



Centre for Sustainable Cropping: long-term research platform

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Background – the global challenge



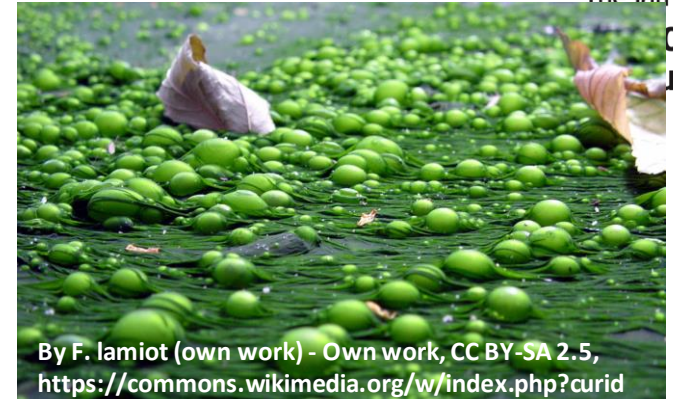
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Food Security

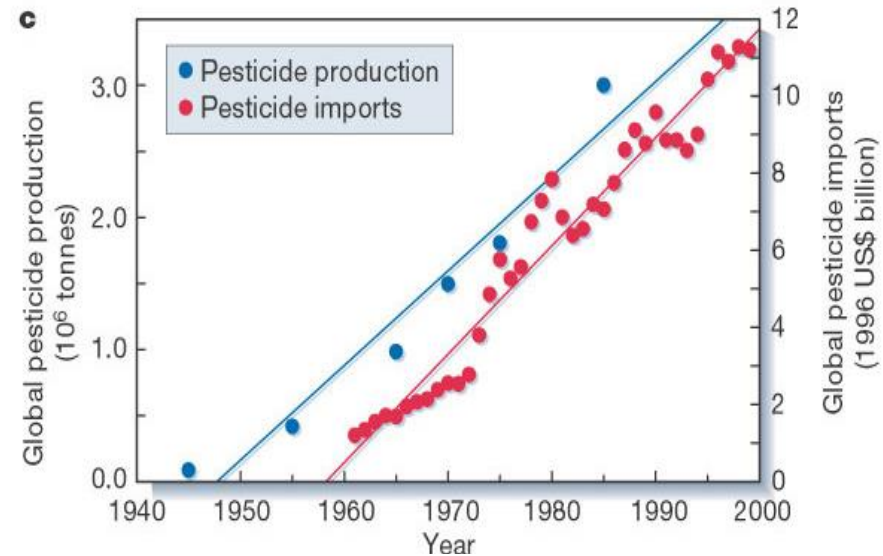
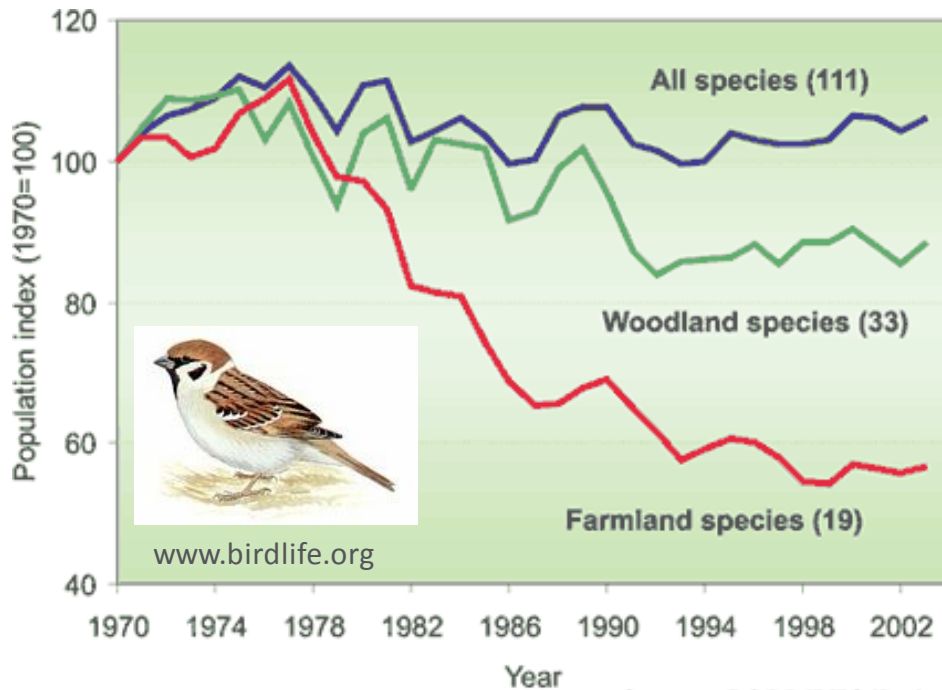
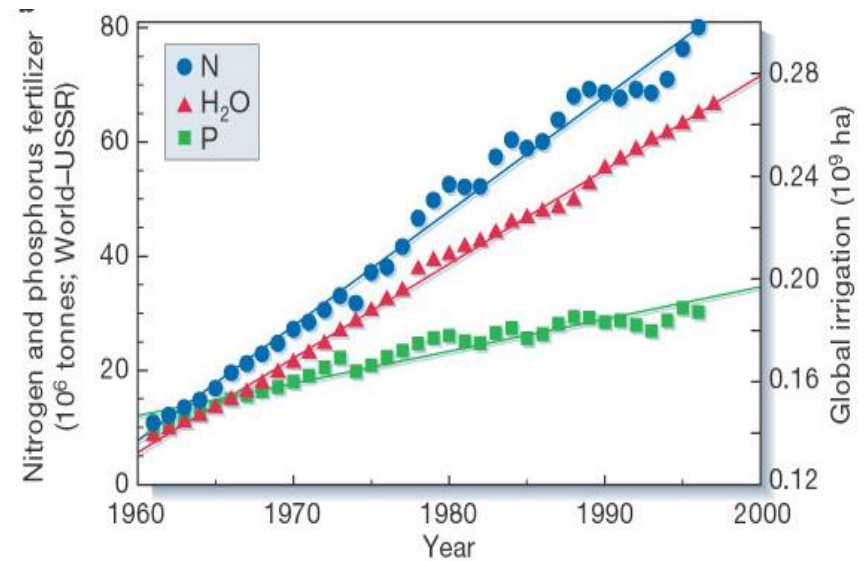
