



# Herbiscopes: Reducing tillage and herbicide use intensity while limiting weed-related yield loss

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Herbology in Field Crops, Agroscope Changins

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# Swiss policy instruments for pesticide use reduction and implementation of IPM strategies

## “Ecological requirements” (obligation) in the agricultural law

Direct payments require the fulfilment of 9 "ecological requirements" described in the Ordinance on Direct Payments.

- **Diversified crop rotation** : at least 4 different crops with a maximum proportion in the crop rotation

Crops	Cereals	Maïs	Sugarbeet, Rapeseed, Potatoes, Soja, Sunflower	Peas
Maximum proportion in the cropping system	66%	40%	25%	15%

- **Limited choice and targeted use of plant protection products**

⇒ Restriction for pre-emergence herbicides and insecticides.

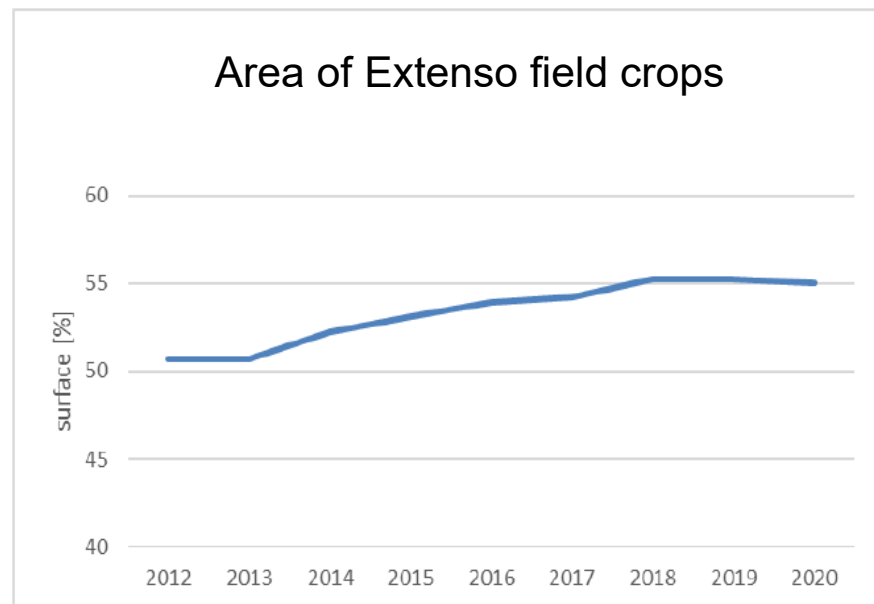
⇒ Consideration of thresholds and recommendations from forecasting and warning services.

## Financial contribution for "extenso" production system on crop scale since 1999 (optional)

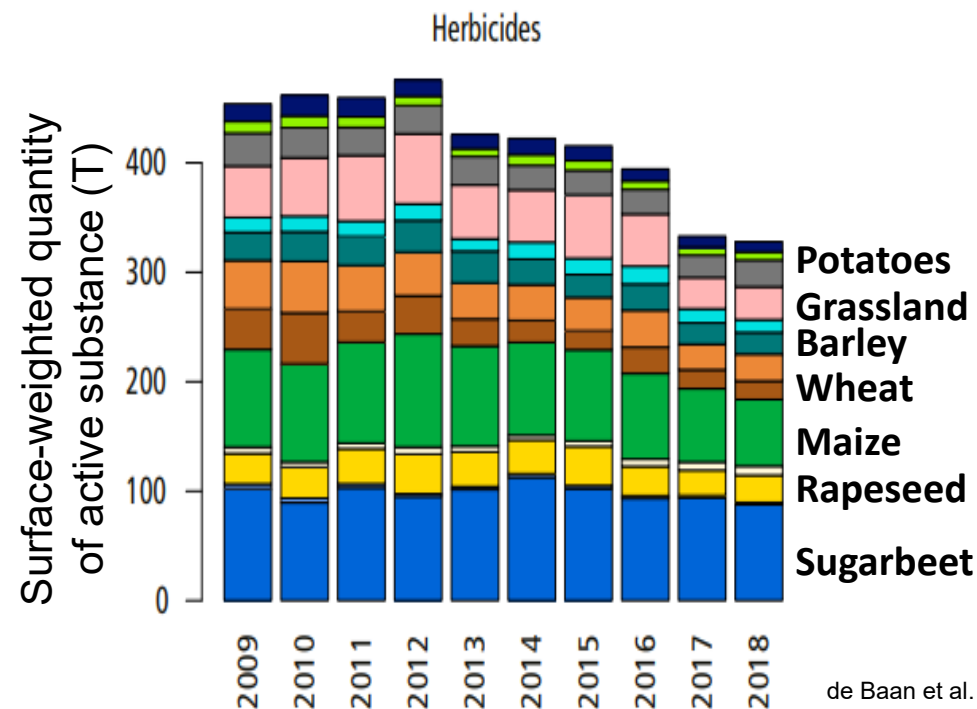
- **No growth regulators, fungicides and insecticides**
- Cereals, rapeseed, peas, faba beans, lupin, sunflowers

