Seeds and Deeds

From variety testing to decision support and systems redesign

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Principal Crops Researcher, Organic Research Centre
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OF&G NOCC 2019 #NOCC19

UK organic combinable crops

2018 data:

- **1.2%** of total combinable crops acreage
- oats: 7.3% **>>> wheat 0.5%**
- UK **less than 30%** self-sufficient

- Can we do more?
- **Starting from the seeds**
- **and from the way we generate and manage data**

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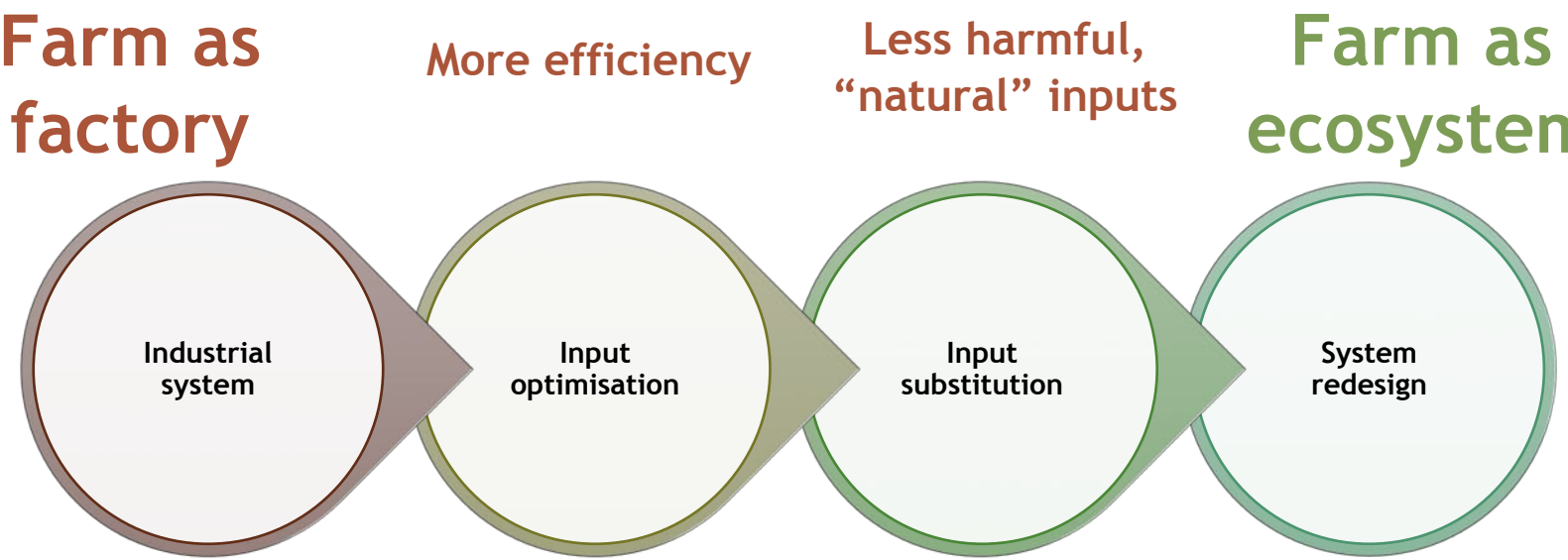
The transition to agroecology



- This is a framework: not necessarily a linear journey
- Easy to find barriers, possible to get backwards
- But useful to understand where we are and where to go

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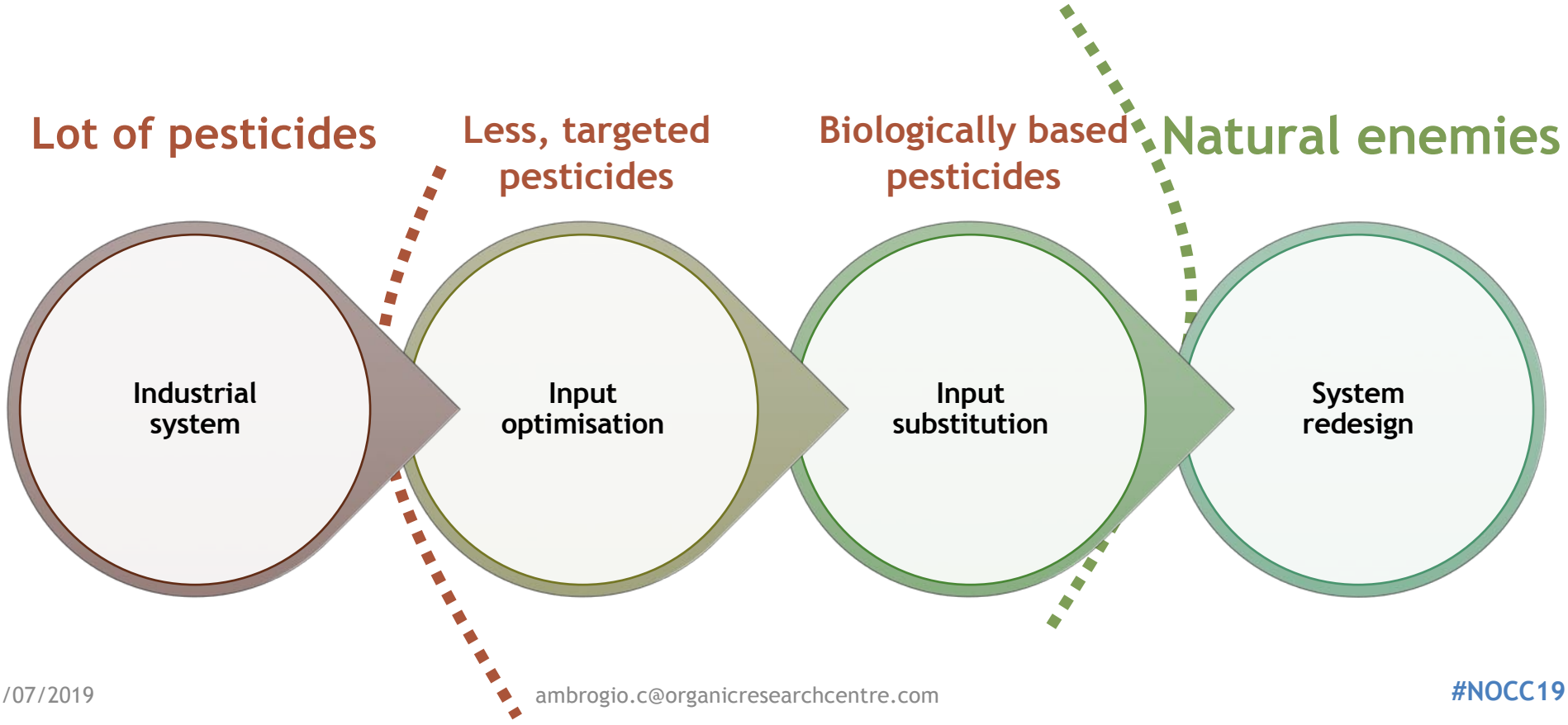
The classic example: pest control