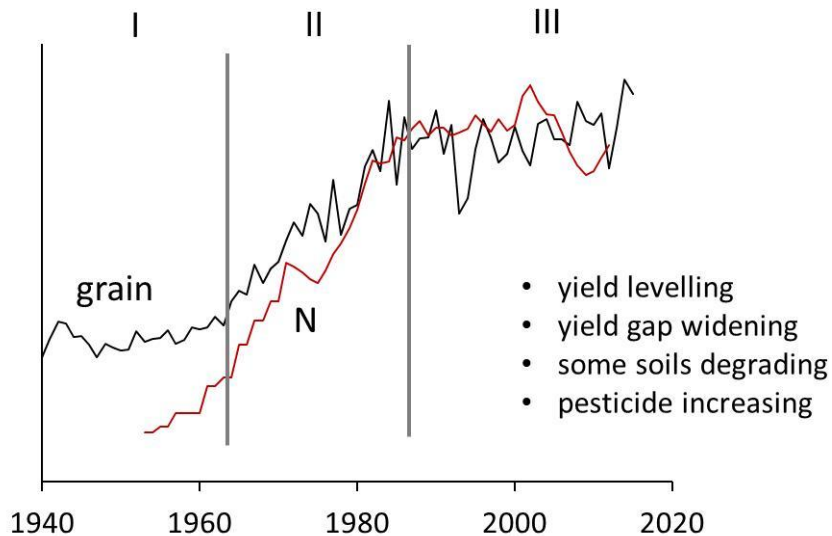
- UN predicts global population of 9.7 billion by 2050
- Food demand to increase by more than 50% (FAO)
- Crop yields plateauing since 2000
- Developing countries' net imports of cereals will more than double by 2050 (FAO)
- Undernutrition contributes to nearly half of all deaths in children under 5 worldwide

