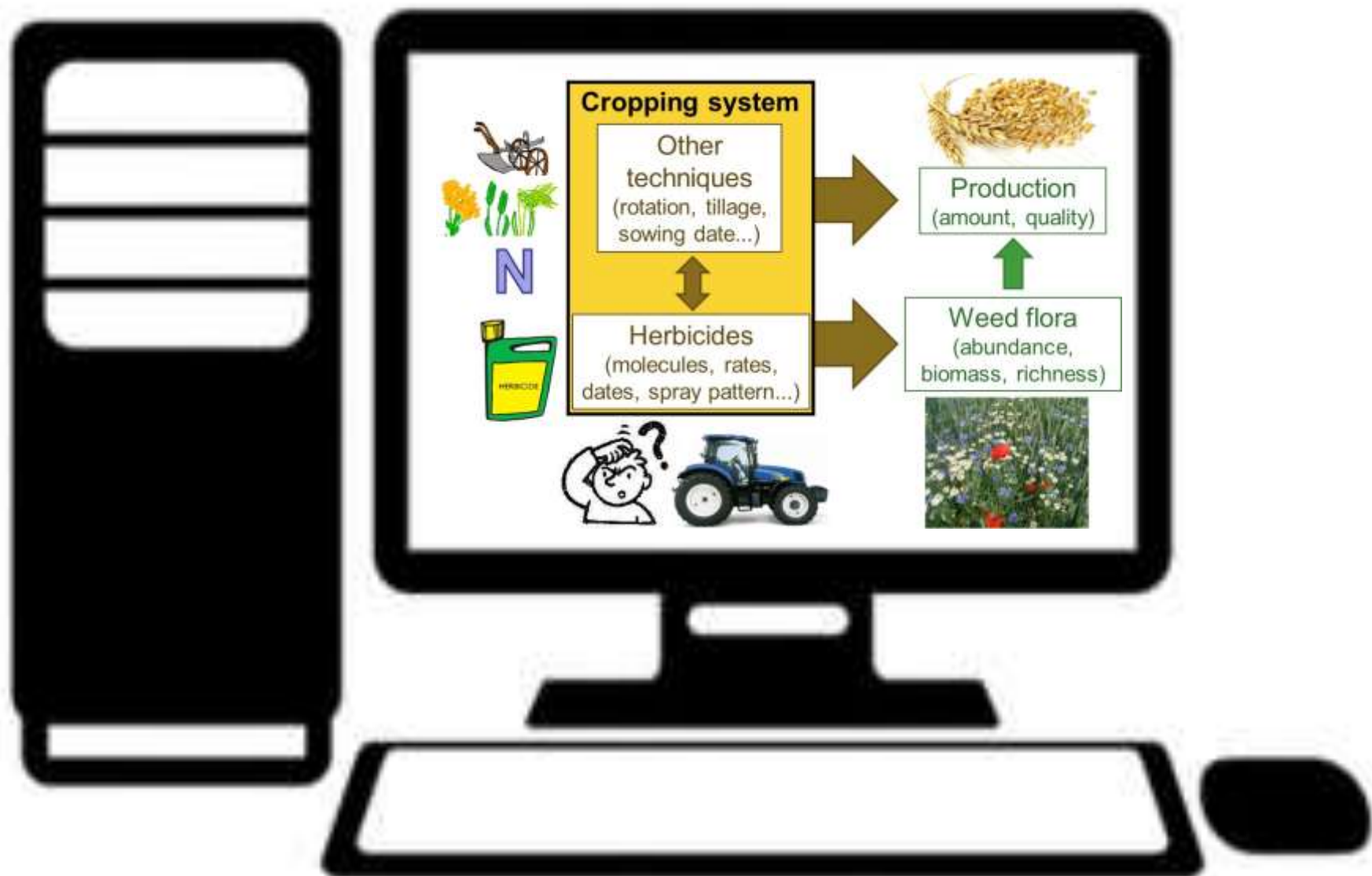
Context and objectives



Context and objectives



Context and objectives



Material and methods: virtual experiments

Identify farmers' practices

272 cropping systems

7 regions

Surveys, Biovigilance, advisors, design...