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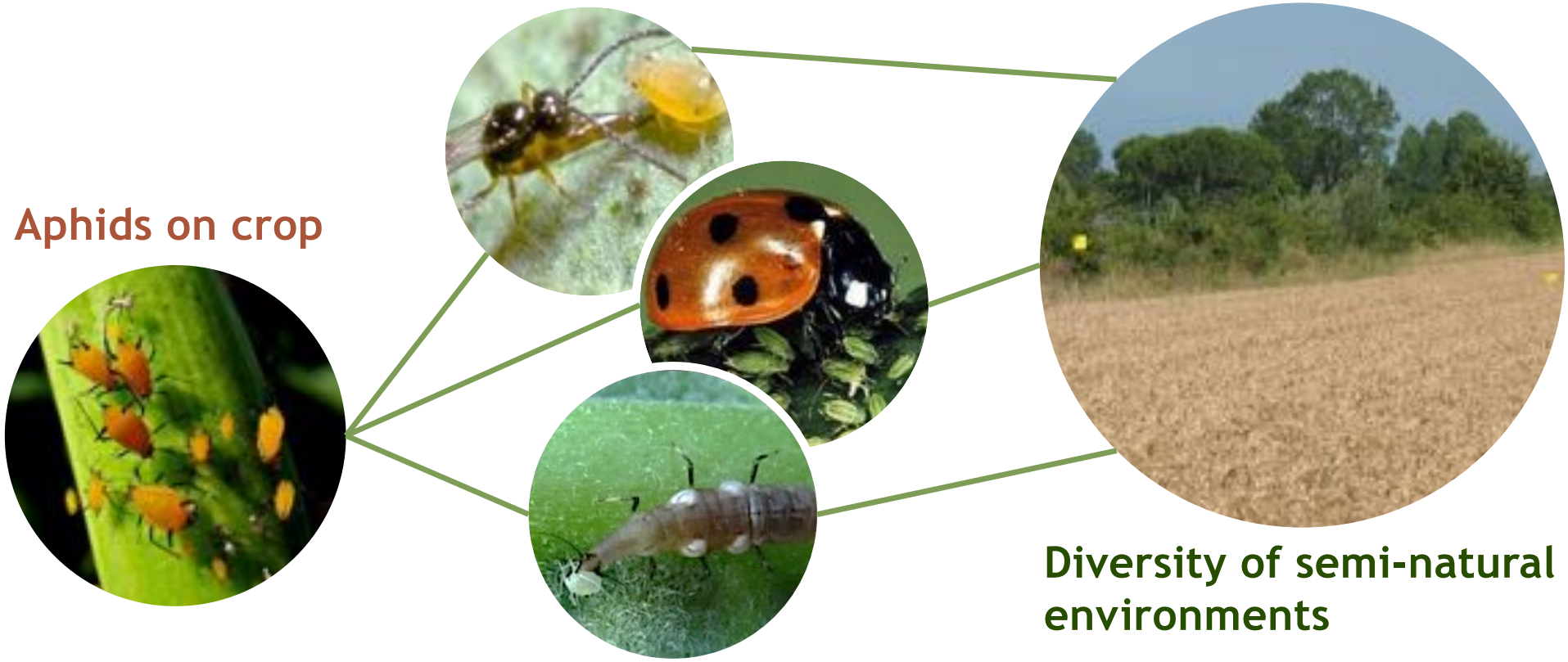

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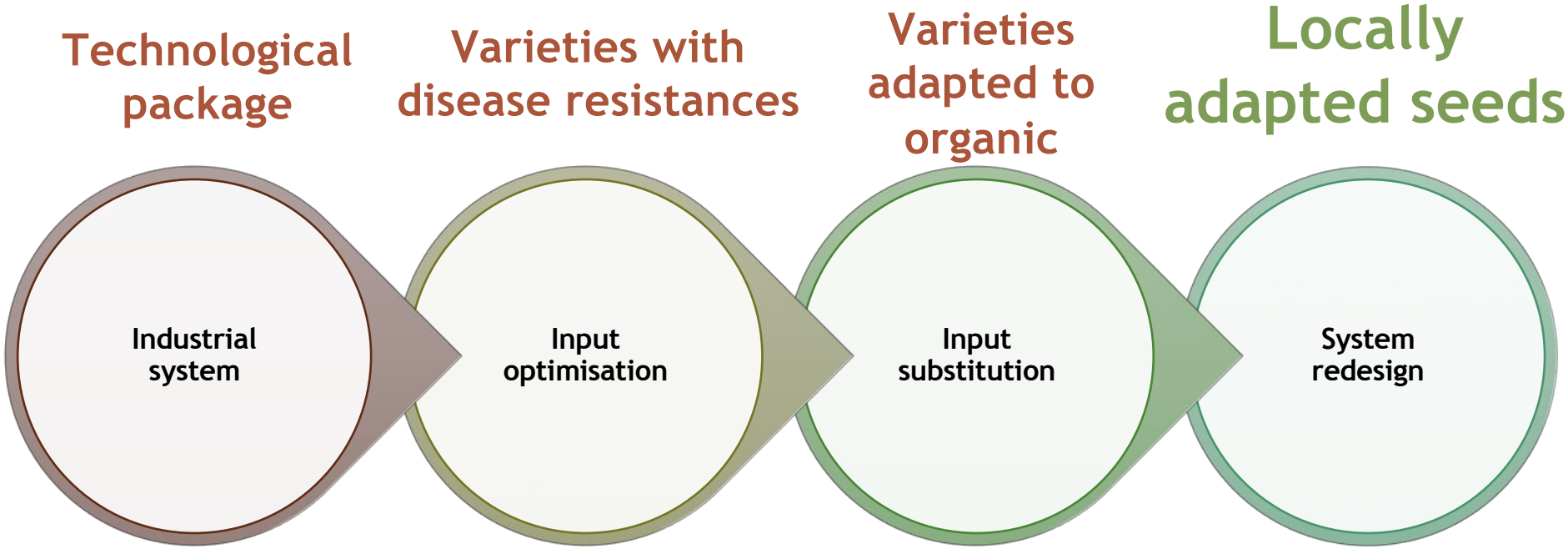
Seeds and deeds in transition



Farm = factory
Seeds = inputs

Farm = ecosystems
Seeds = part of the system

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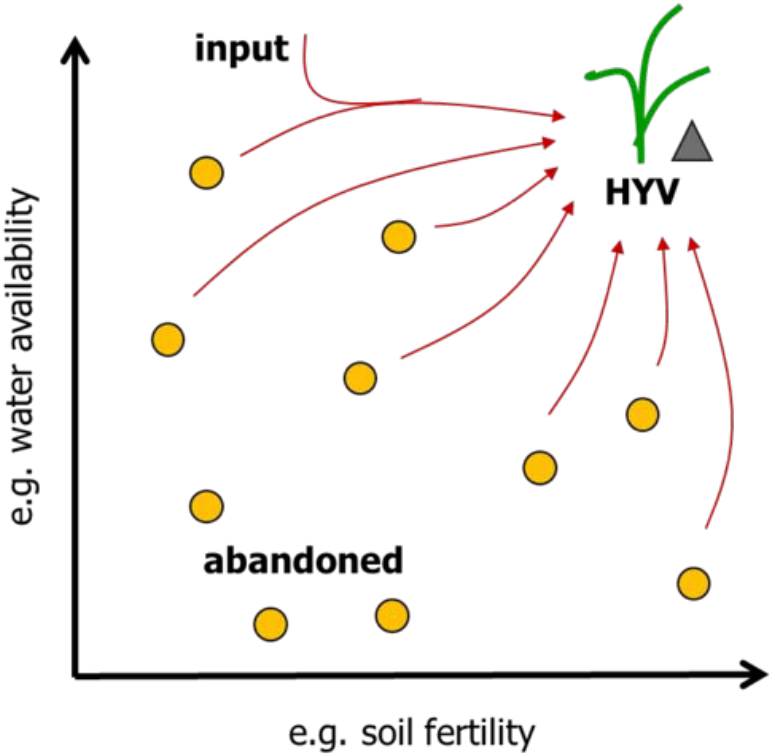
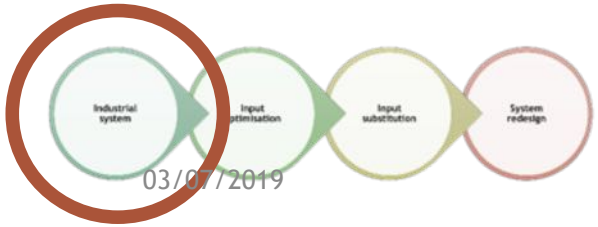
The technological package

