

Crop mixtures

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Scottish Government
Riaghaltas na h-Alba

Monoculture → variety mixtures

Cereal variety mixtures:

- ✓ Increase yield
- ✓ Reduce disease
- ✓ Maintain quality
- ✓ Increase yield stability

Demonstrated in:

- Winter wheat for distilling (and baking)
- Winter barley for feed
- Spring barley for malting and feed

→ More resilient, efficient crops

Limitations...?



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Questions:

Within species

1. How many components?
2. What proportions?
3. What spatial arrangements (structured/random/connectivity/patches)?
4. How diverse can/should components be?
5. What traits complement best (e.g. canopy types, weed competitiveness...) ?
6. Straw biomass effects (/harvest index)?
7. Nutrition and pathogen interactions (nitrogen & fungicides)?

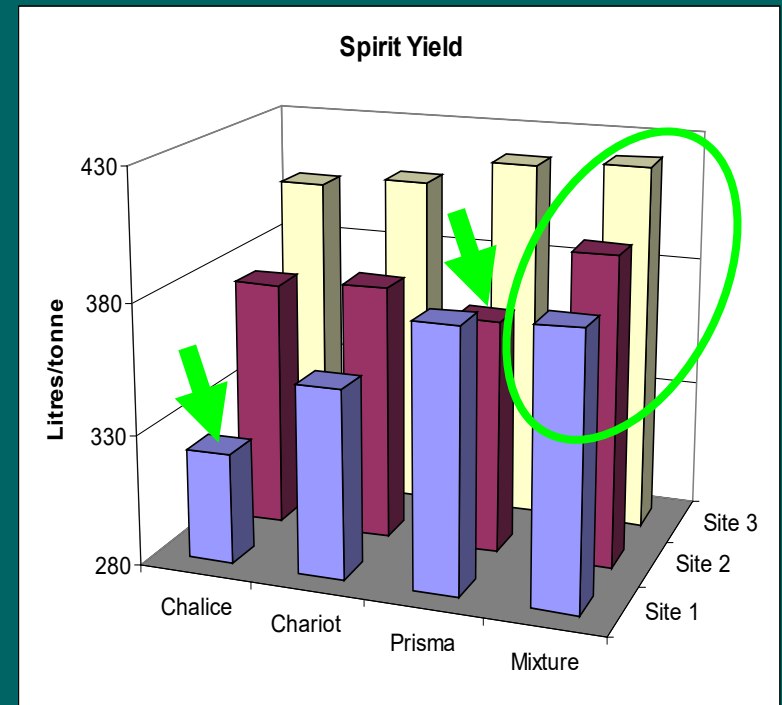
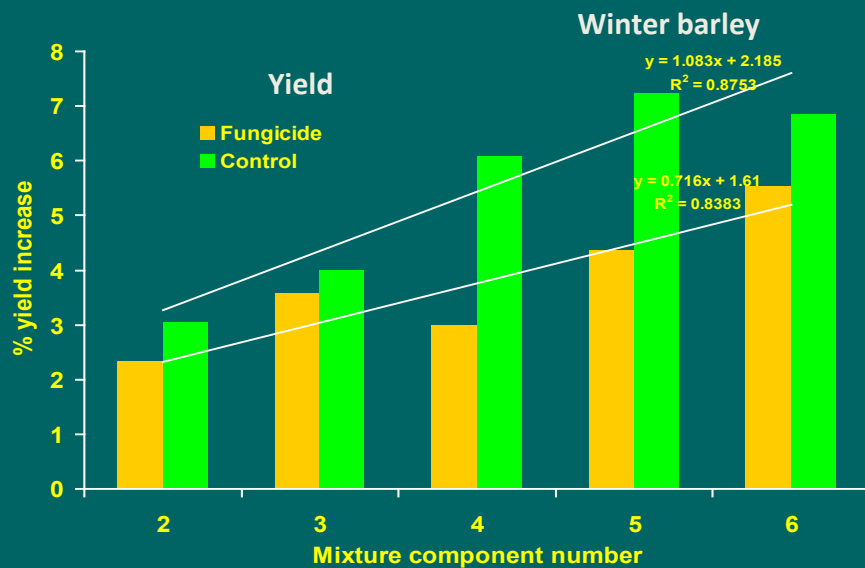
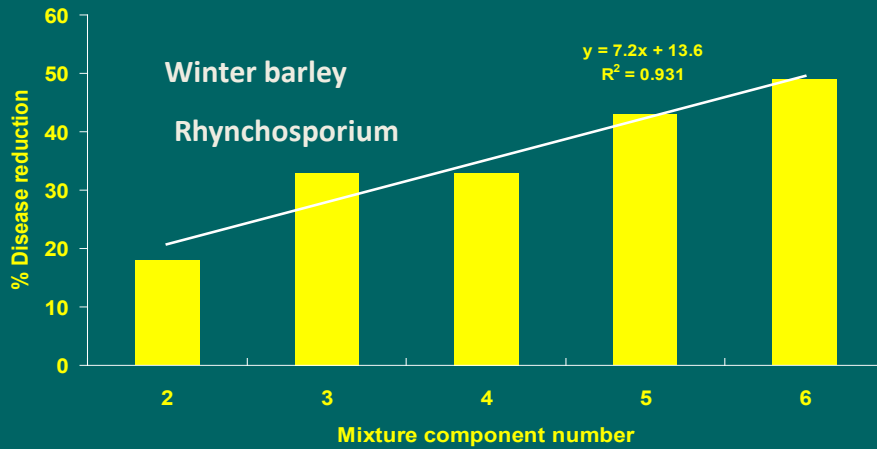
Between species

