How can the industry adapt in the face of rapid change?

The James Hutton Institute

Professor Colin Campbell

Our work is inspired by James Hutton: innovator, polymath and farmer

Creator of “deep time”; author of

- Theory of the Earth;
- Theory of Rain;
- Principle of natural selection
- Theory of Knowledge and
- The Elements of Agriculture

1726-1797

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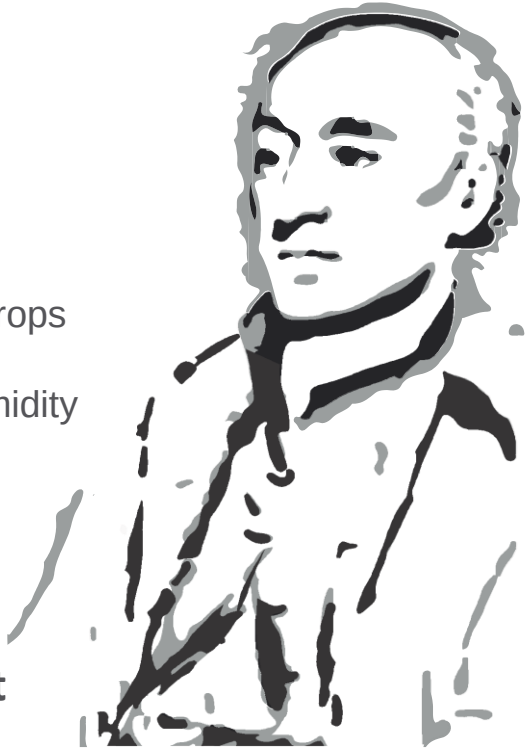
Lessons from History, James Hutton: Agricultural Innovator

- Introduced first metal plough to Scotland
- Lime and drainage to improve productivity
- The Elements of Agriculture
  - Described the relationship between climate, soil and where crops grow best
  - Invented one of first wet/dry thermometers for measuring humidity
  - Calculated the number of “heat days” needed for crop growth
  - Land economy and the relationship of state, the public and farmers

Hutton understood that farming is not static—it must evolve, guided by science, innovation, and a deep respect for the natural world.



1726-1797

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How can the industry adapt in face of rapid change?

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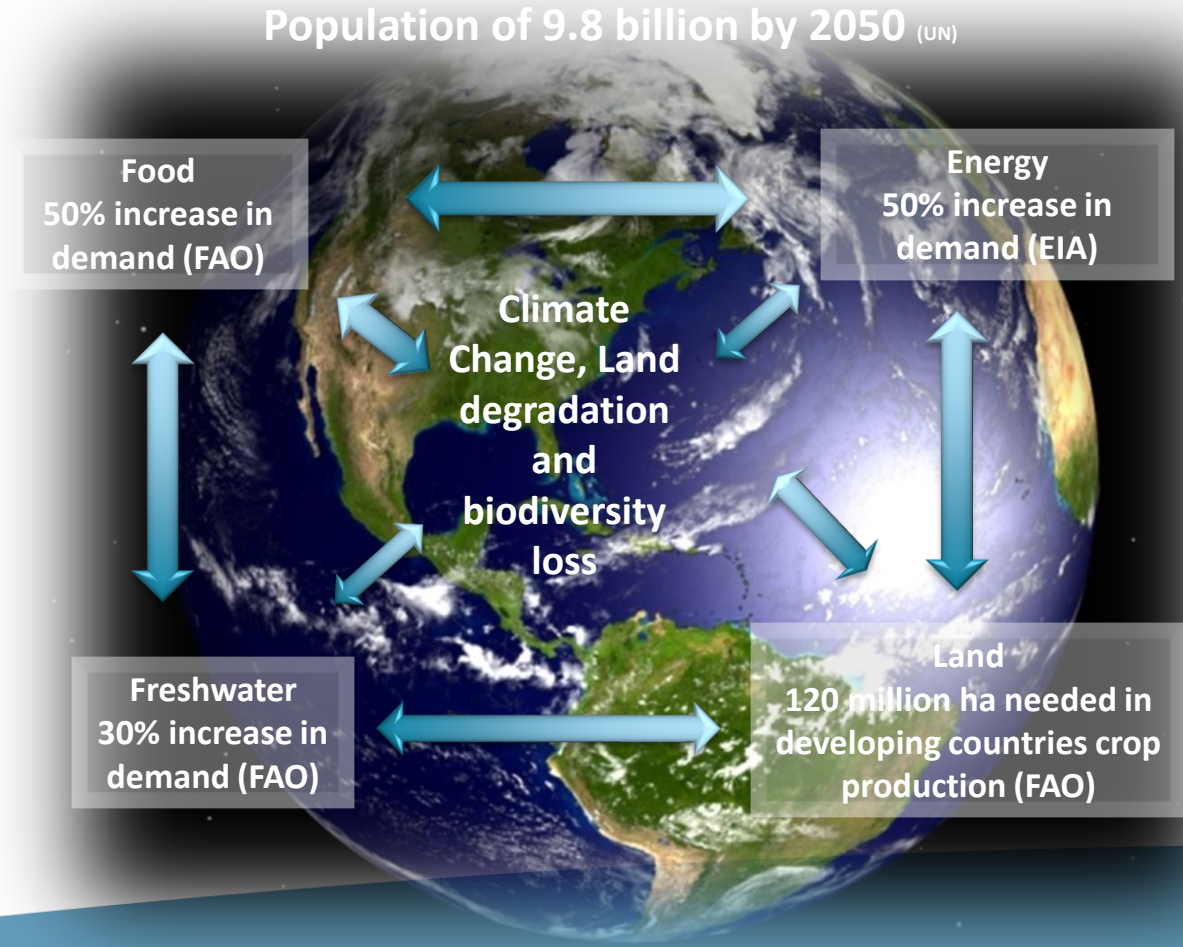
- Be aware of our strengths and weaknesses, and the external opportunities and threats?
- Be aware of what needs to happen and at what pace?
- Align the policy, science and innovation, the supply chain, communities and the sector.