3. Virtual experiments

Identify farmers' practices

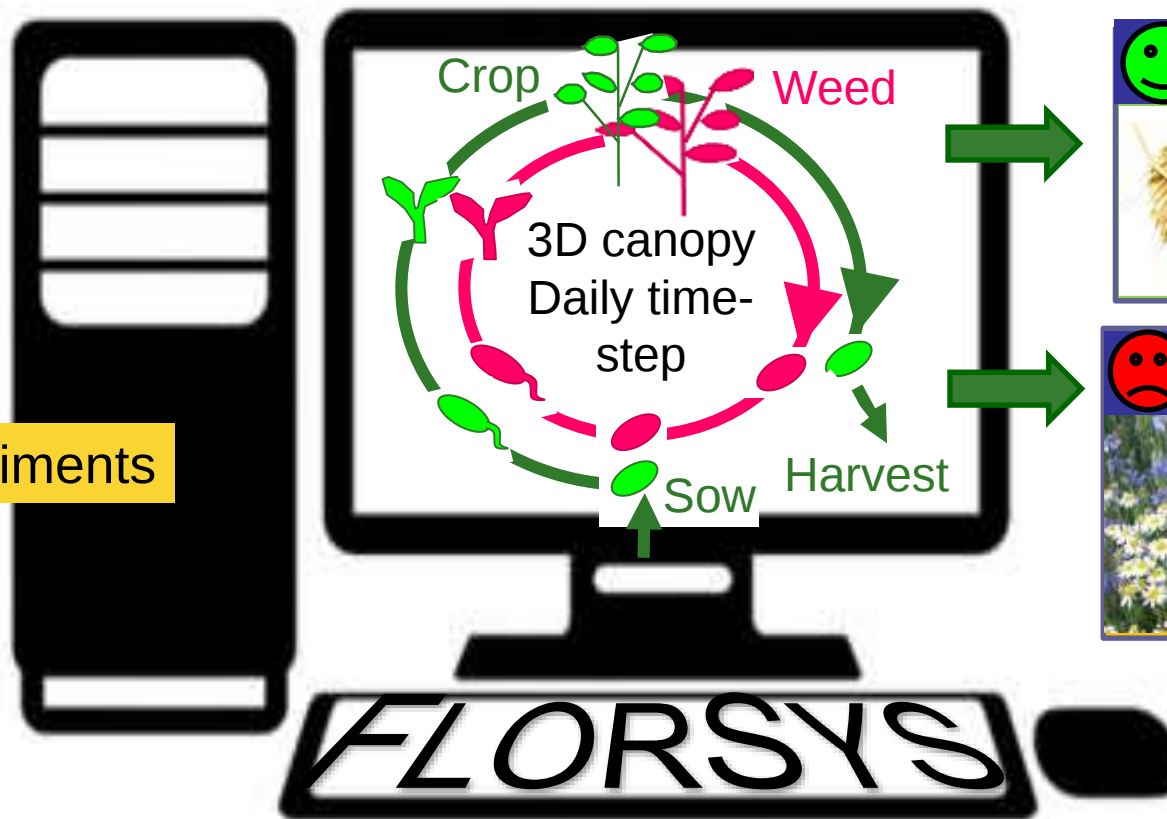
272 cropping systems

7 regions

Surveys, Biovigilance, advisors, design...



Virtual experiments



Colbach et al (2006, 2010, 2014) Eur J Agron, Colbach et al (2007) Ecol Mod; Colbach et al. (2014) Soil Till Res; Weed Res; Colbach et al (2017) Ecol Indic; Gardarin et al. (2012) Ecol Mod; Munier-Jolain et al (2013) Ecol Mod, (2014) Field Crops Res; Mézière et al 2015 Ecol Indi

3. Virtual experiments

Identify farmers' practices

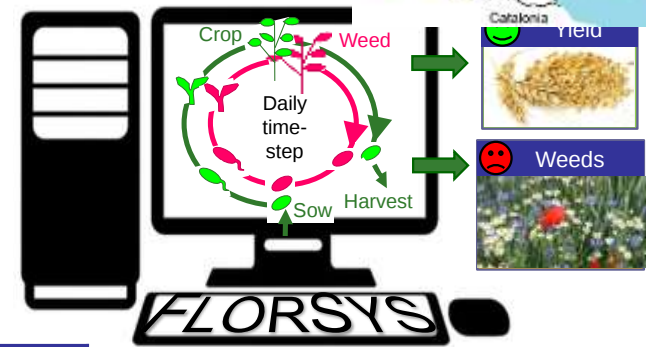
272 cropping systems

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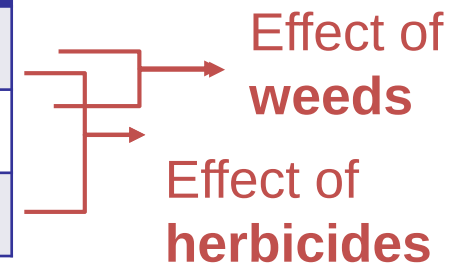
Surveys, Biovigilance, advisors, design...



