Crop yield and weed responses to an integrated cropping system

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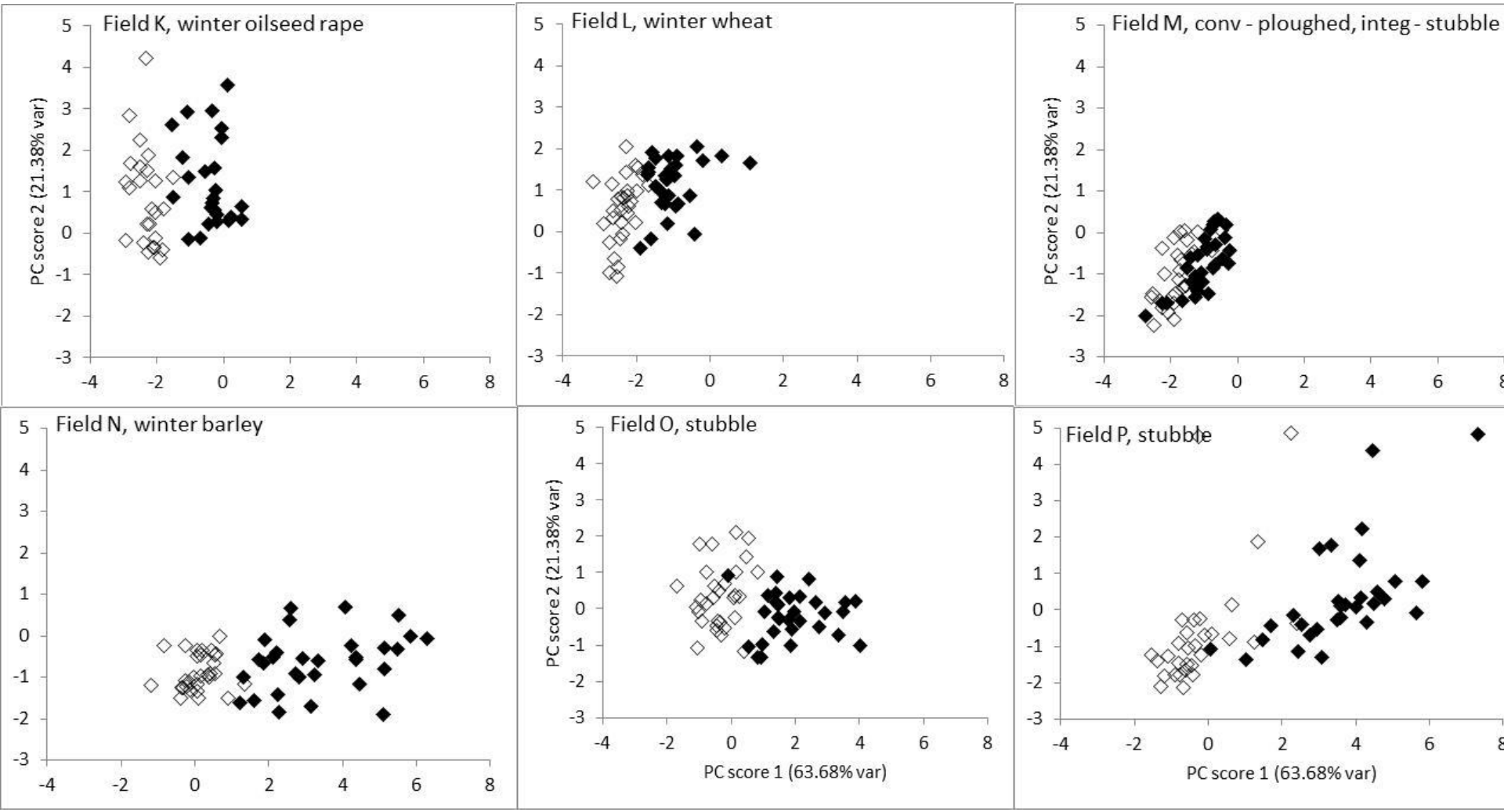
Cropping systems - reminder

Conventional	Integrated
Standard plough and cultivations (every year)	Non-inversion tillage (5 yrs in 6); Tied ridging in potatoes
Standard rate mineral fertiliser	Mineral N at 70% full rate; 35 t per ha municipal compost; Clover under-sowing in sp. barley
Standard rate pesticide inputs	Threshold pesticide applications; Blight forecasting using Hutton Criteria
Recommended herbicide input	Weed management to allow ~10% cover dicot weeds – competitive weeds targeted
Straw baled	Straw chopped and incorporated
	Cover crop after winter barley

Effect of crop system on soil properties

- %N, %C, DOM, P, K, pH – all greater in integrated management treatment

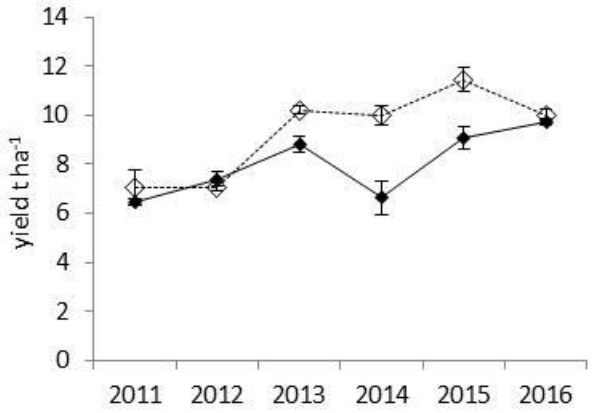


Crop yields

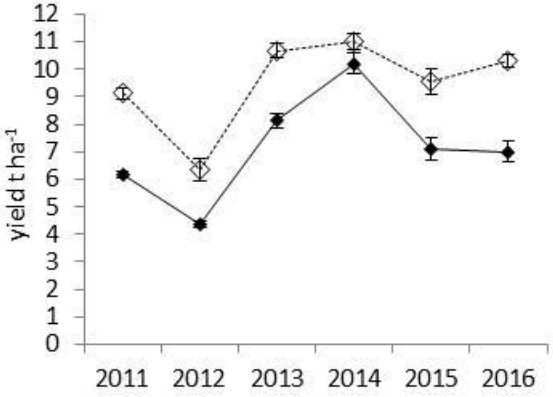
- Yields were maintained for all crops except winter wheat

Integ = solid
Conv = dashed

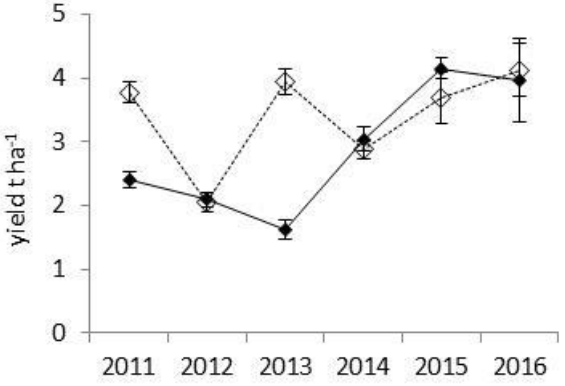
Winter barley (ns: p = 0.06)



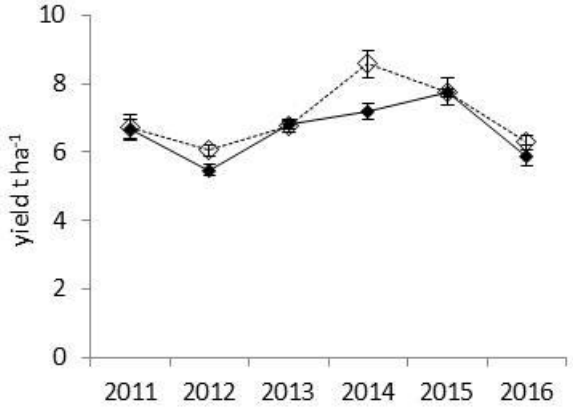
Winter wheat (**)



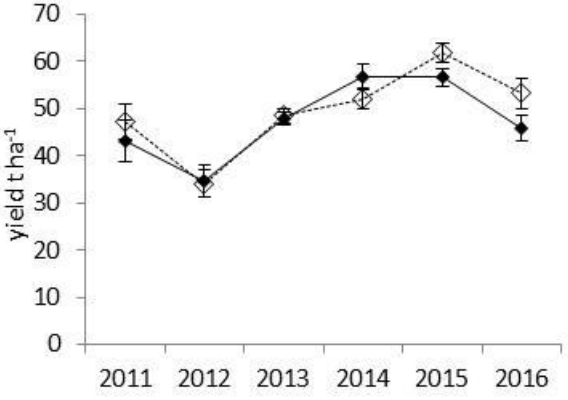
Winter oilseed rape (ns)



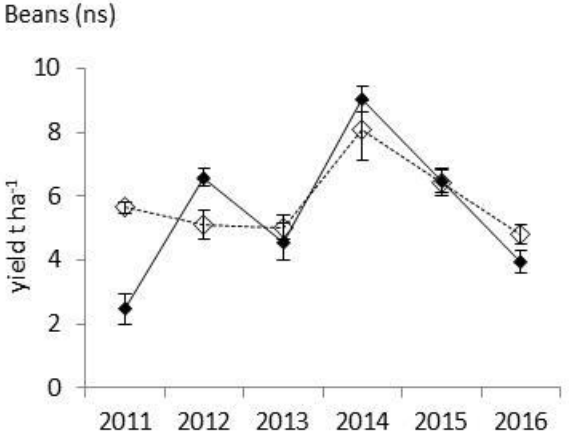
Spring barley (ns)



