A new multi-disciplinary institute of forest research and a new ten-year+ experiment in environmental resilience…potential for future collaborative work

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BIFoR: the need

FOREST VALUE

UK forest industries - £4.2bn Gross Value Added per annum

11,000 direct jobs and ~100,000 downstream jobs.

TRADE GAP

Timber is UK's 6th largest import; 1M tonnes of hardwoods imported annually.

Annual UK trade deficit in wood-based construction materials is ~£1bn

→ Zero-carbon new UK housing would require >>£1bn offsetting just to cover timber

SKILLS GAPS

50-80% of UK woodlands and forests unmanaged (and is the rest managed sustainably?)

"Most Wanted" postgraduate skills: plant pathology, taxonomy, soil science, environmental microbiology, and modelling

SKILLS LEADS

Climate (inc LSM), bioscience (medical), biogeochemistry

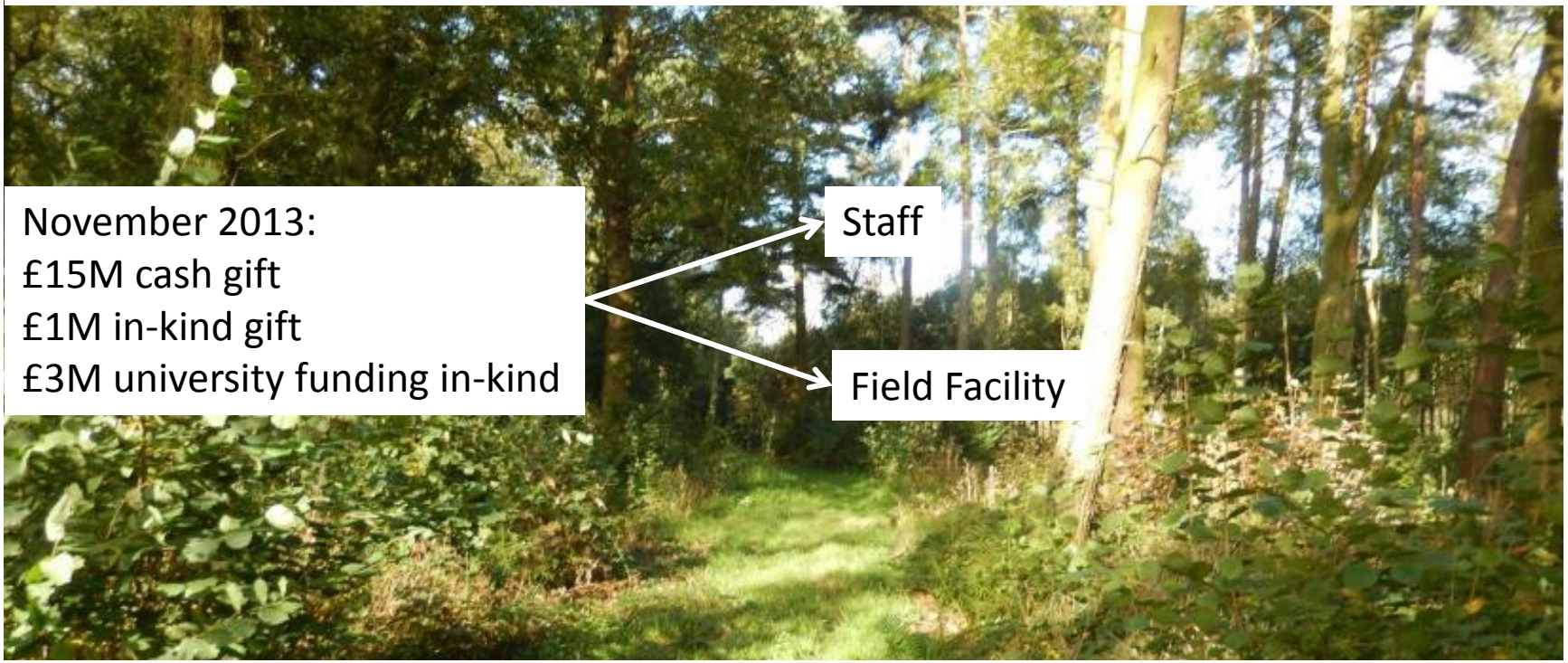
KNOWLEDGE GAPS

The value chain and one-world living

Carbon sink – wood and soil

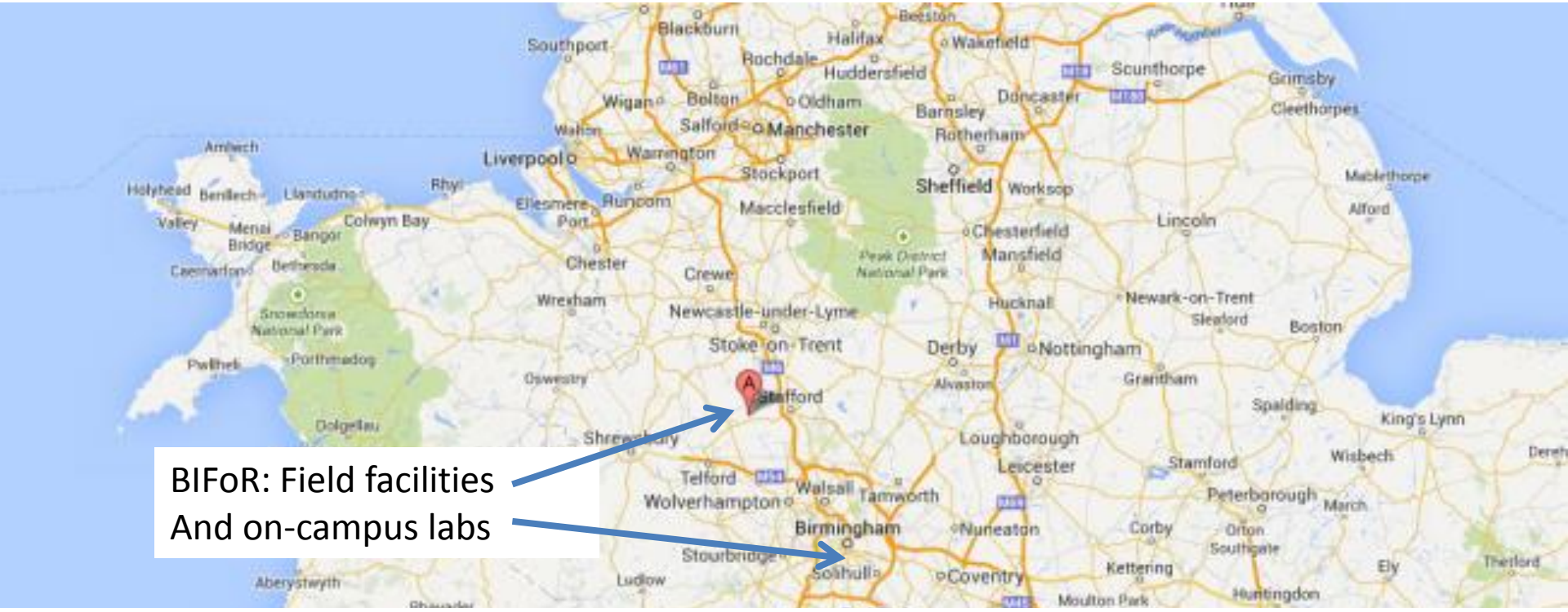
Resilience to biotic and abiotic challenge

BIFoR Research Priorities



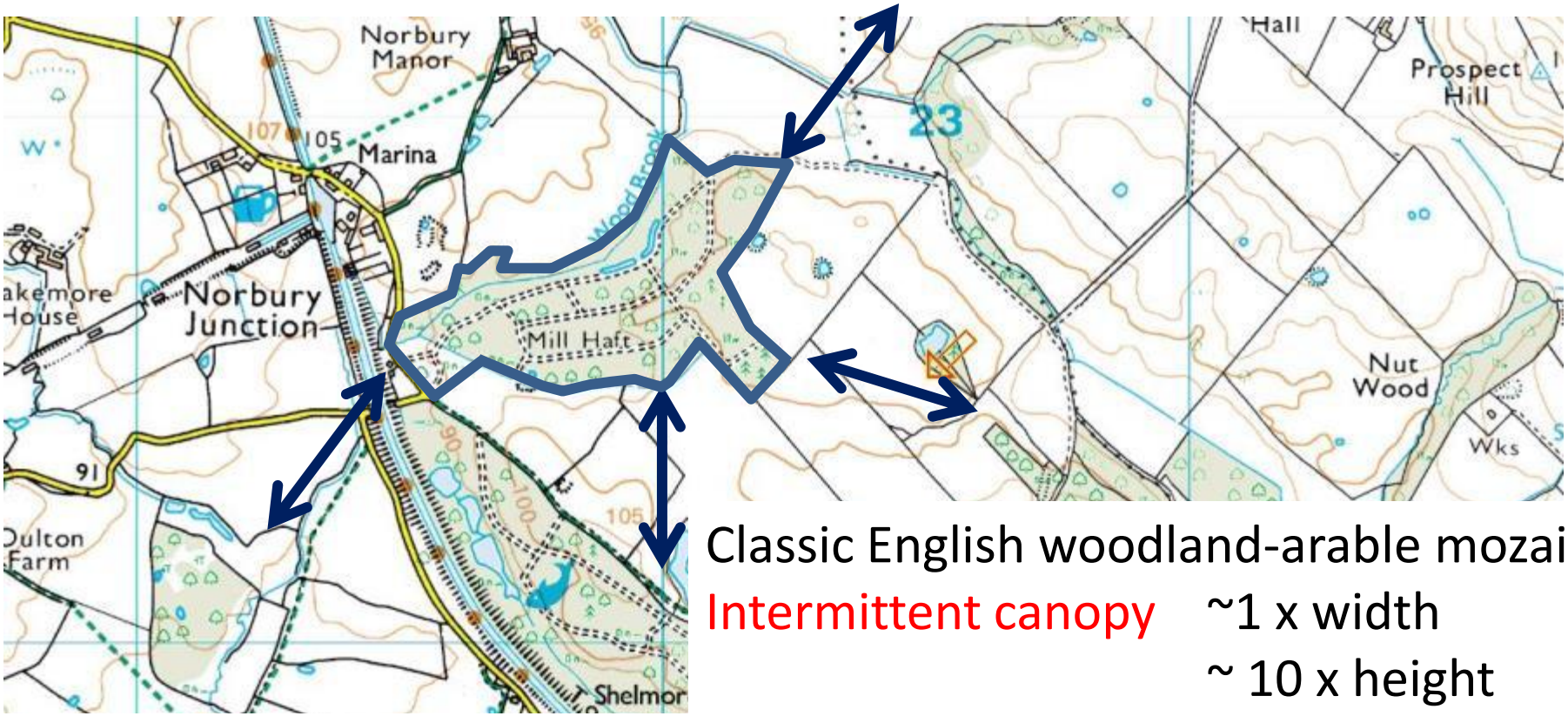
1. **resilience** of forests to pests, pathogens and environmental influences;
2. **solutions** to address tree and forest health, addressing plant disease and its control;
3. **integration** of trees into farming systems;
4. **'barcode of life'** whole-ecosystem genomic characterisation of ancient woodlands; and
5. **governance** incorporating scientific evidence and enabling sustainable management