# Swiss Extenso program

- No growth regulators, fungicides and insecticides



Félix o., OFAG (2022)



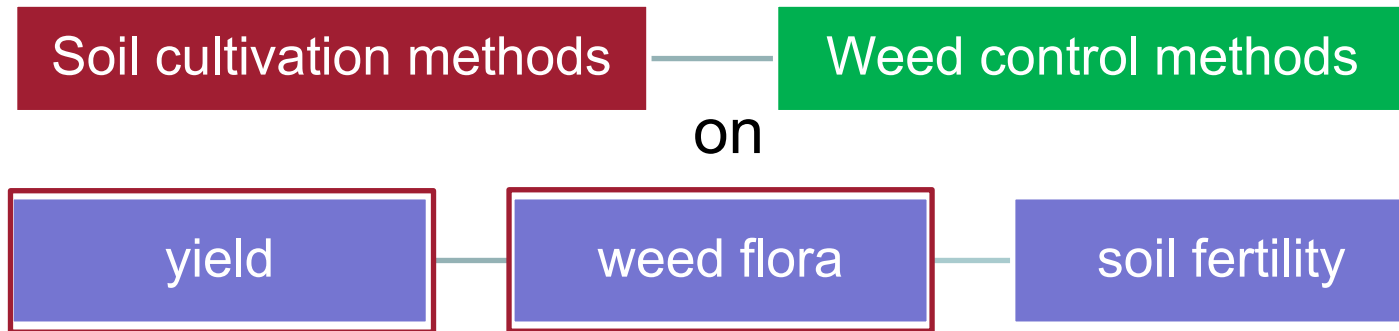
de Baan et al. (2020)

- › Strong reduction of fungicides, insecticides and growth regulators
- › Herbicides are the most applied category in Switzerland



# Herbiscopes: Reducing tillage and herbicide use intensity while limiting weed-related yield loss

Effect of combinations of



- with the aim of **reducing the use of herbicides**
- at the level of a **six-year crop rotation**



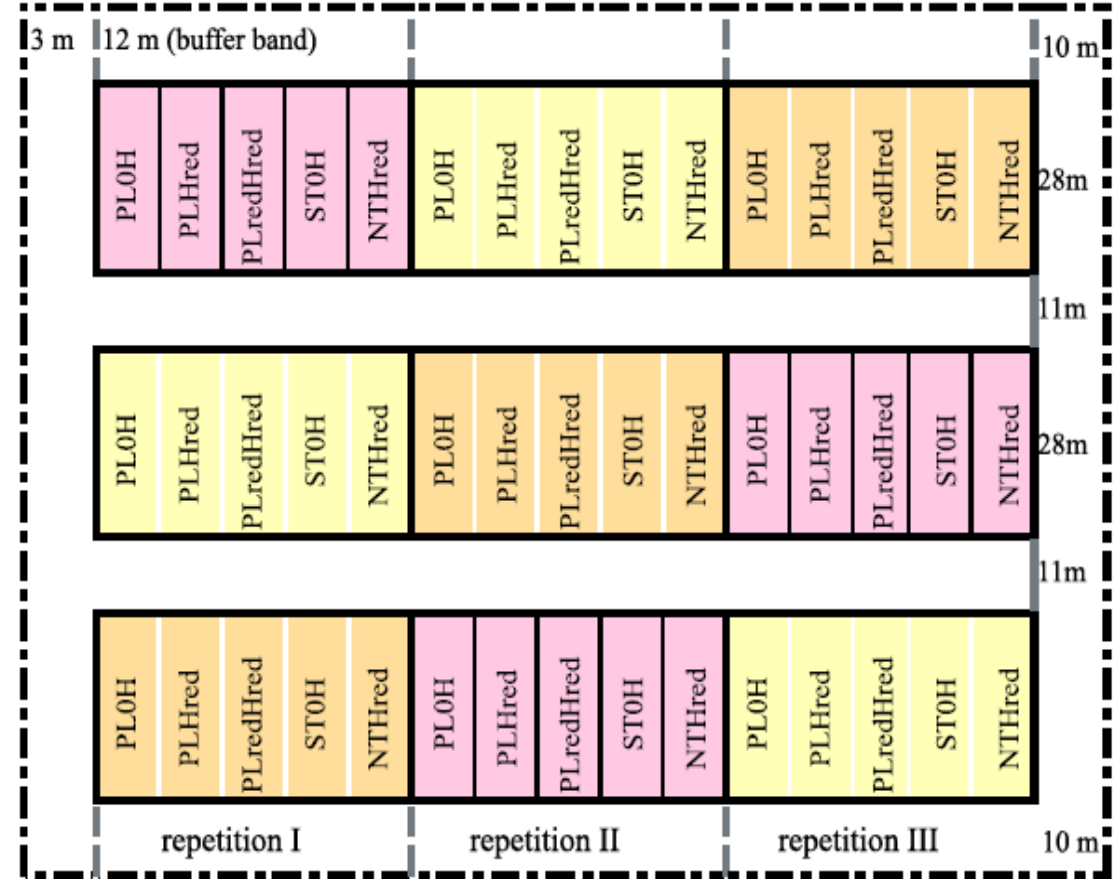
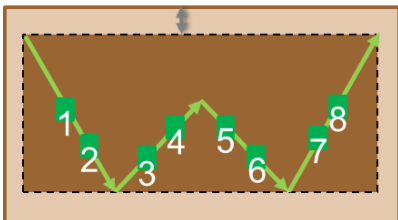