Potato (ns)

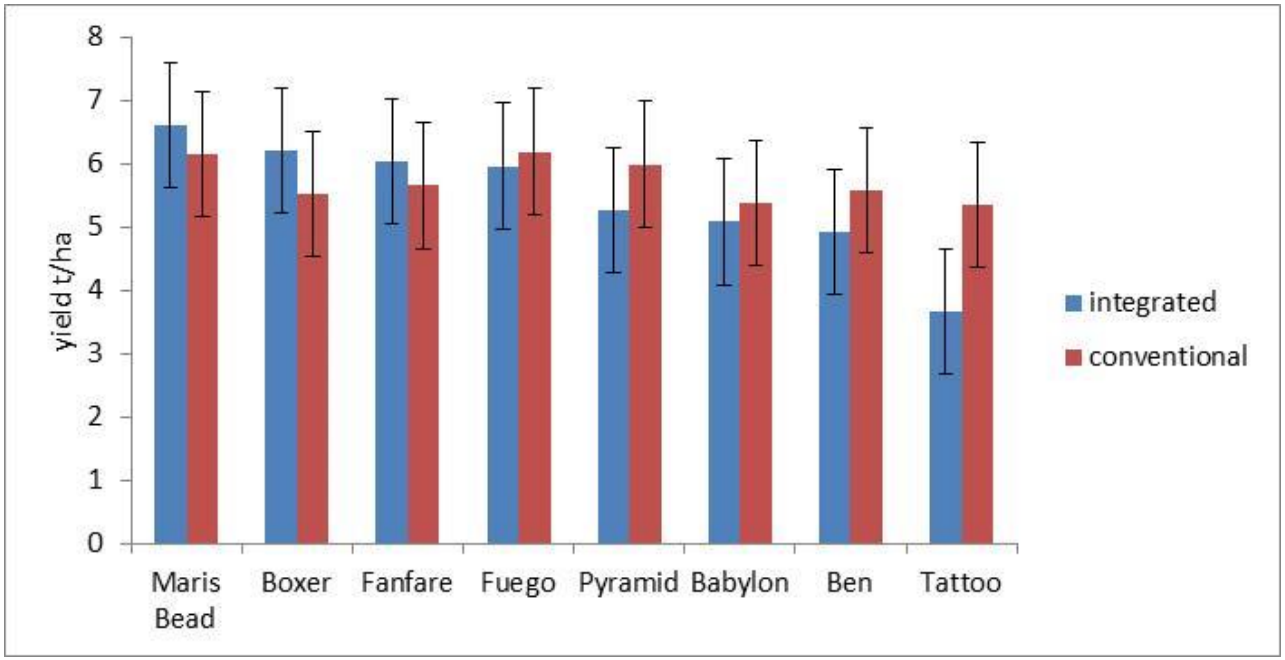


Beans (ns)



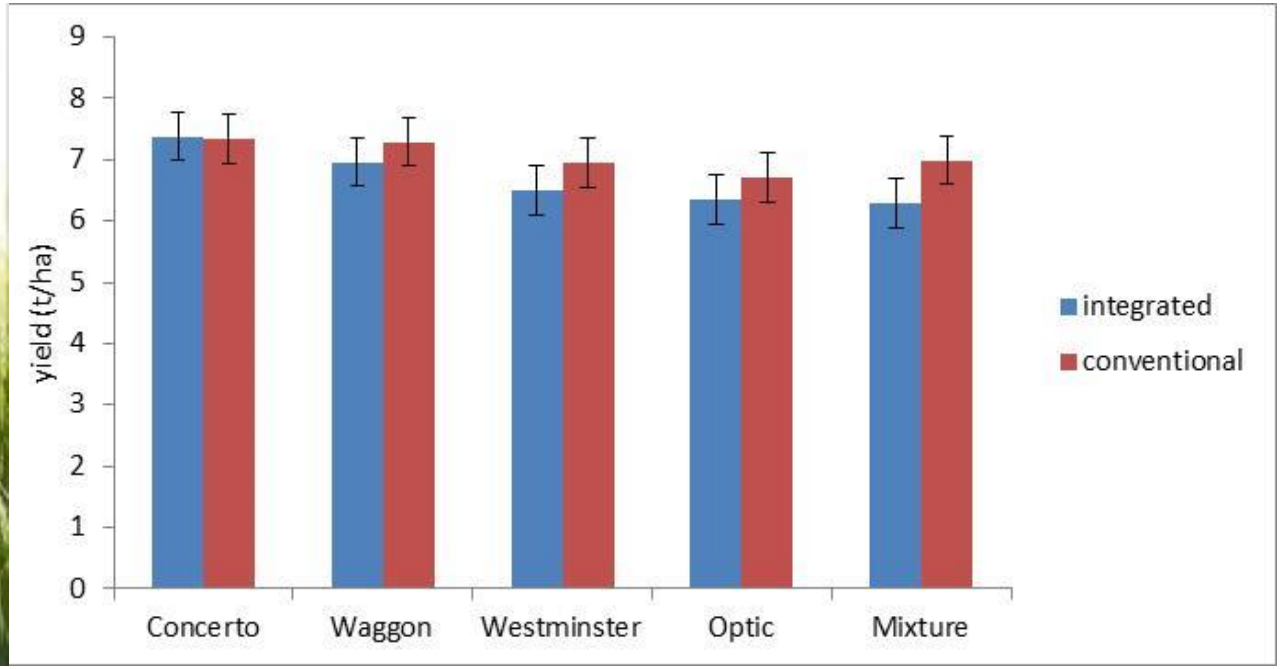
Crop yields - beans

- treatment effect (ns)
- variety effect (ns)
- interaction (ns)



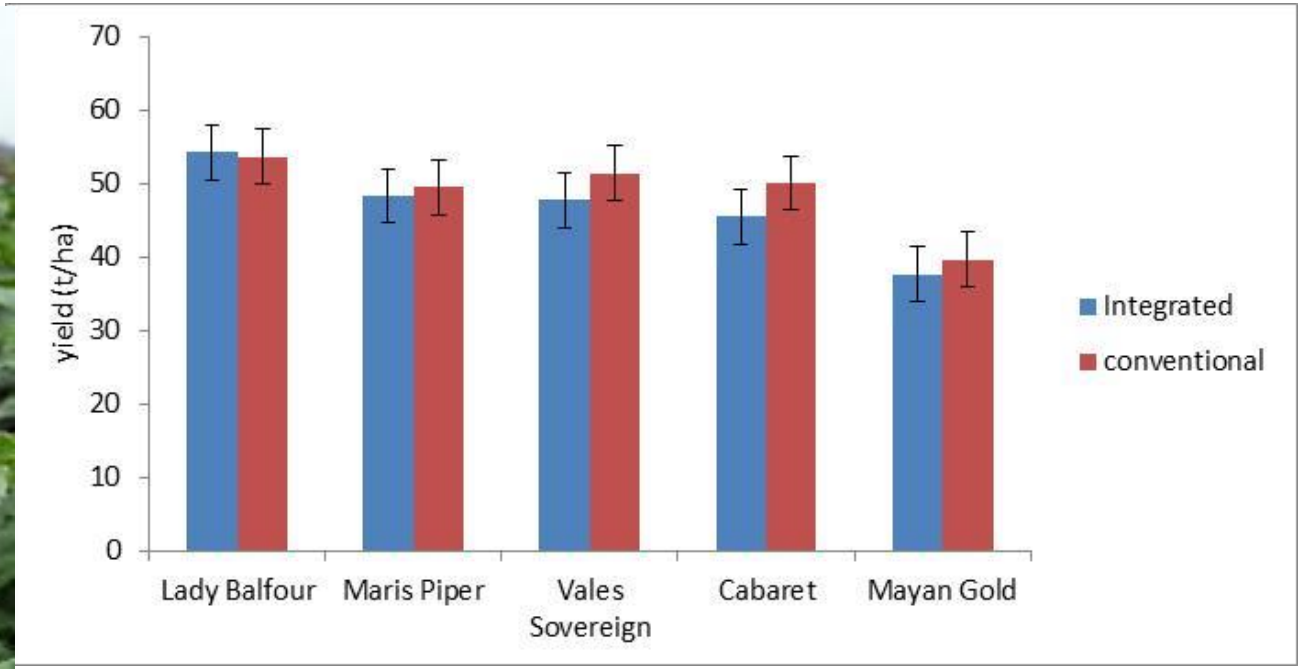
Crop yields – spring barley

- treatment effect (ns)
- variety effect ($p<0.001$)
- interaction (ns)