Unsustainable Agriculture

- Agriculture responsible for 2.8% of energy consumption (EU-28)
- Agriculture accounts for 19% of total greenhouse gas emissions (Scotland)
- 40% of N input remains in the environment (EU-28)
- Farmland birds declined by 50% since 1970 (UK)
- 3.24 t ha⁻¹ yr⁻¹ soil lost from agricultural land (EU-28)



While national yields flat-line...



A systems approach for improving arable sustainability

- *Ecological (biotic)* – enhance biodiversity for provision of ecosystem services (pollination, predation, IPM, decomposition)
- *Environmental (abiotic)* – reducing environmental footprint, improving soil physical condition for plant growth, minimise losses through erosion, runoff, leaching and GHG emissions
- *Economic (financial)* – increasing efficiency (crop varieties, mixtures, intercropping) to maintain or improve yield for economic sustainability, food security and health





The Centre for Sustainable Cropping: putting theory into practice

- design a more sustainable cropping system and
- establish a robust whole-system cost-benefit analysis

Economic: maintain yield with less non-renewable inputs

Environmental: reduce environmental footprint

Ecological: enhancing biodiversity for ecosystem services



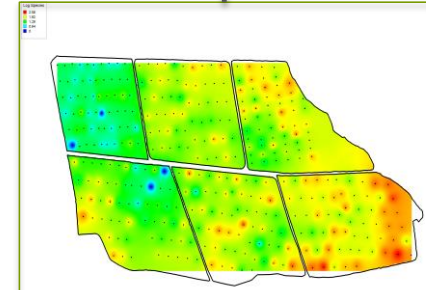
Crop yield & quality



Nutrient budgets



Soil structure



Biodiversity



Design

- A long-term platform for research on sustainable arable systems
- 46 ha over six fields comparing an integrated cropping system with standard commercial practice



- Open access resource for collaborators:
 - field treatments
 - archived samples
 - data
- Demonstration site for industry, scientists, policy makers

