Meta-analysis of IWM Trials

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Meta-analysis of IWM Trials

- IWMPraise trails did not follow standardised protocols; they tested very different interventions in different combinations, different crops and different experimental designs!
- It is difficult to identify an ‘IWM treatment’ and a control treatment.
- Can we *quantify IWM* to benchmark and compare systems?

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Meta-analysis of IWM Trials – the approach

1. Standardise ‘response data’ (yield, weeds, profit) across trials.

2. Design a conceptual framework for objectively combining weed control interventions in a *system.*

3. Model response variables along a gradient of IWM.

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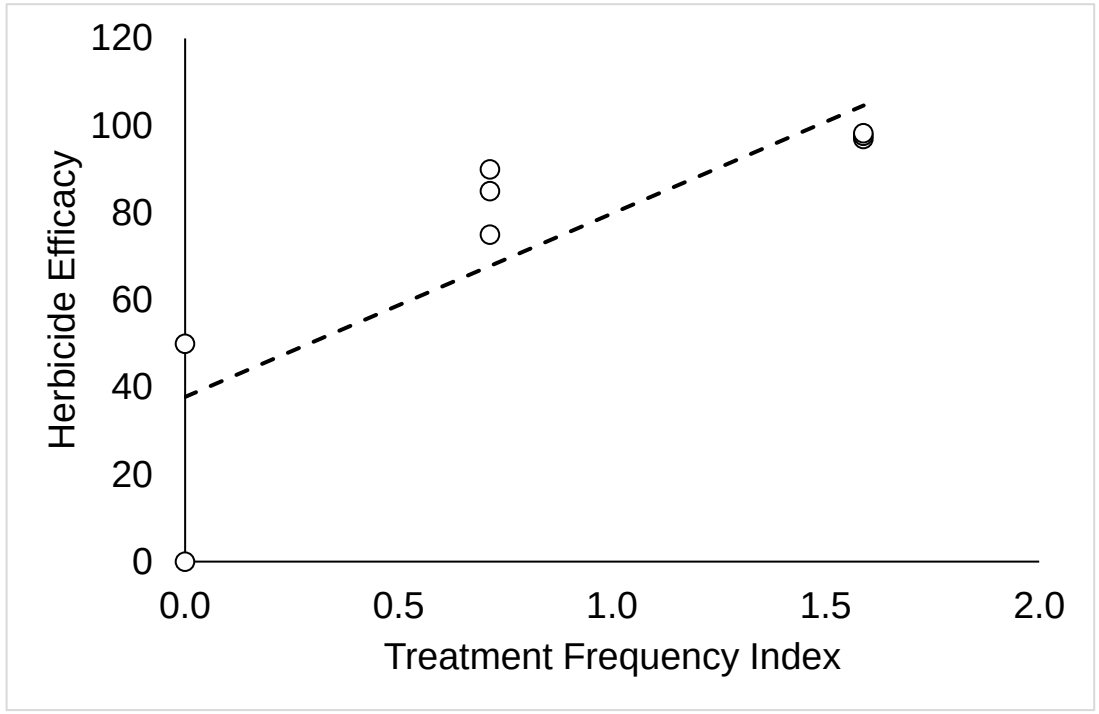
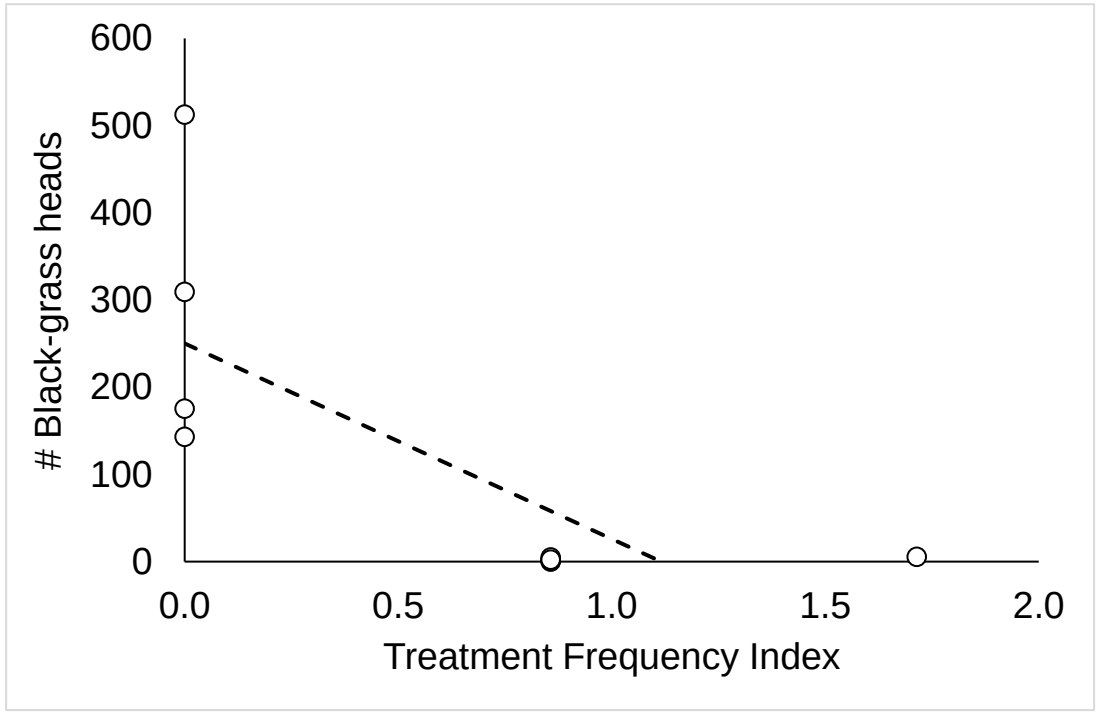
Standardise data across trials





- Convert efficacy to numbers of remaining weeds (using constant) – standardises direction of response
- Standardise weed data, yield and gross margin using zero mean, unit standard deviation (X' = (X-mean)/stdev)
- TFI expressed as zero mean

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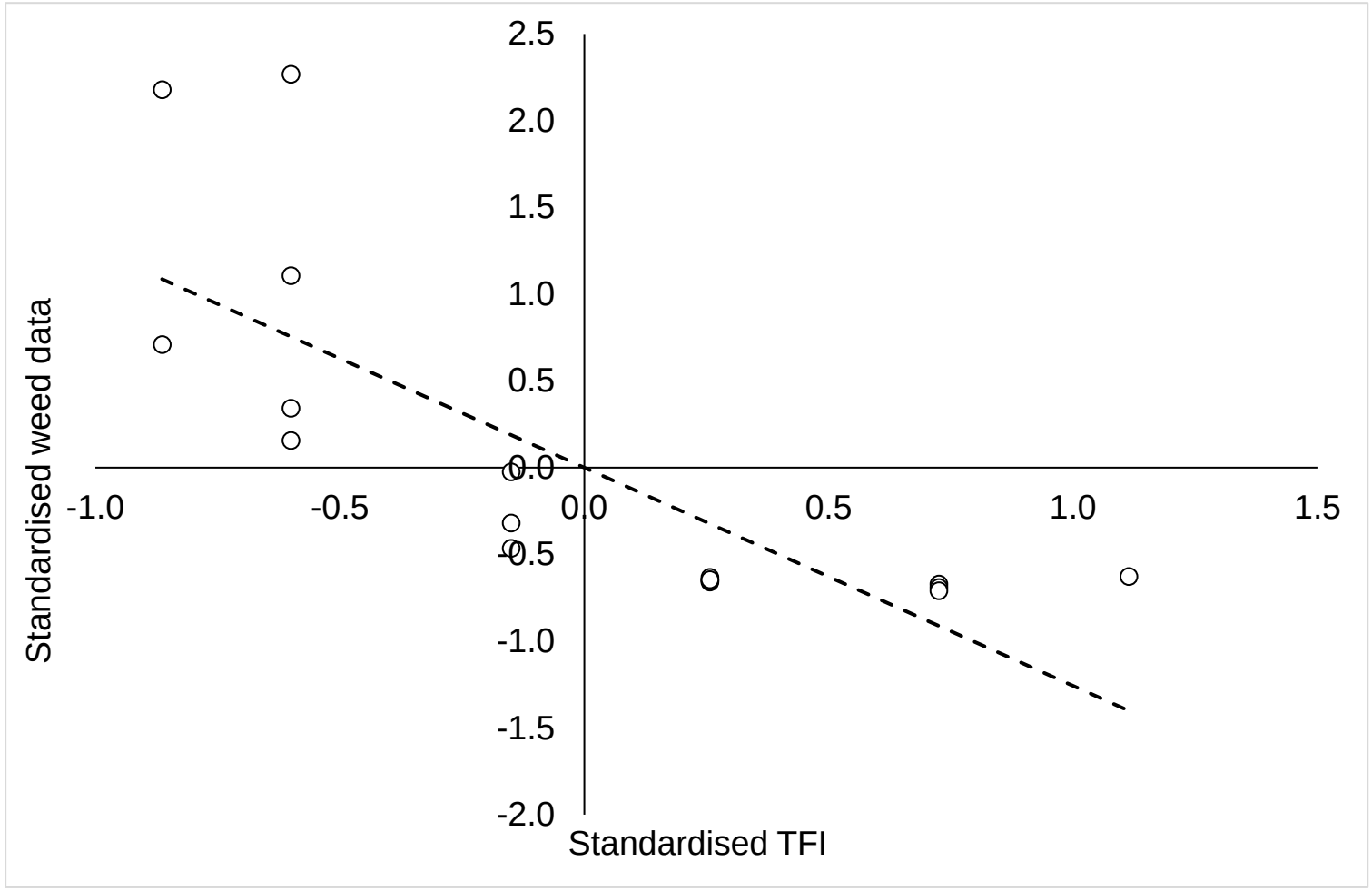
Standardise data across trials



What happens if we do this for 26 experiments and 240 treatments?