BIFoR Infrastructure



Combine field studies with controlled environment studies on campus

The BIFoR Field Facility: Mill Haft



Classic English woodland-arable mozaic

Intermittent canopy ~1 x width

~ 10 x height

150-year-old oak canopy ~ 25m

Coppiced hazel, birch and sycamore understorey ~ 8m

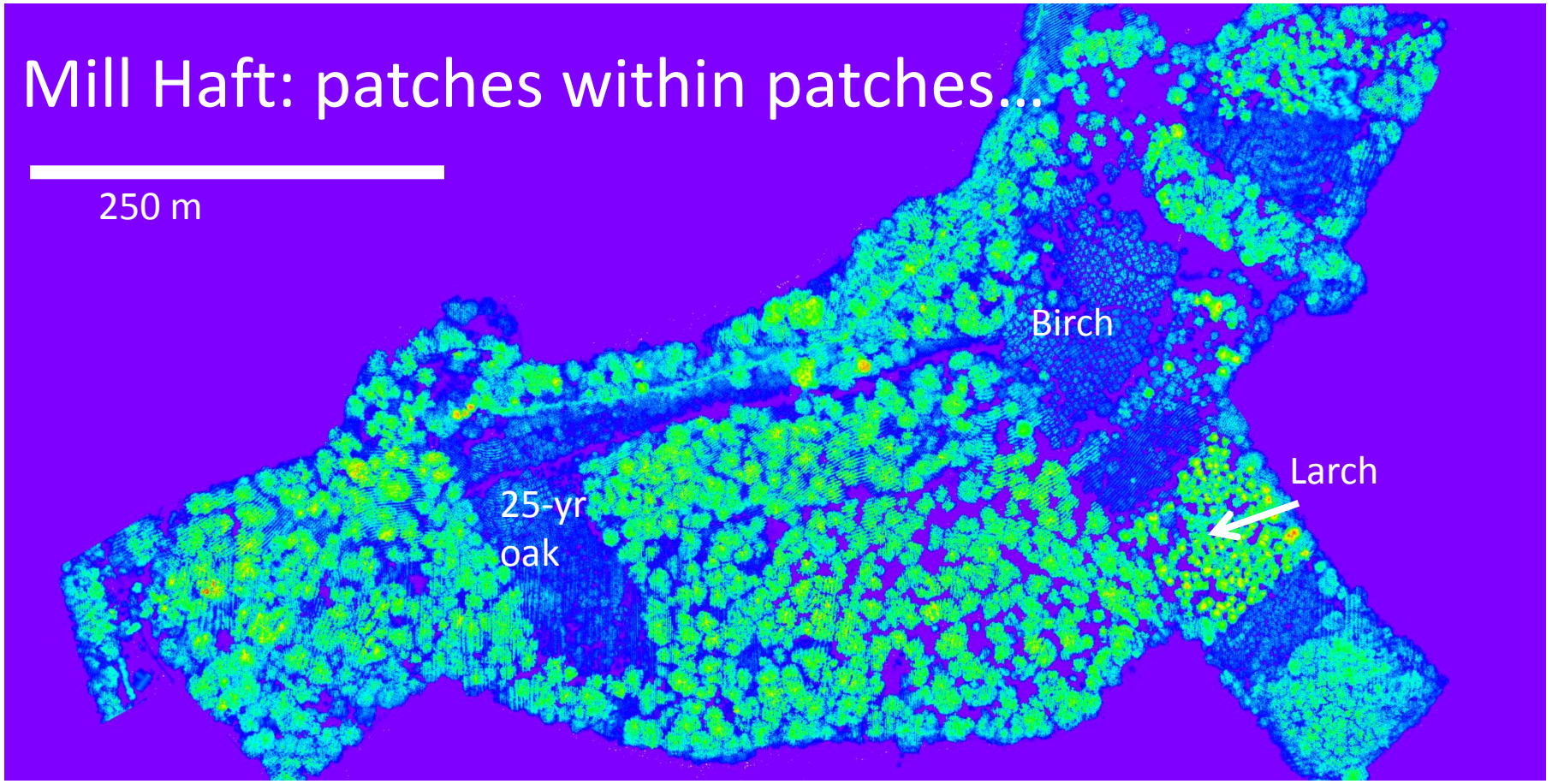
Gently undulating terrain – steep wooded slopes on aquaducts