Global Challenges



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Range of Farming / land systems

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Ecosystem services

External inputs

Territorial embeddedness

Relationships based on global market prices

Agro-forestry + CA + ICLS

Biodiversity-based FS in globalised commodity-based food systems

Conservation Agriculture

Integrated Crop-Livestock Systems

Integrated Food-Energy Systems

Biodiversity-based FS in alternative food systems & circular economy

Integrated landscape approaches

Biodiversity-based FS in alternative food system, circular economy & collectively managed multi-service landscape

Biological input-based FS in globalised commodity-based food systems

Specialised crop/livestock FS

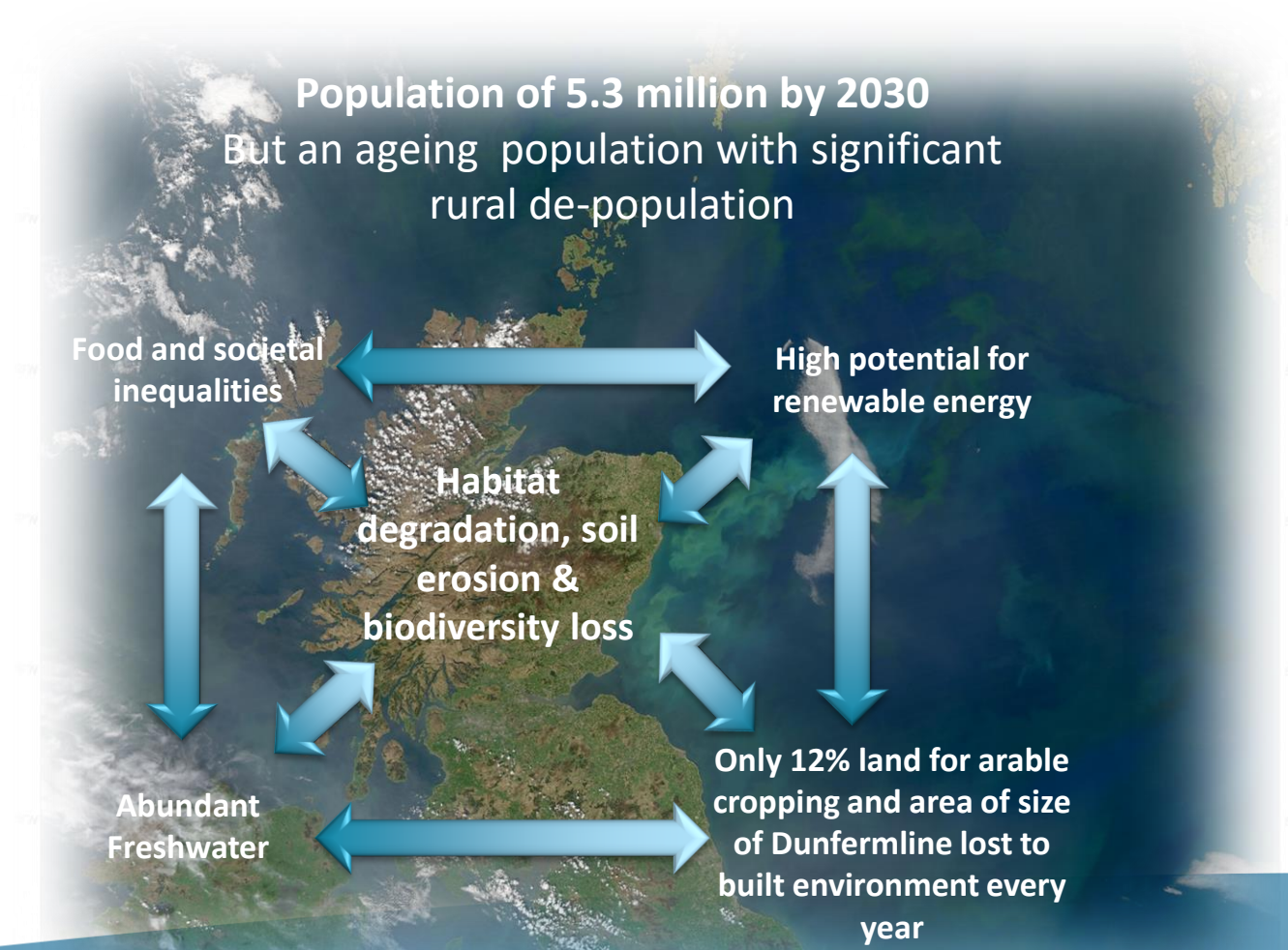
Chemical input-based FS in globalised commodity-based food systems