- → How different crop species interact (cereal-legume etc.), for either biomass (for anaerobic digestion) or silage use

Practicalities

- Quality... As good / better / less variable than monoculture

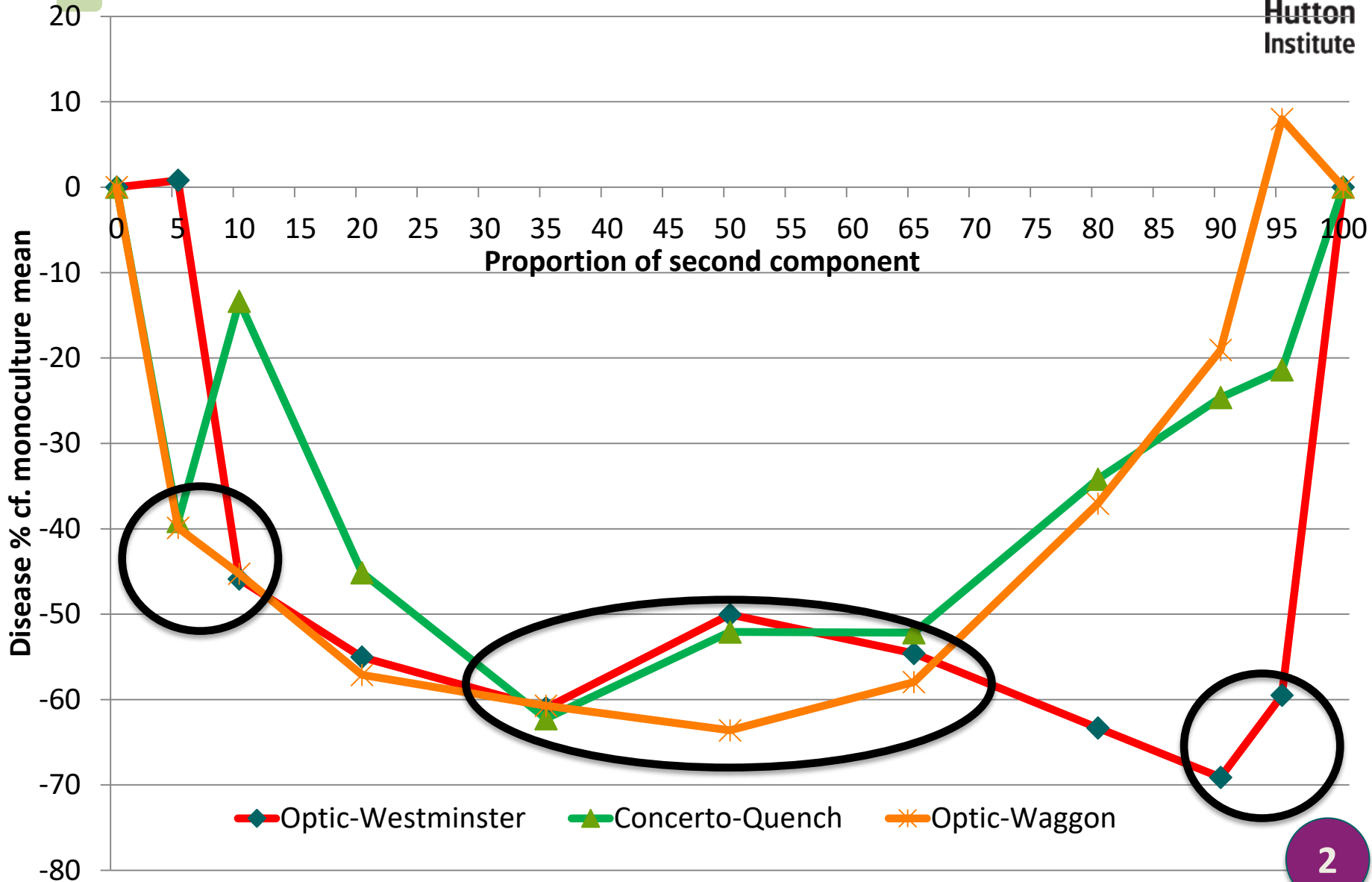
Mixtures: Disease reduction, yield increase and stability



- Less lodging in mixtures – structural support
- Convergence of heading dates, maturity and height



Component proportions



Structured resistance gene deployment

1	A	A	A	A
	B	B	B	B
	C	C	C	C
	D	D	D	D
2	W	W	W	W
	X	X	X	X
	Y	Y	Y	Y
	Z	Z	Z	Z

a) Monoculture

ABC DWX YZ	ABC DWX YZ	ABC DWX YZ	ABC DWX YZ
ABC DWX YZ	ABC DWX YZ	ABC DWX YZ	ABC DWX YZ
ABC DWX YZ	ABC DWX YZ	ABC DWX YZ	ABC DWX YZ
ABC DWX YZ	ABC DWX YZ	ABC DWX YZ	ABC DWX YZ
ABC DWX YZ	ABC DWX YZ	ABC DWX YZ	ABC DWX YZ
ABC DWX YZ	ABC DWX YZ	ABC DWX YZ	ABC DWX YZ
ABC DWX YZ	ABC DWX YZ	ABC DWX YZ	ABC DWX YZ
ABC DWX YZ	ABC DWX YZ	ABC DWX YZ	ABC DWX YZ