Mill Haft: complicated canopy structure

150-year-old oak canopy ~ 25m

Overstood hazel, birch and sycamore coppice ~ 8m

Gently undulating terrain – steep wooded slopes on aquaducts



150-year-old oak canopy ~ 25m

Small patches cleared and re-planted ~25 years ago

Repeat active and passive remote sensing - UAVs and towers

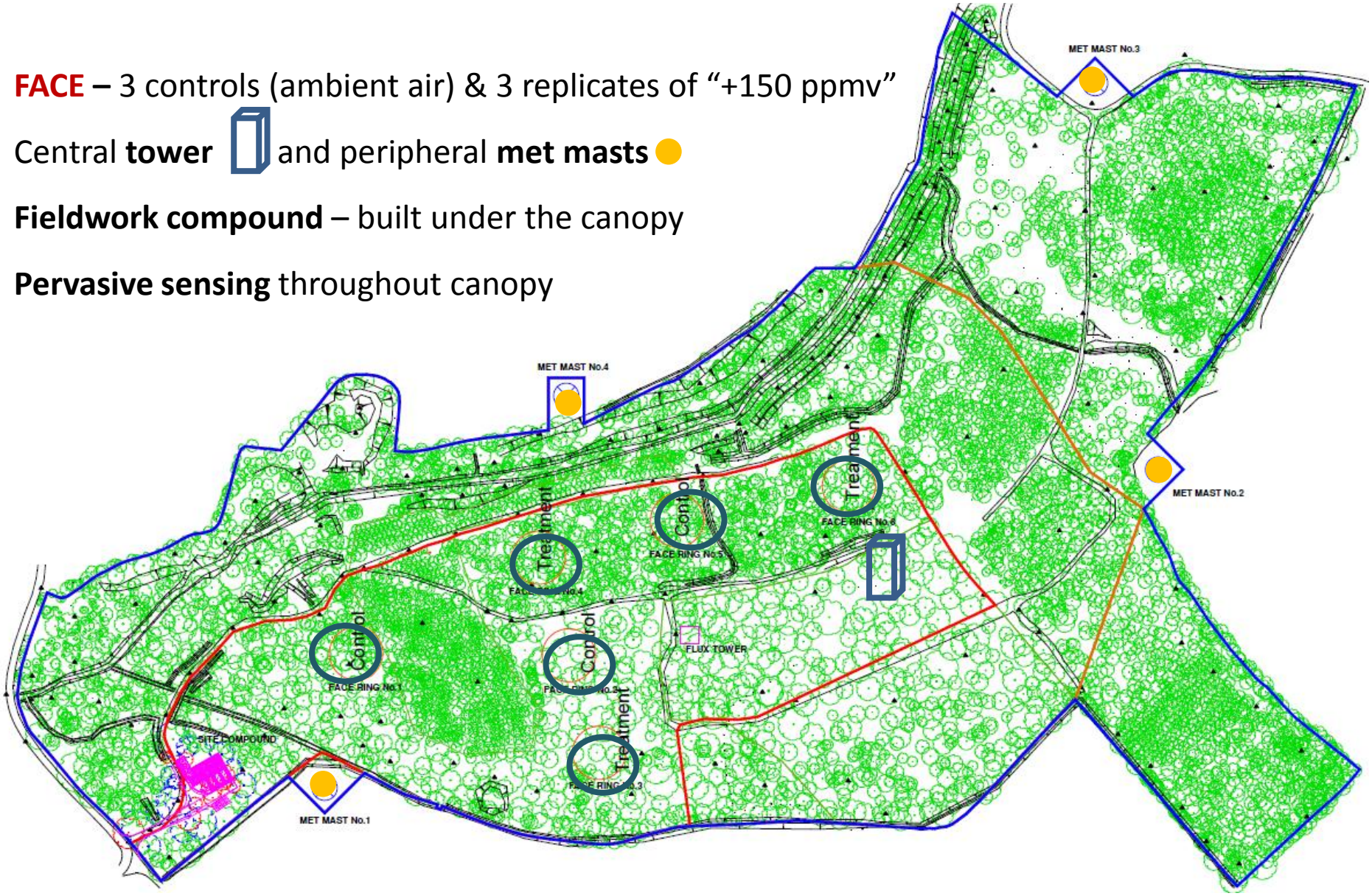
The BIFoR Field Facility

FACE – 3 controls (ambient air) & 3 replicates of “+150 ppmv”