Final analysis will include more experiments – wide row crops

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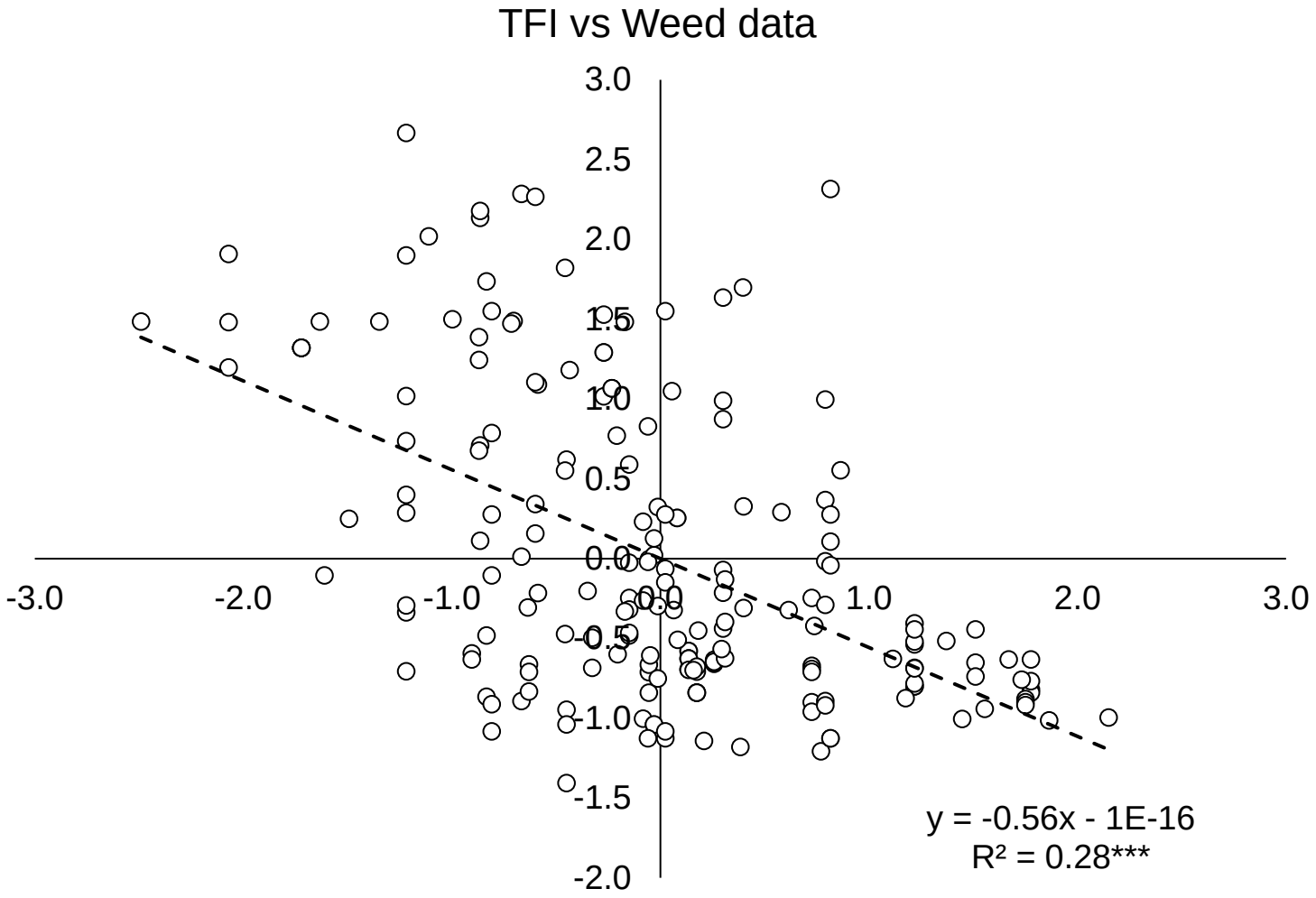
Herbicides work!



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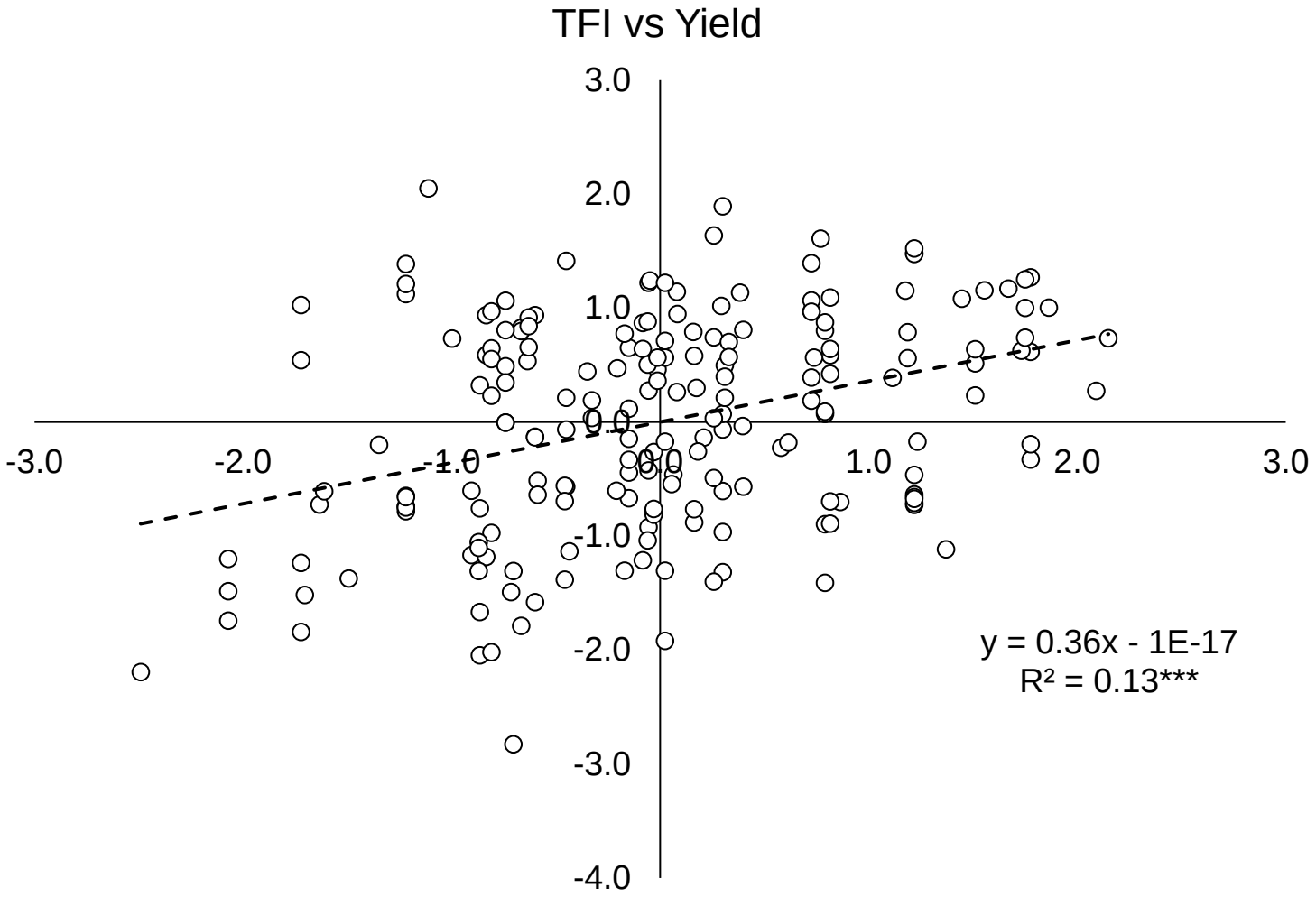
Using more herbicide increases yields!