# Five IWM strategies in a field trial

PL_0H	PL_Hred	PLred_Hred	ST_0H	NT_Hred
<ul style="list-style-type: none"> <li>Annual moldboard ploughing</li> <li>no herbicides</li> </ul>	<ul style="list-style-type: none"> <li>Annual moldboard ploughing</li> <li>reduced herbicide use</li> </ul>	<ul style="list-style-type: none"> <li>occasional moldboard ploughing</li> <li>reduced herbicide use</li> </ul>	<ul style="list-style-type: none"> <li>shallow tillage (5-10 cm)</li> <li>no herbicides</li> </ul>	<ul style="list-style-type: none"> <li>no tillage</li> <li>reduced herbicide use</li> </ul>

The IWM strategies are tested in all crops  
 The same strategy remains at the same place over 6 years  
 All other measures are equal (varieties, sowing, fertilization, etc.)

- Weed data collection 4 times per year
- Weed species present
  - Weed density on the plot level (plants/m<sup>2</sup>)
  - Weed biomass per frame (0.25 m<sup>2</sup>)



- A** Wheat (2020)
- B** Wheat (after soybean, 2020)
- C** Wheat (after soybean, 2021 and Barley, 2020)



# Scientific questions and hypotheses

- Depending on the IWM strategies with different combinations of soil cultivation and weed control,
  - are there differences in **crop yield**?
  - is the **weed flora** under control?
  - which **weed control tactics** are necessary?
- Are the results stable over the years?
  - After 1, 2, 3, 4, 5 or 6 years of implementing the measures on the same plot?
  - Does **weed diversity** change over time?



# Results from Winter Wheat (2020 to 2022, Extenso)





# Management tactics in the 5 IWM strategies (Extenso)

Year			Operation	PL_0H		PL_Hred		PLred_Hred		ST_0H		NT_Hred					
2020	2021	2022															
WW			inversion tillage	1		1		1		0		0					
S	WW			1	1	1	1	1	0	0	0	0	0				
WB	S	WW		1	1	1	1	1	1	0	0	0	0	0			
WW			shallow tillage	1		1		1		0		0					
S	WW			1	1	1	1	1	0	1	2	1	0				
WB	S	WW		1	1	1	1	1	1	2	0	1	2	0	0		
WW			harrowing	2		2		0		2		0					
S	WW			4	3	4	2	0	2	4	3	3	0				
WB	S	WW		2	2	5	0	0	1	0	0	3	0	0	1		
WW			herbicide	0		0		1		0		1					
S	WW			0	0	0	1	1	1	0	0	1	1				
WB	S	WW		0	1 <sup>a</sup>	0	1	2	1 <sup>b</sup>	1	2	0	0	1 <sup>a</sup>	0	1	3