Virtual experiments



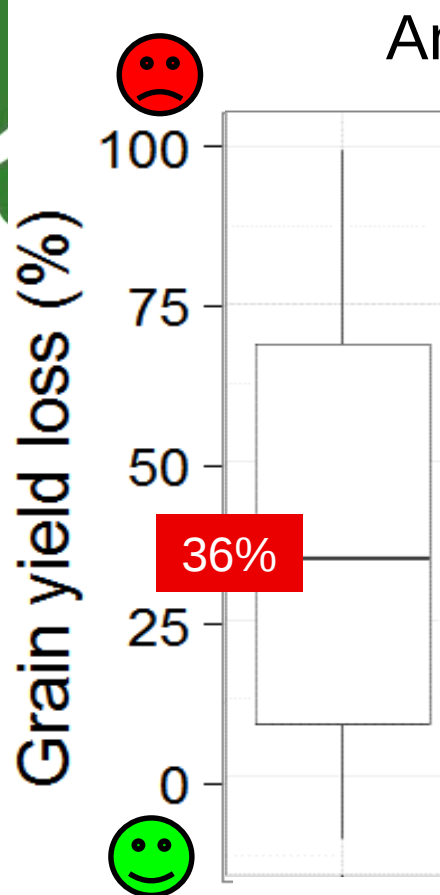
Scenario	Herbicide	Weeds
Reference	Farmers' practices	Regional flora
Weed-free	Farmers' practices	None
Herbicide-free	None	Regional flora



Simulation plan (30 years x 10 weather repetitions)

(Colbach & Cordeau 2018 EJA)

Weeds reduce crop production



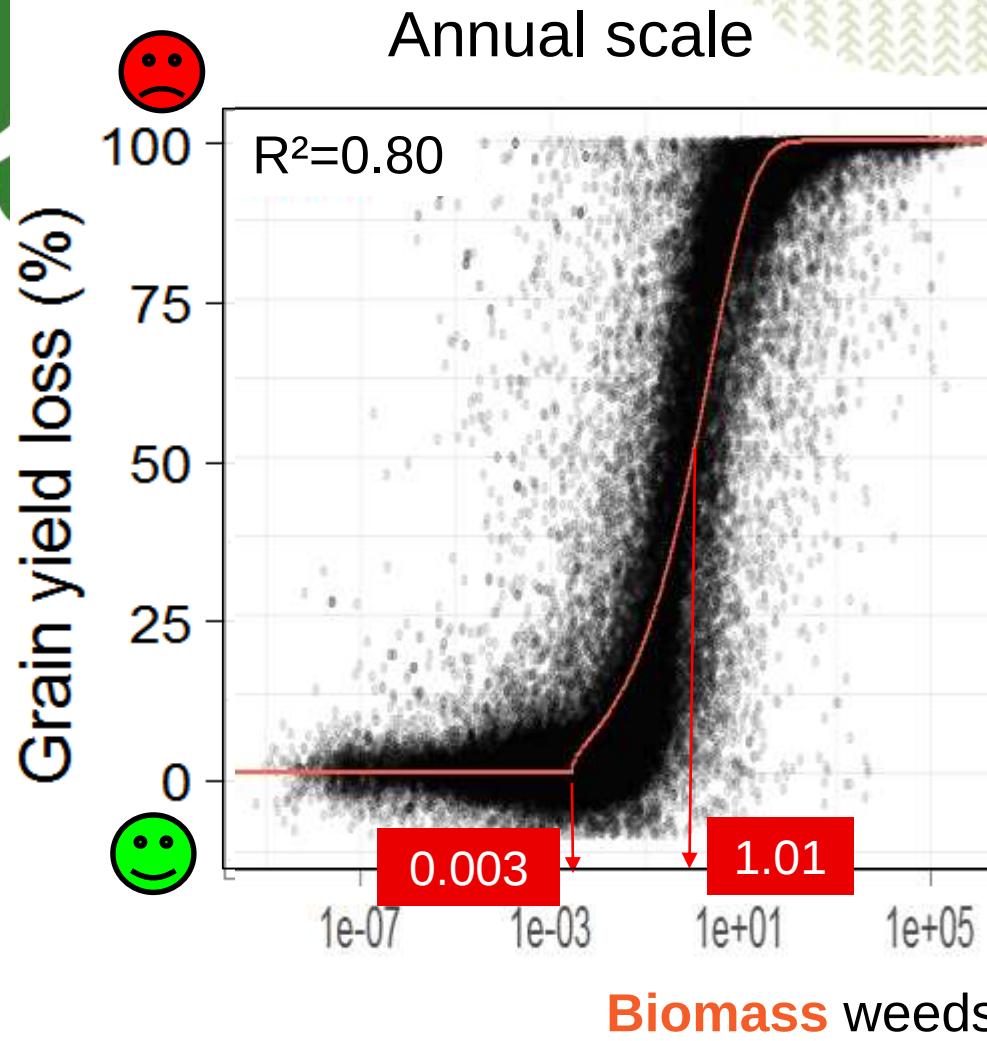
→ Yields loss >> 0

$$\text{Yield loss (\%)} = \frac{100 (\text{Yield without weeds} - \text{yield with weeds})}{\text{Yield without weeds}}$$