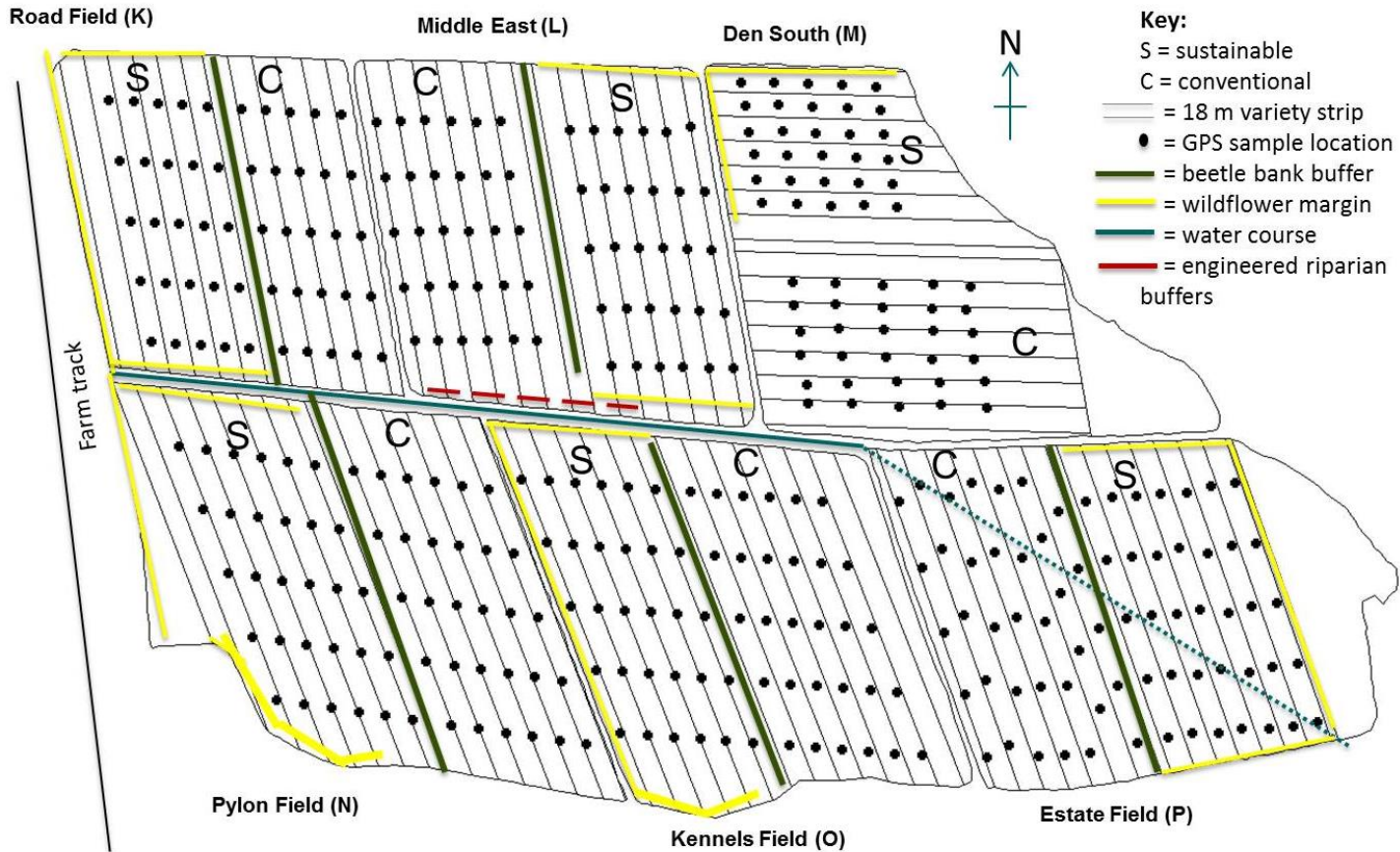




Design



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- Key:**
- S = sustainable
 - C = conventional
 - = 18 m variety strip
 - = GPS sample location
 - = beetle bank buffer
 - = wildflower margin
 - = water course
 - = engineered riparian buffers

* → potato → winter wheat → winter barley → oilseed rape → faba beans → spring barley

* cover crop





Integrated cropping system



- **Improve soil structure for better plant rooting and to minimise erosion/run-off losses:**
 - conservation tillage (non-inversion, moving to direct drill/no-till)
 - increase soil carbon (green waste compost, straw incorporation)
 - cover cropping over winter
 - tied-ridging in potatoes
- **Sustainable supply of plant nutrients:**
 - under-sowing and inter-cropping legumes for BNF
 - renewable sources of nutrients, e.g. digestates, urea (under investigation)
 - reduced rates of mineral fertiliser (moving to replacement)
- **Enhancing arable biodiversity for ecosystem services:**
 - targeted weed control to allow dicot weed understorey
 - IPM options (e.g. blight forecasting) to reduce crop protection inputs
 - wildflower margins to support populations of pollinators and natural enemies