- ‘Green Revolution’ model
- input-responsive varieties + inputs
- Adapting the environment to the variety

What Are Improved Seeds? An Epistemology of the Green Revolution*

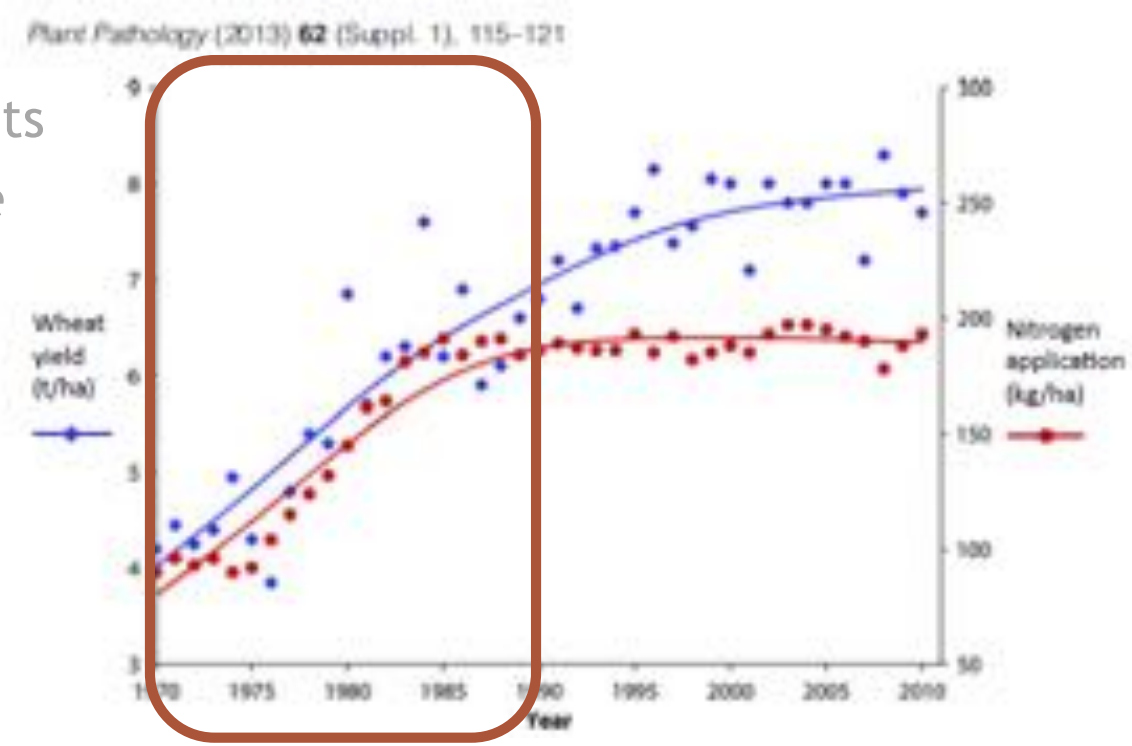
Lakshman Yapa
Department of Geography, Pennsylvania State University, University Park, PA 16802

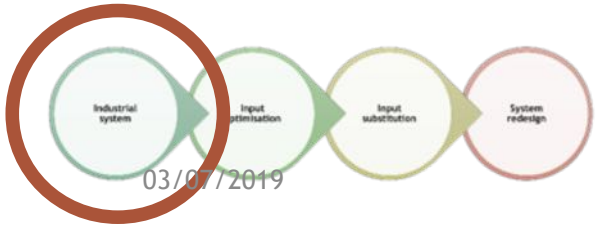




The technological package

- ‘Green Revolution’ model
- input-responsive varieties + inputs
- Adapting the environment to the variety
- **1970-90: more N, more yield**





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The technological package

- ‘Green Revolution’ model
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- Adapting the environment to the variety
- **1970-90: more N, more yield**
- **1980s: more fungicides**

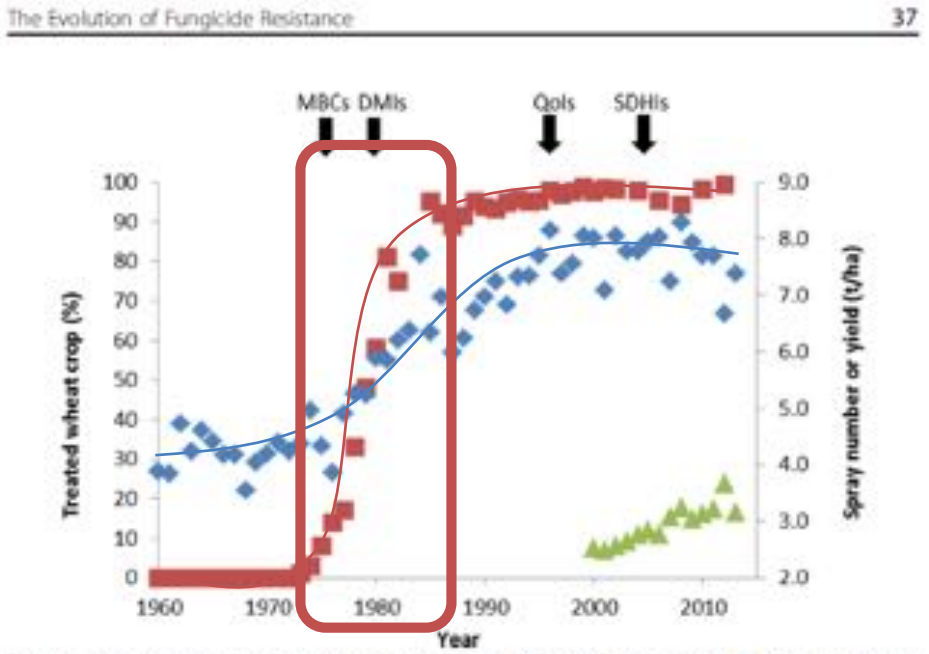
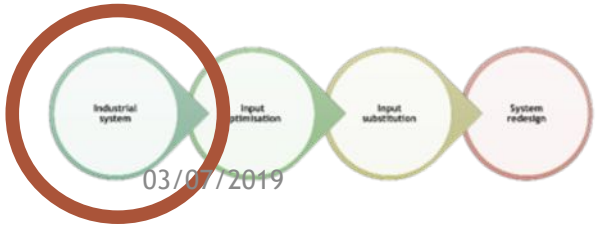


Figure 2 *Wheat yields and fungicide use in the UK, 1960–2013.* ◆ Wheat yields (source: Cereal Production Surveys, Defra); ■ percentage of crops sprayed with fungicides; ▲ average number of sprays per season (Defra annual survey of winter wheat pests and diseases); ▮ introduction of main fungicide groups; updated from Lucas (2006).