Biological input-based FS in circular economy

Exchanges between crop & livestock FS

From: A new analytical framework of farming system and agriculture model diversities. A review Six key models of agriculture (*blue text*) according to the degree to which biotechnical functioning of farming systems (*FS*) is based on ecosystem services versus external inputs (*Y*-axis) and the degree to which their relationships with socio-economic contexts are based on global market prices versus territorial embeddedness (*X*-axis). Iconic examples are presented in *grey*. *CA* conservation agriculture, *ICLS* Integrated Crop Livestock System

Challenges in Scotland



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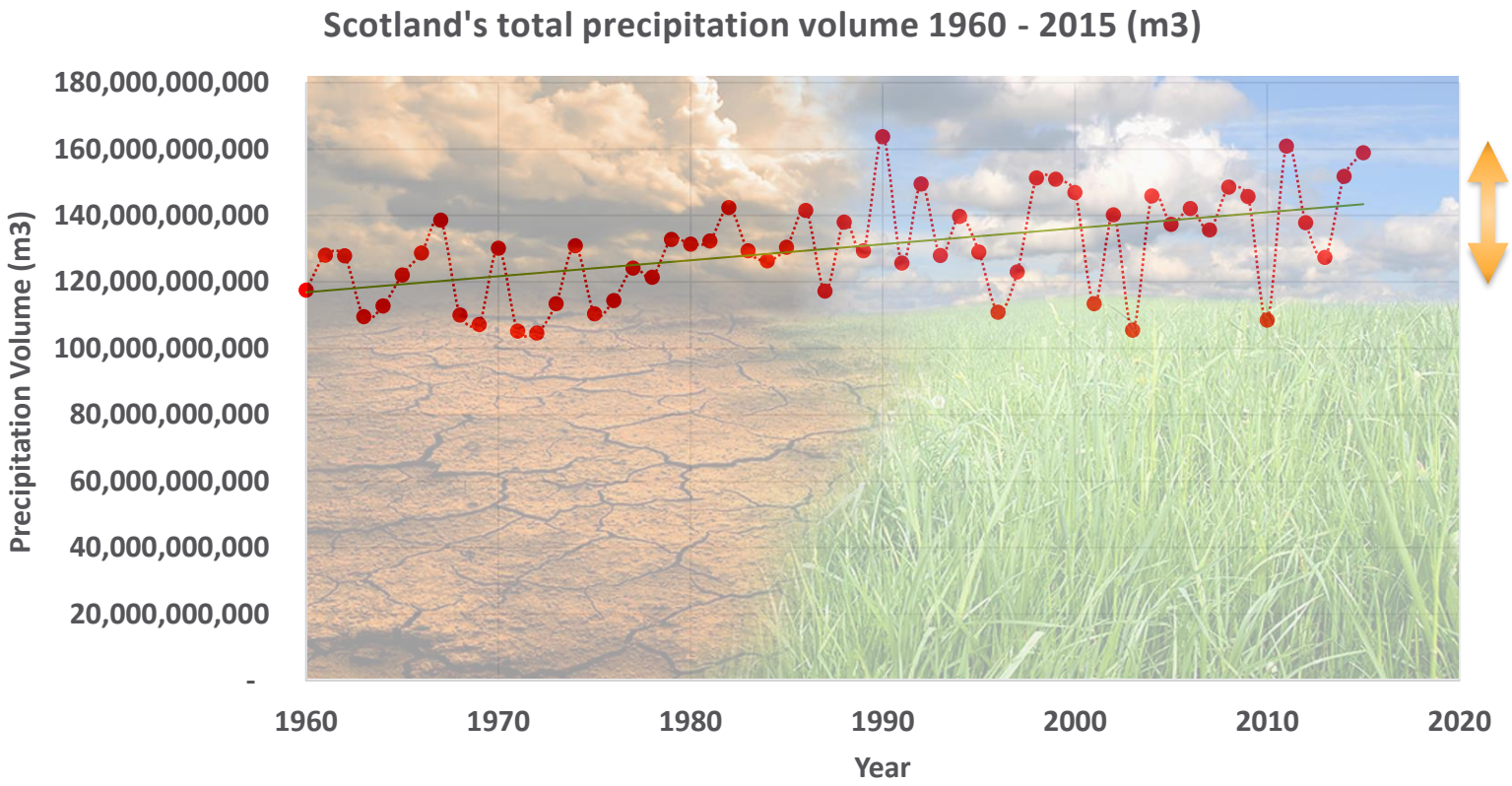
Scotland's Climate Future is more variable – take rainfall