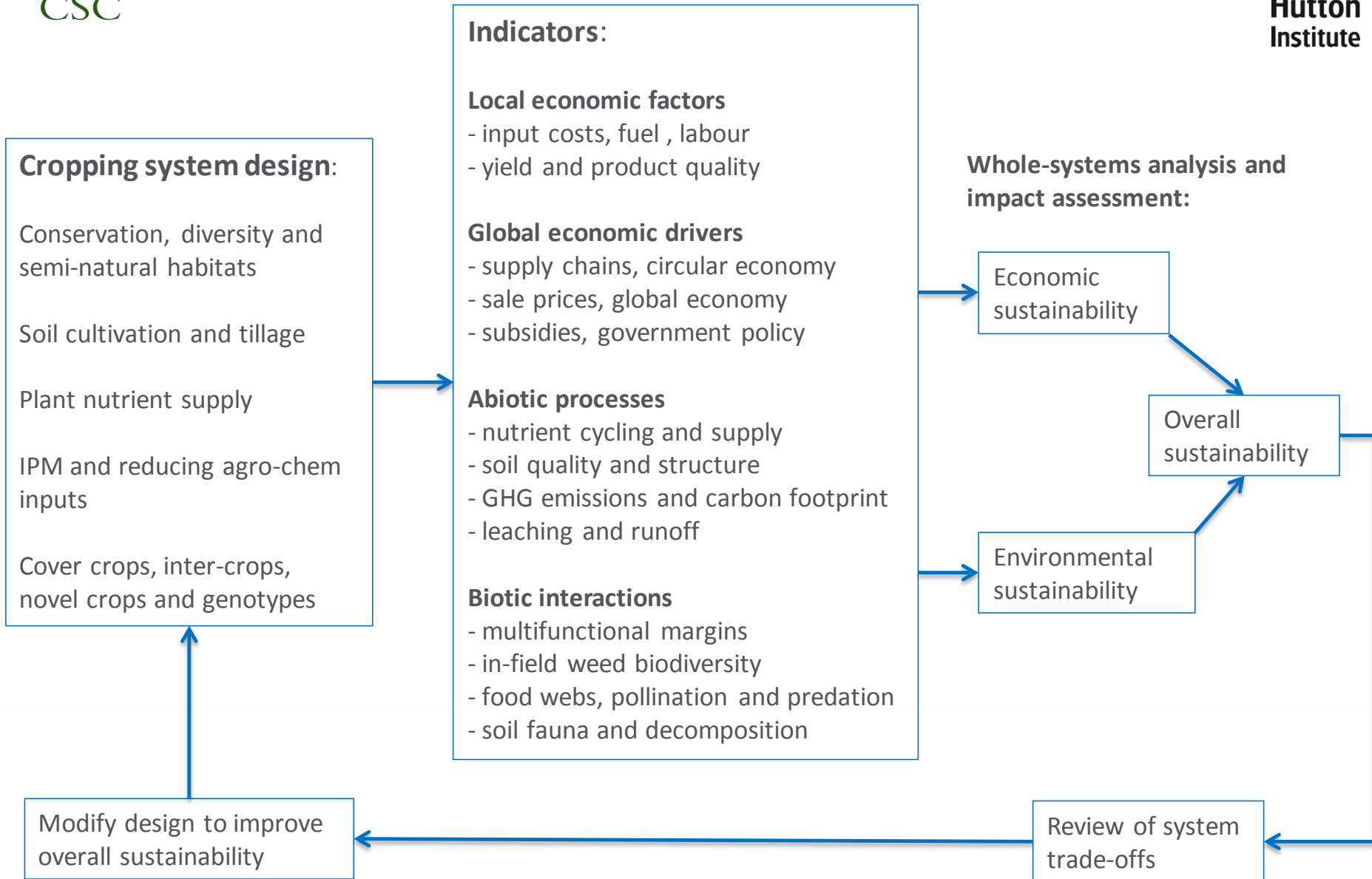


Whole systems approach

(Hawes et al. 2016)



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Whole systems approach

(Hawes et al. 2016)



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Cropping system design:

Conservation, diversity and semi-natural habitats

Soil cultivation and tillage

Plant nutrient supply

IPM and reducing agro-chem inputs

Cover crops, inter-crops, novel crops and genotypes

Indicators:

Local economic factors

- input costs, fuel , labour
- yield and product quality

Global economic drivers

- supply chains, circular economy
- sale prices, global economy
- subsidies, government policy

Abiotic processes

- nutrient cycling and supply
- soil quality and structure
- GHG emissions and carbon footprint
- leaching and runoff

Biotic interactions

- multifunctional margins
- in-field weed biodiversity
- food webs, pollination and predation
- soil fauna and decomposition

Whole-systems analysis and impact assessment:

Economic sustainability

Overall sustainability

Environmental sustainability

Modify design to improve overall sustainability

Review of system trade-offs