Rotary harrow and stubble cultivation

Graminicides

+ glyphosate 2022



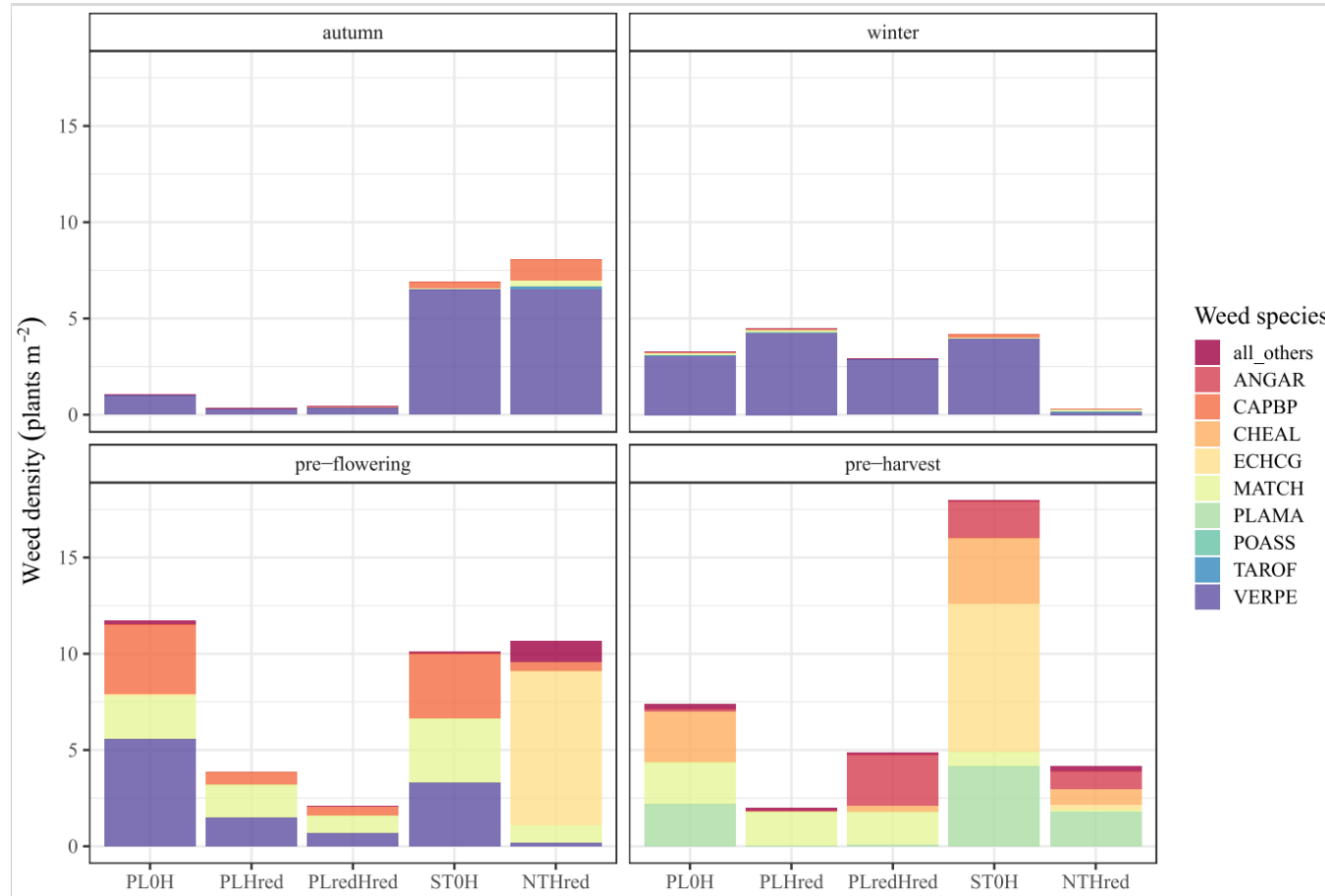
PL_0H	PL_Hred	PLred_Hred	ST_0H	NT_Hred
<ul style="list-style-type: none"> <li>Annual moldboard ploughing</li> <li>no herbicides</li> </ul>	<ul style="list-style-type: none"> <li>Annual moldboard ploughing</li> <li>reduced herbicide use</li> </ul>	<ul style="list-style-type: none"> <li>occasional moldboard ploughing</li> <li>reduced herbicide use</li> </ul>	<ul style="list-style-type: none"> <li>shallow tillage (5-10 cm)</li> <li>no herbicides</li> </ul>	<ul style="list-style-type: none"> <li>no tillage</li> <li>reduced herbicide use</li> </ul>

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# Mean weed density per species in the five IWM strategies after weeding



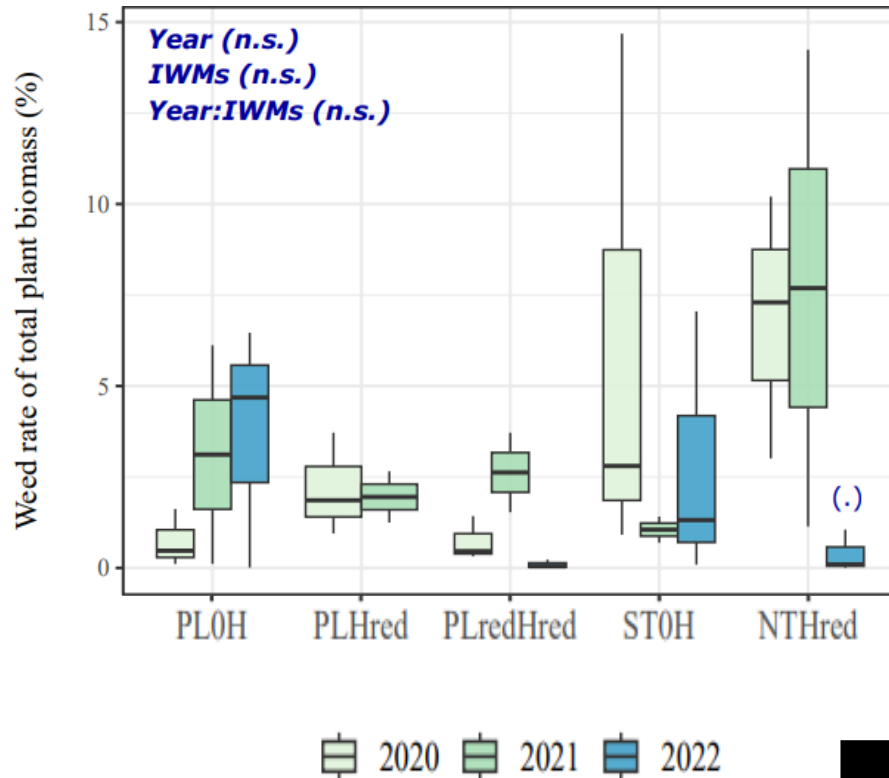
Weed density by species for the 9 most abundant weeds in winter wheat (2020–2022).