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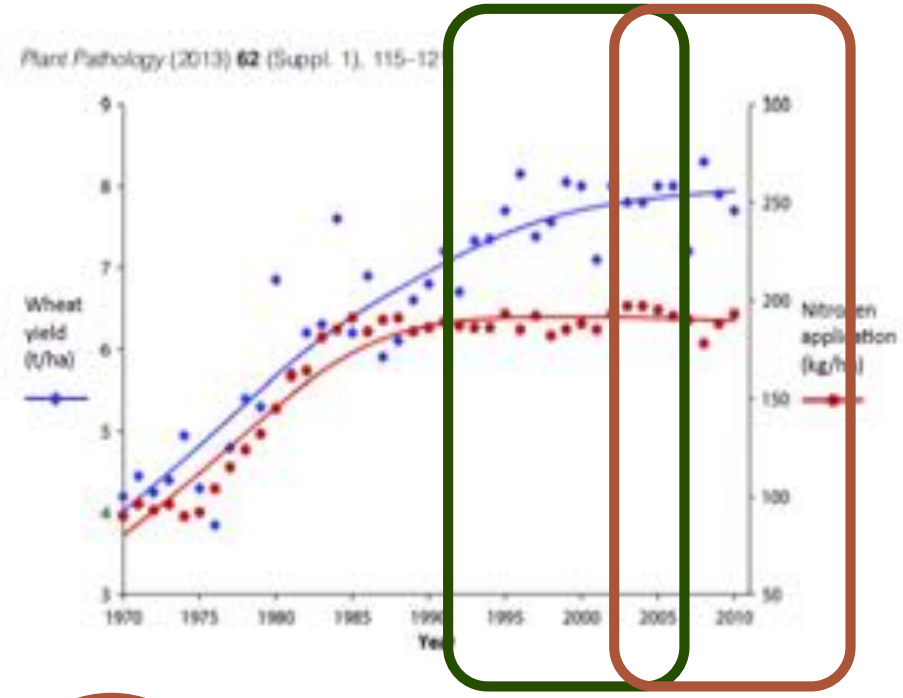
Optimising inputs

1. Better nutrient use efficiency



- **1990s-2000s,**
  "more yield with same N"
  Input optimisation
- **2010s… yield plateau, what next?**

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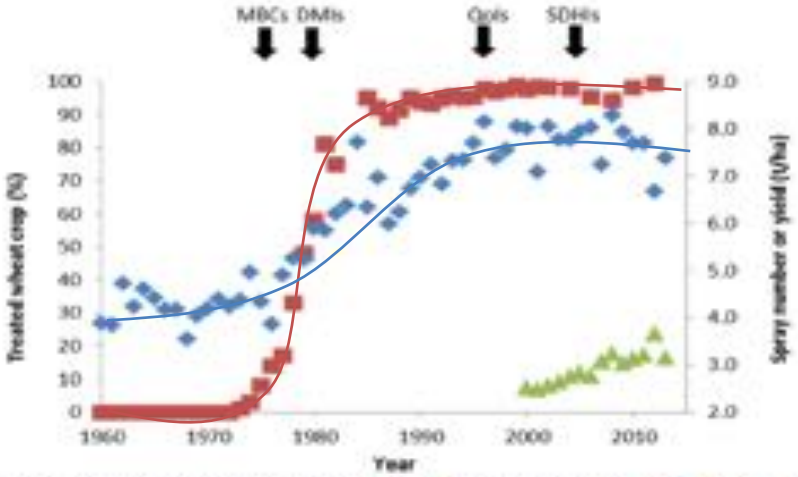
Optimising inputs

2. less fungicides …



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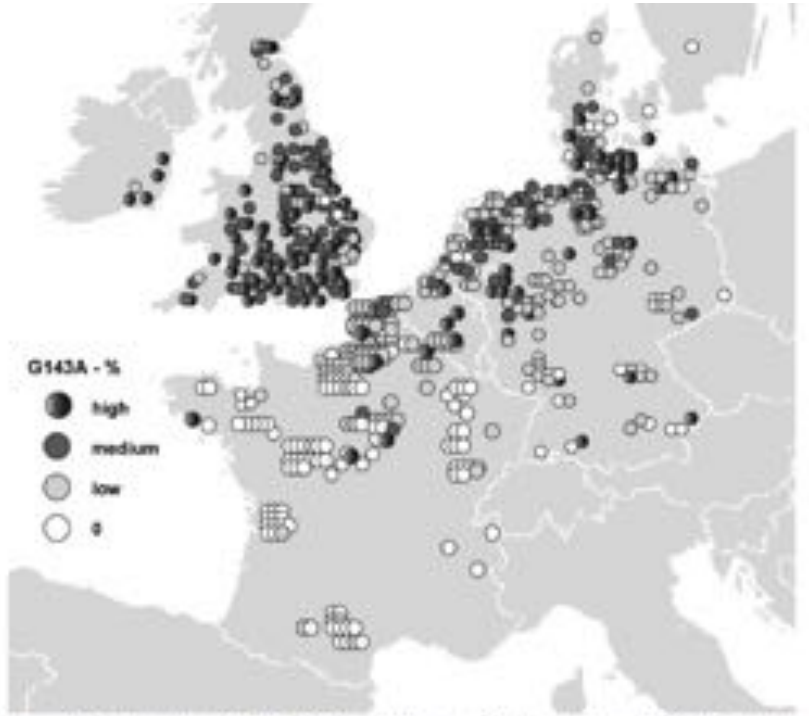

Figure 4 The incidence of the G143A mutation conferring resistance to QoI fungicides in European populations of Zymoseptoria tritici in 2003. From Lucas and Fraaije (2008b). Original data provided by K. H. Kuck and the Fungicide Resistance Action Committee.


CHAPTER TWO

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The Evolution of Fungicide Resistance

John A. Lucas[1], Nichola J. Hawkins and Bart A. Fraaije

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Optimising inputs

2. … thanks to disease-resistant varieties

Disease resistance

a key trait in contemporary breeding

Contents lists available at ScienceDirect

Infection, Genetics and Evolution

journal homepage: www.elsevier.com/locate/meegid

Review

Durable resistance: A key to sustainable management of pathogens and pests ☆

Christopher C. Mundt *

However …

PHILOSOPHICAL TRANSACTIONS B

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Review

Rapid emergence of pathogens in agro-ecosystems: global threats to agricultural sustainability and food security

Plant Pathology (2013) 62 (Suppl. 1), 115–121 Doi: 10.1111/ppa.12165

Constraints on breeding for disease resistance in commercially competitive wheat cultivars

R. W. Summers[a]* and J. K. M. Brown[b]

[a]RAGT Seeds Ltd, Grange Road, Ickleton, Saffron Walden, CB10 1TA; and [b]John Innes Centre, Norwich Research Park, Colney, Norwich NR4 7UH, UK

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Optimising inputs

2. … thanks to disease-resistant varieties

FW LATEST

Louise Impey

12 June 2019

Cereals 2019: Alarm as rusts infect resistant wheat varieties

There are growing concerns that new races of yellow and brown rust have overcome varietal resistance in wheat, with high levels of both diseases being seen on varieties with good resistance ratings.

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Substitute inputs
with varieties bred for organic systems

The organic gap

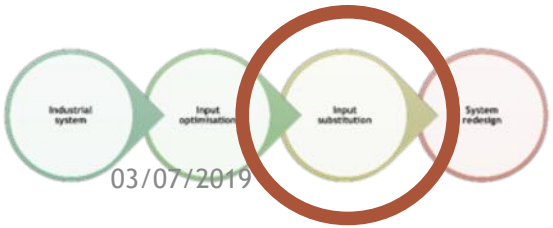
nature COMMUNICATIONS

DOI: 10.1038/s41467-018-05956-1 OPEN

A global meta-analysis of yield stability in organic and conservation agriculture

Samuel Knapp [1,2] & Marcel G.A. van der Heijden [1,3]

Organic seems to be
less productive and ***less stable***
than conventional



Useful varieties lost along the way?