(Colbach & Cordeau 2018 EJA)



Yield loss is linked to weed biomass



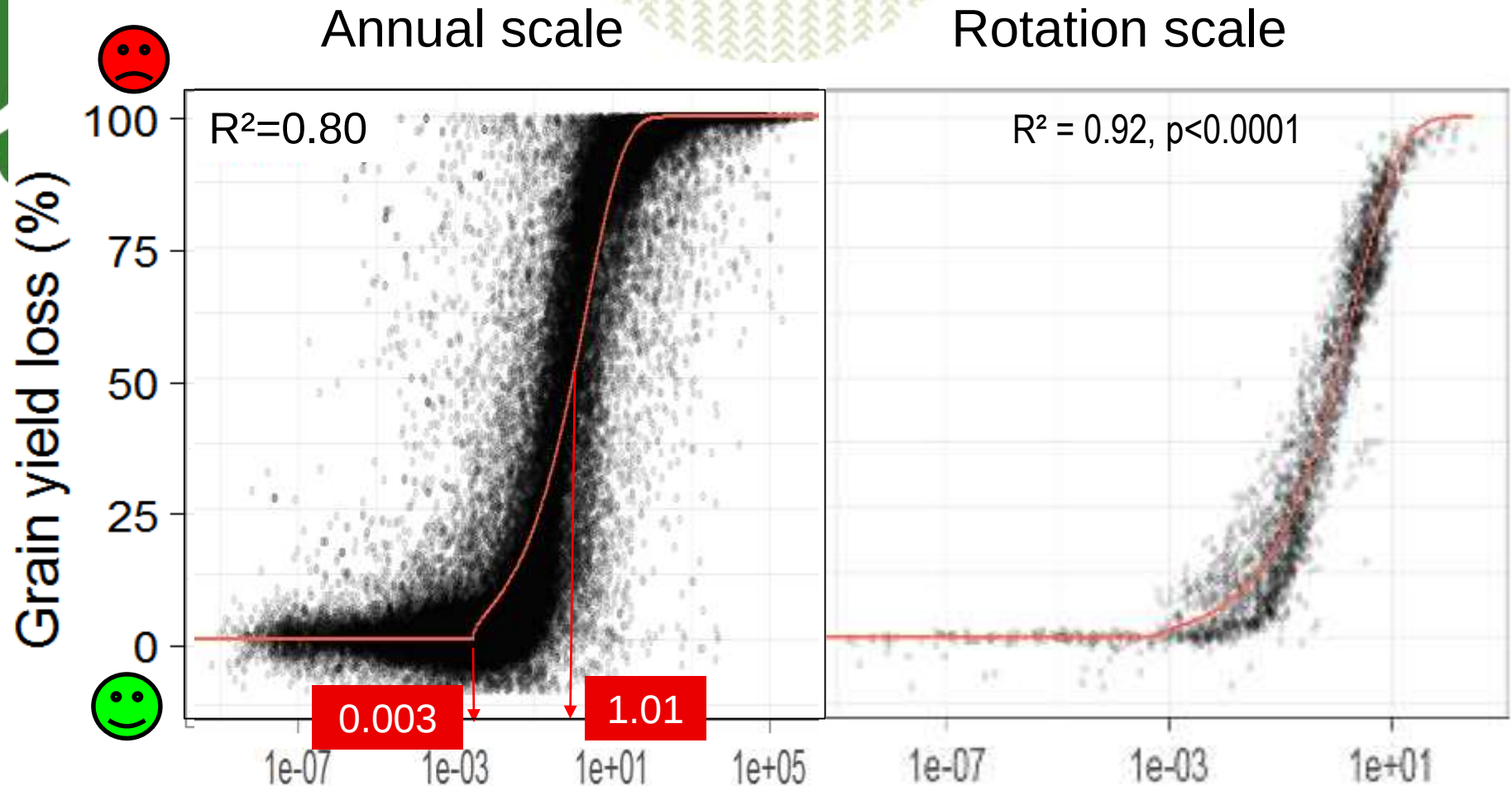
→ Linked to weed biomass (~~density~~)

Yield loss > 0
if weed biomass >
0.003 crop biomass

(Colbach & Cordeau 2018 EJA)



Yield loss is linked to weed biomass



Biomass weeds/crops at flowering(g/g)