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PL_0H	PL_Hred	PLred_Hred	ST_0H	NT_Hred
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# Proportion (in %) of weed biomass in total biomass (above ground) at crop flowering



Low level of weed infestation (median < 8%)  
in all strategies

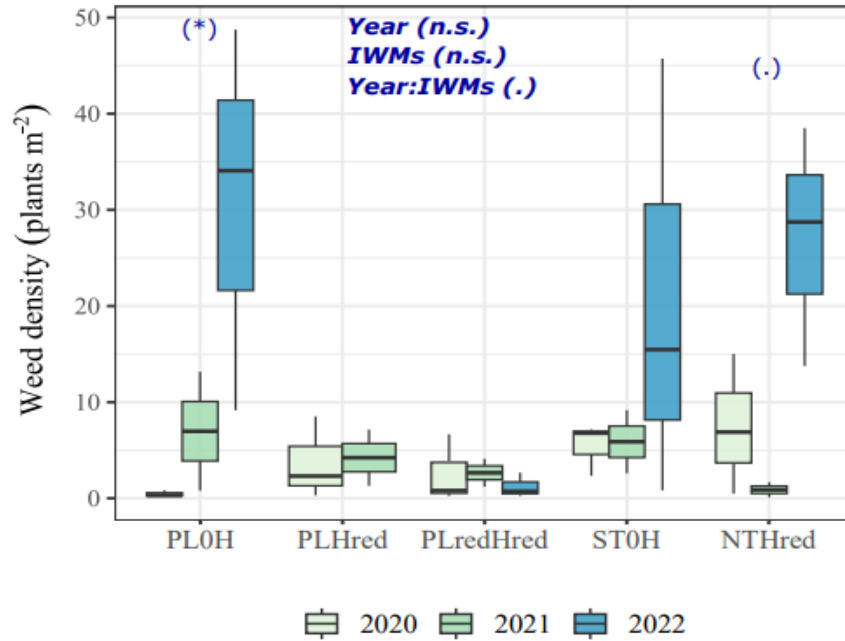
No significant difference between the IWM  
strategies

→ weed control was always effective

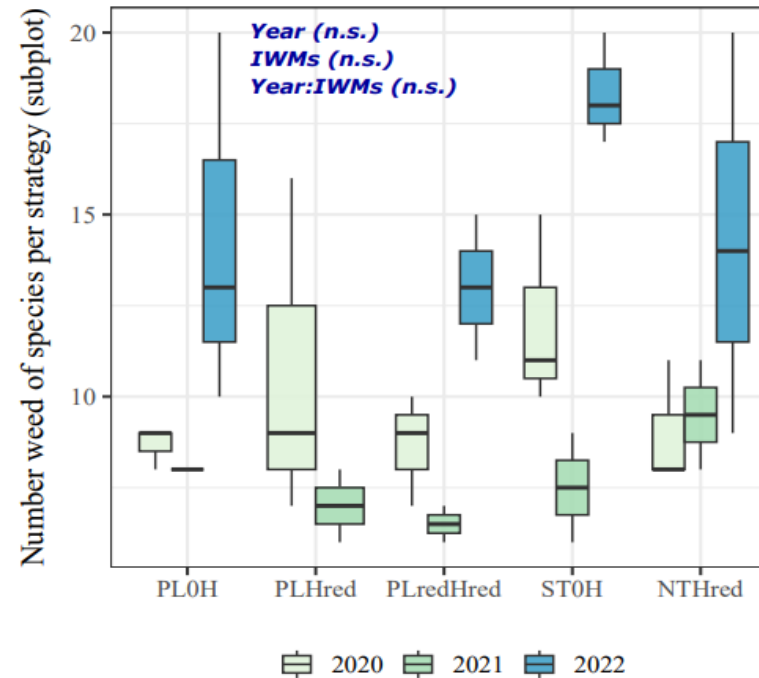
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# Mean weed density and species richness in the five IWM strategies at crop flowering