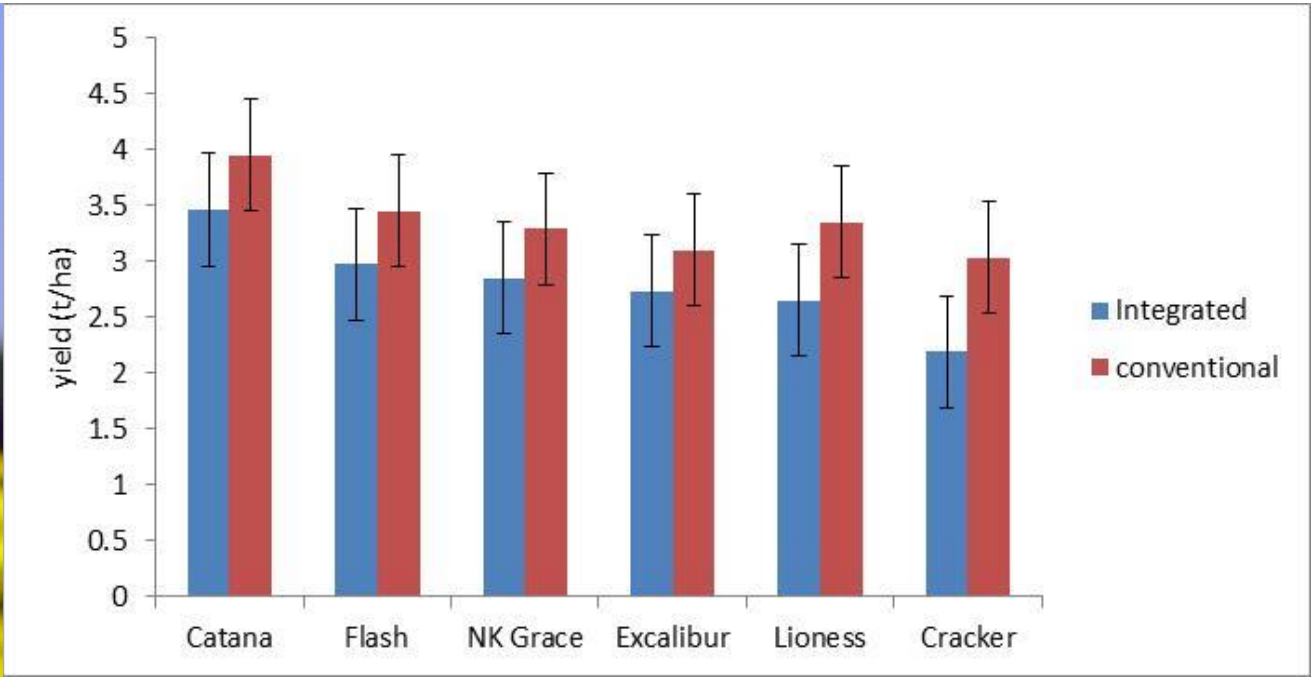
Crop yields – potato

- treatment effect (ns)
- variety effect ($p<0.001$)
- interaction (ns)



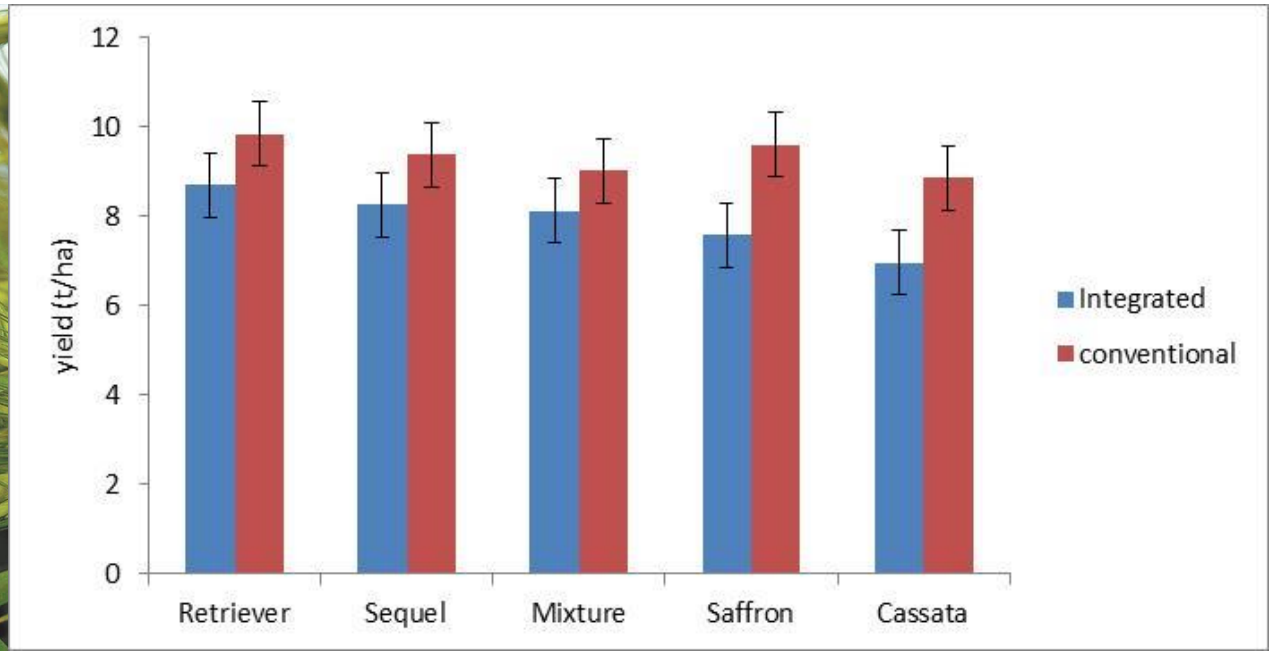
Crop yields – winter oilseed rape

- treatment effect (ns)
- variety effect (p = 0.001)
- interaction (ns)



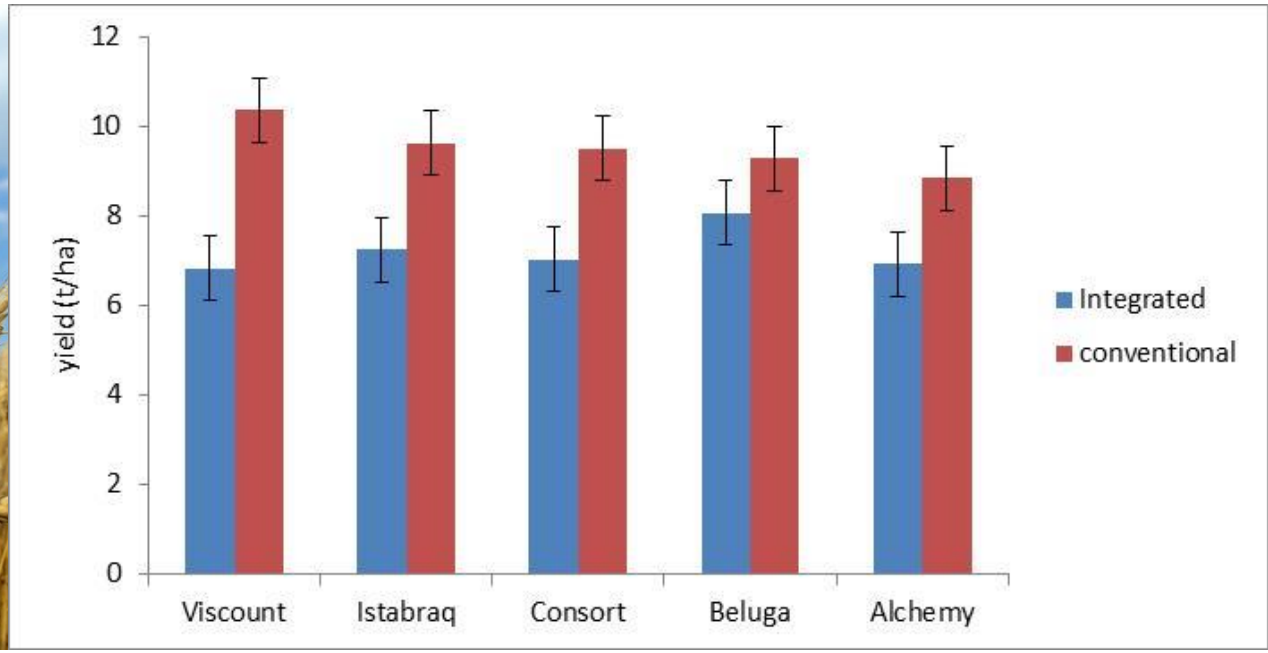
Crop yields – winter barley

- treatment effect (ns, p = 0.06)
- variety effect (p <0.001)
- interaction (ns)



Crop yields – winter wheat

- treatment effect (p = 0.001)
- variety effect (p = 0.04)
- interaction (p = 0.004)