b) Homogeneous

C	Y	ABC	ABD
W	A	ACD	B
BCD	WXY	C	WXZ
ABD	BCD	Z	WYZ
WXZ	W	XYZ	D
B	ABC	X	XYZ
ACD	D	A	Y
X	Z	WYZ	WXY

c) Structured

Selection for: a) Simple

b) Complex

c) Simple and Complex and Groups

Mildew¹ 4.09^a

4.69^a

2.61^b

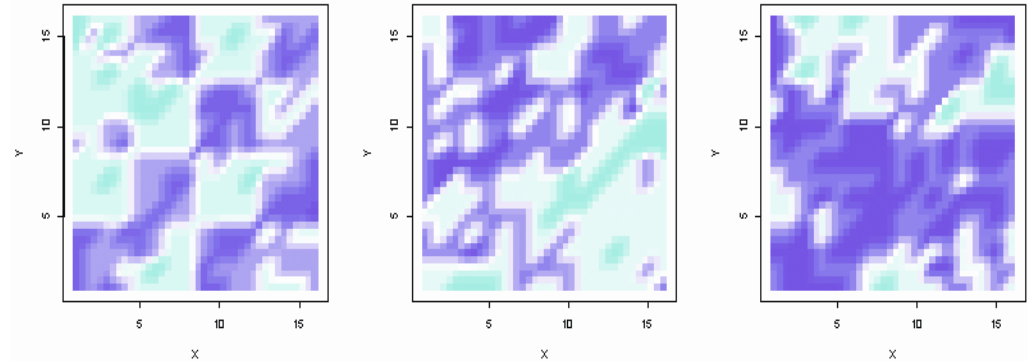
LSD 1.06 ¹ Percentage whole plant infection.



Thoroughly mixed or patchy?

Structure and scale

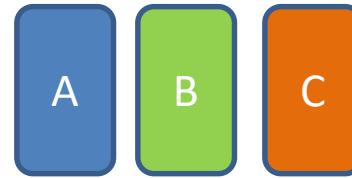
- **Random**
Homogeneous or patchy?
- **Regular**
Small or large areas?
- **Structure**
Complex and simple?
- **Proportions**
Connectivity and ratio?



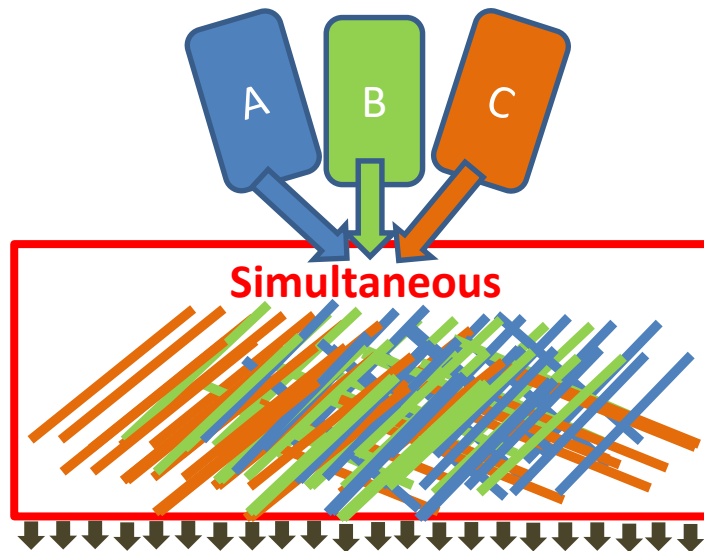
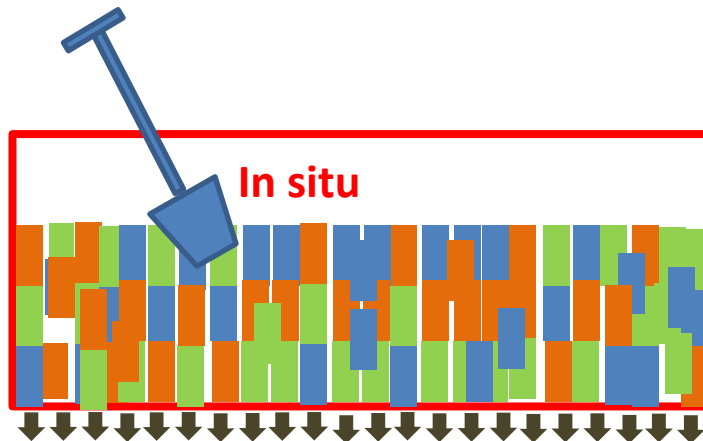
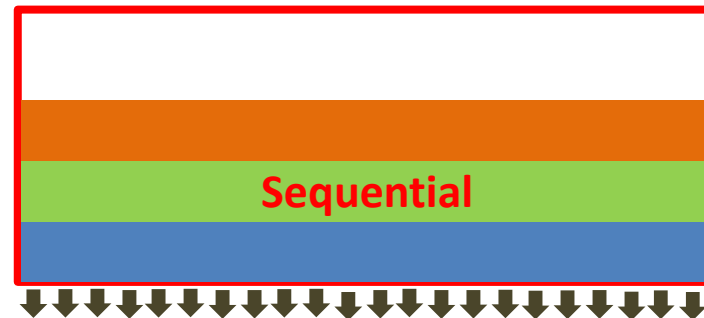
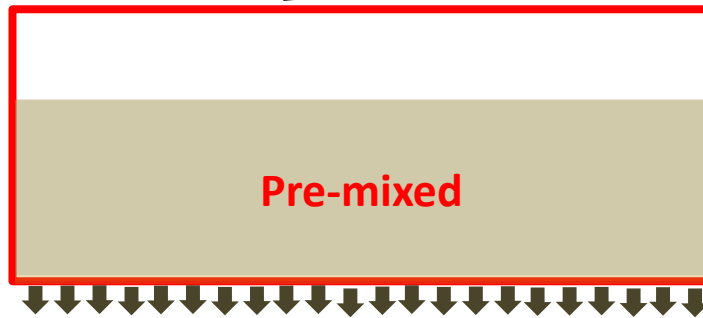
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A	A	A	A	B	B	B	B	A	A	A	A	B	B	B	B
A	A	A	A	B	B	B	B	A	A	A	A	B	B	B	B
B	B	B	B	A	A	A	A	B	B	B	B	A	A	A	A
B	B	B	B	A	A	A	A	B	B	B	B	A	A	A	A
B	B	B	B	A	A	A	A	B	B	B	B	A	A	A	A
B	B	B	B	A	A	A	A	B	B	B	B	A	A	A	A
A	A	A	A	B	B	B	B	A	A	A	A	B	B	B	B
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B	B	B	B	A	A	A	A	B	B	B	B	A	A	A	A
B	B	B	B	A	A	A	A	B	B	B	B	A	A	A	A
B	B	B	B	A	A	A	A	B	B	B	B	A	A	A	A
B	B	B	B	A	A	A	A	B	B	B	B	A	A	A	A