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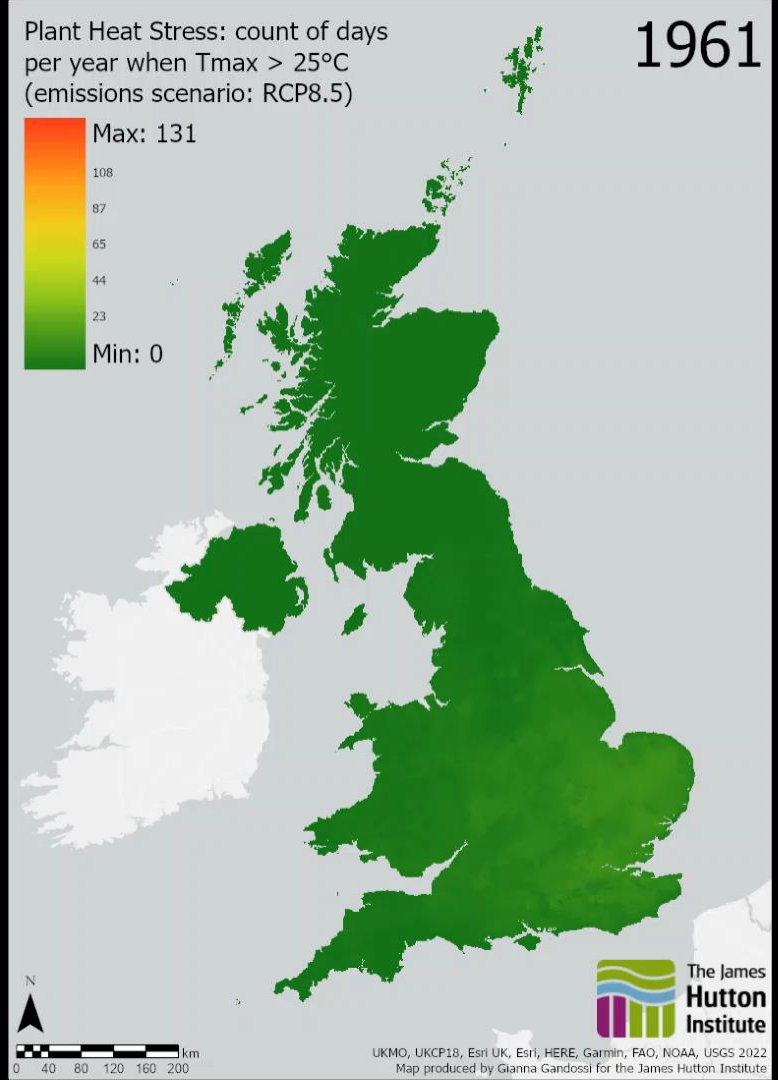
Mike Rivington

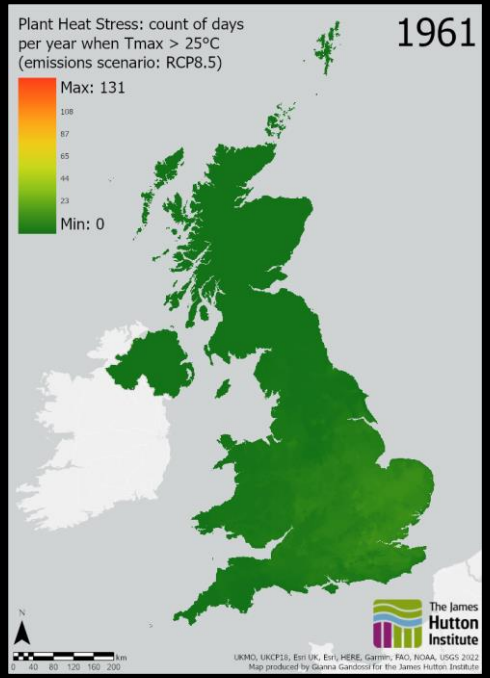
Visualisation of projections:

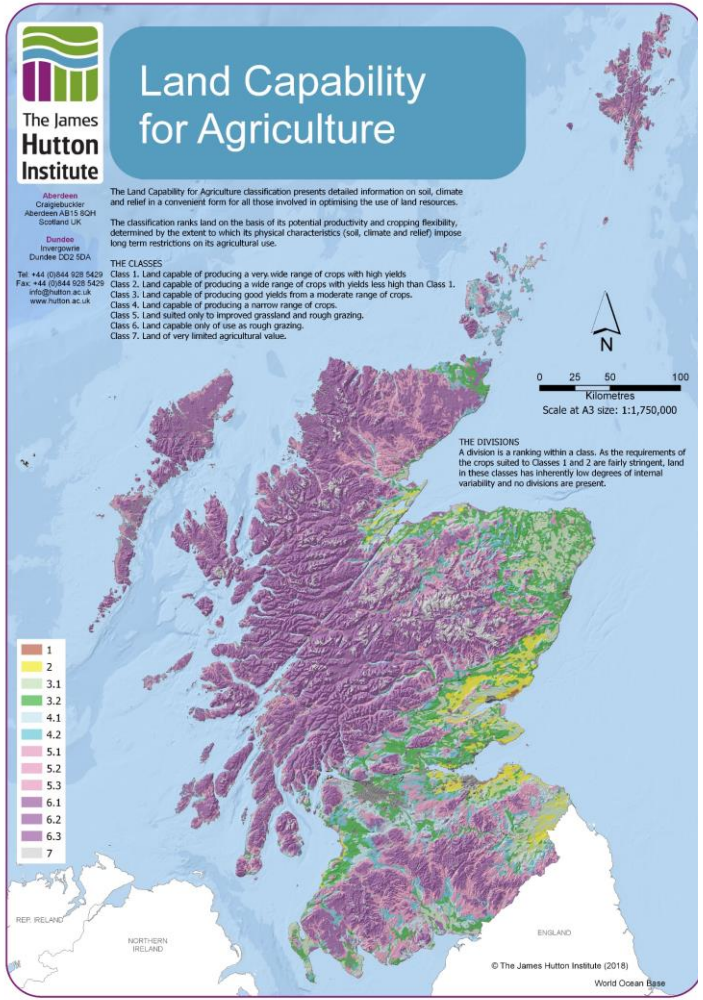
Observed data 1960 – 2020
Modelled data 2021 – 2098