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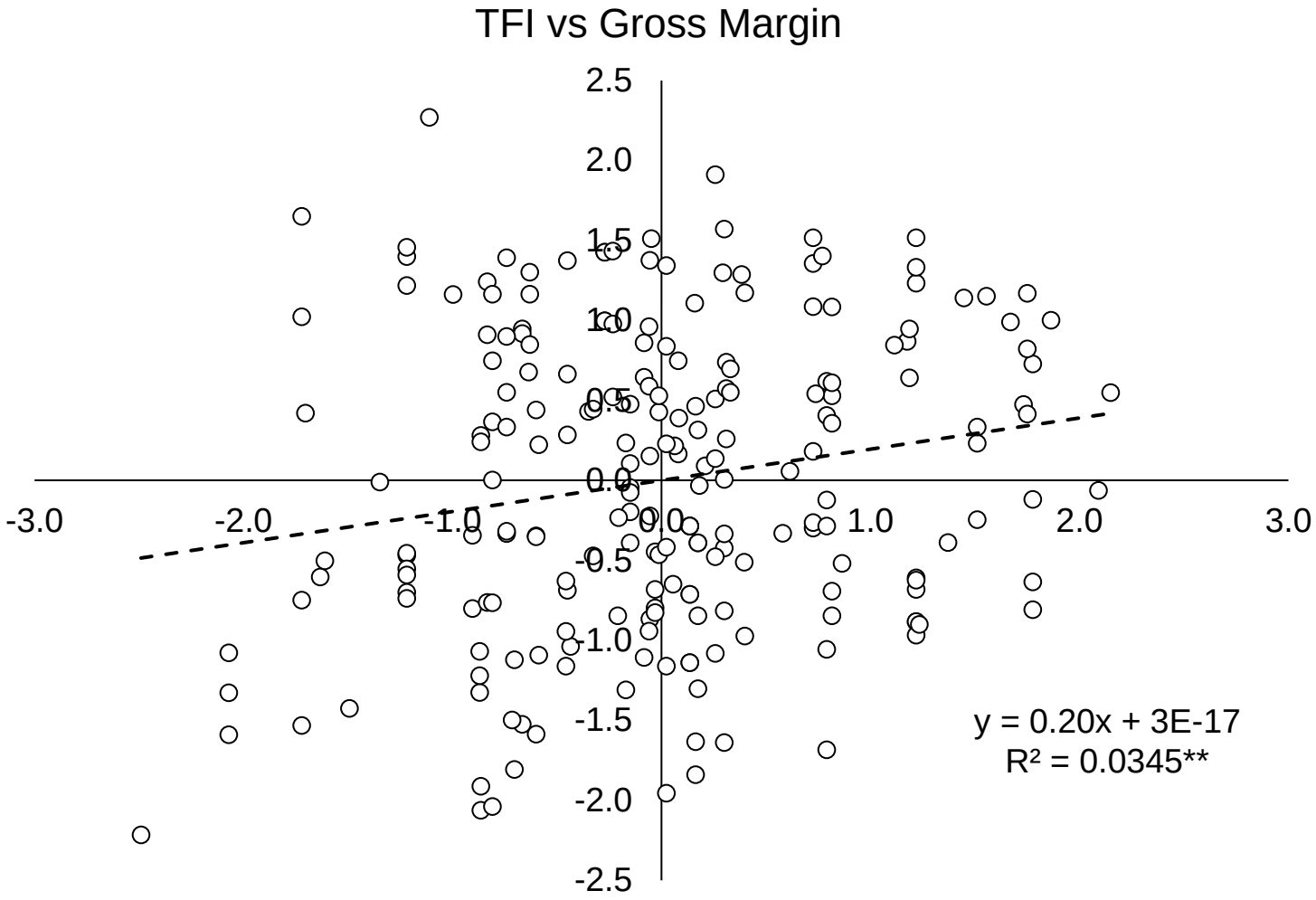
Is using more herbicide more profitable?



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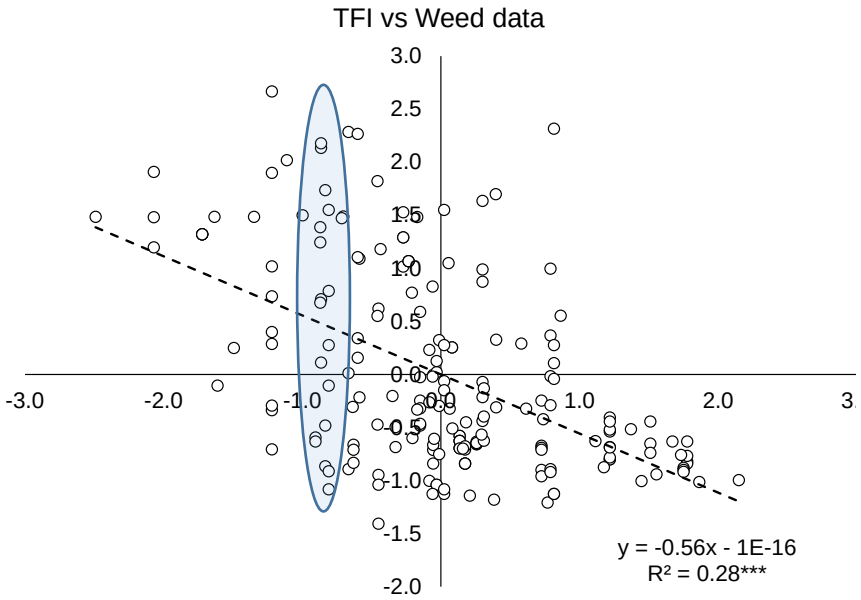
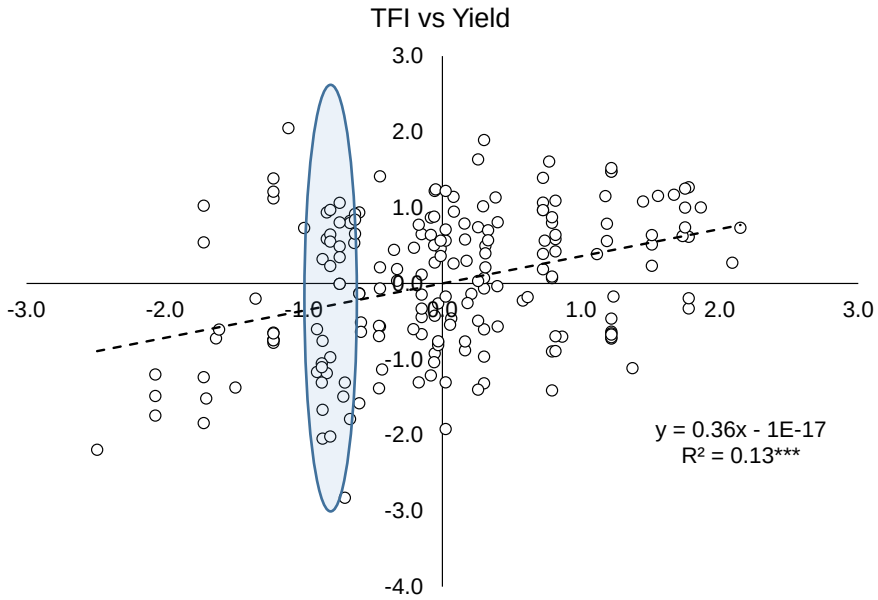
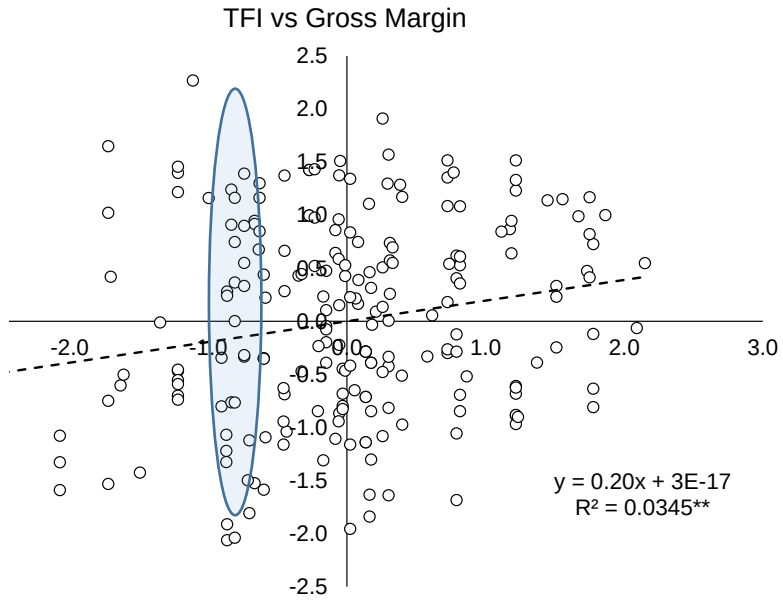
What is the risk of reducing herbicide intensity?







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What is the potential to reduce herbicide use?

- Decreasing herbicide use has a proportionally greater impact on weeds, less on yield and even less on gross margin.
- [The relative benefit of herbicides is determined by potential crop yield.]
- This implies there is scope to ‘leave weeds’ and reduce herbicide use (although we are only looking at within season impacts).

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Meta-analysis of IWM Trials – the approach

1. Standardise ‘response data’ (and TFI) across trials.

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3. Model response variables along a gradient of IWM.