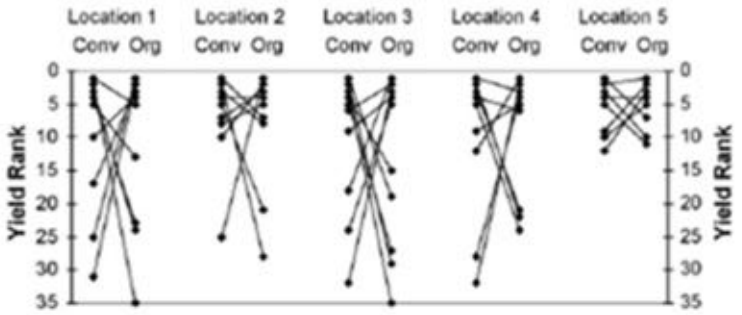


Fig. 1. Genotypic change in rank between organic and conventional wheat nurseries. The top five ranking genotypes for yield in both organic and conventional systems were compared at each location. Genotypes are ranked from 1 = highest yield to 35 = lowest yield.

Evidence of varietal adaptation to organic farming systems

Kevin M. Murphy [a], Kimberly G. Campbell [b], Steven R. Lyon [a], Stephen S. Jones [a]

But what are 'organic systems' actually?
One-size-fits-all?

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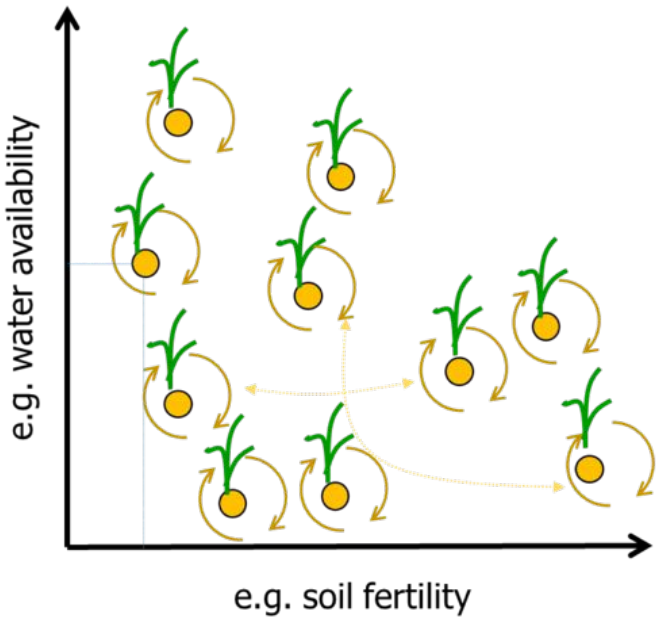
Seeds as part of the agro-ecosystem

but where to start from?

Breeding for specific adaptation



One variety for each farm?

- Breeding business model is for wide, not specific adaptation

• Think outside the box

- Evolutionary breeding
- Integrate **breeding** and **management** at a **landscape scale**

• Better decision support

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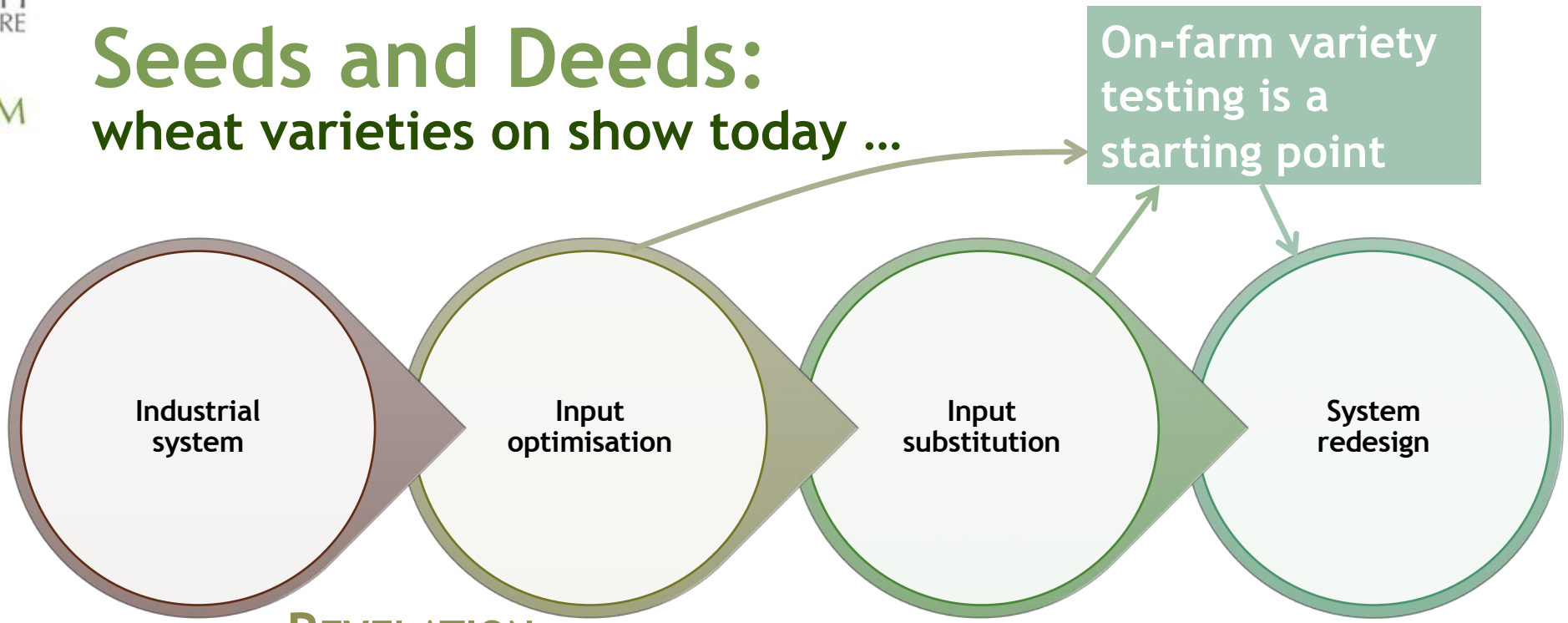
Seeds and Deeds:

wheat varieties on show today …



REVELATION, EVOLUTION, CRISPIN, DUNSTON*, MOSCHUS*

Bred in and for "optimised conventional" (UK, *Germany)

EHOGOLD, EDELMANN

Bred for organic in central Europe

ORC WAKELYNS POPULATION

Evolutionary breeding *into* organic in UK

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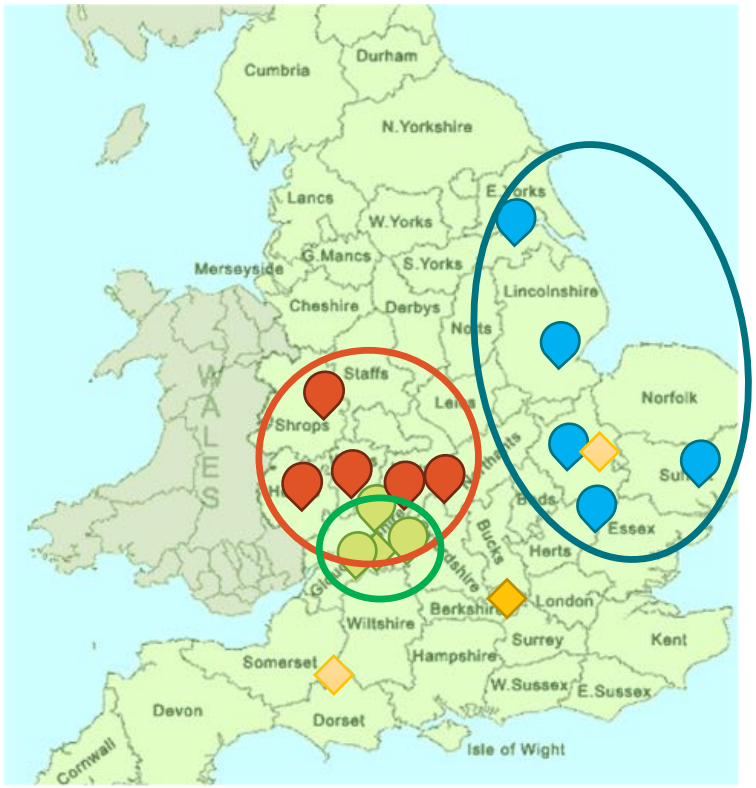
Seeds and Deeds:

… as part of a collective experiment



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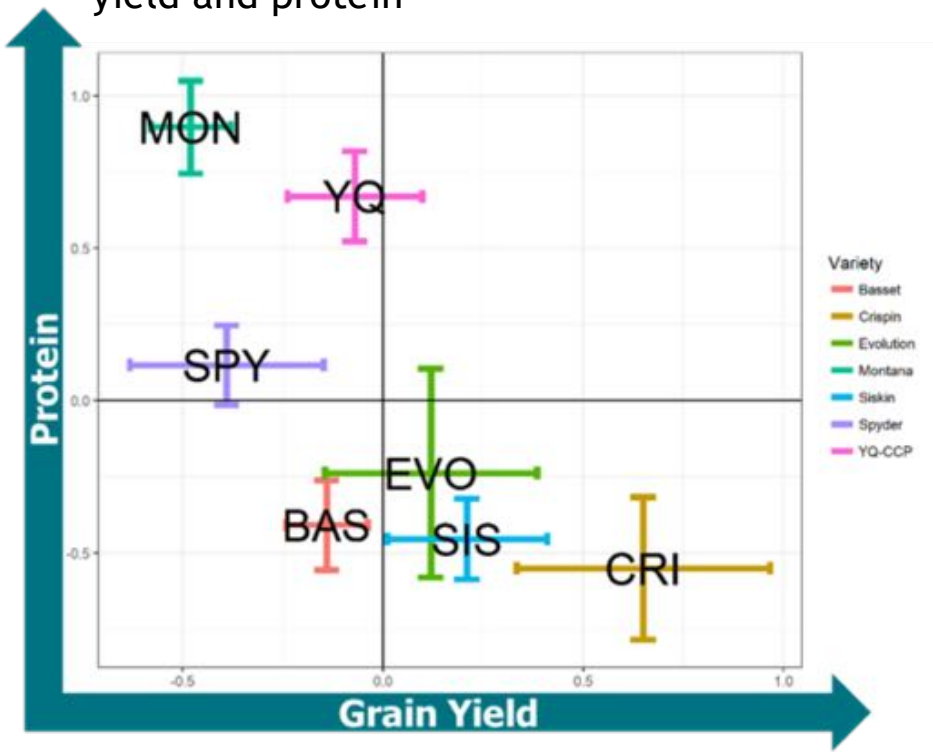
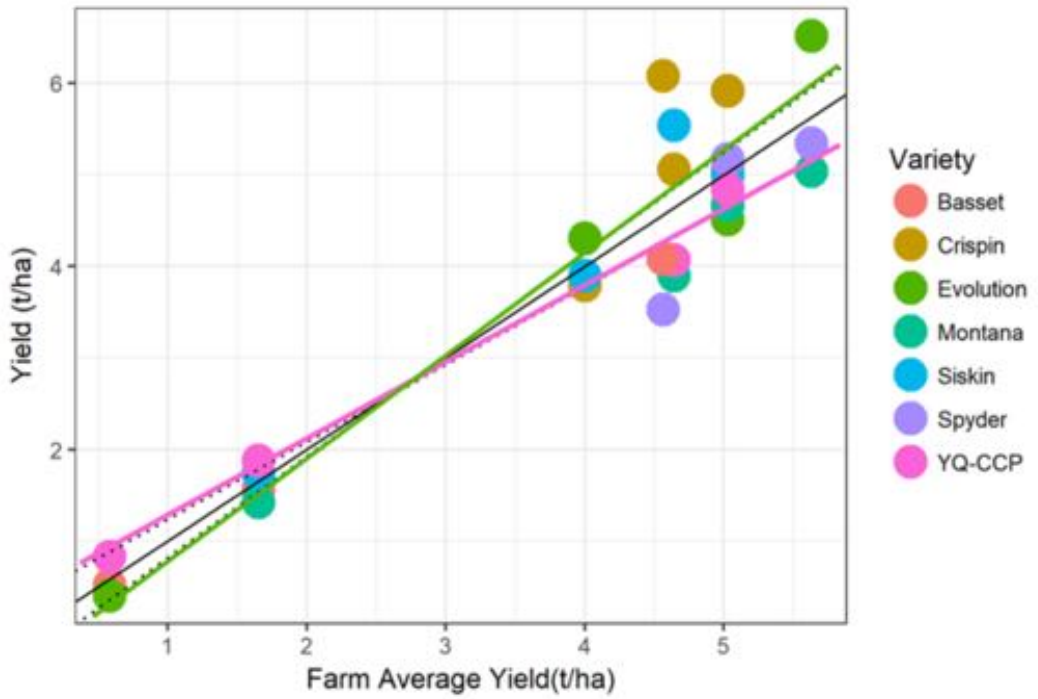
Seeds and Deeds

an evidence base of varietal performance…

2017/18 interim results
yield and protein





How yields and varietal ranking changed across participating farms in 2017/18

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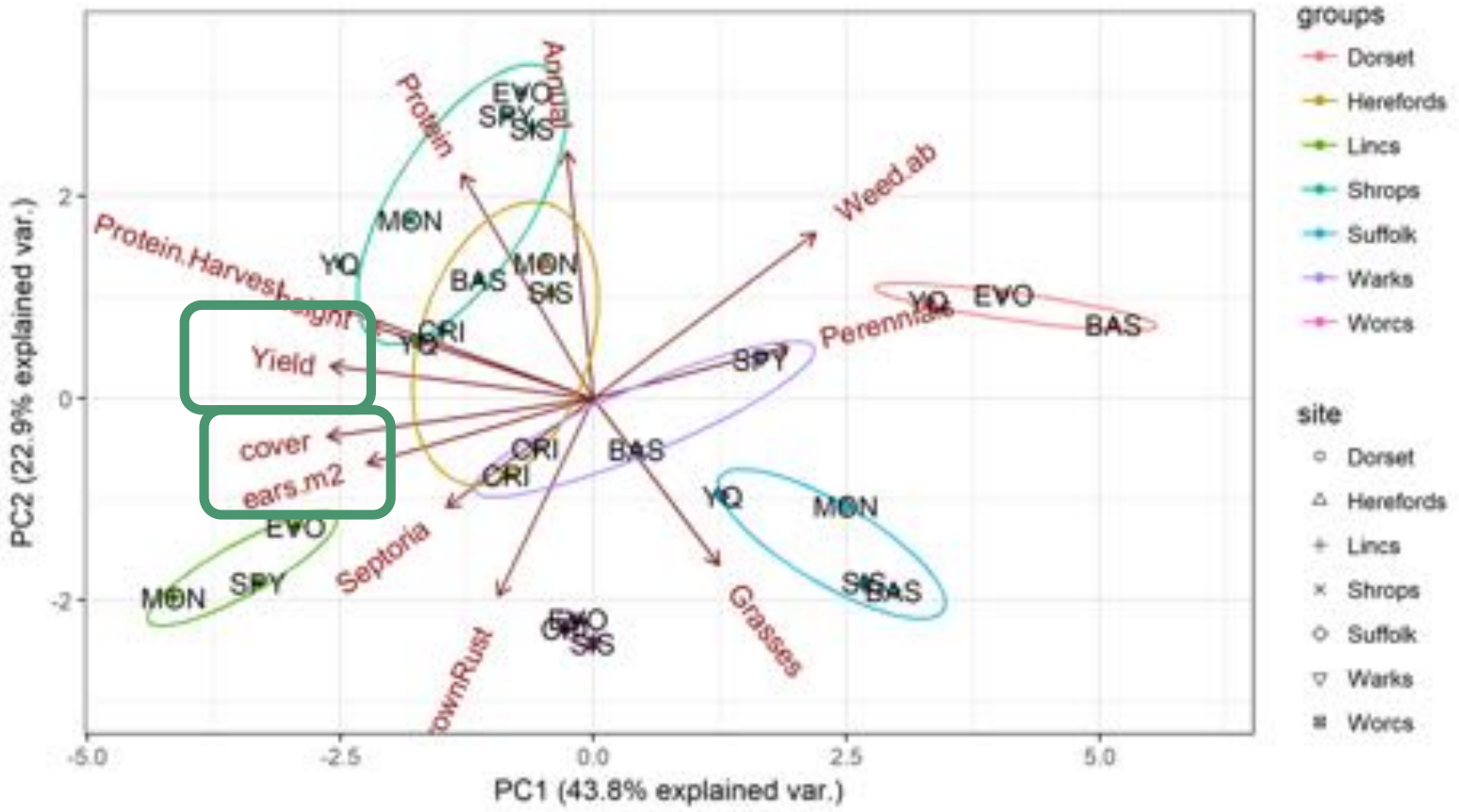
Seeds and Deeds