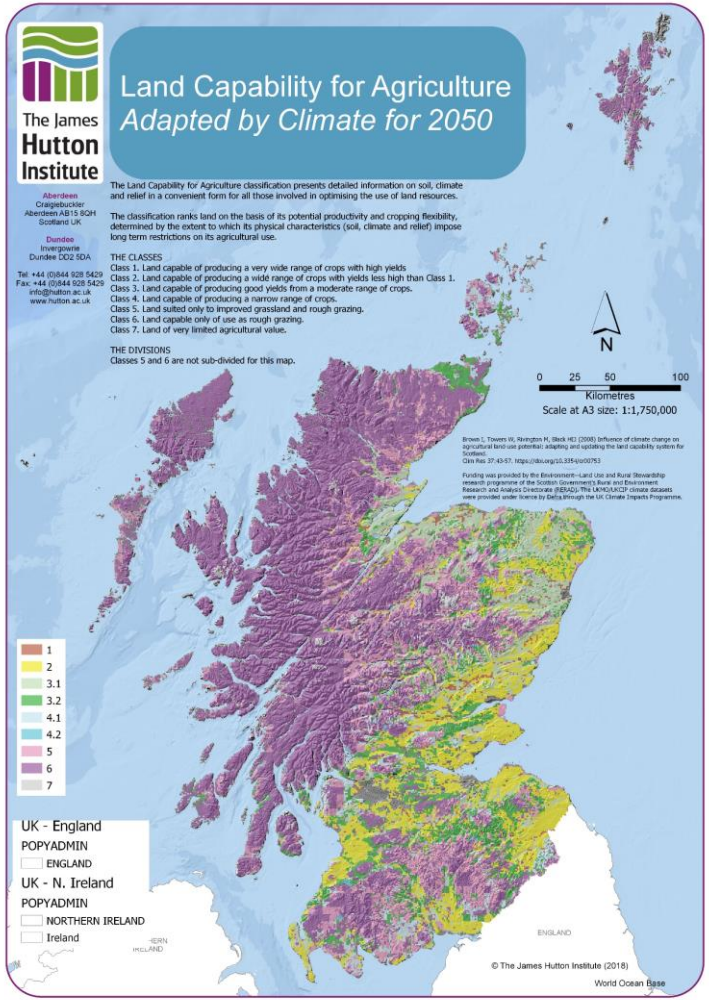
Look out for 1976, 2003 and 2018 as a guide to the scale of future changes.

Note how Scotland is less impacted compared to the south-east (continental effect).









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Future LCA

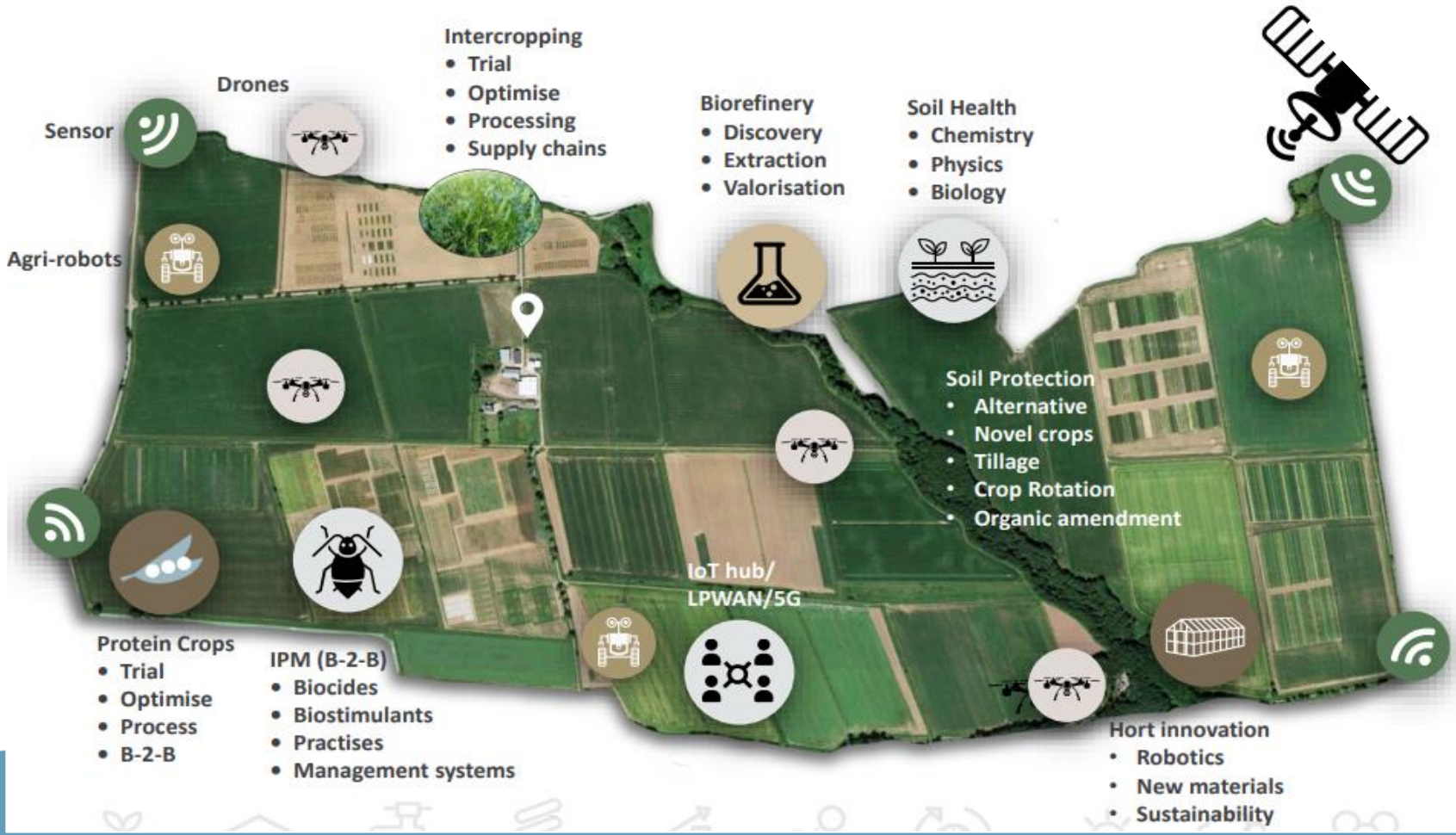
Increases in class 2 and 3 area based on changes in climate constraints