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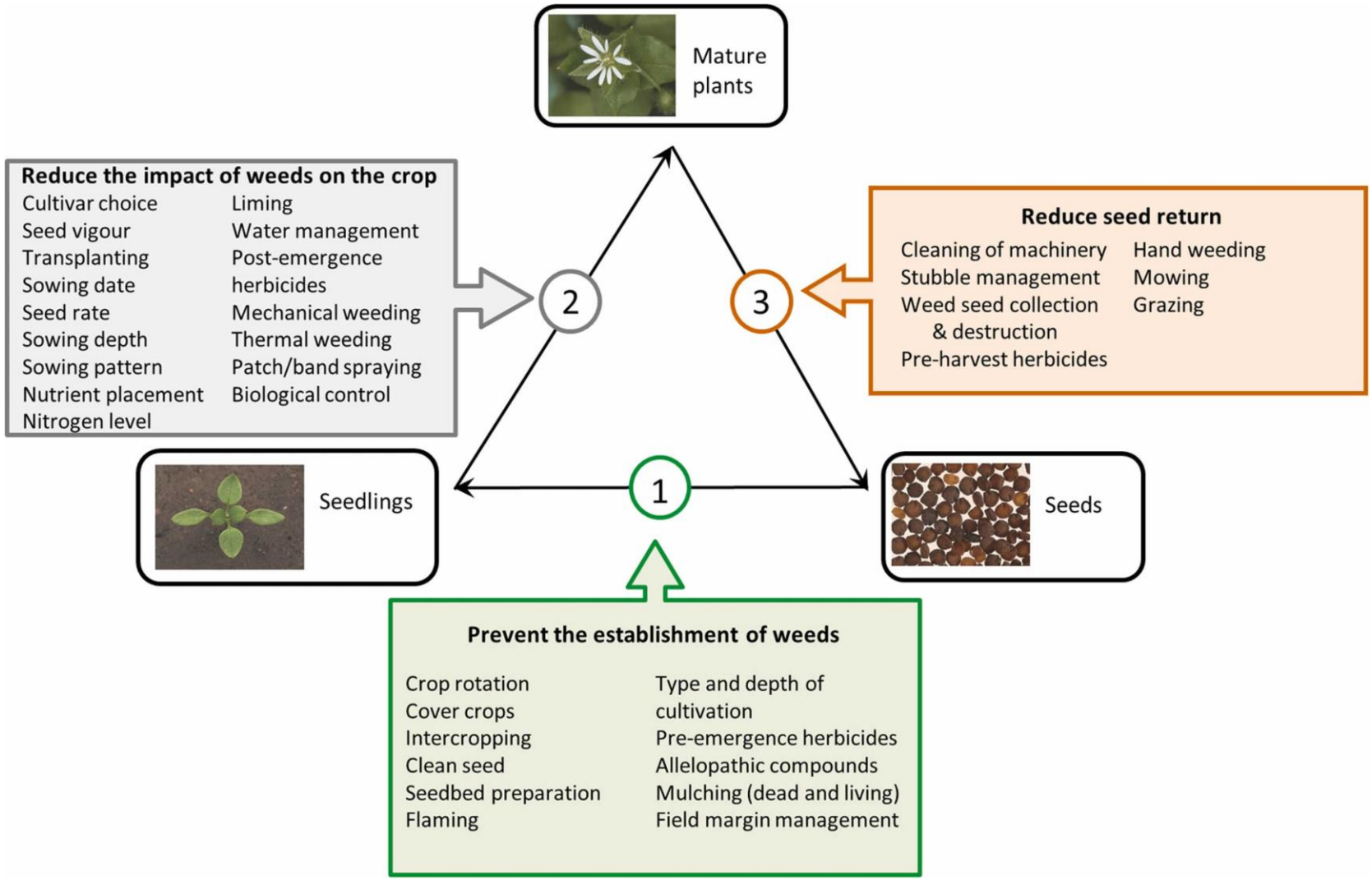
A new conceptual framework for deriving a gradient of IWM



Riemens *et al.* (2022) *European Journal of Agronomy* **133**: 126443

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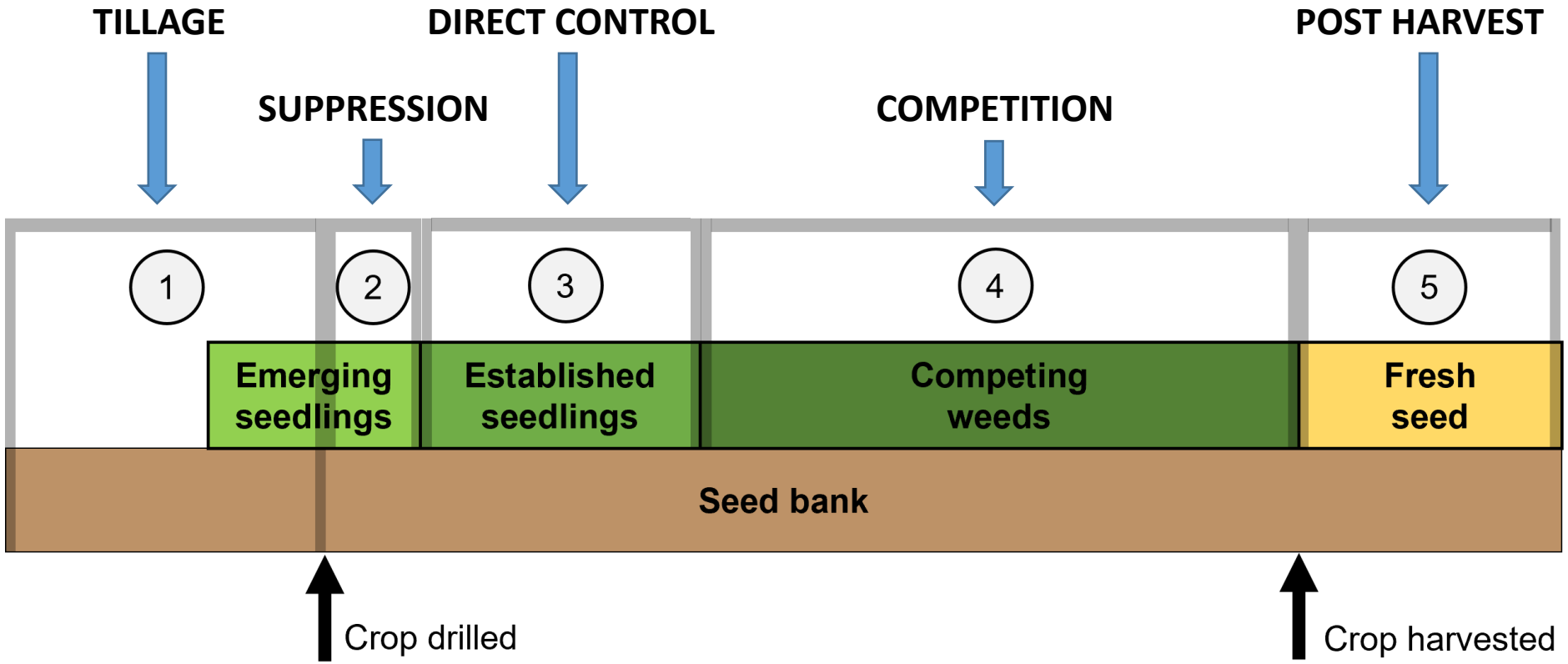

Storkey *et al.* (2021) *Agronomy-Basel* **11**: 747

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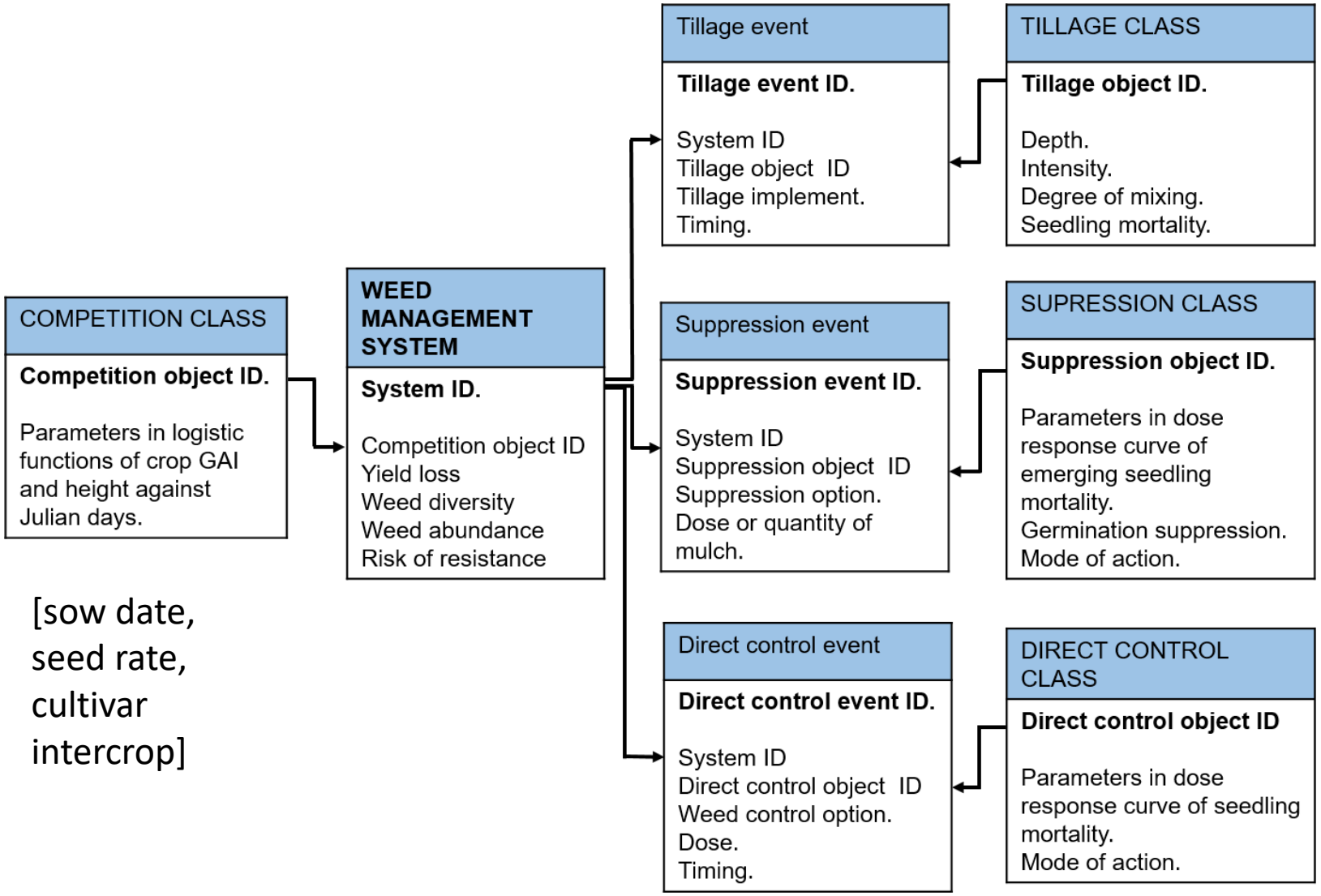