But on a REAL farm...

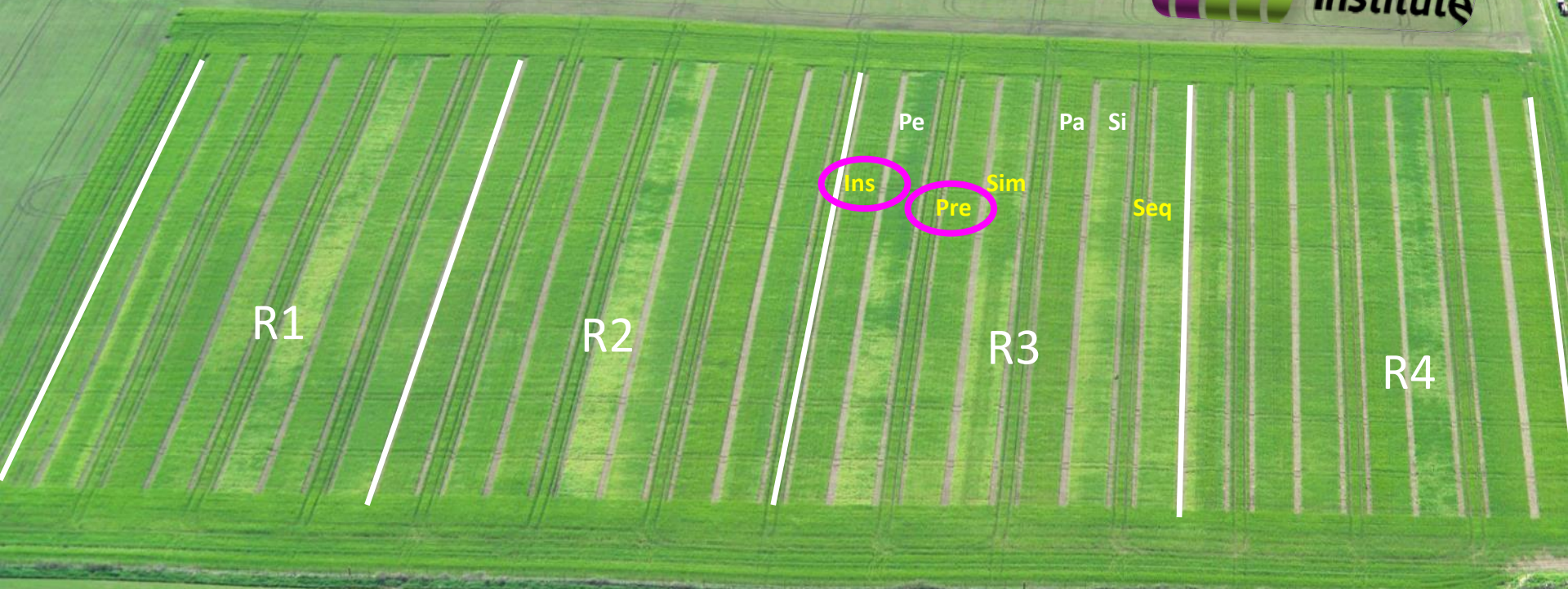
3 different varieties



Drill hopper



Patchy arrangements in the field



Yield

Mixtures cf. mono mean: 2005
2006

In situ