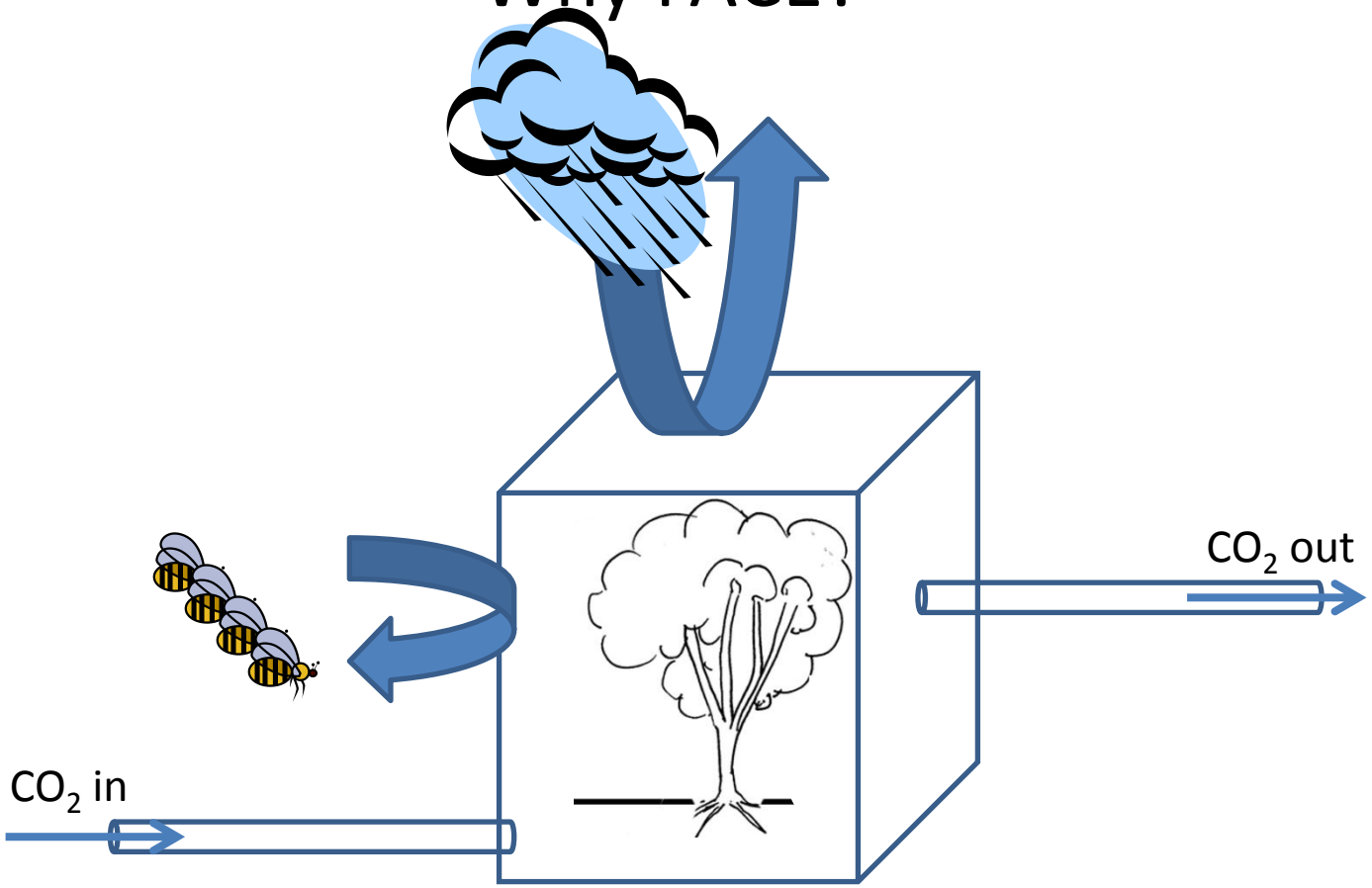
Central **tower** and peripheral **met masts**

Fieldwork compound – built under the canopy

Pervasive sensing throughout canopy



Why FACE?