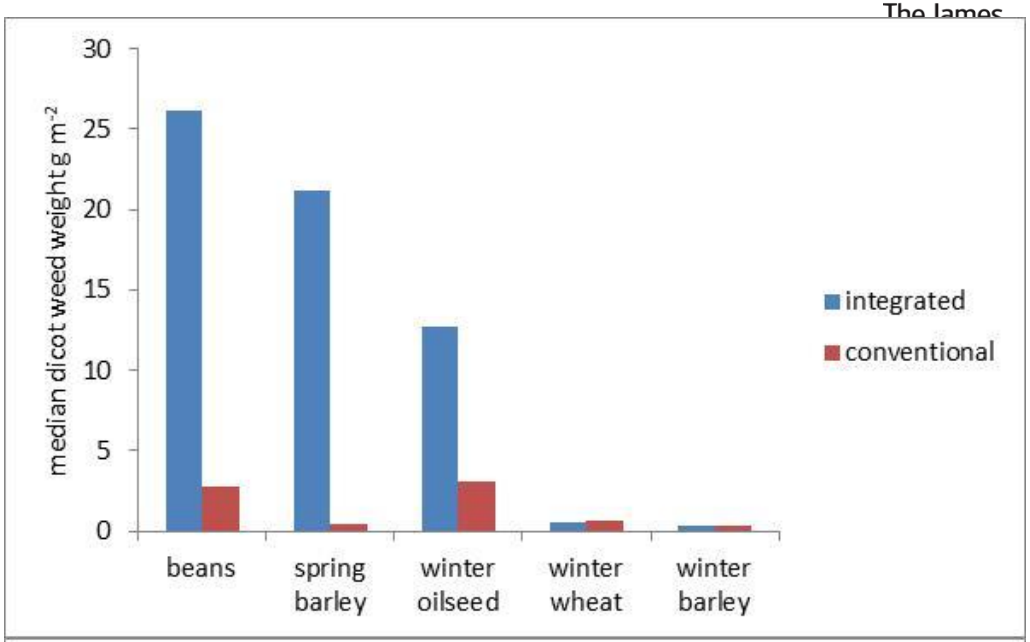


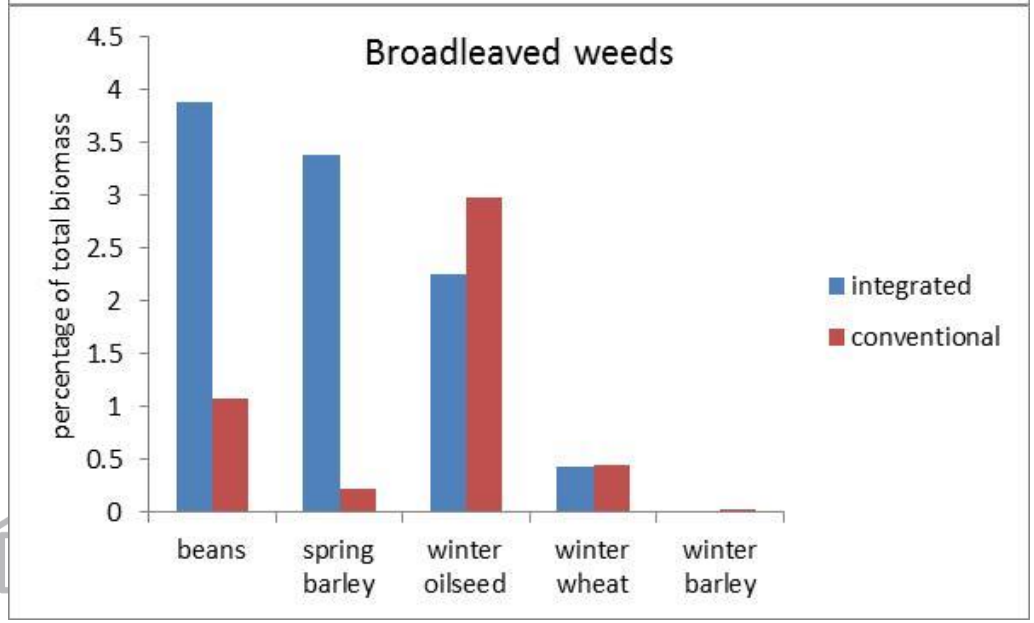
Biodiversity - arable plant biomass

- Density of crop and weeds estimated as g m^{-2} dry matter
- All plant material from 0.5 x 1 m quadrats collected in July
- Separated into dicots, monocots, crop stems and ears
- Dried at 70 ^{o}C for 48 hrs
- Weighed to give estimate of biomass production per unit area

Biodiversity – broadleaved weeds

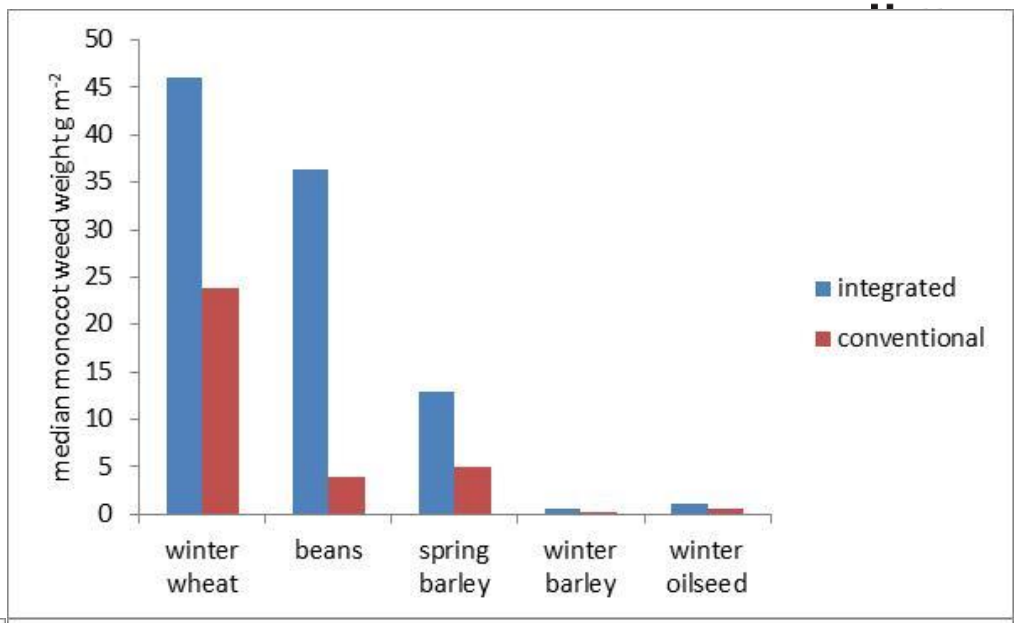
- More dicot weeds in integrated management (20 g m^{-2}) than conventional (9 g m^{-2}), p = 0.02
- Effect due to difference in spring crops and OSR
- Biodiversity benefit (pollinators and natural enemies – to be tested)

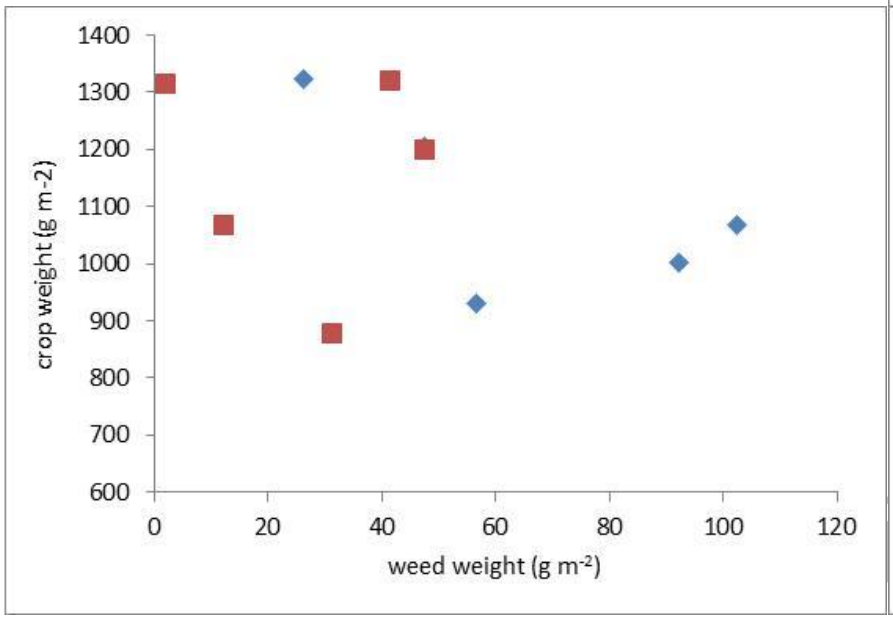


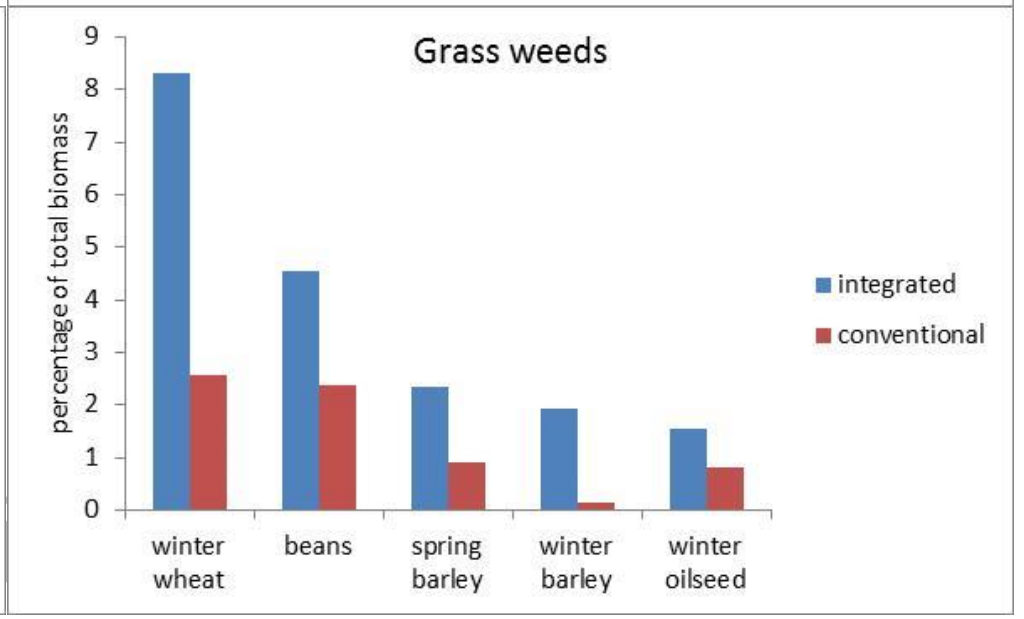


Biodiversity – grass weeds

- More grass weeds in integrated management (40 g m^{-2}) than conventional (16 g m^{-2}), p = 0.04
- Crop-weed competition?
- Crop weight v weed weight p <0.001, -ve slope 0.04