+13%***
+17%***

Pre-mix

-4%
+10%

Rhynchosporium

Mixtures cf. mono mean: 2005
2007

In situ

-34%***
-58%***

Pre-mix

+10%
-35%

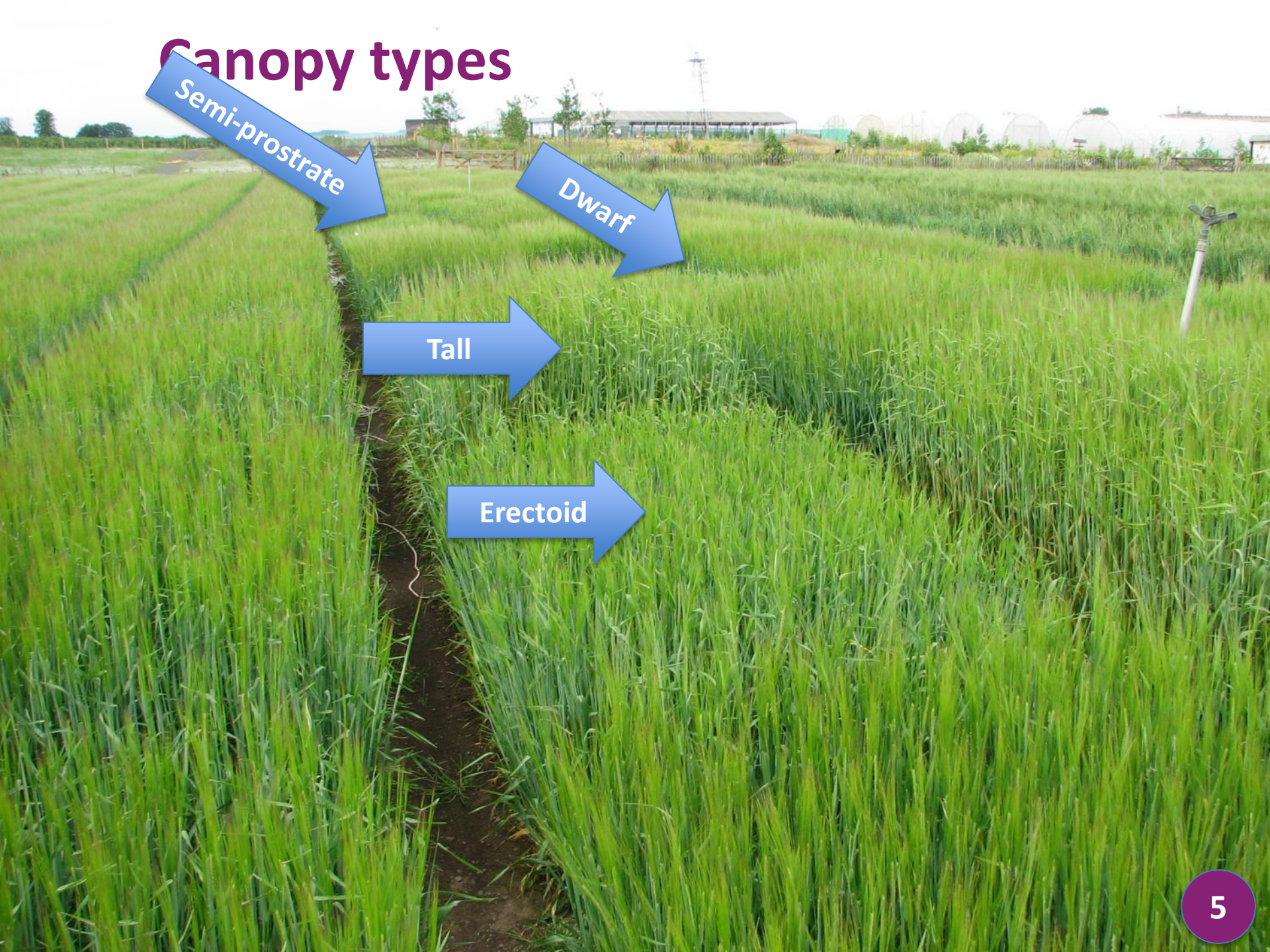
Canopy types