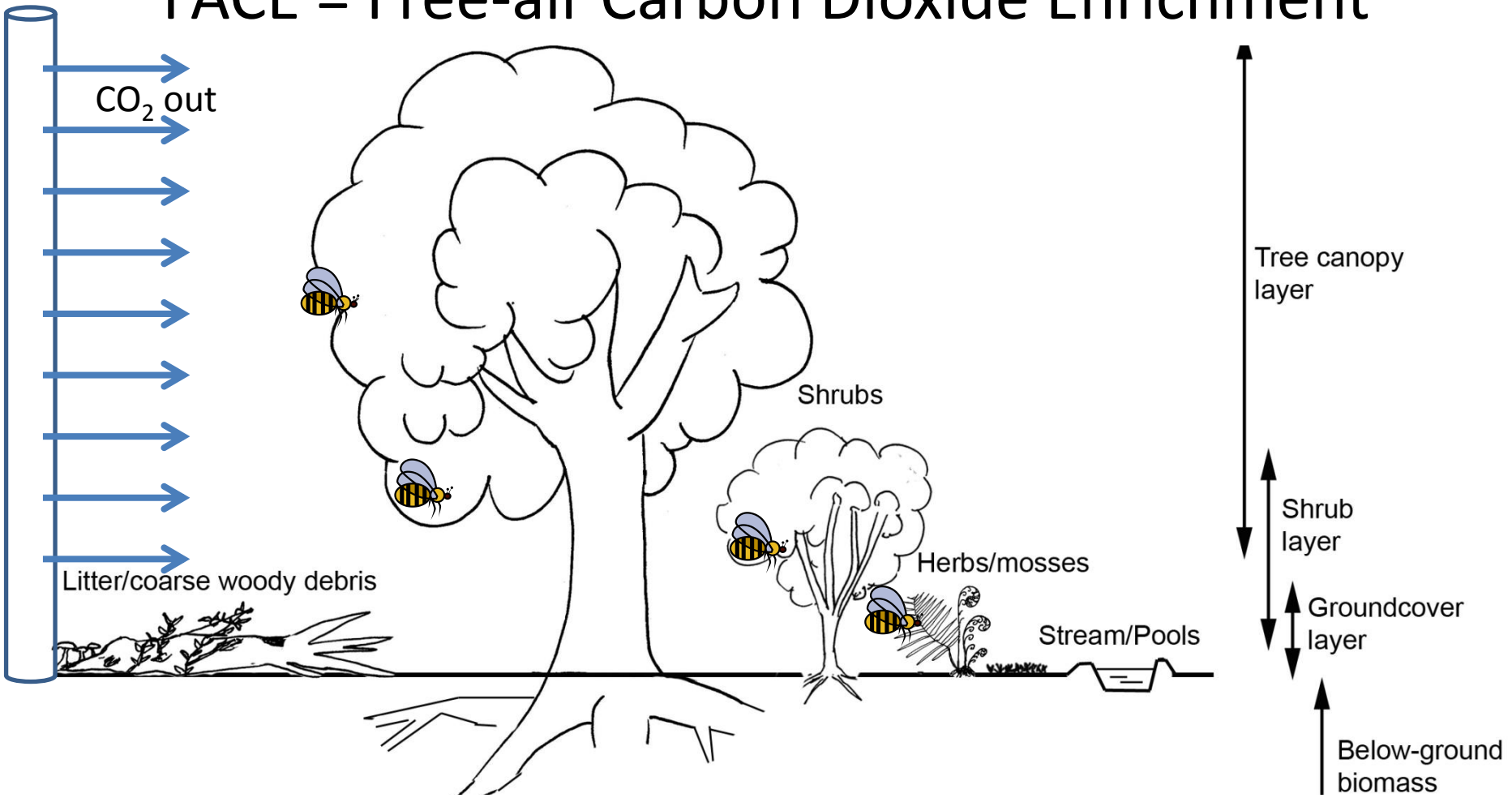


Frugal use of CO_2

Artificiality of **chamber methods** compromises results

- Use small, young plants, often in pots
- Chamber micro-climate
- Useful to study individual processes but can be misleading when applied to environment

FACE = Free-air Carbon Dioxide Enrichment



Substantial CO_2 requirements

FACE method minimises chamber effects

- Mature plants – canopy, sub-canopy, ground shrubs – in their own soil
- Free-flow of water, air, and animals
- Studies the system in-situ

BIFoR FACE top-level research questions

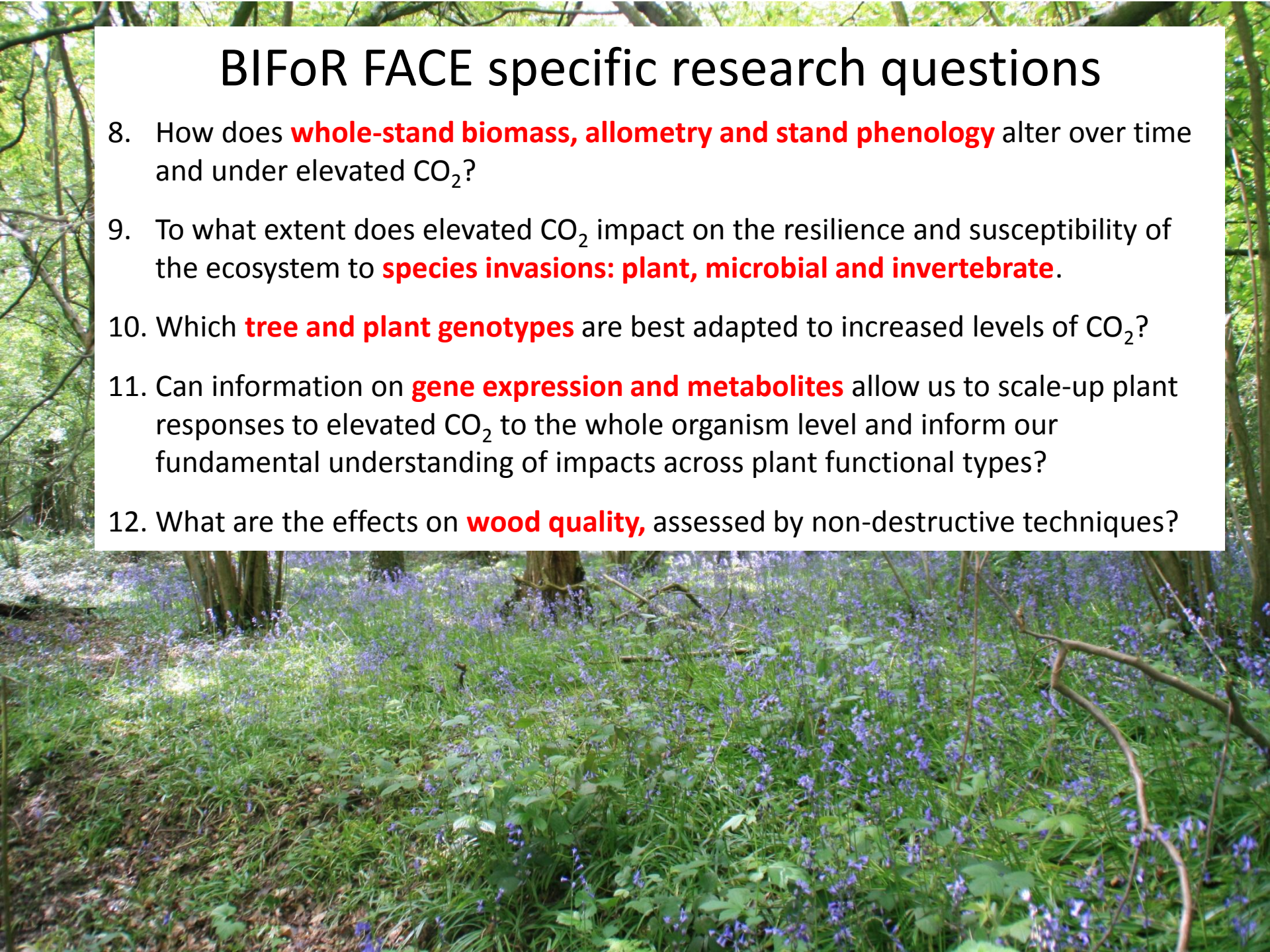
1. Does elevated CO_2 increase the **carbon storage** in a mature temperate deciduous woodland ecosystem?
2. Do other **macro- or micro-nutrients** limit the uptake of carbon in this ecosystem now, or are they likely to in the future?
3. What aspects of **biodiversity and ecosystem structure-and-function** alter under elevated CO_2 and how do these alterations feed back onto carbon storage?
4. How can this woodland best be **managed for carbon storage** under climate change, and what general lessons can be learnt?