[sow date, seed rate, cultivar intercrop]

Just for the narrow row crop experiments we have:

493 tillage events
438 direct control events
164 suppression events

Storkey *et al.* (2021) *Agronomy-Basel* **11**: 747

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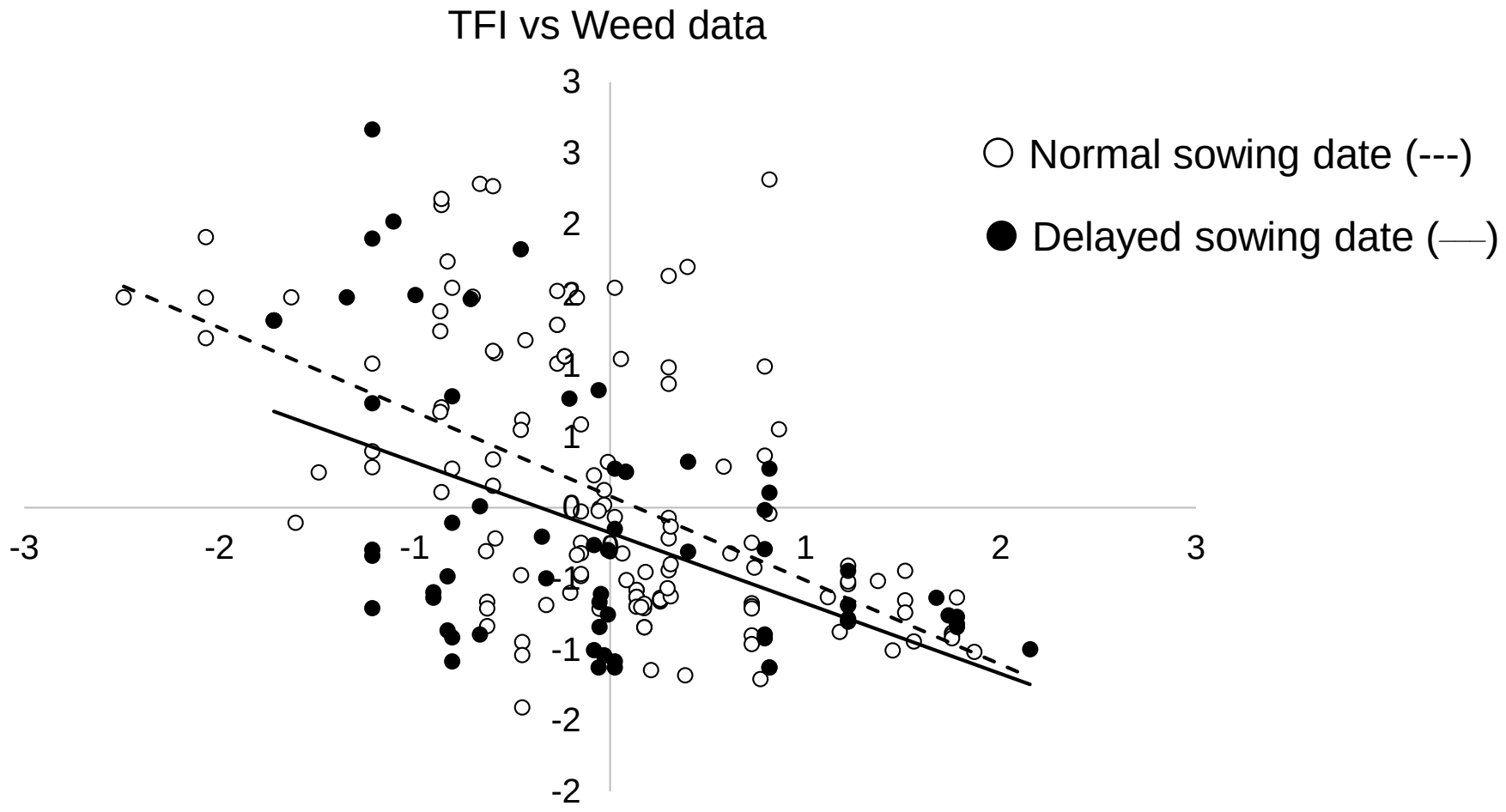
Delayed drilling has an additive effect with TFI



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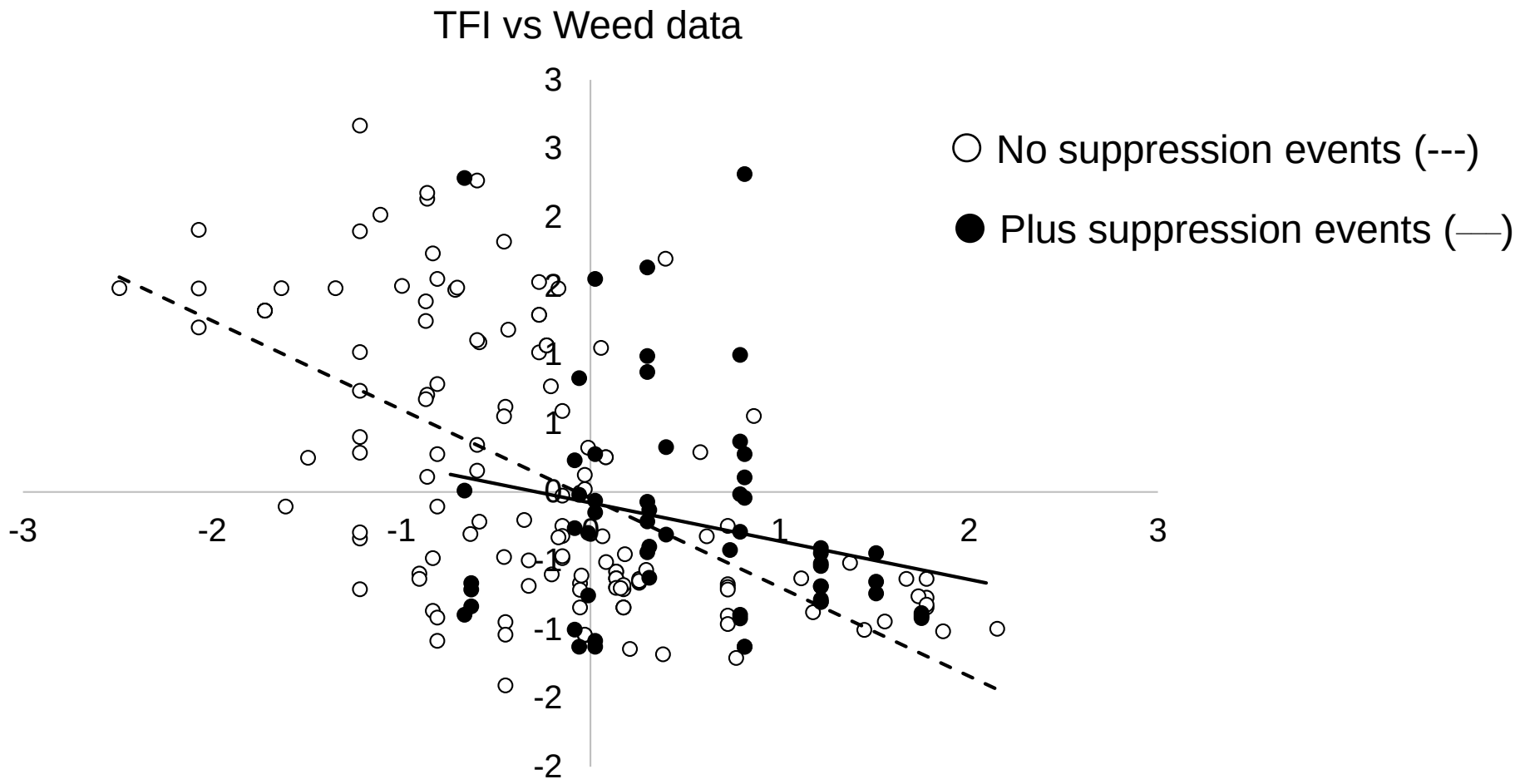
Suppression events interacted with TFI



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Meta-analysis of IWM Trials: initial conclusions

- There is evidence that delayed sowing and control in window 2 suppression is consistently beneficial and can be used to reduce herbicide use.
- Mechanical control & cultivation were not significant in the models (but only narrow row crops analysed).
- Systems are currently being modelled…

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IWM and impact on biodiversity

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IWM and impact on biodiversity

- Can we use weed community dynamics models to predict long-term consequences of experimental systems?
- Can we identify emergent ‘real world systems’ and compare impact on biodiversity?
- Can we predict the wider behaviour of alternative systems in terms of economic performance?