Semi-prostrate

Dwarf

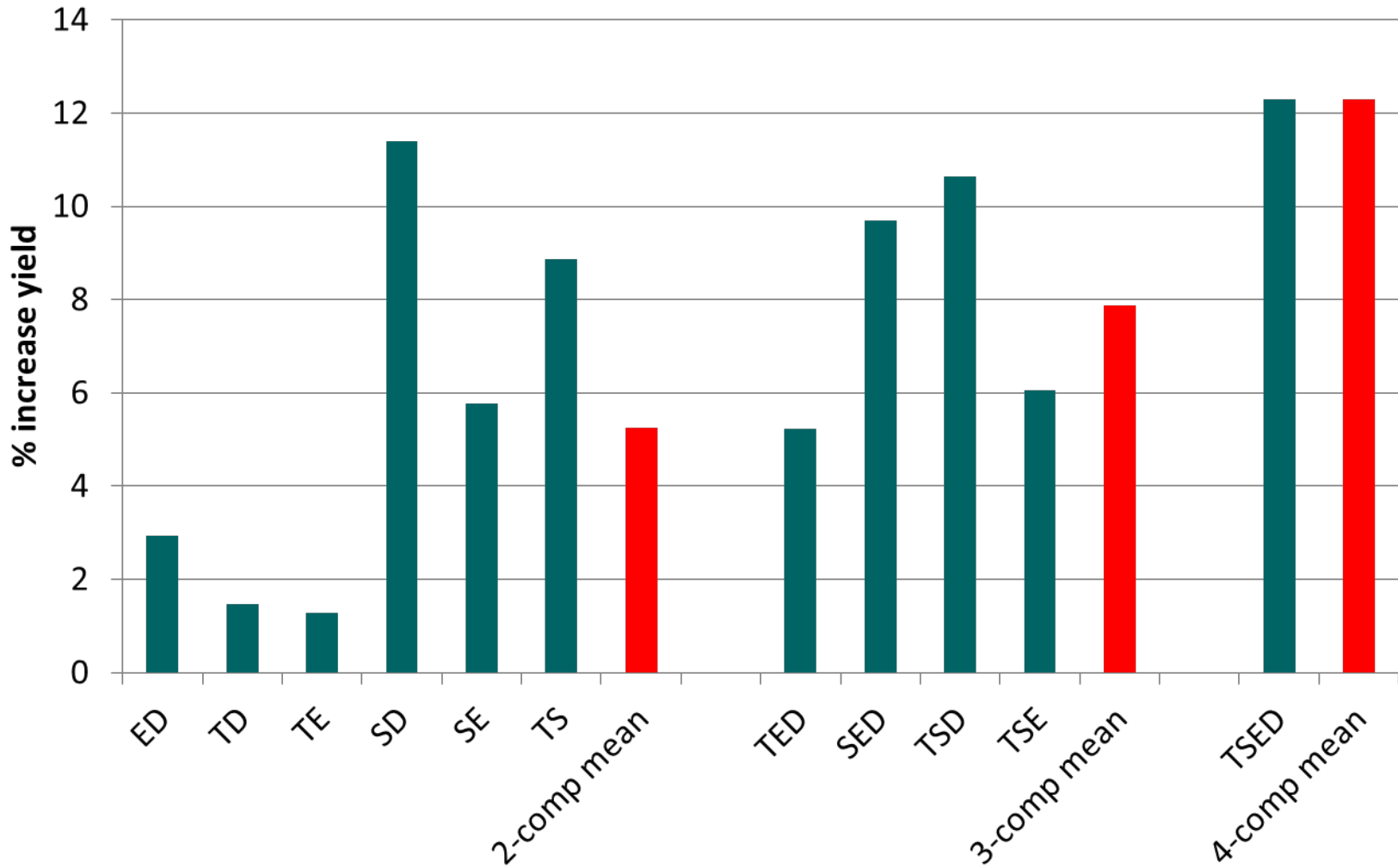
Tall

Erectoid





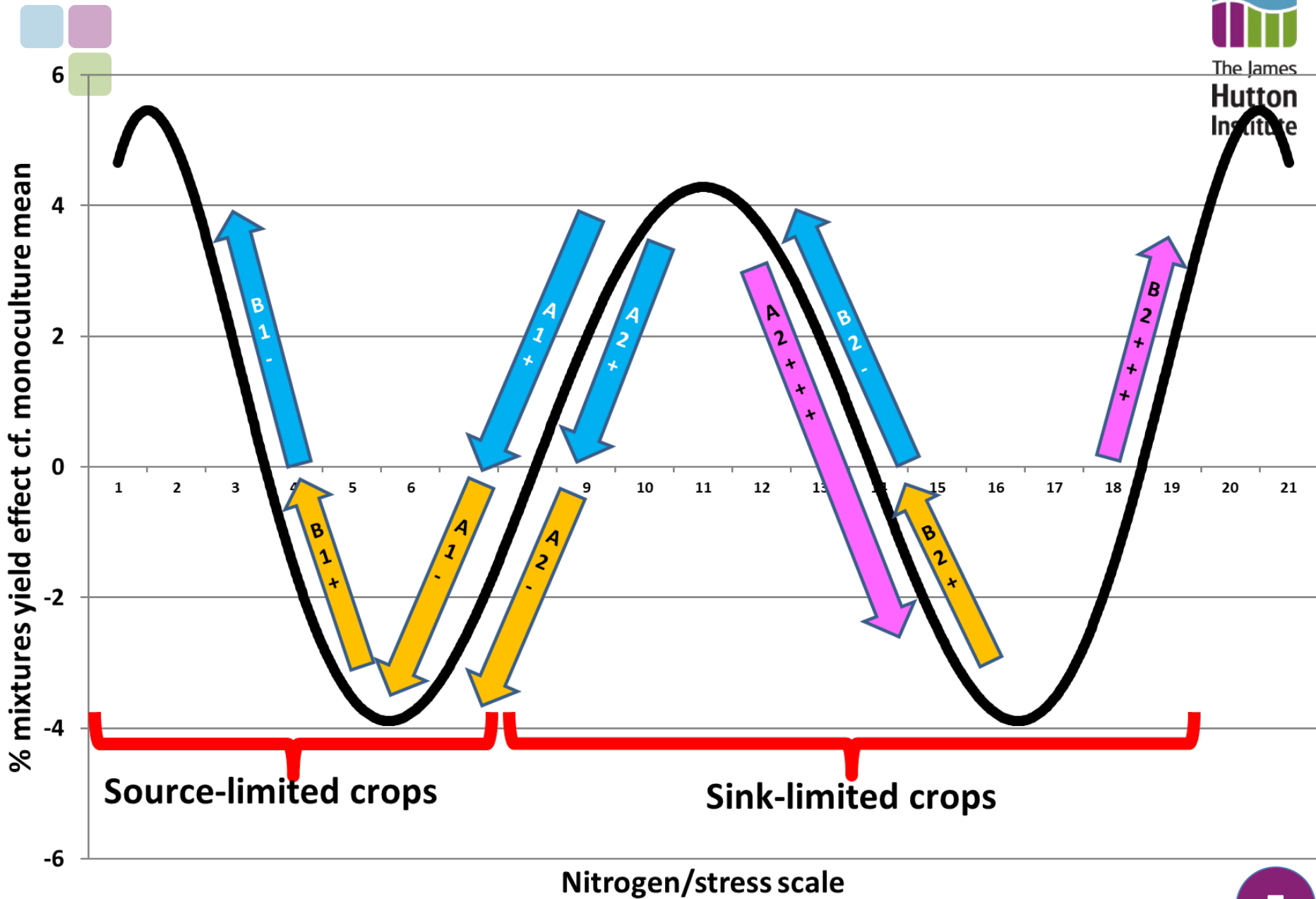
Mixed canopy habits





Are mixtures always beneficial?