… and of all the real-farm variables behind it

2017/18
All data, all variables (PCA)

Yield correlated with cover and ear density



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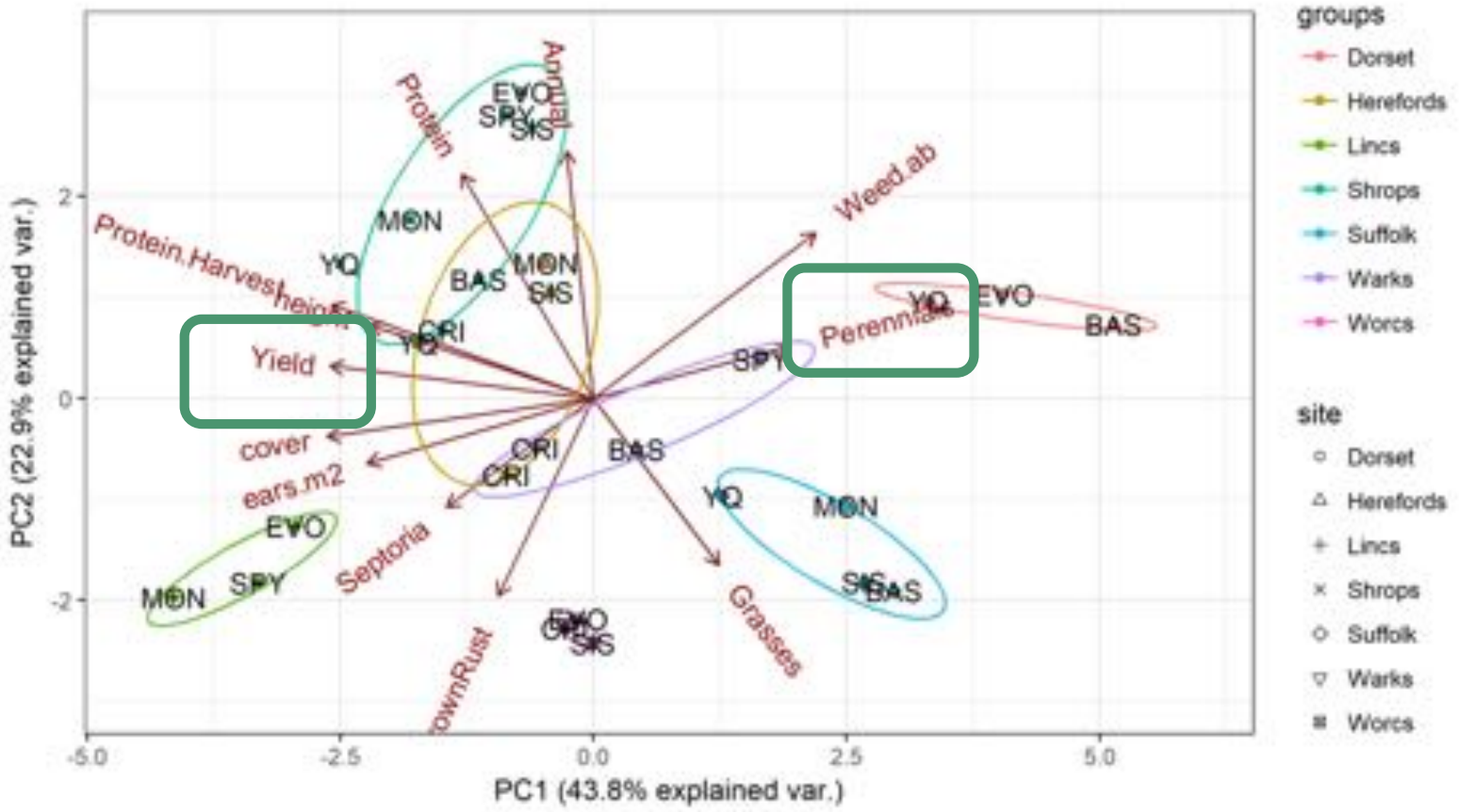
Seeds and Deeds

… and of all the real-farm variables behind it

2017/18
All data, all variables (PCA)

Yield constrained by abundance of perennial weeds



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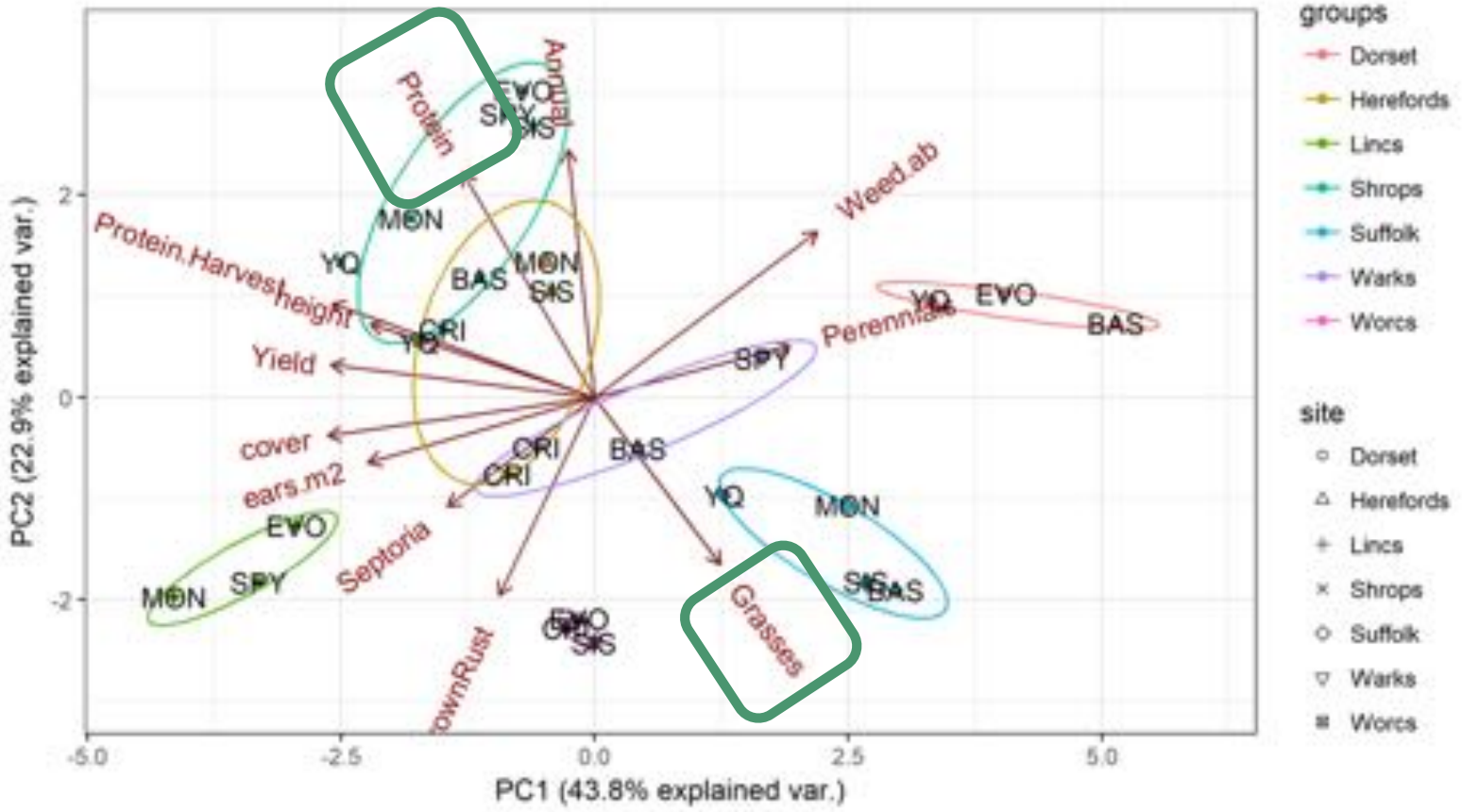
Seeds and Deeds