BIFoR FACE specific research questions

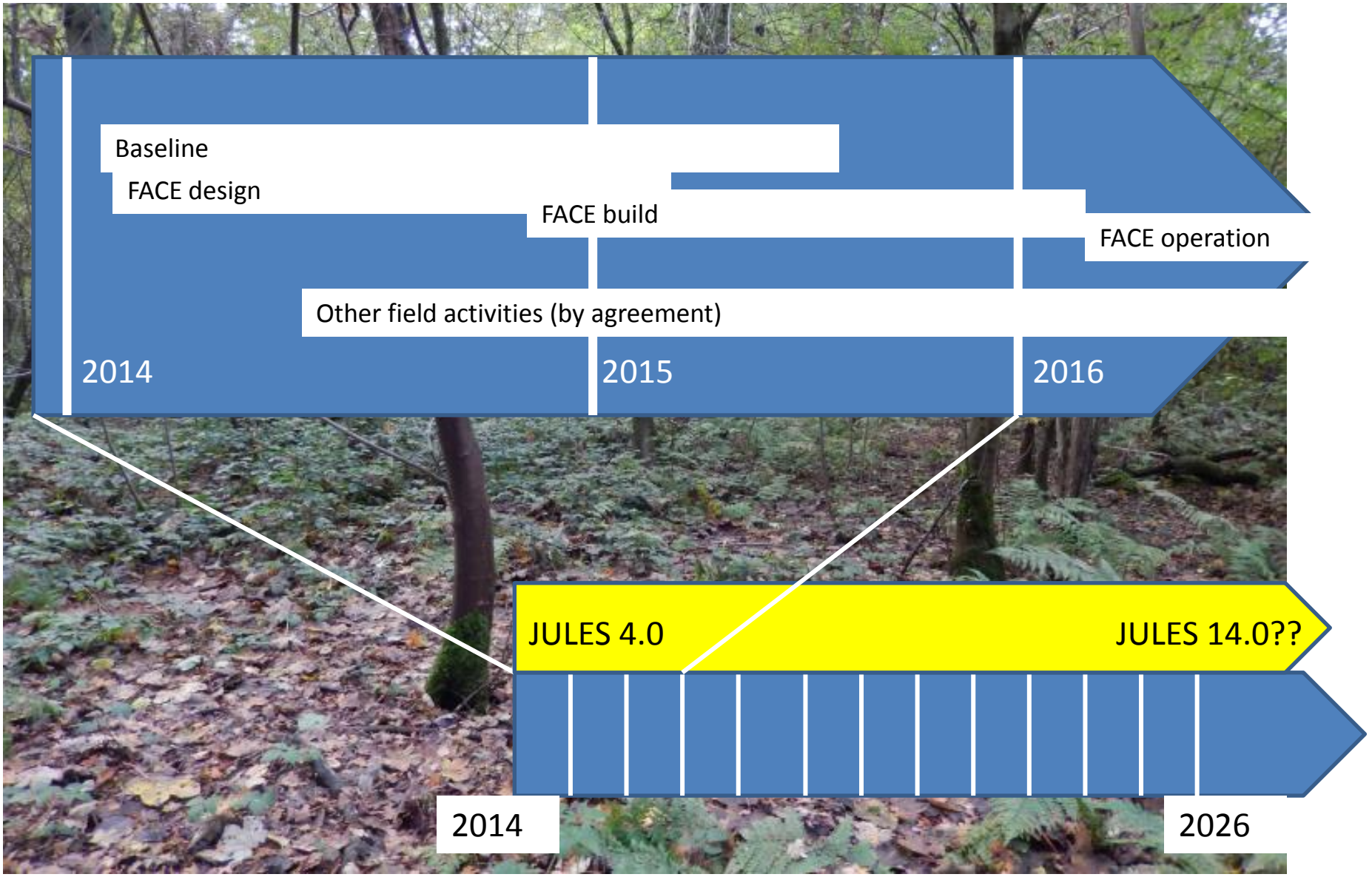
1. What **impacts of wet and dry years** on carbon storage?
2. What are the impacts of **threshold environmental events** (e.g., snow, flood)?
3. What impacts of elevated CO_2 on **susceptibility and resistance to pathogens**?
4. What impacts of elevated CO_2 on **production, dispersion, and fate of propagules**?
5. What direct and indirect (e.g., through changes in herbivory) effects of elevated CO_2 on the **production of plant volatiles**?
6. What **fluxes of energy, momentum, and trace gases** over the agricultural mosaic landscape including the BIFoR FACE woodland?
7. What contributions of gas-phase, aqueous-phase, and aeolian-dust **transport of carbon and nutrients** into and out of the FACE woodland?