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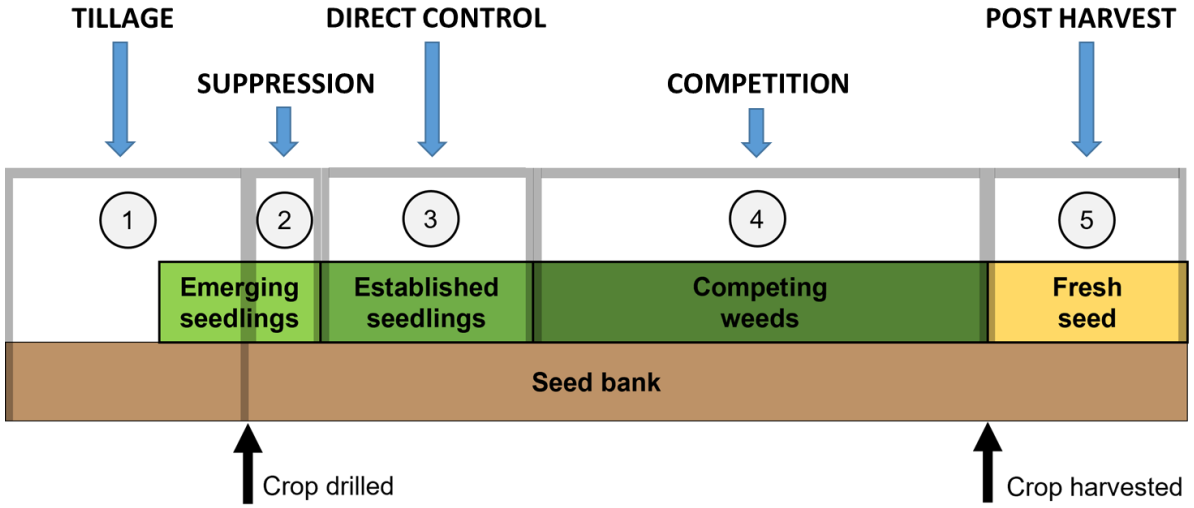
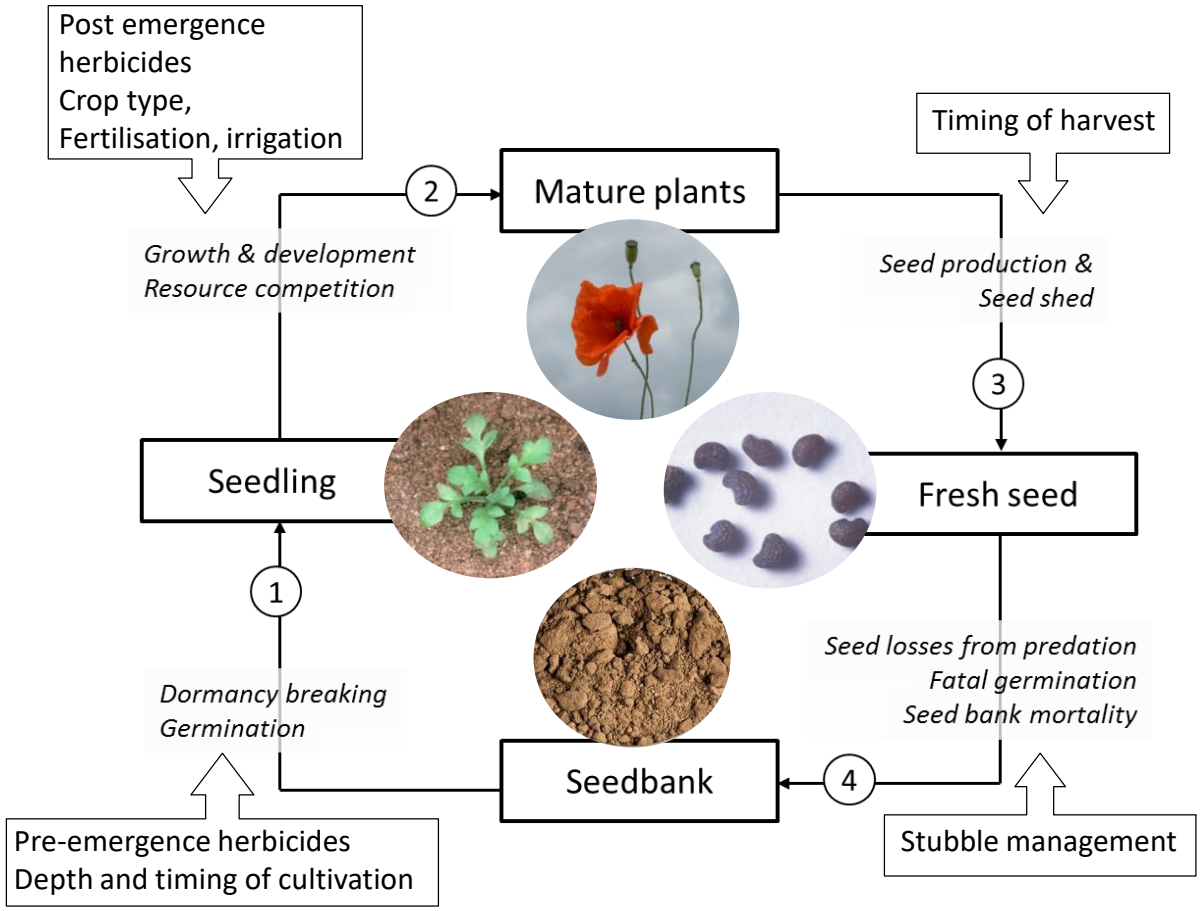
Modelling weed community dynamics





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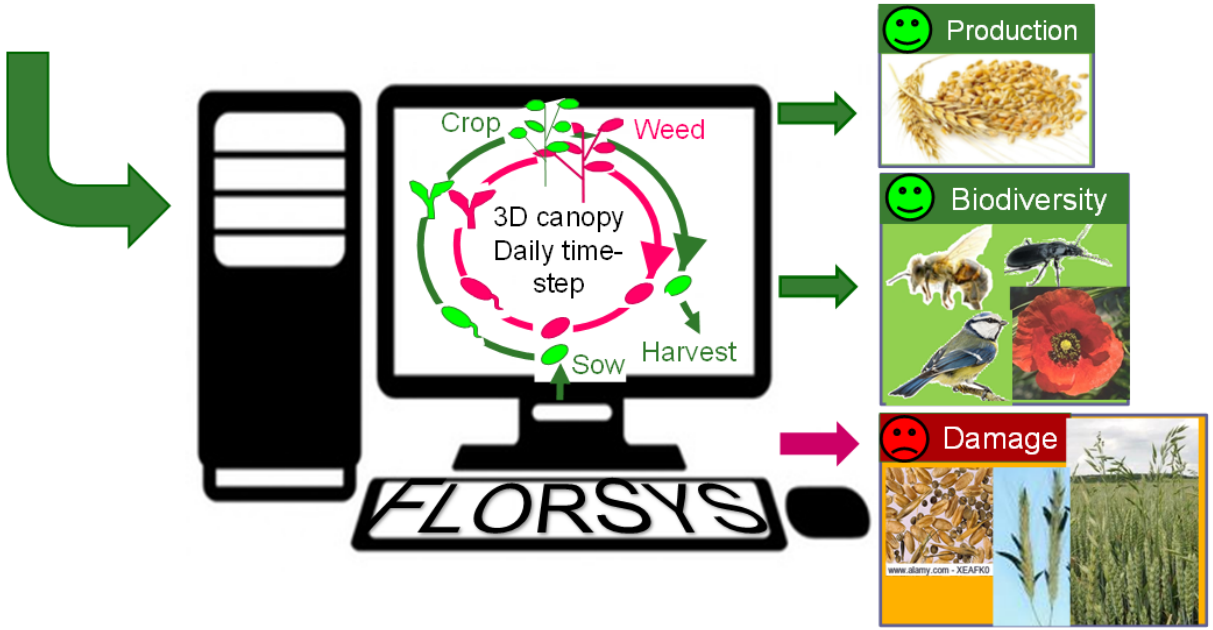
Modelling weed community dynamics: FLORSYS

3 Danish cropping systems	
Intensive reference: OSR/wheat/barley with fescue/fescue/fescue	
Mechanical weeding: more tillage, larger interrows, fewer herbicides	
Delayed sowing: fewer herbicides	
Danish weed flora	14 species: 73% of observed species x densities



Colbach *et al.* (2019) *European Journal of Agronomy* **87**: 59-73

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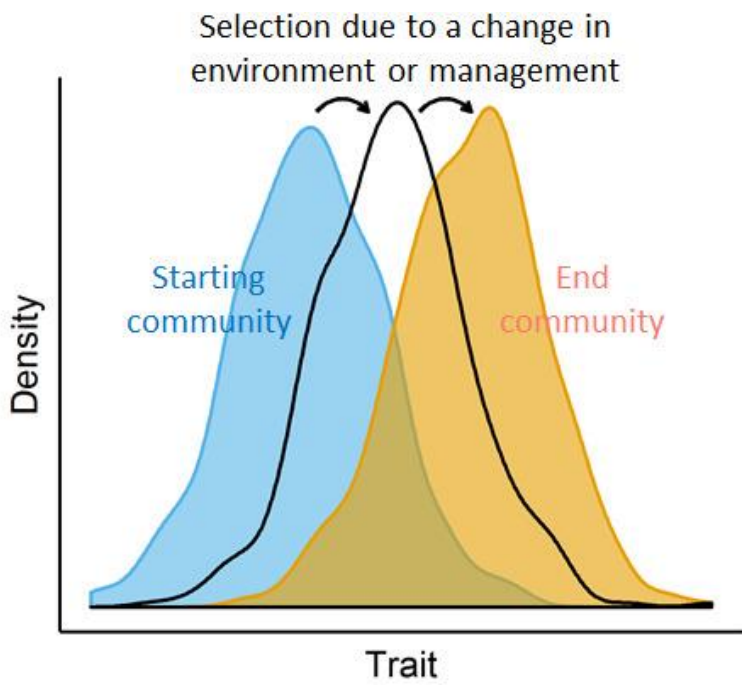
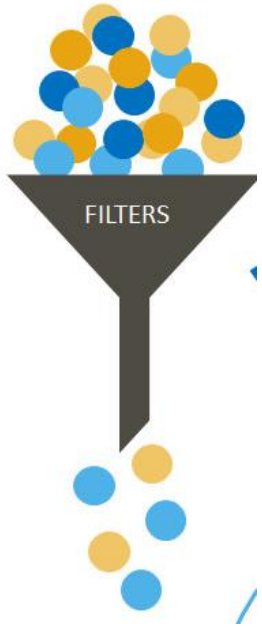
Modelling weed community dynamics: Functional traits





How do different combinations of IWM options interact to determine functional diversity?