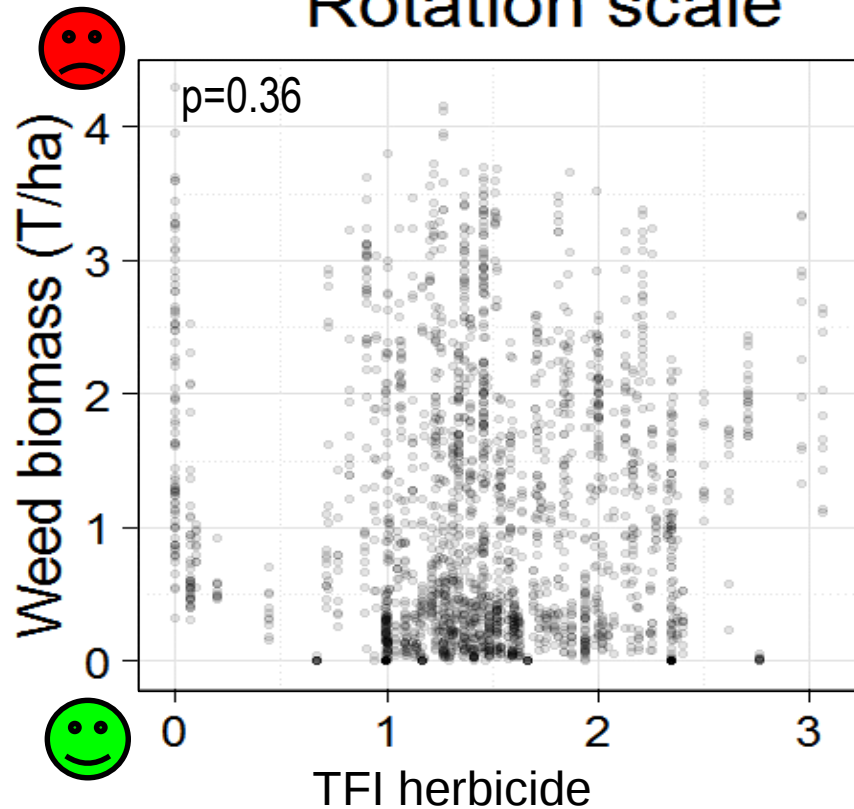
→ + visible at rotation vs annual scale

(Colbach & Cordeau 2018 EJA)



Weeds do not depend on farmers' herbicide use intensity

Rotation scale



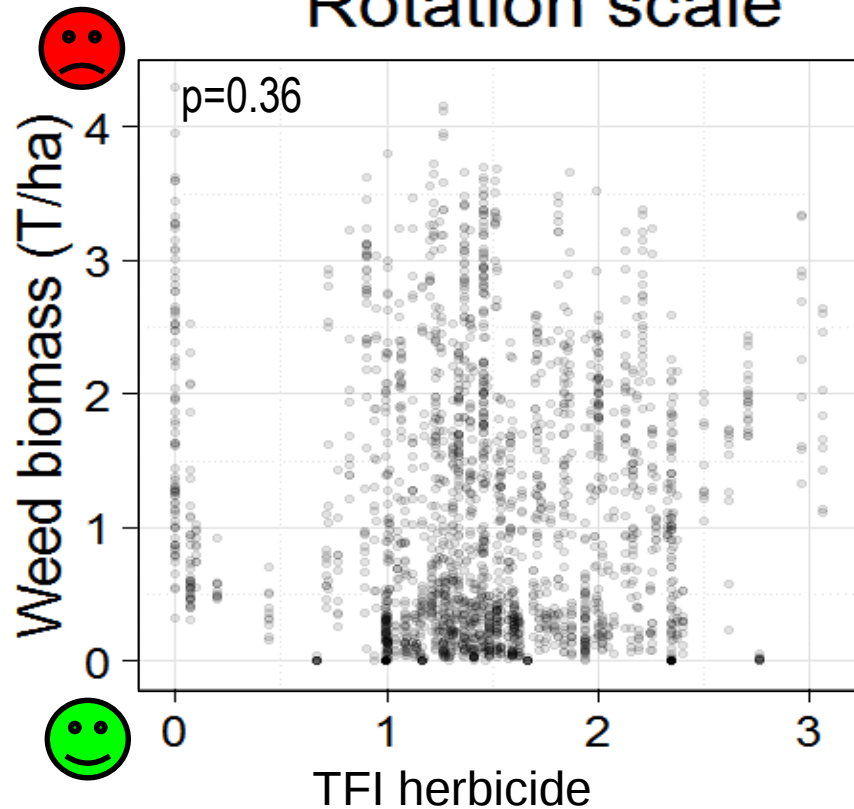
TFI = treatment frequency index
= *number of herbicides at full dosage sprayed over whole field per year*