Trial	Crop
DC	WW
DP	WW
DZ	WW
CU	SB
GCh	WB
DC	WB
EV	WB
DP	WB
EK	WB
GCb	WB
EL	WW
CX	WW
GL	SB
DK	SB



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Cereals with legumes...



Rye-pea

Barley-pea





**Regrowth
after
cutting**

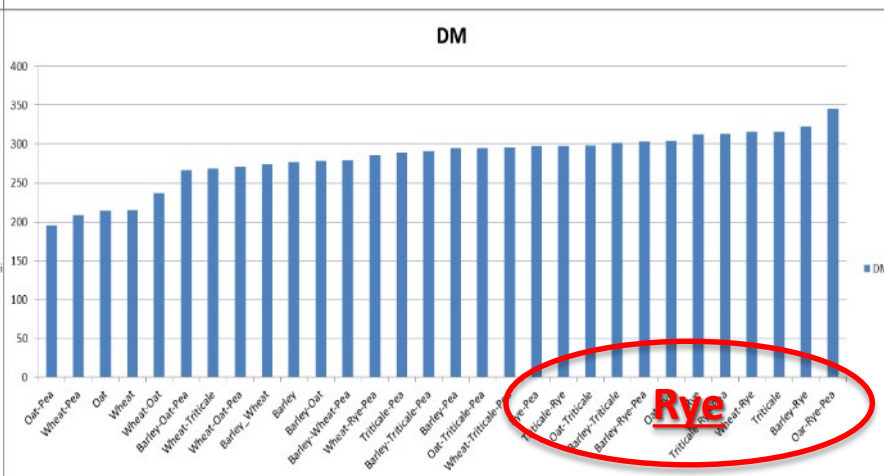
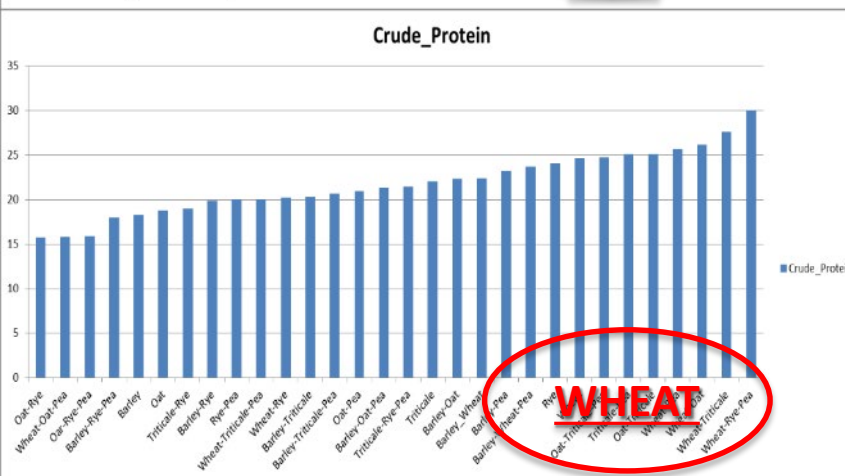
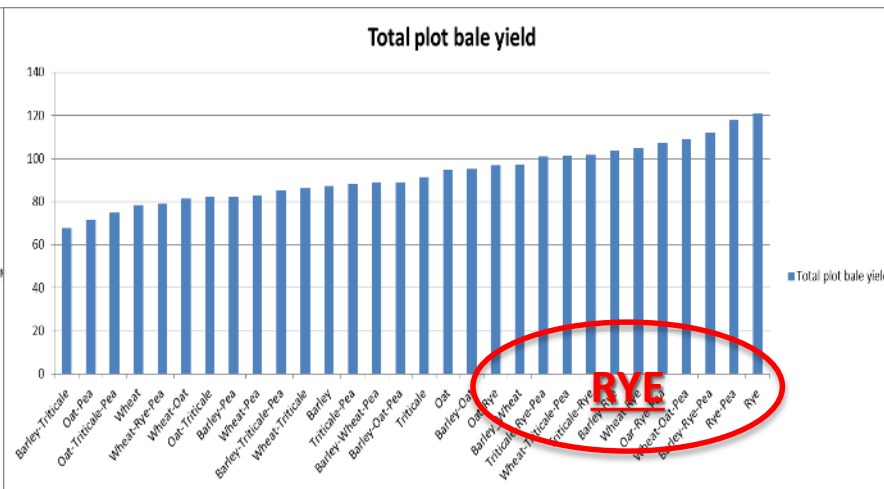
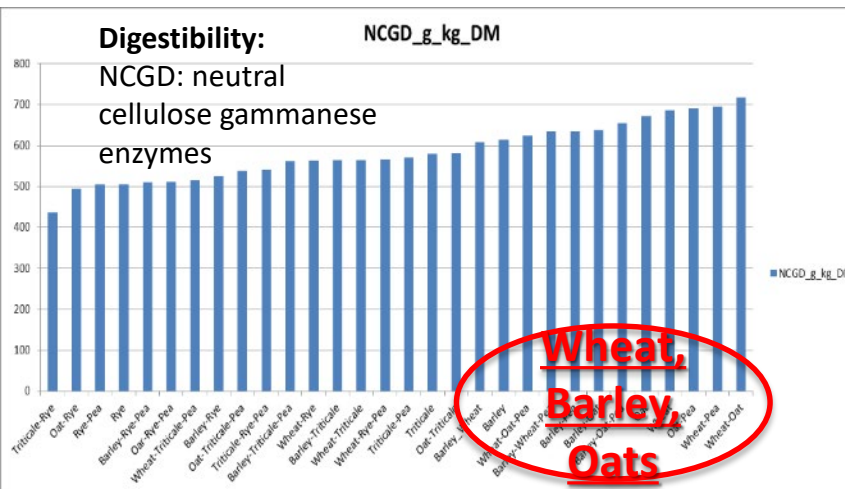
Ryegrass