Metcalfe *et al.* (2020) *Ecology* **101**: e03167

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Modelling weed community dynamics: Functional traits

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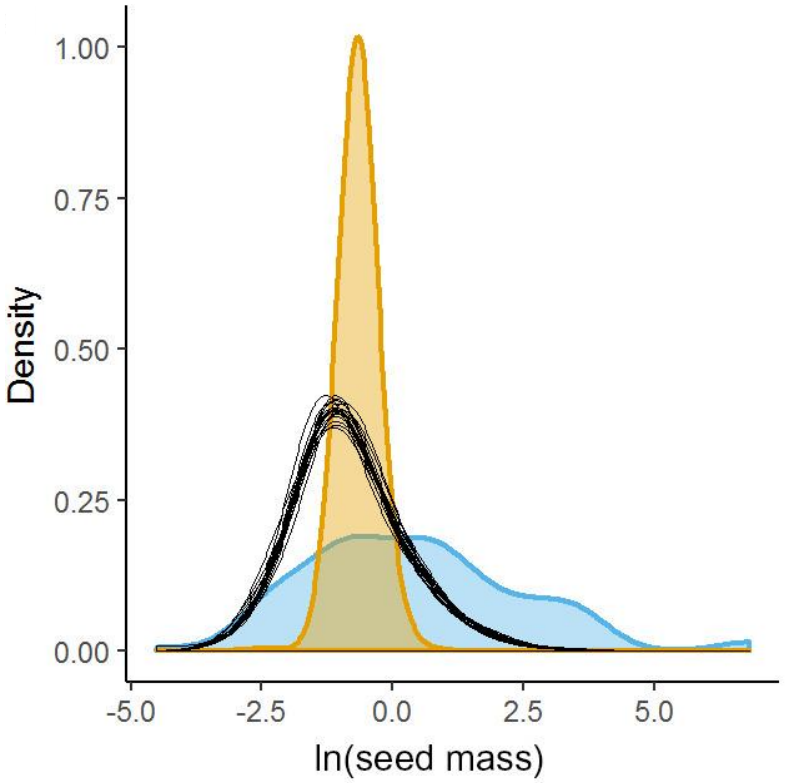
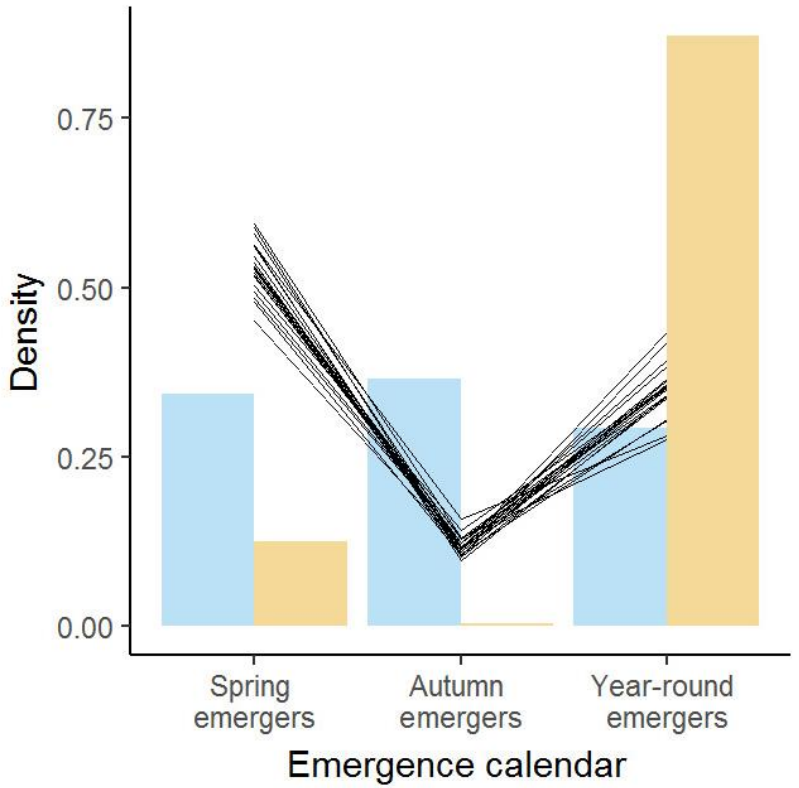
Modelling weed community dynamics: Functional traits





Metcalfe *et al.* (2020) *Ecology* **101**: e03167

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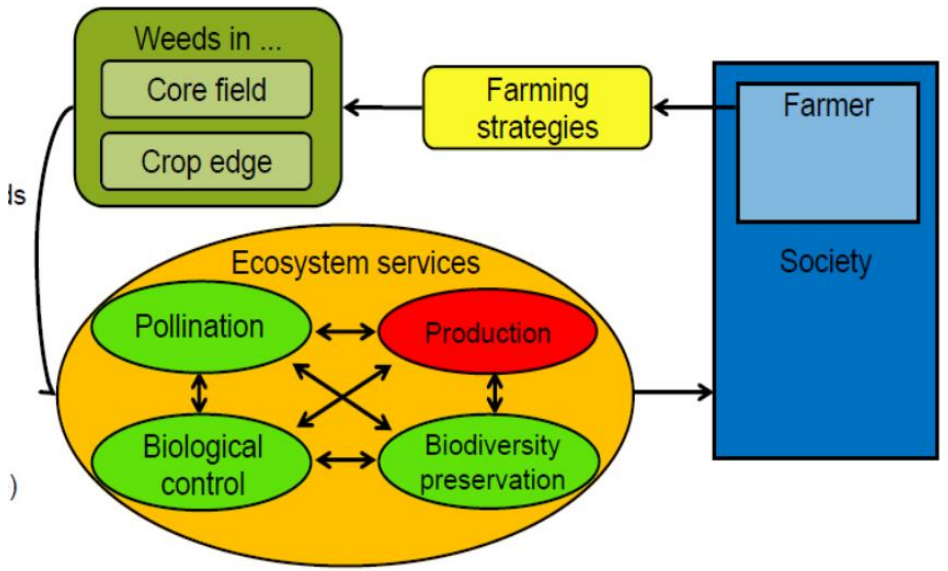
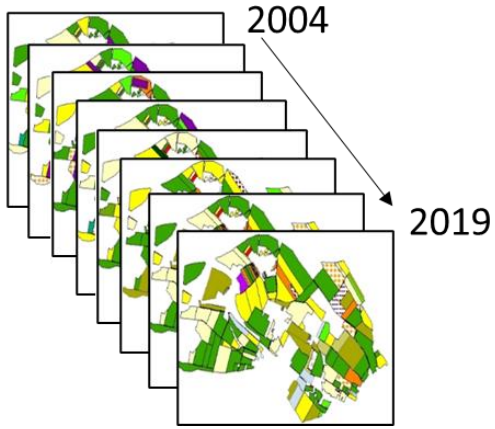
Impact of real-world systems on biodiversity: FENAY





Weed data: 2006-2019 (*c.a. 1850 sampling)*
68 fields monitored annually, 147 weed species

Yvoz *et al.* (2020) *European Journal of Agronomy* **115**: 126009

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Impact of real-world systems on biodiversity: FENAY

Summary description of the 8 farming strategies. "Short/Intermediate/Diversified" refers to the number of crops in the crop rotation.
+ intensity of the practice higher than the mean, +/- intensity close to the mean, - intensity lower than the mean.