→ No link with herbicide use intensity

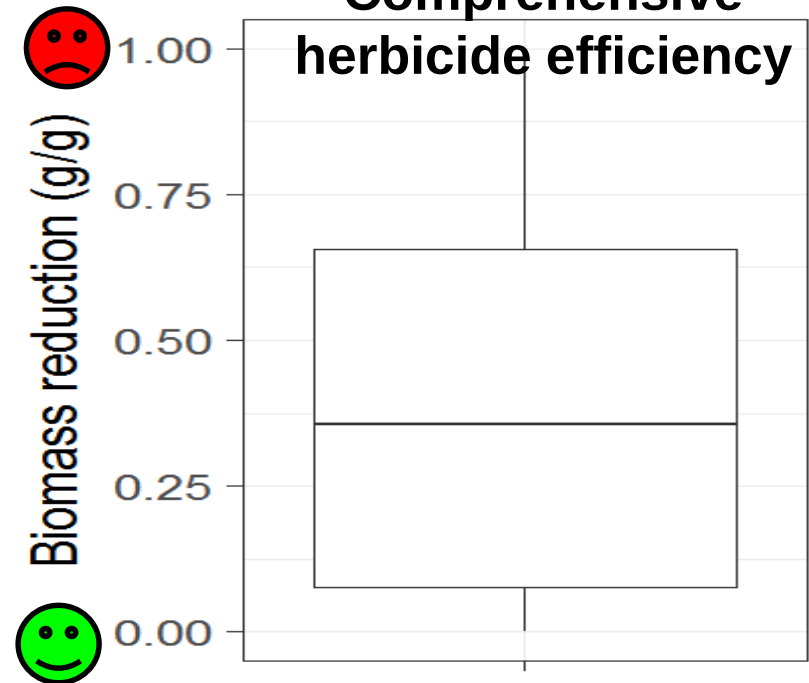
(Colbach & Cordeau 2018 EJA)

Weeds do not depend on farmers' herbicide use intensity

Rotation scale



Comprehensive herbicide efficiency



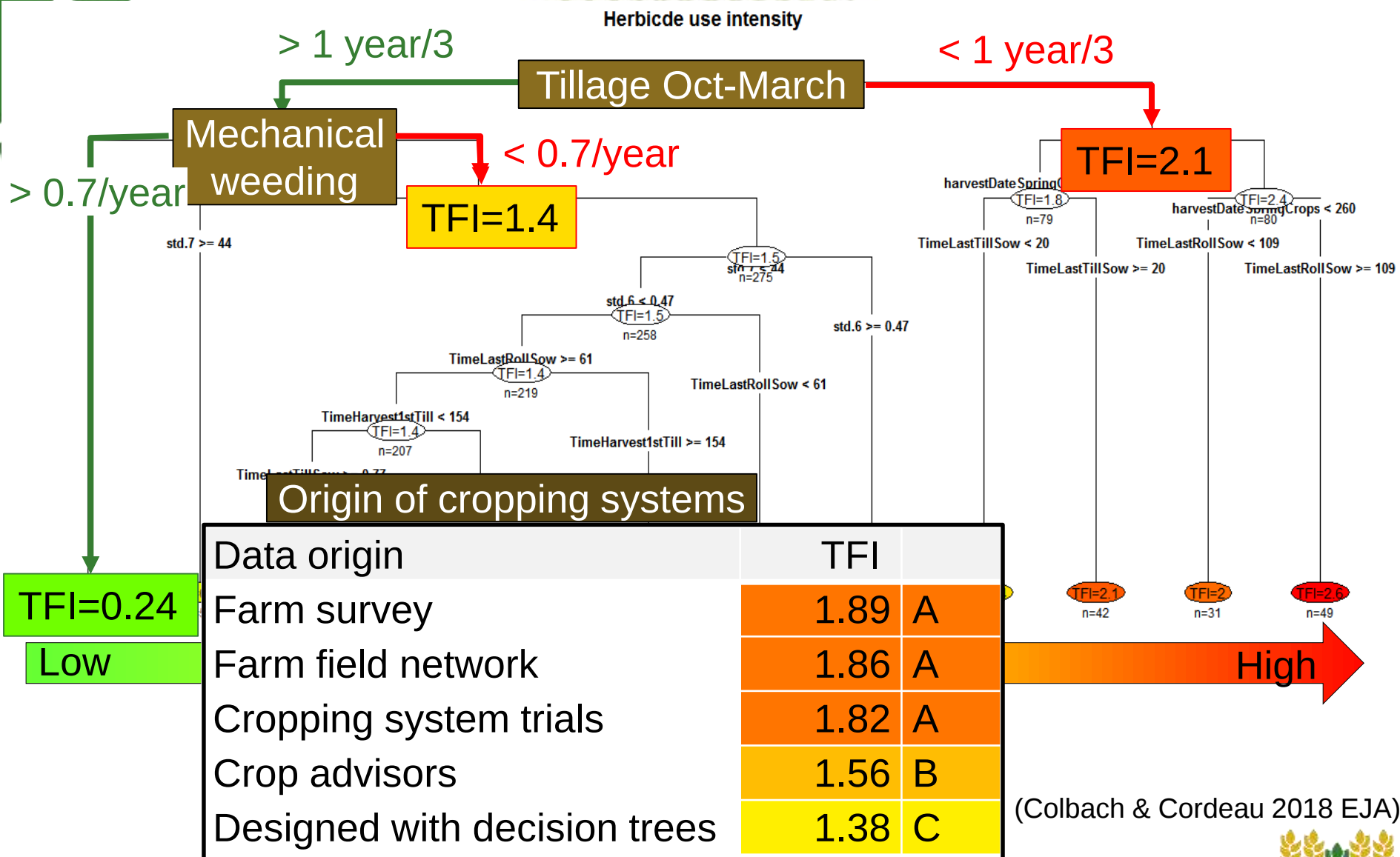
Weeds at flowering – simulations with vs. without herbicides with same weed flora before the herbicide treatment