Weed density increased for four strategies over years → significant for PL\_0H

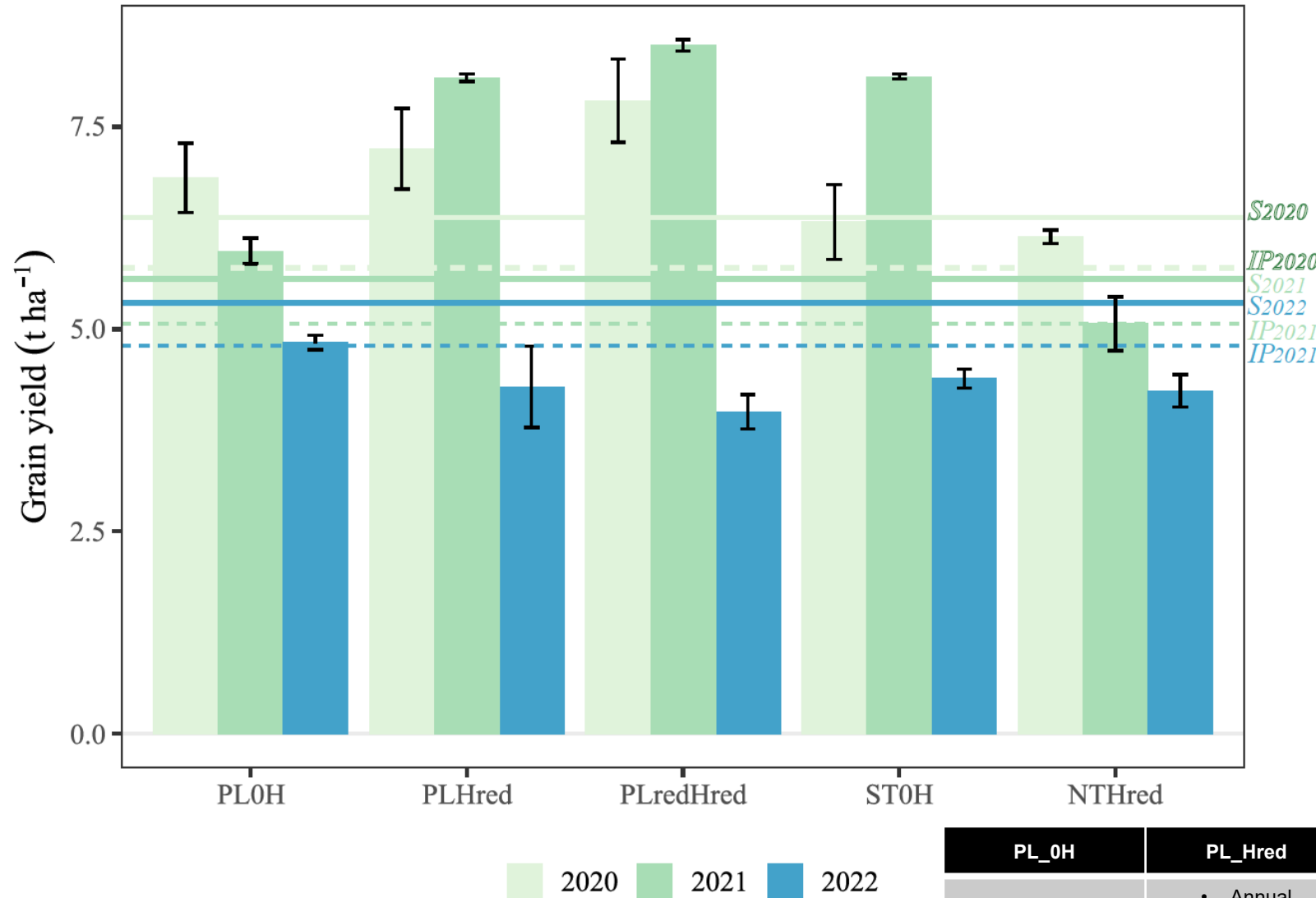


Number of weed species increased over time but not significant

PL_0H	PL_Hred	PLred_Hred	ST_0H	NT_Hred
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# Grain yield response to the five IWM strategies



- no significant yield differences between the 5 IWM strategies
- satisfactory yield

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PL_0H	PL_Hred	PLred_Hred	ST_0H	NT_Hred
<ul style="list-style-type: none"> <li>• Annual moldboard ploughing</li> <li>• no herbicides</li> </ul>	<ul style="list-style-type: none"> <li>• Annual moldboard ploughing</li> <li>• reduced herbicide use</li> </ul>	<ul style="list-style-type: none"> <li>• occasional moldboard ploughing</li> <li>• reduced herbicide use</li> </ul>	<ul style="list-style-type: none"> <li>• shallow tillage (5-10 cm)</li> <li>• no herbicides</li> </ul>	<ul style="list-style-type: none"> <li>• no tillage</li> <li>• reduced herbicide use</li> </ul>



# Conclusions Wheat

Satisfactory yield and successful weed control in all IWM strategies

IWM strategies with reduced or no use of herbicides performed equally as weed control strategies with herbicides

The intensity of farming practices increased over time in the alternative weed management strategies

more mechanical weeding ↑ (OH)

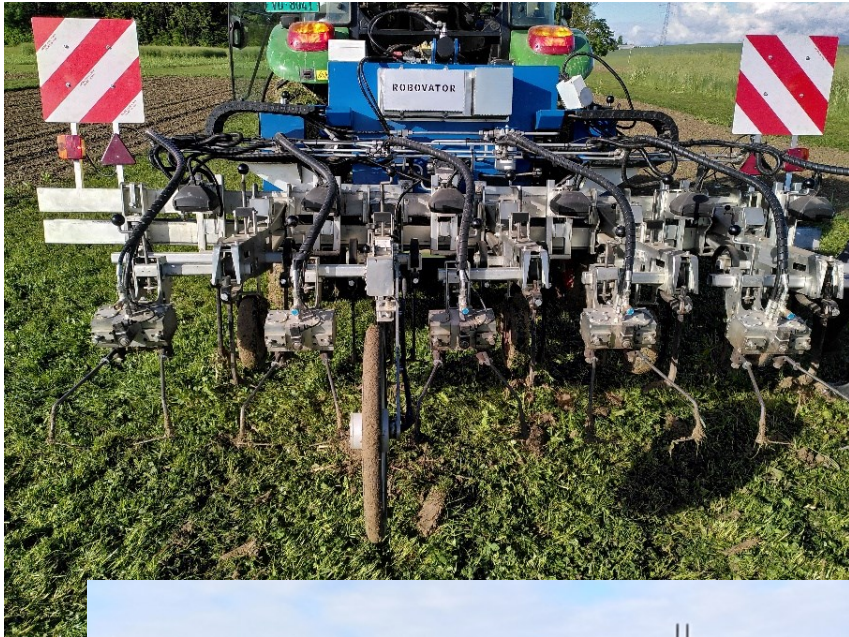
more herbicides ↑ in no till strategies (NT)