Strategy	Name	Crop diversity	Herbicide use	Tillage intensity	Ploughing frequency	Other pesticide	N input	Nb fields	Nb farmers
S1	Chemical-based short rotation	-	+	+/-	+/-	+	+/-	9	2
S2	Ploughing chemical-based short rotation	-	-	+	+	+	+/-	31	7
S3	Tillage chemical-based short rotation	-	+/-	+	+/-	+	+	42	5
S4	Ploughing chemical-based intermediate rotation	+/-	+/-	+/-	+	+	+	13	3
S5	Tillage herbicide-based intermediate rotation	+/-	+	+	-	-	-	20	4
S6	Medium range inputs diversified rotation	+	+/-	-	+/-	-	+	36	4
S7	Low inputs reduced tillage diversified rotation	+	-	+/-	-	-	+/-	29	7
S8	Herbicide-based reduced tillage diversified rotation	+	+	-	-	-	-	23	6

Yvoz *et al.* (2020) *European Journal of Agronomy* **115**: 126009

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Impact of real-world systems on biodiversity: FENAY

Strategy	Mean Richness	Cumulated Richness	Mean Abundance	Weeding failure frequency
Strategy 1	8.68 (a)	19.9 (a)	29.41 (b)	0.620 (b)
Strategy 2	4.86 (a)	12.1 (a)	5.71 (a)	0.154 (a)
Strategy 3	5.05 (a)	11.7 (a)	6.55 (a)	0.170 (a)
Strategy 4	4.71 (a)	14.2 (a)	4.71 (a)	0.108 (a)
Strategy 5	5.30 (a)	13.4 (a)	9.47 (ab)	0.346 (ab)
Strategy 6	6.43 (a)	15.9 (a)	7.45 (a)	0.255 (ab)
Strategy 7	6.70 (a)	15.8 (a)	14.76 (ab)	0.208 (a)
Strategy 8	7.58 (a)	12.3 (a)	1.67 (a)	0.115 (a)

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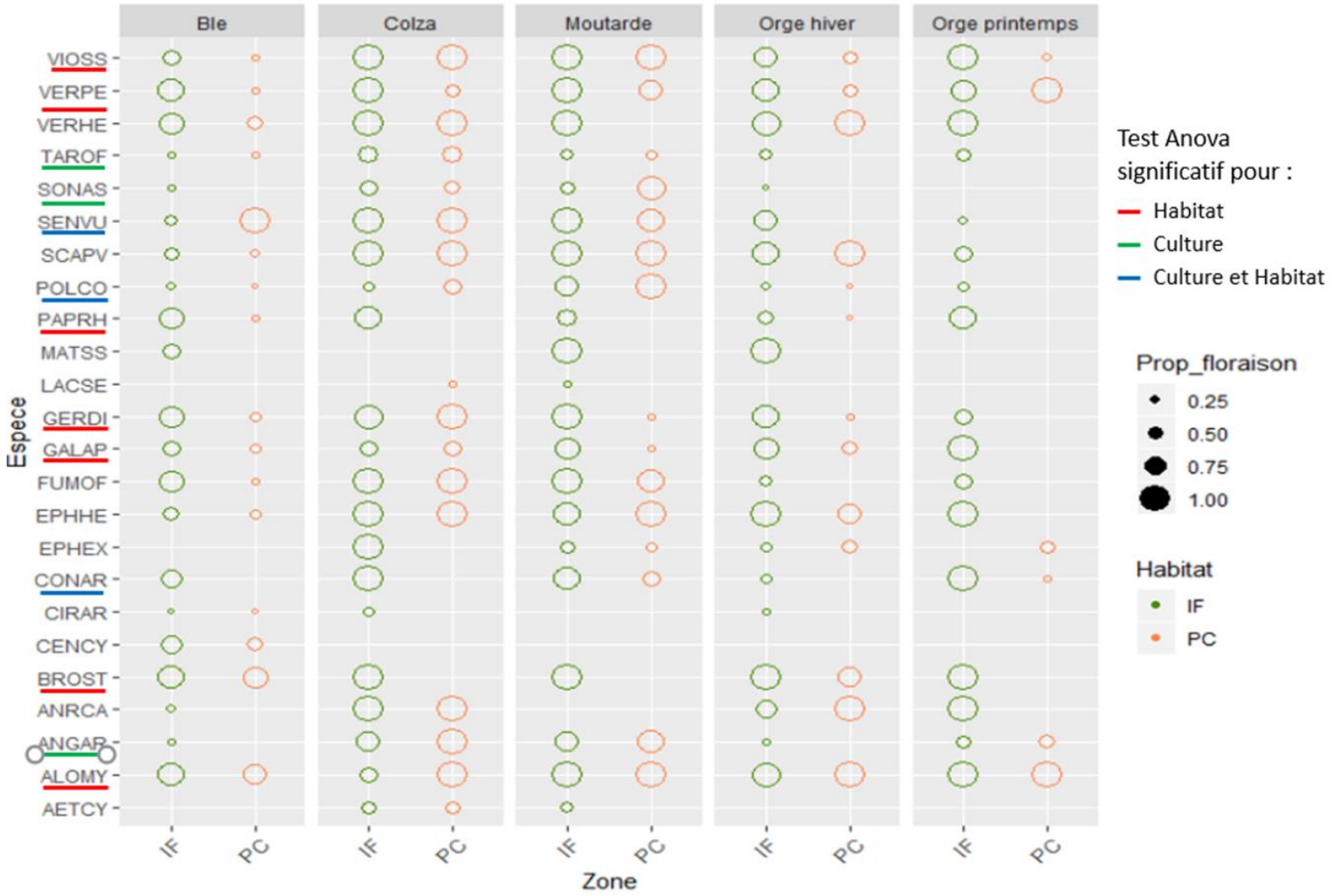
Impact of real-world systems on biodiversity: FENAY



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Multi-criteria assessment of alternative systems

- Farmers in FENAY region interviewed to explore implications of alternative IWM strategies.
- Business Economic Analysis (BEA) tool used to audit costs and revenue.
- Environmental impact will also be assessed.

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Multi-criteria assessment of alternative systems

- Strategy 1: Mustard : wheat : barley : soyabean : wheat, chemical control.
- Strategy 2: Mustard : wheat : barley : soyabean : wheat, mechanical control where possible (**substitution**)
- Strategy 3: Mustard: wheat : barley: soyabean : wheat : lucerne x3, only mechanical control (**redesign**).

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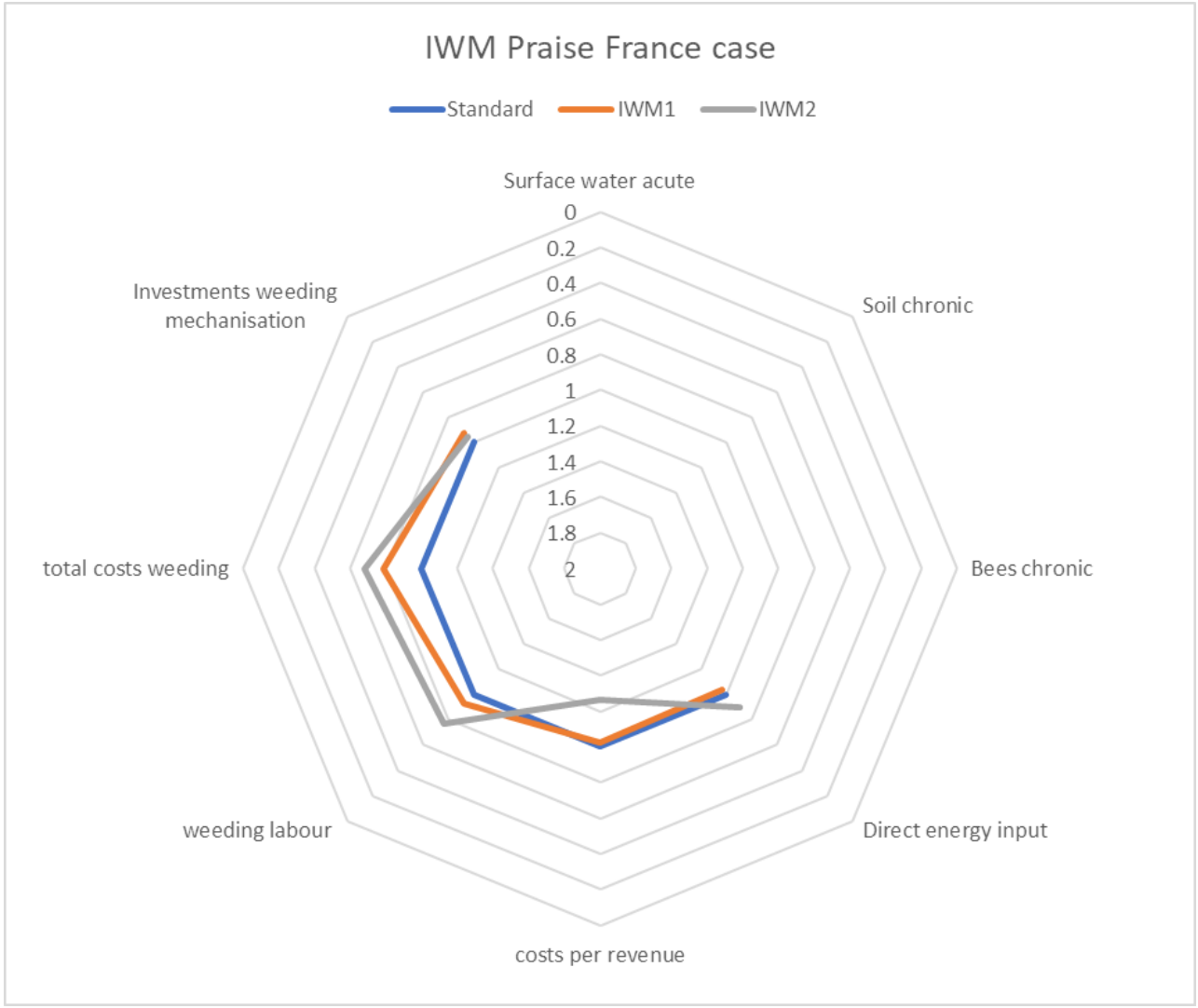
Multi-criteria assessment of alternative systems



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Multi-criteria assessment of alternative systems

Absolute data of the investments in machines for both total and weeding management. The costs are calculated by using the annual costs for the machines (depreciation expense of the replacement value).

	total investments machines	investments weeding machines	Percentage weeding machines investment of total machine investment
investments weeding mechanisation - standard	€ 77 492	€ 13 444	17%
investments weeding mechanisation – IWM1	€ 77 492	€ 12 408	16%
investments weeding mechanisation – IWM2	€ 82 112	€ 13 605	17%