Other constraints (drainage, stoniness, soil depth etc.) will still remain.

Increased risks for classes 1-3 due to drier soils

Note: this version is for Medium-high emissions scenario

Role of Science - Balrudderv LEAF Innovation Farm



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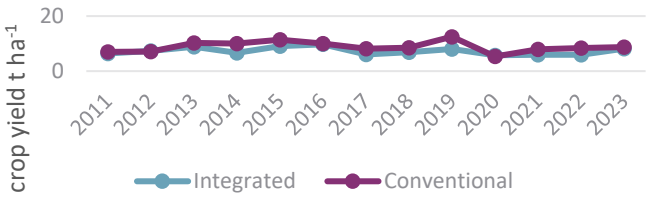
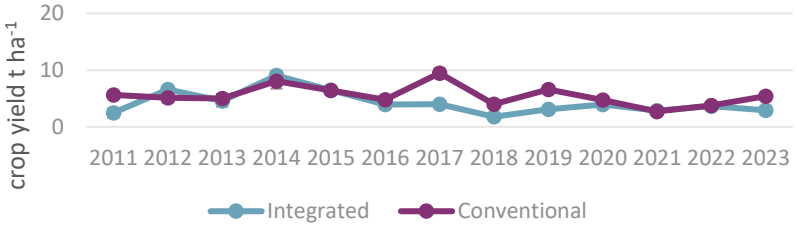
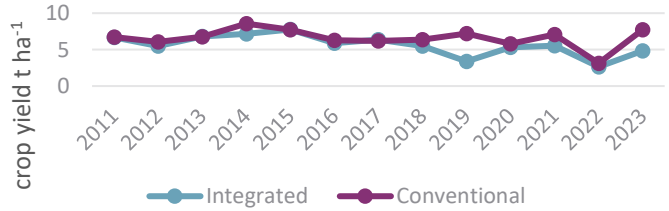
winter barley, slightly lower yield in integrated treatment but not statistically significant over all years



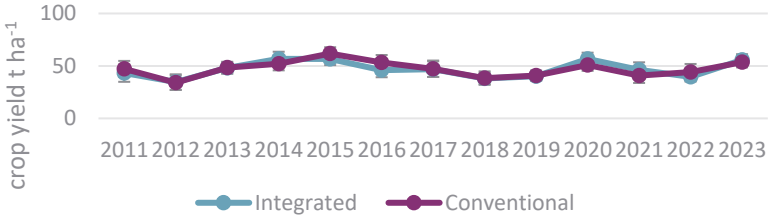
faba beans – n.s. in 1st rotation, lower yield in 2nd rotation for some yields – poorer establishment in direct drill situations



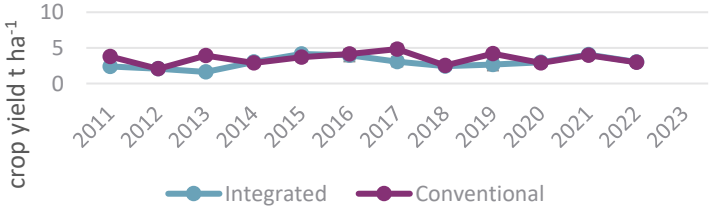
spring barley – n.s. overall but lower yield in some years (weed competition in some fields)



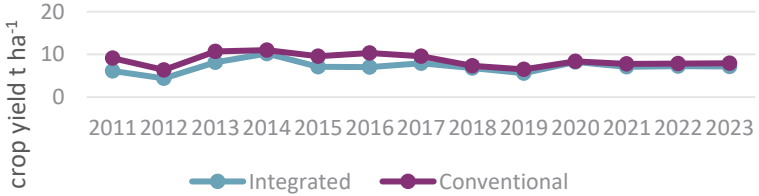
Potato (n.s. treatment effect)



oilseed rape – n.s. overall but highly variable and lower yields in some years due to establishment issues through crop residue and pigeon damage



winter wheat – significantly lower in rotation 1, n.s. rotation 2 after improvement in crop system design



100 years of breeding – over 200 plant varieties bred by the James Hutton Institute, its commercial subsidiaries and predecessors

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131 Potato

3 Barley

12 oats

17 Turnip & Swede

3 Forage Rape

6 Kale

3 Common bean

1 Salad Rape

Hot Stuff

29 Blackcurrant

23 Raspberry

Plus the Tayberry and Tummelberry

8 Strawberry

4 Blackberry

1 Gooseberry

Net Zero Barley

- Current modern varieties developed to work in high input systems and maximising yield
- Future varieties need to be more climate resilient and reduce GHGe
- There are many levers to pull in getting to a Net Zero Barley - genetics is key to them all
  - Reducing inputs – regenerative farming, higher nitrogen use efficiency, the right root microbiome, symbiotic associations with mycorrhiza
  - Re-balancing carbon allocations – maintaining yields but perhaps having bigger, better root systems for drought resilience, going back to longer stems so that more carbon goes back into the ground to help soil health and store carbon
  - Improving spent grain feed quality to improve livestock GHGe
- We have the germplasm and immense un-tapped diversity but we need to do this faster and use the range of genomic technologies and speed breeding approaches