Oats

2015 trial:



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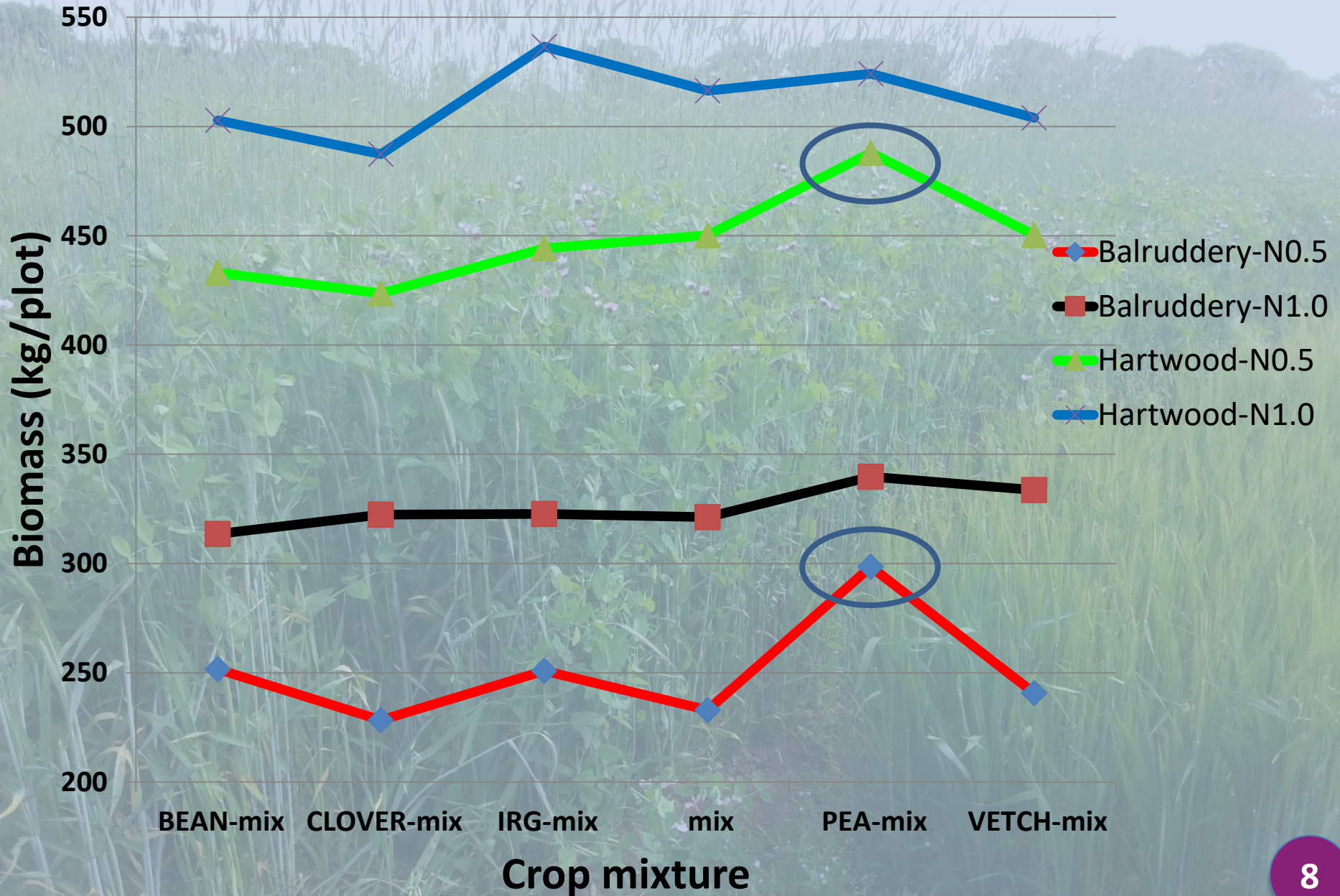
Top biomass combinations 2016:

- Rye+Oats+Vetch 452
- Rye+Oats 448
- Rye+Oats+Pea 433
- Oats+Barley+Pea 444
- Oats+Barley+Vetch 428
- Oats+Triticale+Pea 434

(Wheat not in 2016 trial)

**Pea very +ve if N reduced
(LAE increased)**

Winter cereal-legume biomass crops





Conclusions

Many...

Practical and beneficial...

Thank you!



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