Adobe Stock | #44255383



# Results from Sugar beet (2021 to 2023)



Betteraves LAB0H – 17.05.2023



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# Management tactics in the 5 IWM strategies

Interventions	year	PL_OH	PL_Hred	PLred_Hred	ST_OH	NT_Hred	
Inversion tillage	2021	1	1	1	0	0	
	2022	1	1	0	0	0	
	2023	1	1	0	0	0	
Shallow tillage (false seedbed)	2021	2 ↓	2 ↓	2 ↓	3 ↓	1.5	0.5 = strip till
	2022	2 ↓	2 ↓	2 ↓	3 ↓	1	
	2023	4 ↓	4 ↓	4 ↓	4 ↓	1	
Mechanical weeding	2021	3 ↓	0	2	3 ↓	0	
	2022	4 ↓	3	3	4 ↓	2	
	2023	6 ↓	1	1	6 ↓	2	
Herbicides	2021	0	3.5	2	0	3.5 ↓	0.5 = band application
	2022	0	3	3	0	4	
	2023	0	3	3	0	5 ↓	

hoeing, harrowing, weed puller (2022) robovator, (2023) no hand weeding

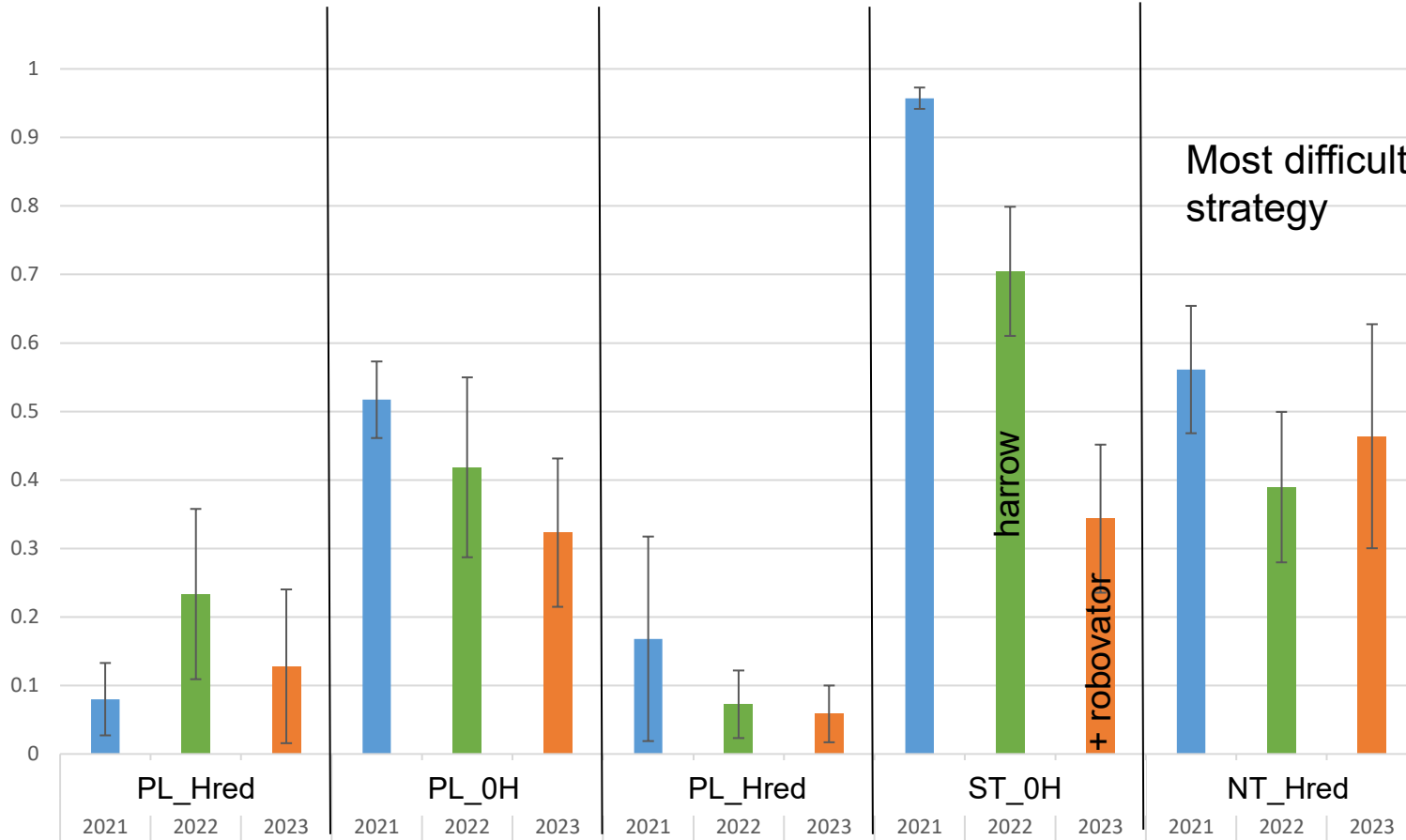
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# Proportion (in %) of weed biomass in total biomass (above ground)