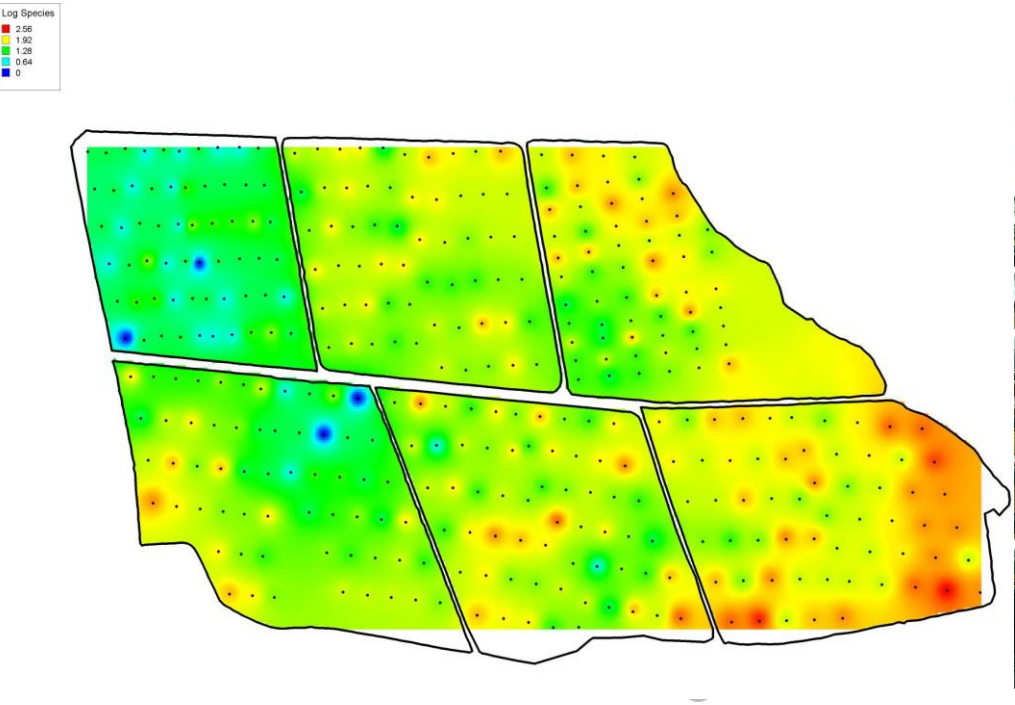






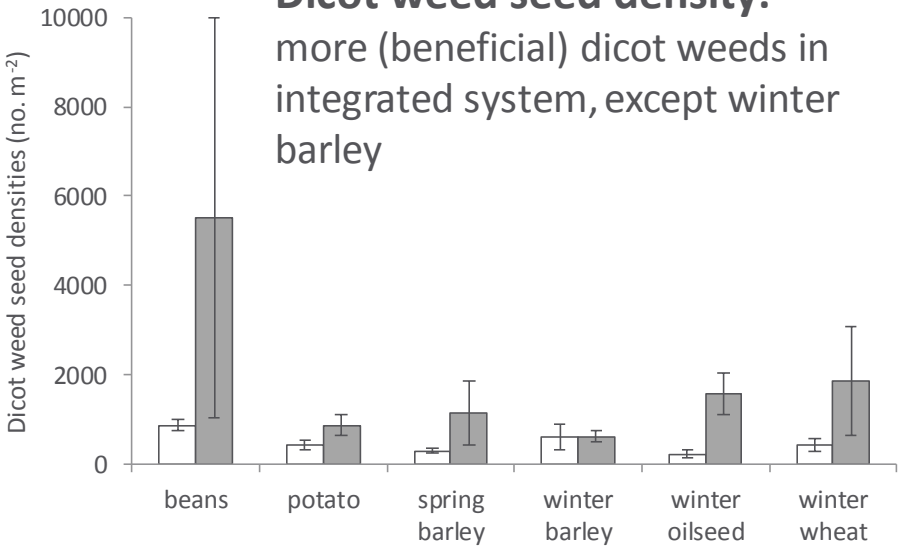
Biodiversity - arable weed seedbank

- Seedbank sampled every spring from 350 GPS locations
- Emerged weed seeds from each sample identified and removed
- Number of individuals per species across all fields/treatments through the rotation

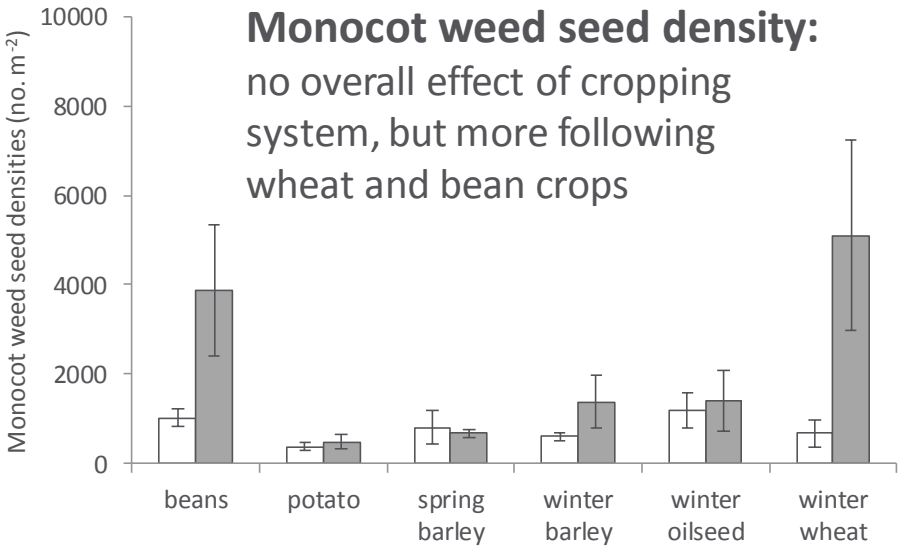


Biodiversity - arable weed seedbank

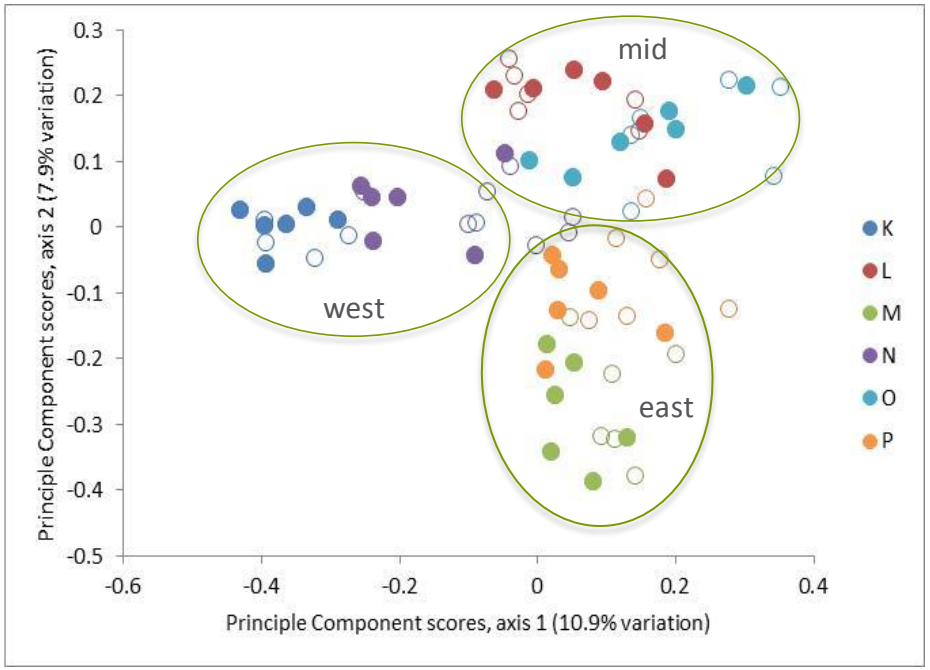
Dicot weed seed density:
more (beneficial) dicot weeds in integrated system, except winter barley



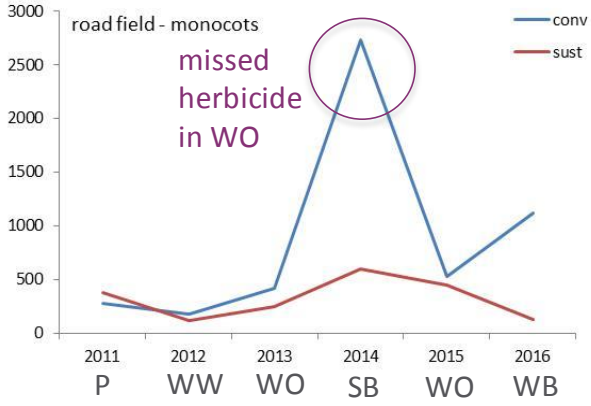
Monocot weed seed density:
no overall effect of cropping system, but more following wheat and bean crops