- No link with herbicide use intensity
- Even though herbicides are efficient

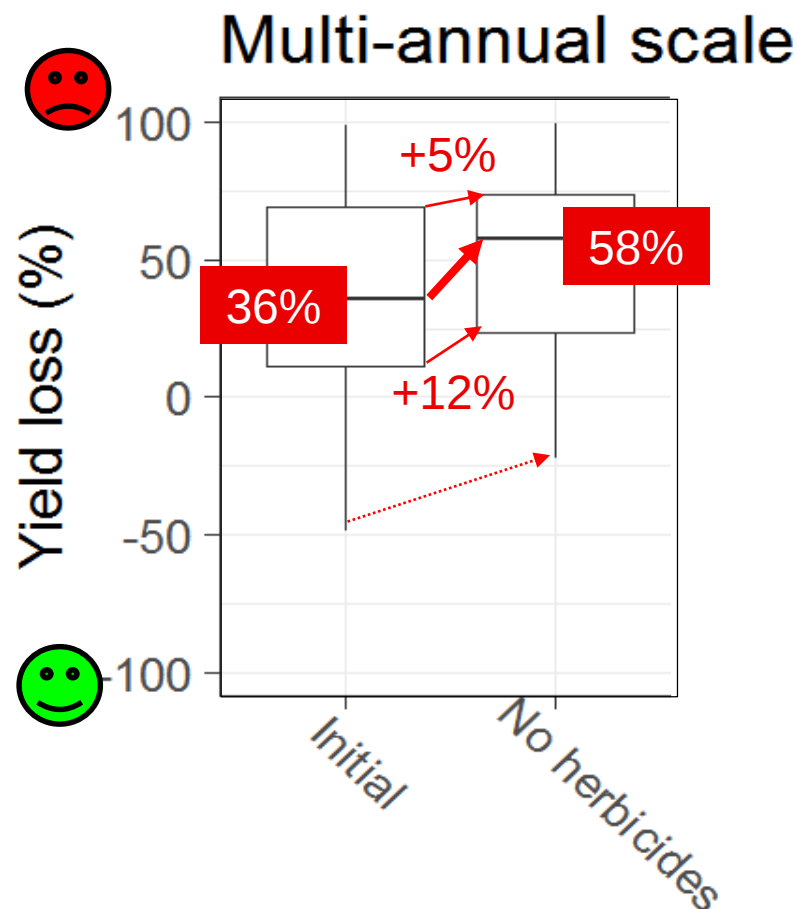
Farmers compensate reduced herbicide use with other measures

(Colbach & Cordeau 2018 EJA)