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Glensaugh Climate Positive Farm Initiative – every mitigation, every adaptation, all on one farm

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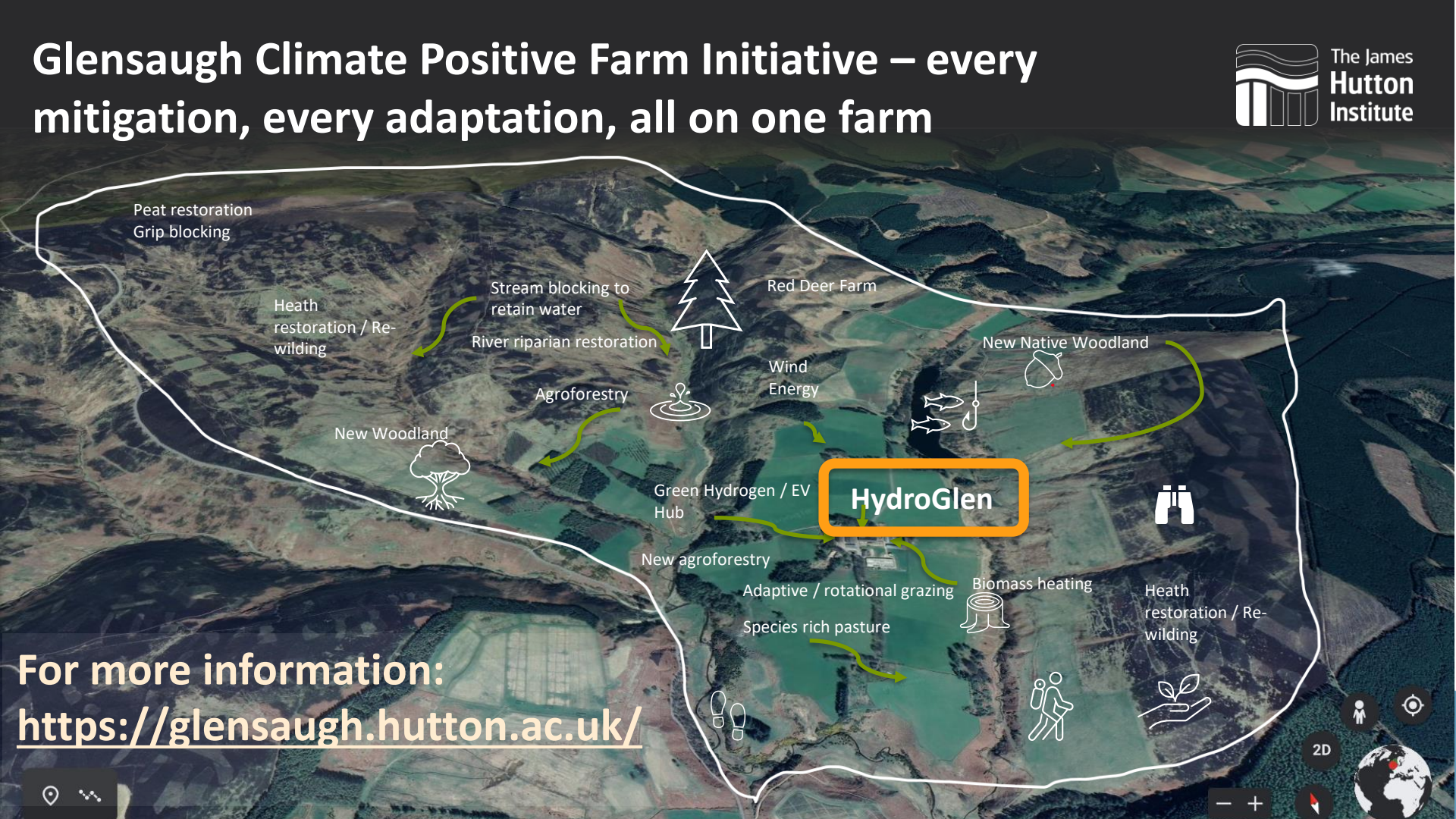

For more information:
https://glensaugh.hutton.ac.uk/

HydroGlen

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A green hydrogen-powered farm pilot at Glensaugh, Aberdeenshire

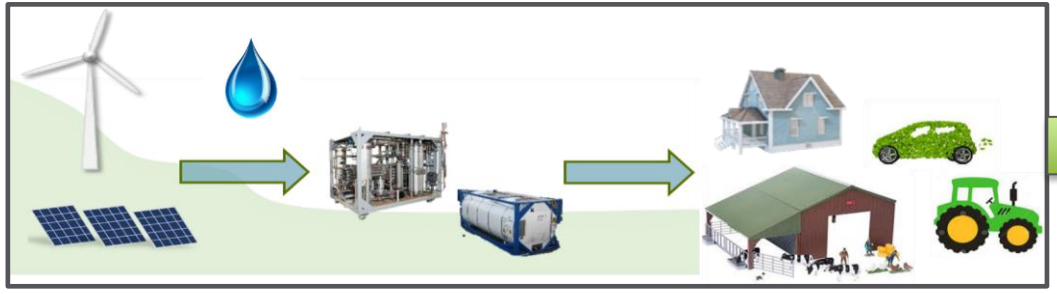
To demonstrate how **100%** of the farms community's electricity, heating and transport energy requirements can be self-generated renewably