BIFoR FACE specific research questions

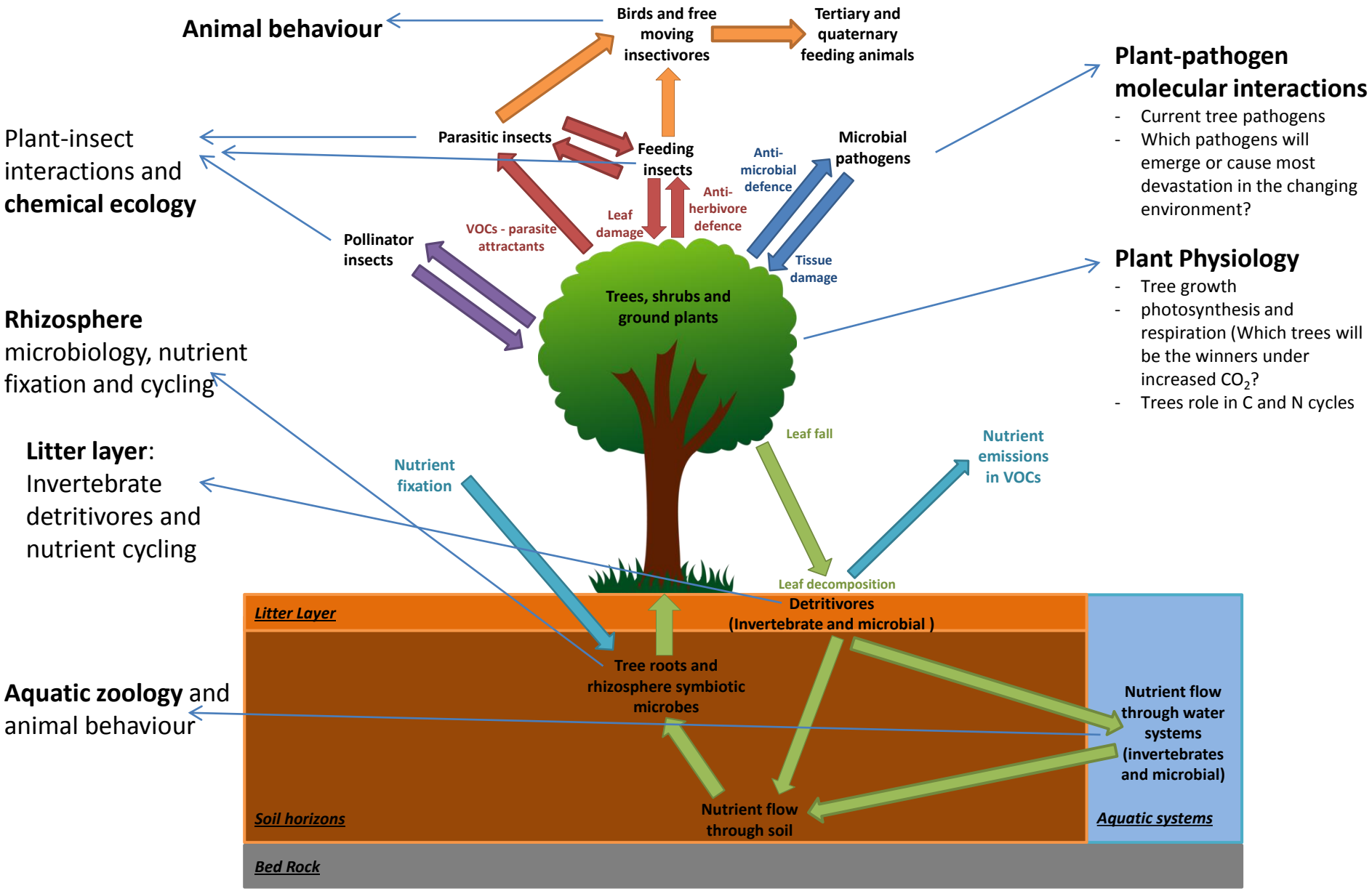
8. How does **whole-stand biomass, allometry and stand phenology** alter over time and under elevated CO_2?
9. To what extent does elevated CO_2 impact on the resilience and susceptibility of the ecosystem to **species invasions: plant, microbial and invertebrate**.
10. Which **tree and plant genotypes** are best adapted to increased levels of CO_2?
11. Can information on **gene expression and metabolites** allow us to scale-up plant responses to elevated CO_2 to the whole organism level and inform our fundamental understanding of impacts across plant functional types?
12. What are the effects on **wood quality,** assessed by non-destructive techniques?



BIFoR Field Facility: Timeline



JULES 14.0 …SEX AND DEATH???



BIFoR Stakeholders

JABBS Foundation

Norbury Estate

Grown in Britain

Woodland Trust

National Association of Cider Makers

John Horseman Trust

Brookhaven National Laboratory

University of Illinois at Urbana-Champaign

Hawkesbury Inst of Environment

Oak Ridge National Lab

China National GeneBank

Forest Research/Forestry Commission

120 person-months of visiting fellowships –travel and subsistence and small consumables budget.

Prof Dave Ellsworth (Hawkesbury); Dr Debbie Hemming (Met Office)

Site for **field Intensives**

Data to **challenge models – ensure measurements are fit-for-purpose**


Thank you
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