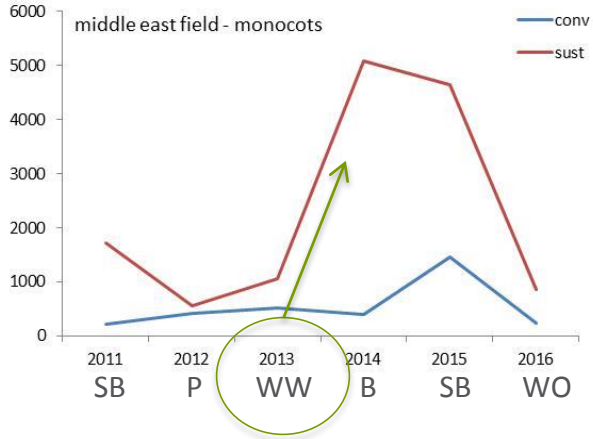


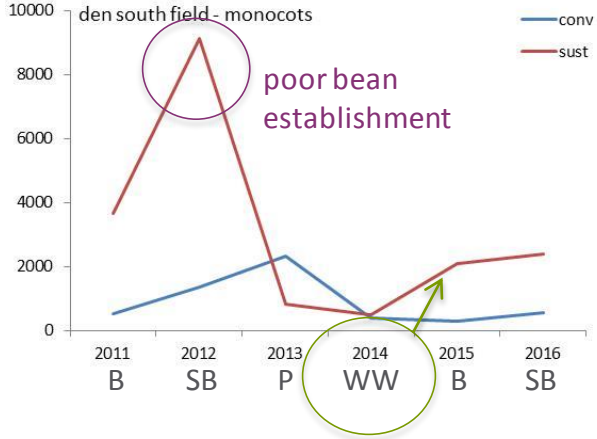
Field effect stronger than crop or treatment in determining species composition

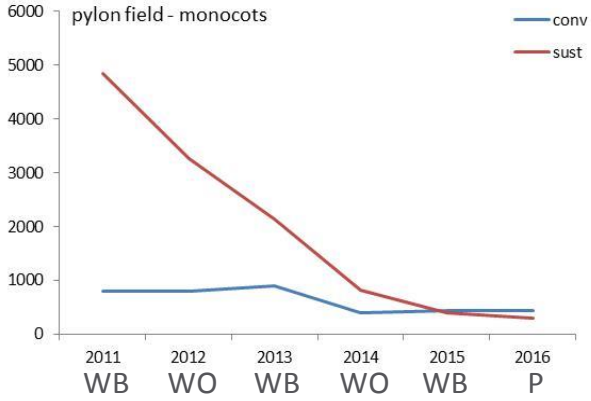


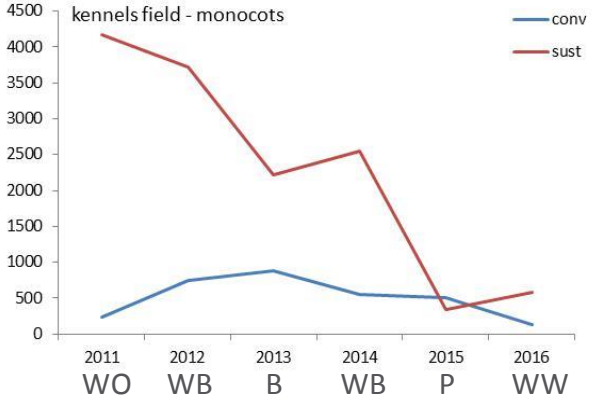
Biodiversity – seedbank temporal trends

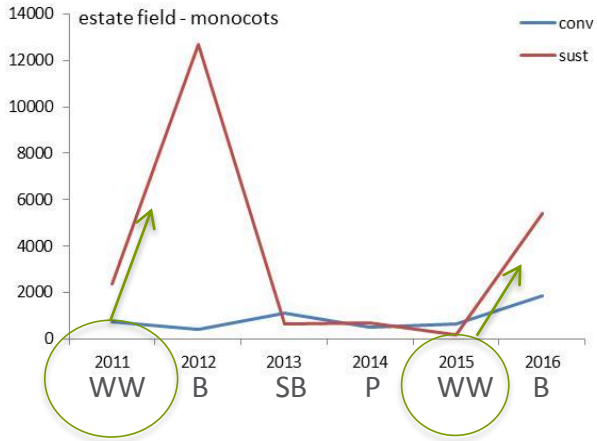












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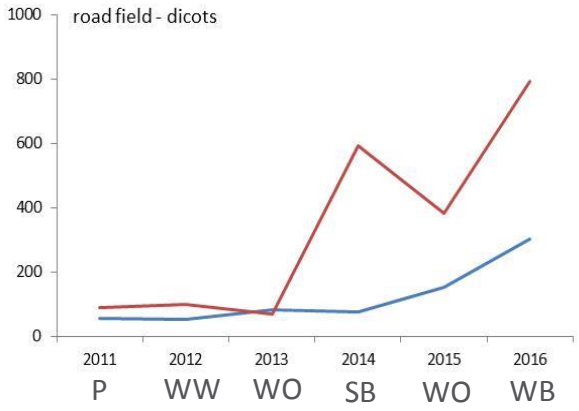
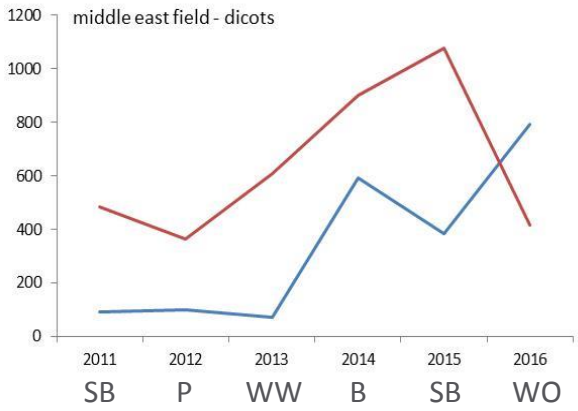
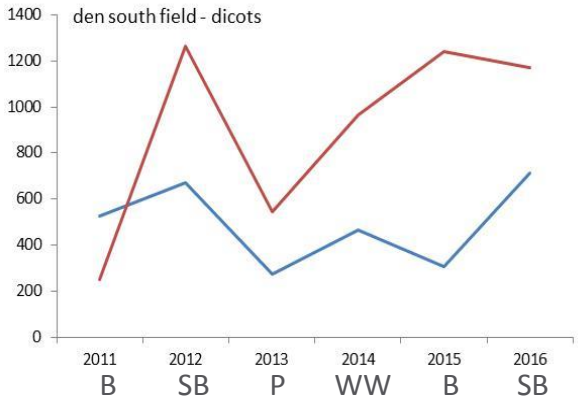
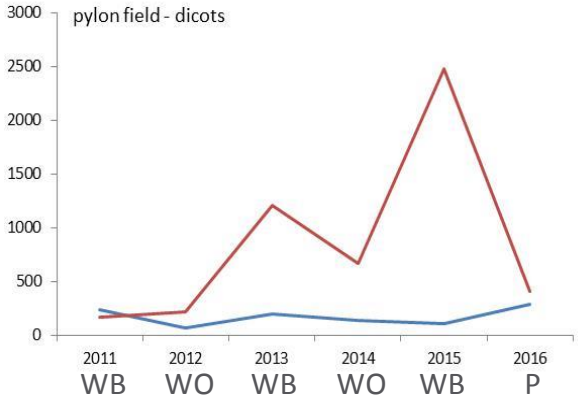
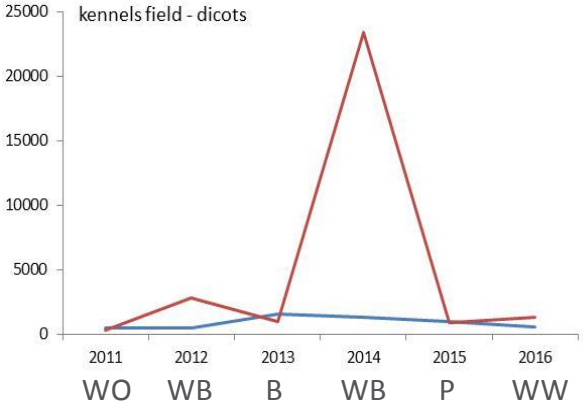
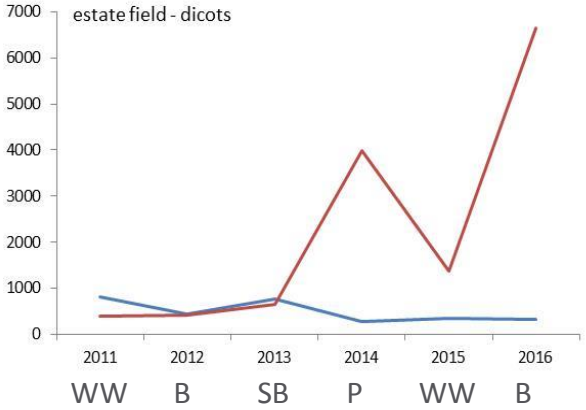












Biodiversity - field margins

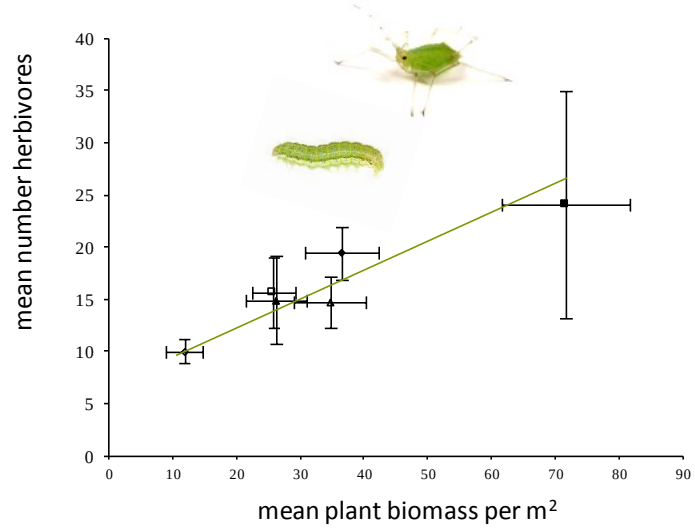
- Wildflower mix sown to attract pollinators and natural enemies
- Plant species combinations to be tested for optimal wildlife benefit and nutrient uptake
- Greenhouse gas emissions
- Predation and pollinator activity