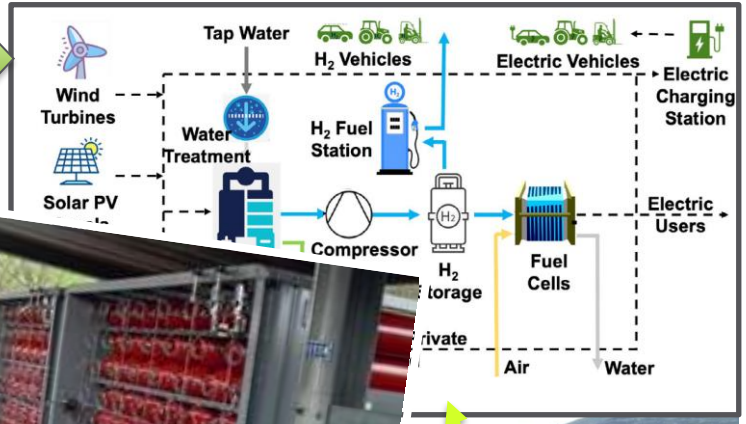
To replace diesel and reduce Farm GHGe by **10%**

To have off-grid capability and so be resilient in the face of more frequent storms that interrupt power supplies

Demo innovative and practical energy solutions for the region and beyond where around **45%** of people in the North-East live in rural areas.

HydroGlen – basic operating model





Important elements:

- 'Build-ready' – using commercially available technologies…
- Different hydrogen / battery EV vehicle combinations…
- Replicability - both on- and off-grid systems…
- Modular and scalable components...

Future science …really big opportunities

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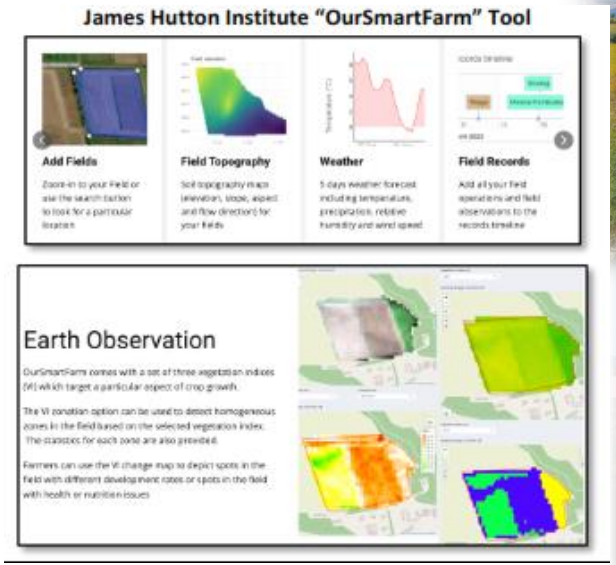
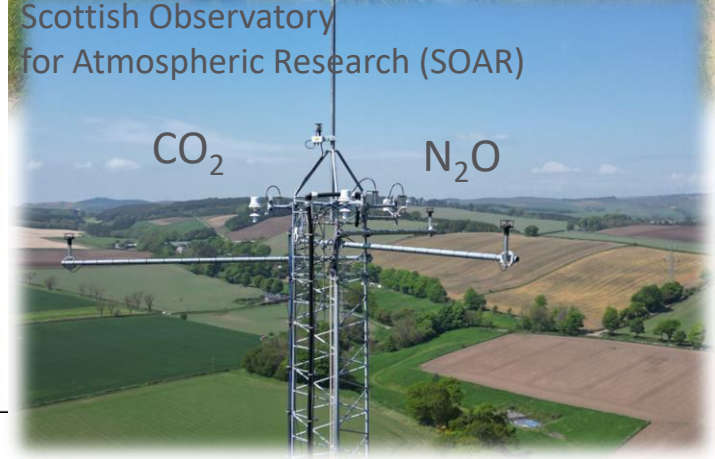
- New crop varieties for low input systems
- Measuring Greenhouse gases with tall towers
- Eco-acoustics for biodiversity
- In field sensors for essential farm management information about soil, weather, livestock, and crops linked to national and global satellite information



Scottish Observatory for Atmospheric Research (SOAR)



1726-1797

“Let us never lose sight of this great principle, that the produce of the earth is the means of population, and the bond of union to a people. Let us not forget that while husbandry of a country is promoting the prosperity of the state, there is a reciprocal duty which the state owes to the husbandry of the country”

Hutton recognised that the primary importance of the products from the land for prosperity and sustenance of people and that the state had a fundamental duty to safeguard this.

(Elements of Agriculture, Chapter 7)

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A Just Transition – Policy, Science, and Innovation Must Align

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Transitioning to a new farming future will take time. But it is possible—if we can align:

1. **Clear policy direction** – signals that reward resilience, soil health, and environmental stewardship
2. **Scientific innovation** – research and evidence that supports farmers in making changes that are practical and profitable and sustain a livelihood
3. **Technology and knowledge-sharing** – ensuring farmers have evidence and access to the tools they need to make informed decisions
4. **Cooperation** across supply chains and the sector

Acknowledgements

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Thank You