… and of all the real-farm variables behind it

2017/18
All data, all variables (PCA)

Protein negatively correlated to the abundance of monocot weeds



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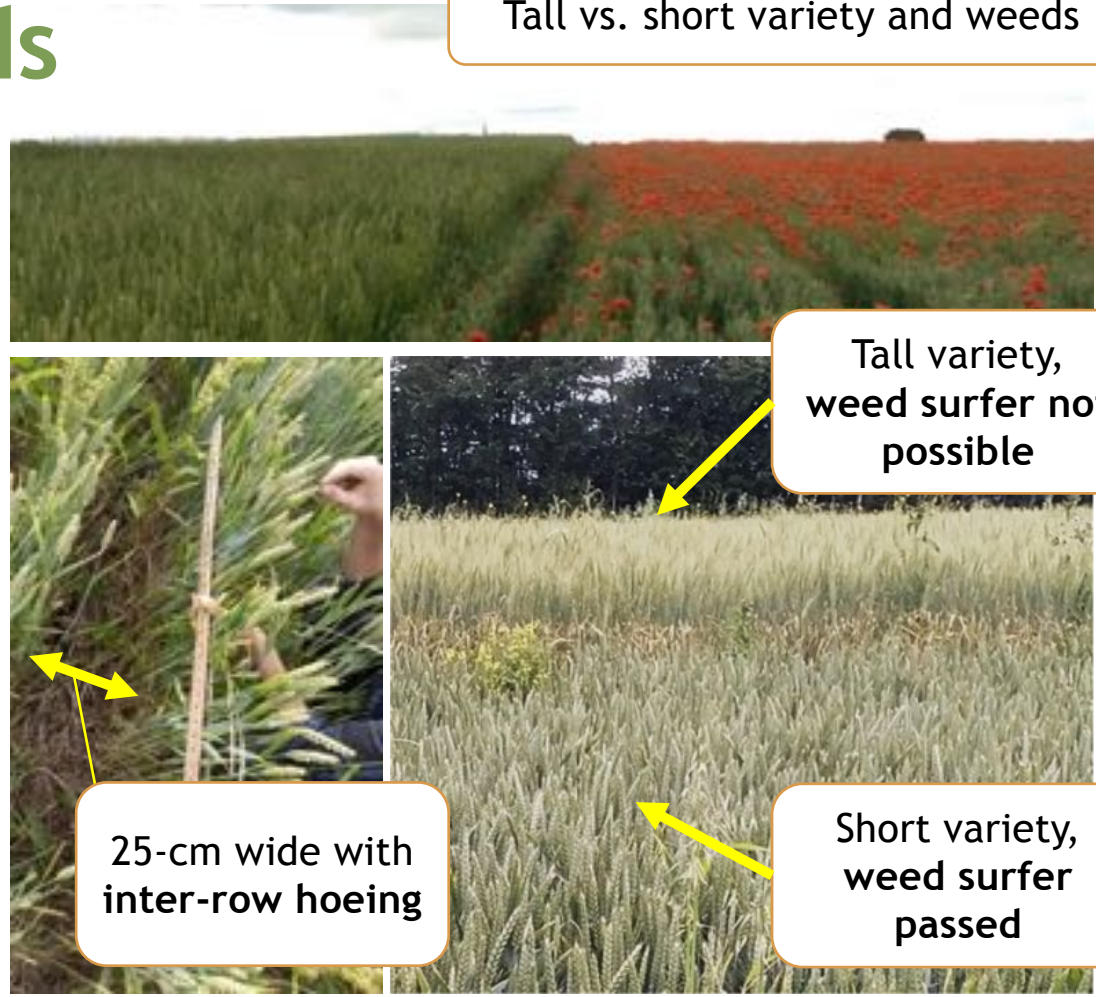
Seeds and Deeds

including real-farm management

- Plot-scale = the potential
- **Field-scale = the system** especially weed management

Tall vs. short variety and weeds



Field-scale experiments reveal persistent yield gaps in low-input and organic cropping systems

Alexandra N. Kravchenko[a,1], Sieglinde S. Snapp[a], and G. Philip Robertson[a,b]

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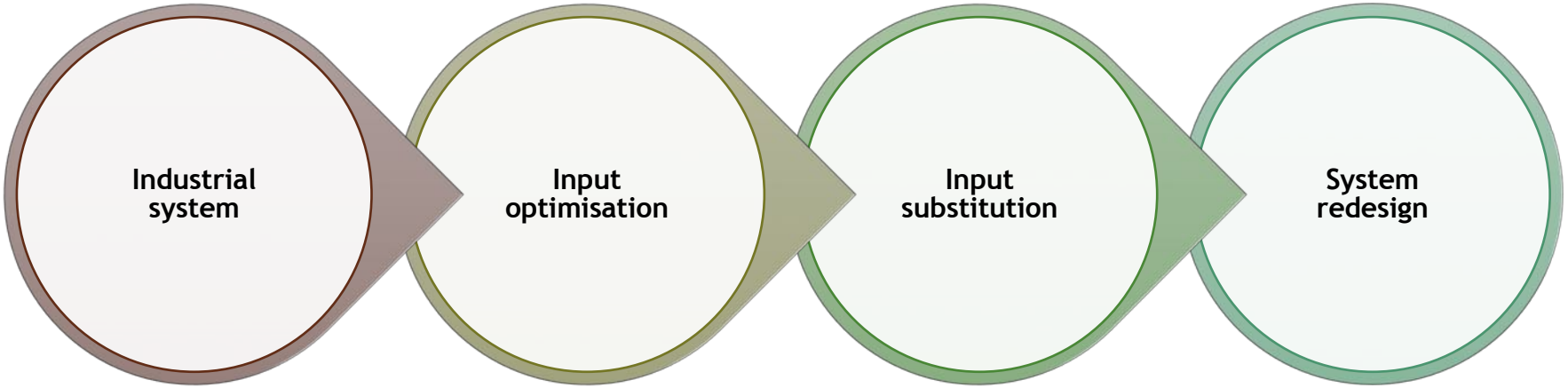
In conclusion

Embedding the research process in farming *is* system redesign:

- empowerment, capacity building, 'working together'
- *can* generate solid evidence and
- provide decision support for all farmers, supply chains and more



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Thank you

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