Ratio de la biomasse adventices sur la biomasse totale à couverture du sol



Most difficult strategy

High levels of weed, especially without ploughing

→ weed control was not always effective

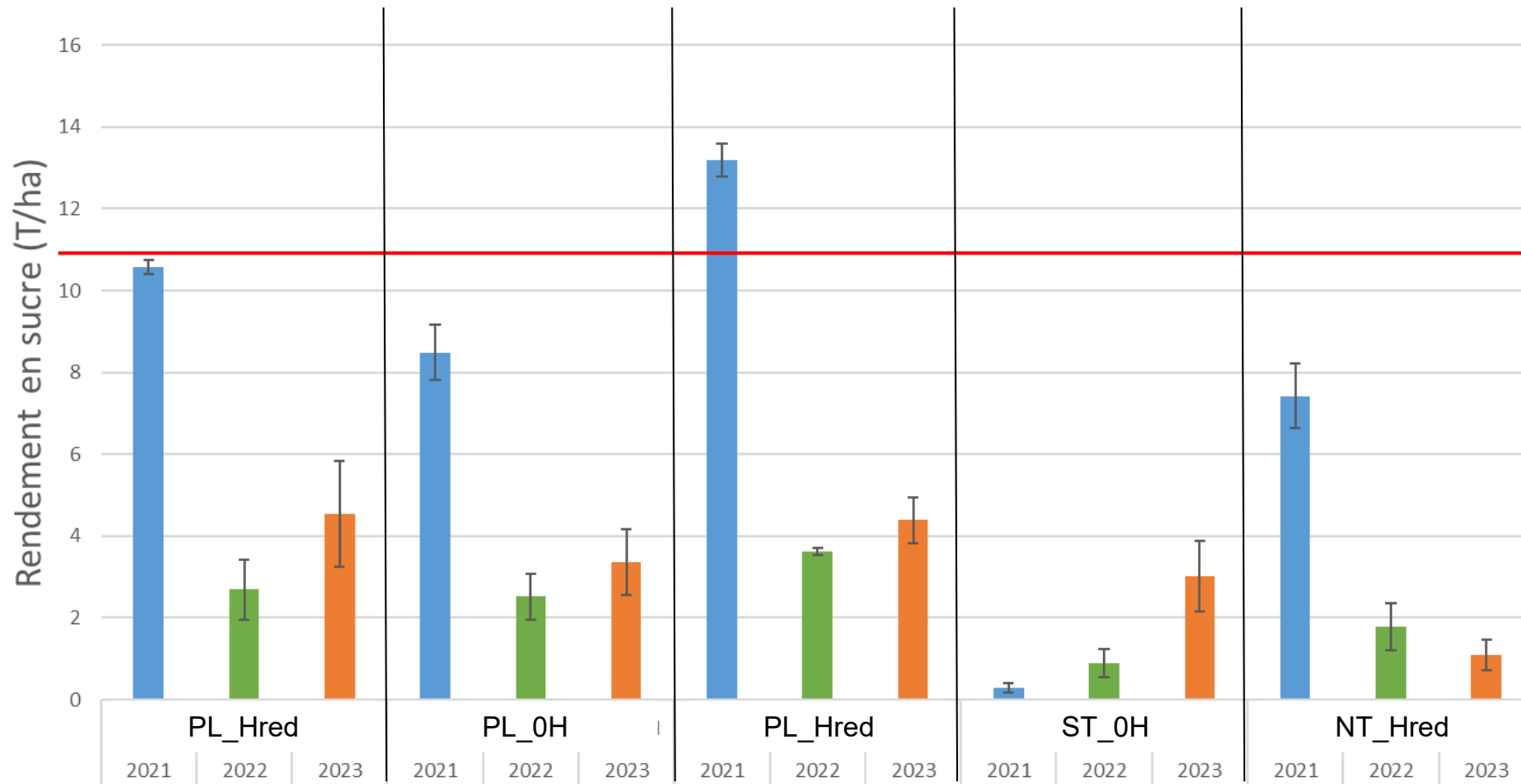
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# Grain yield response to the five IWM strategies



reference yield  
Changins

- Very low yield in 2022 and 2023
- 2022 and 2023 very dry and hot years, no irrigation

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PL_0H	PL_Hred	PLred_Hred	ST_0H	NT_Hred
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# Conclusions Sugarbeet

No satisfactory yields were obtained  
weed control was not always successful

Sugar beet cultivation without ploughing is very difficult

Sugar beet cultivation without herbicides is very time consuming and necessitates a lot of mechanical weeding





**Thank you for your attention**

**Judith Wirth**

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