Herbicide use intensity depends on other practices



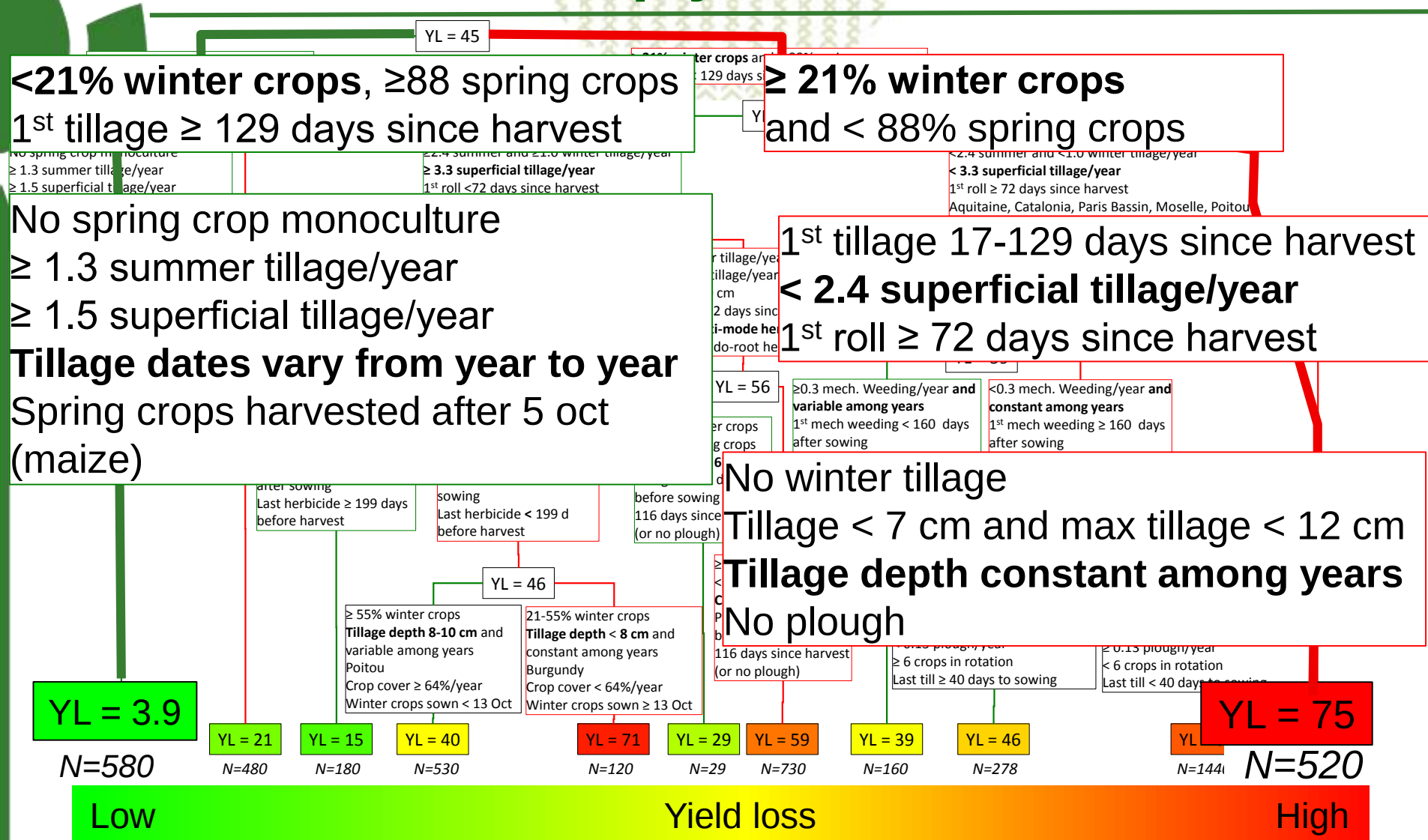
When herbicides are deleted ...



- Loss increases if herbicides taken out without compensation
- + visible at rotation vs annual scale

(Colbach & Cordeau 2018 EJA)

How to reduce crop yield loss?



(Colbach & Cordeau 2018 EJA)



Conclusion

Methodology is important to detect weed & herbicide effects

- Scale: rotation >> annual
- Weed state variable: biomass >> density
- Farmers' mental models: a technique is reasoned = f(other techniques)



Implications for weed management

- Weeds ↘ production (quantity and quality)
- Eliminating herbicides ↗ weeds/yield loss if no compensation
- **Weeds/Yield loss can be reduced with few or no herbicides**



Limits

- Model limited to crop:weed competition for light (*but see Moreau*)
- Beneficial weed effects on crop auxiliaries were neglected



Perspectives

- Identify traits driving yield loss (*see Colbach et al*)
- Guidelines for farmers





Thank you for your attention

Colbach N, Cordeau S (2018) Reduced herbicide use does not increase crop yield loss if it is compensated by alternative preventive and curative measures. *Eur J Agron* 94:67-78. doi:<https://doi.org/10.1016/j.eja.2017.12.008>

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Munier-Jolain NM, Guyot SHM, Colbach N (2013) A 3D model for light interception in heterogeneous crop:weed canopies. Model structure and evaluation. *Ecol Modelling* 250:101-110. doi:<http://dx.doi.org/10.1016/j.ecolmodel.2012.10.023>