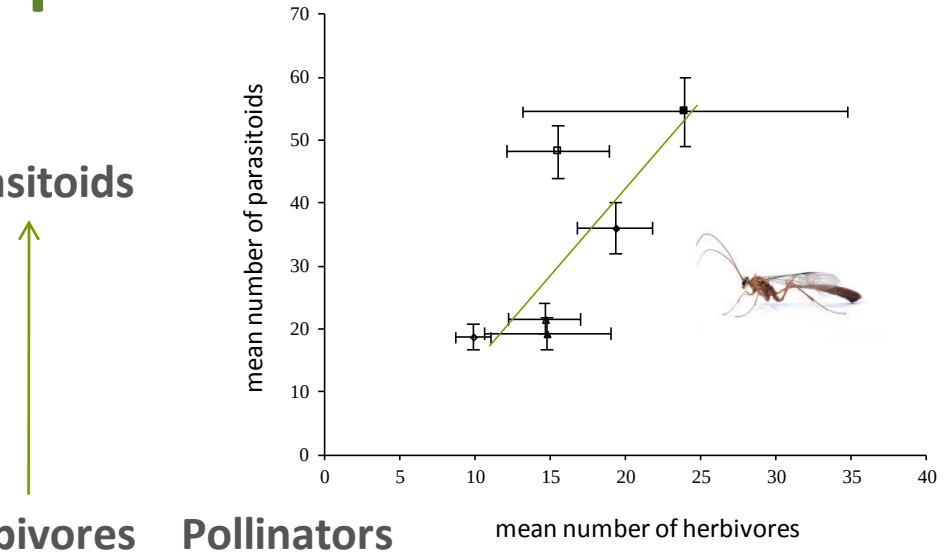
"Magic margins" win Innovation Award at RSPB Nature of Scotland Awards

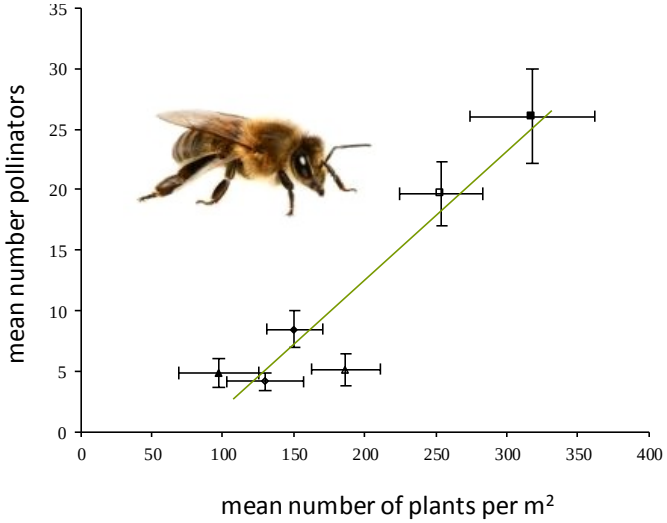
- Magic Margins developed by Euan Caldwell and the Farm team
- Deployed across the farm
  - Greater surface area
  - More plant diversity
  - Erosion trap
  - Reduced traffic

Biodiversity – plant-insect interactions

- Dicots support insect populations
- Positive relations between resource and consumers
- Depends on plant quality

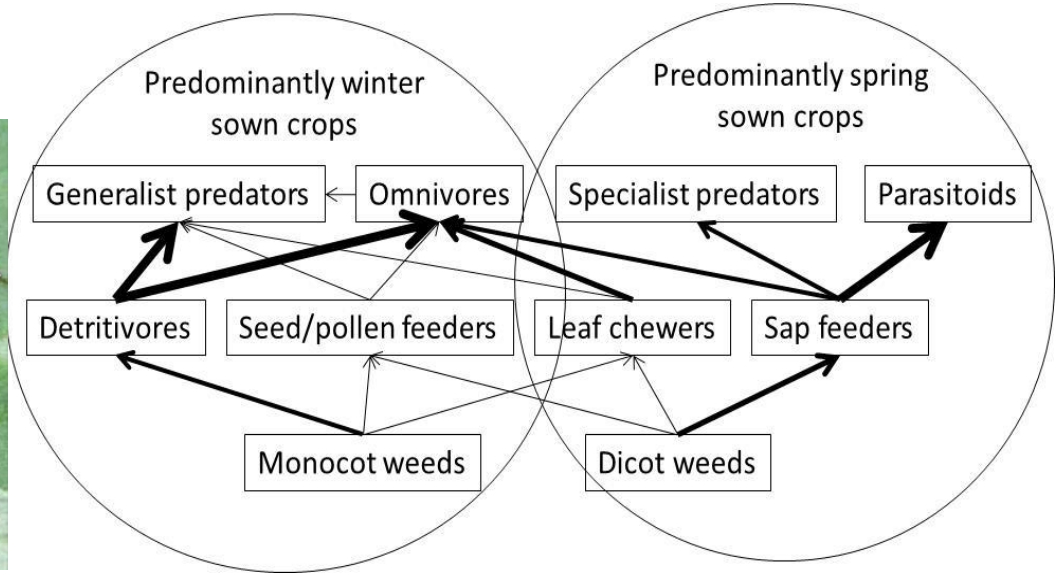






Biodiversity – invertebrate foodwebs

- Vortis suction sampling for all invertebrates inhabiting weed, margin and crop vegetation
- Pitfall trapping for surface-active invertebrates in margins and fields
- Bee and butterfly transects for pollinator activity



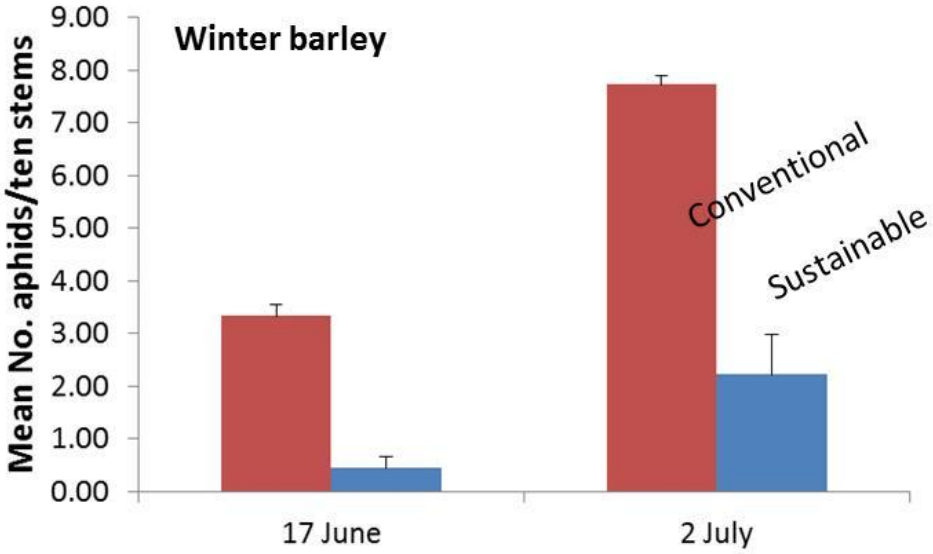
Biodiversity – pest biocontrol

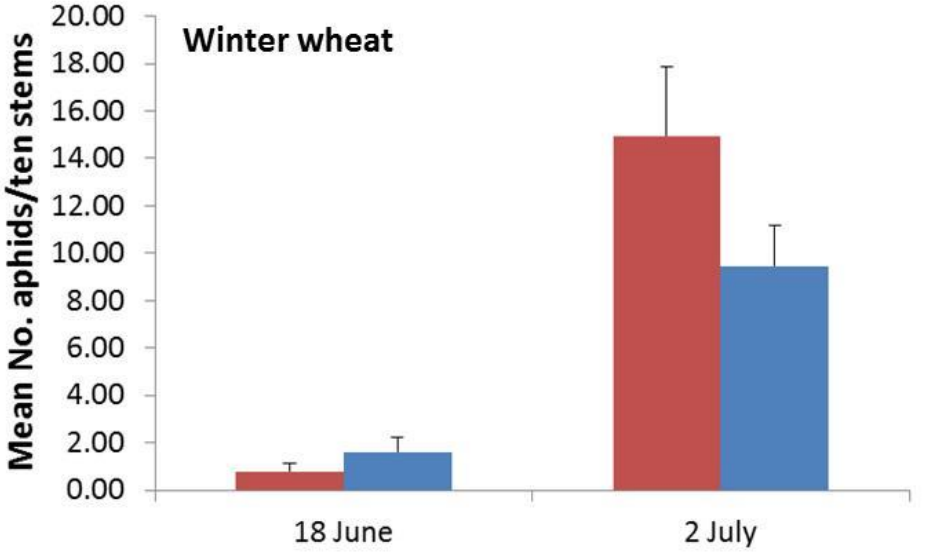
- Does integrated management affect populations of crop pests?
- Is the abundance and activity of natural enemies that regulate pest populations altered?
- Can we relate changes in pest abundance to natural enemy presence and activity?

Biodiversity – pest biocontrol

Pest numbers in winter cereals

- Seasonal increase in aphid numbers
- Evidence for reduced aphid abundance in sustainable treatment

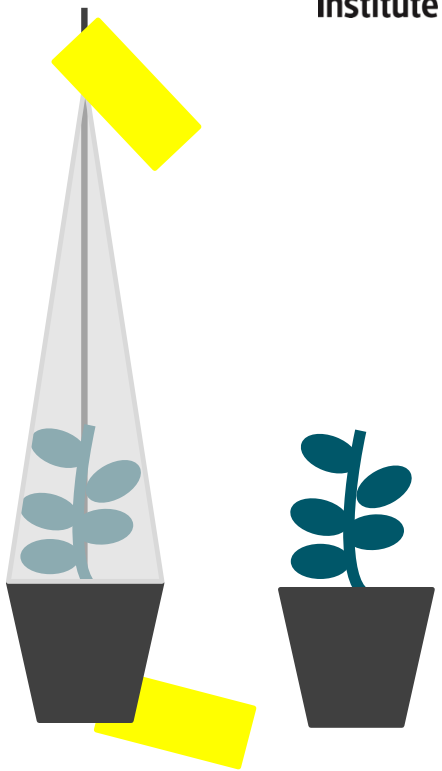




Biodiversity – pest biocontrol

Aphid-infested bait plants to assess NE activity:

- Spring barley, bean, potato (sustainable *vs.* conventional)
- Pre-flowering plants of spring barley, bean and potato were grown in pots in glasshouse
- Plants were enclosed in net bags and infested with *R. padi*, *A. pisum* and *M. euphorbiae*
- Plants in each crop were randomly assigned 'open' or 'closed' treatment (n=9)
- Aphid numbers on bagged plants were recorded before placing in the field and after 24 h exposure to field conditions
- Conducted in last week of July



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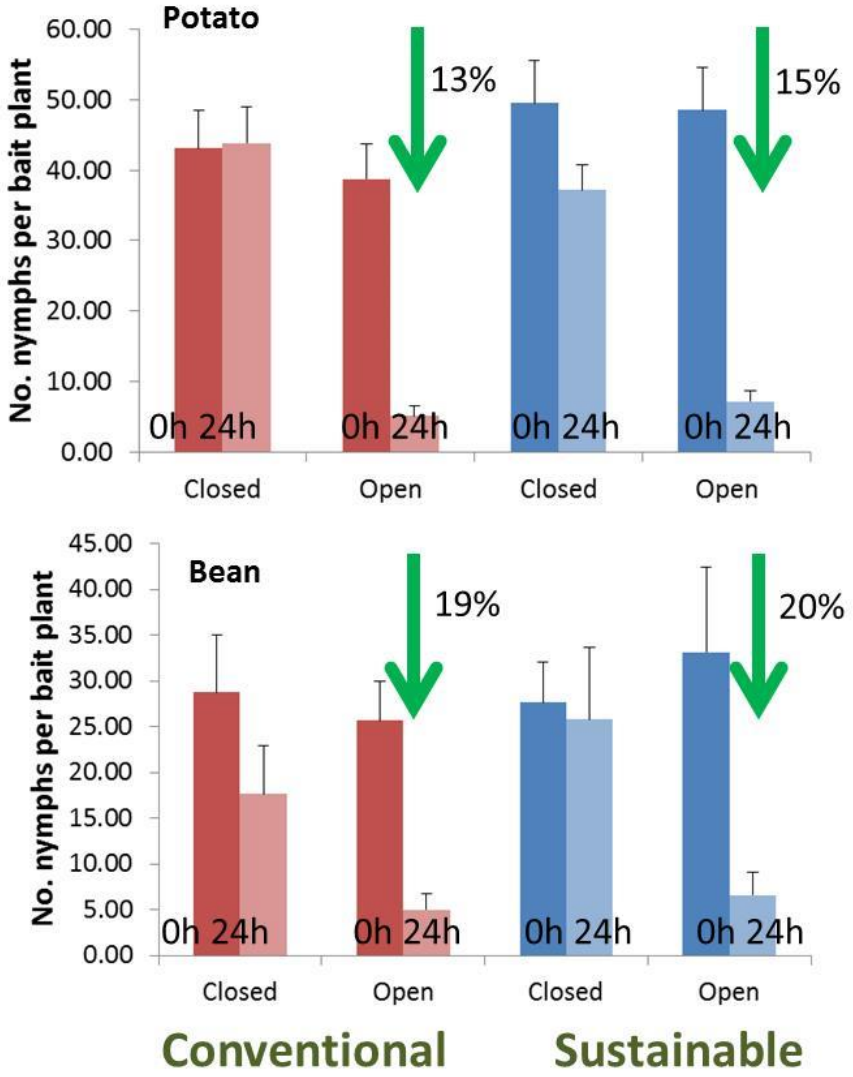
Contact: Ali Karley

Biodiversity – pest biocontrol



Aphid-infested bait plants to assess NE activity

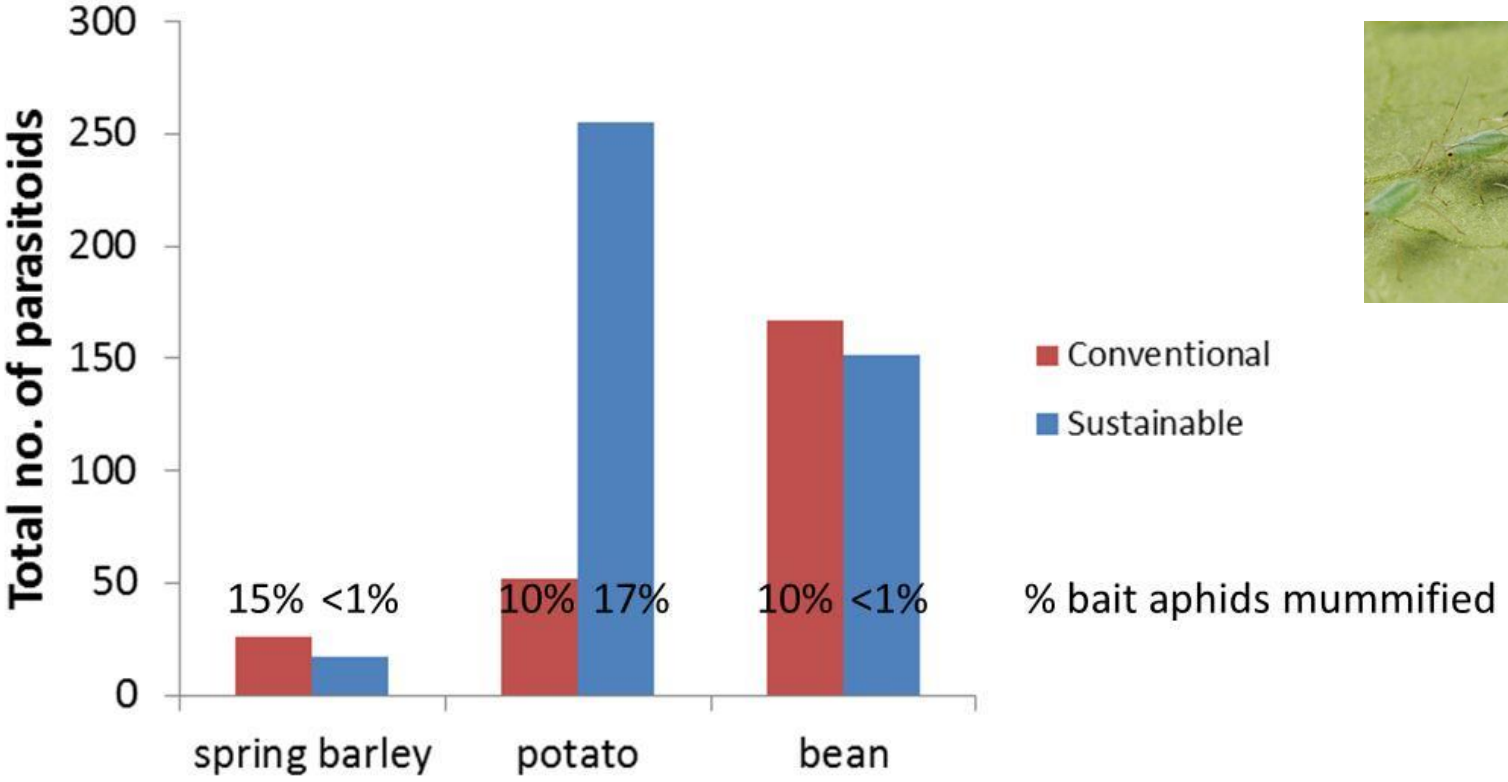
- Evidence for decrease in aphid numbers when 'exposed'
- Decrease in aphid numbers was similar between crop treatments

Contact: Ali Karley

Biodiversity – pest biocontrol

Parasitoid monitoring: sticky traps

- Parasitoid abundance on sticky traps varied between crop types and treatments - highest in sustainable potato
- No clear correlation between parasitoid abundance and aphid parasitism rates



Conclusions

Integrated cropping system for first 6 year rotation, results in:

- More soil organic matter, plant nutrients and higher pH
- Maintained crop yields (except for winter wheat)
- More beneficial weeds in field and soil seedbank
- More grass weeds in field, but no evidence for build-up in seedbank over time
- Greater within-field biodiversity
- Fewer aphids in winter cereals
- More parasitoids and parasitism rates in potato crops

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