

The Royal Botanic Gardens, Kew's Millennium Seed Bank - a global partnership for plant conservation, supporting innovation and adaptation in forestry

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Royal Botanic Gardens, Kew



Outline of talk



- **Kew Gardens**
- **Diminishing diversity**
- **Why are plants important?**
- **Millennium Seed Bank**
- **Conserving plant diversity**
- **Enabling innovation & adaptation**
- **Habitat restoration**
- **Ecosystem services**
- **Adaptation**
- **Challenges**



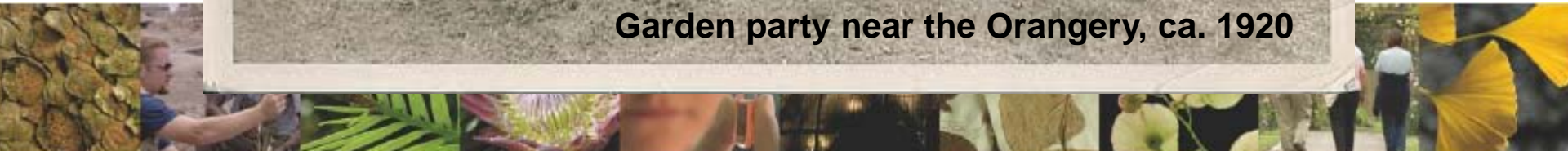


View from the Pagoda, ca 1910





Garden party near the Orangery, ca. 1920





Princess Augusta (1719-1772)



King George III
(1738-1820)

'To inspire and deliver science-based plant conservation worldwide to enhance the quality of life'

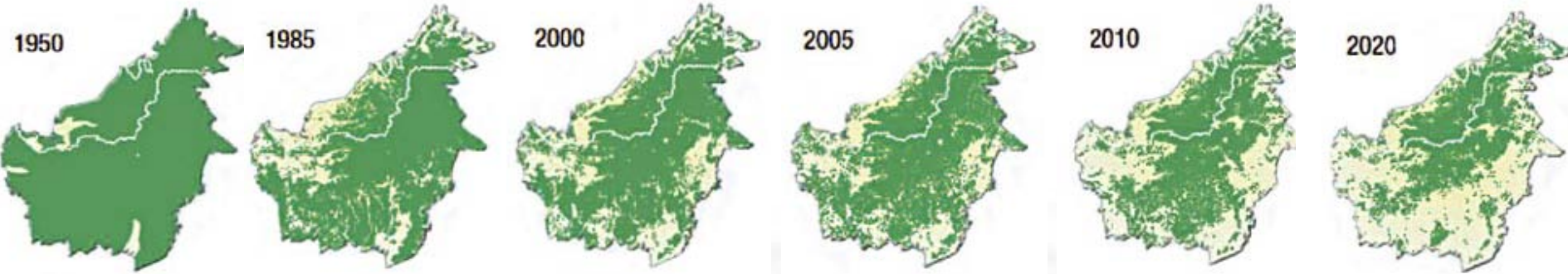
Our role (and that of other plant science institutions) is to work with society to enable human innovation, adaptation and resilience.

Our role is primarily in providing plant-based solutions to the environmental challenges that we all face.



Sir Joseph Banks (1743-1820)

Diminishing diversity



Oil palm plantation, East Kalimantan, © CIFOR



Diminishing diversity

20% of plant species are currently threatened with extinction



© Joseph S. Venus

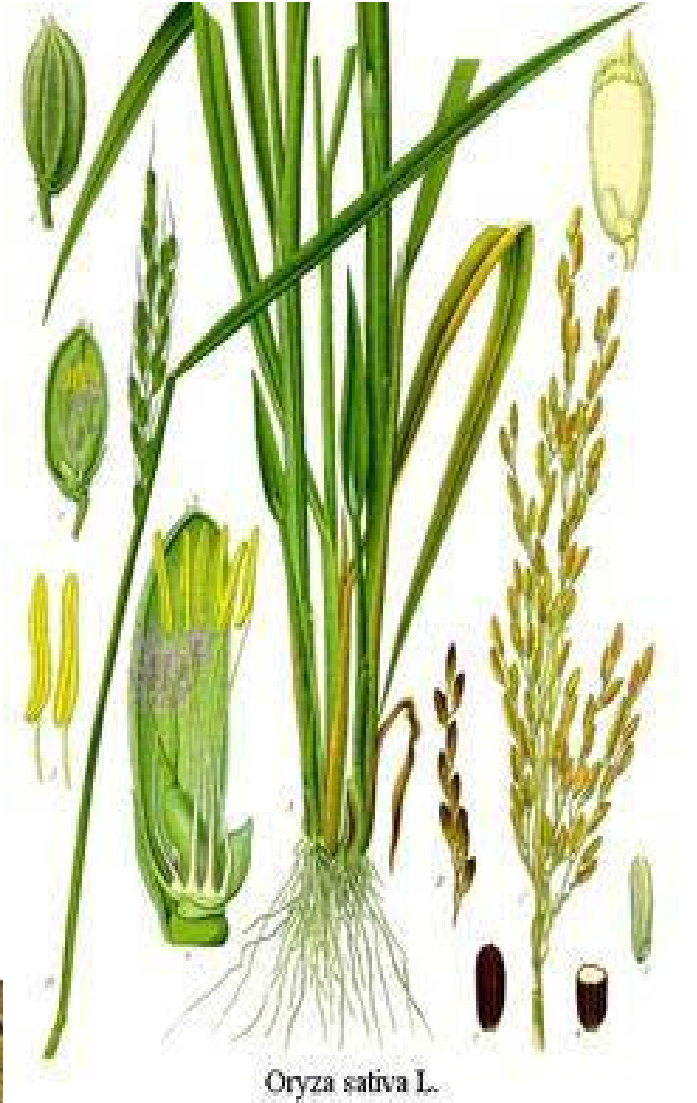
(www.millenniumassessment.org)



Diminishing diversity



Why are plants important?



Globally, **80%** of our plant-based food intake comes from just **12** domesticated plant species, **8** cereals and **4** tubers

An estimated **7,000** species are collected and cultivated for food; **23,000** others known to be edible

Can we continue to rely on such a tiny fraction of edible plant diversity for all our future needs?



Why are plants important?



Do we have all the medicines we need?

75% of the world's population relies on traditional medicines.

Traditional Chinese medicine uses > 10,000 plant species. 7,000 species are used for medicine in India.



Why are plants important?



Plant-based solutions will be required for all the major environmental challenges

- **Food security**
- **Water scarcity**
- **Energy**
- **Human health**
- **Loss of biodiversity**
- **Climate change**



Photo: F de la Cruz, Bioversity International



Why are plants important?

There are ca. 60,000 trees species in the world. We have detailed knowledge of only about 1,000.

The 59,000 that we don't currently grow are the basis of future innovation, adaptation and resilience

→ Seed banks can help by providing seeds and information on seed biology, germination and propagation



Garcinia arenicola seedling, Photo: W. Stuppy

Millennium Seed Bank

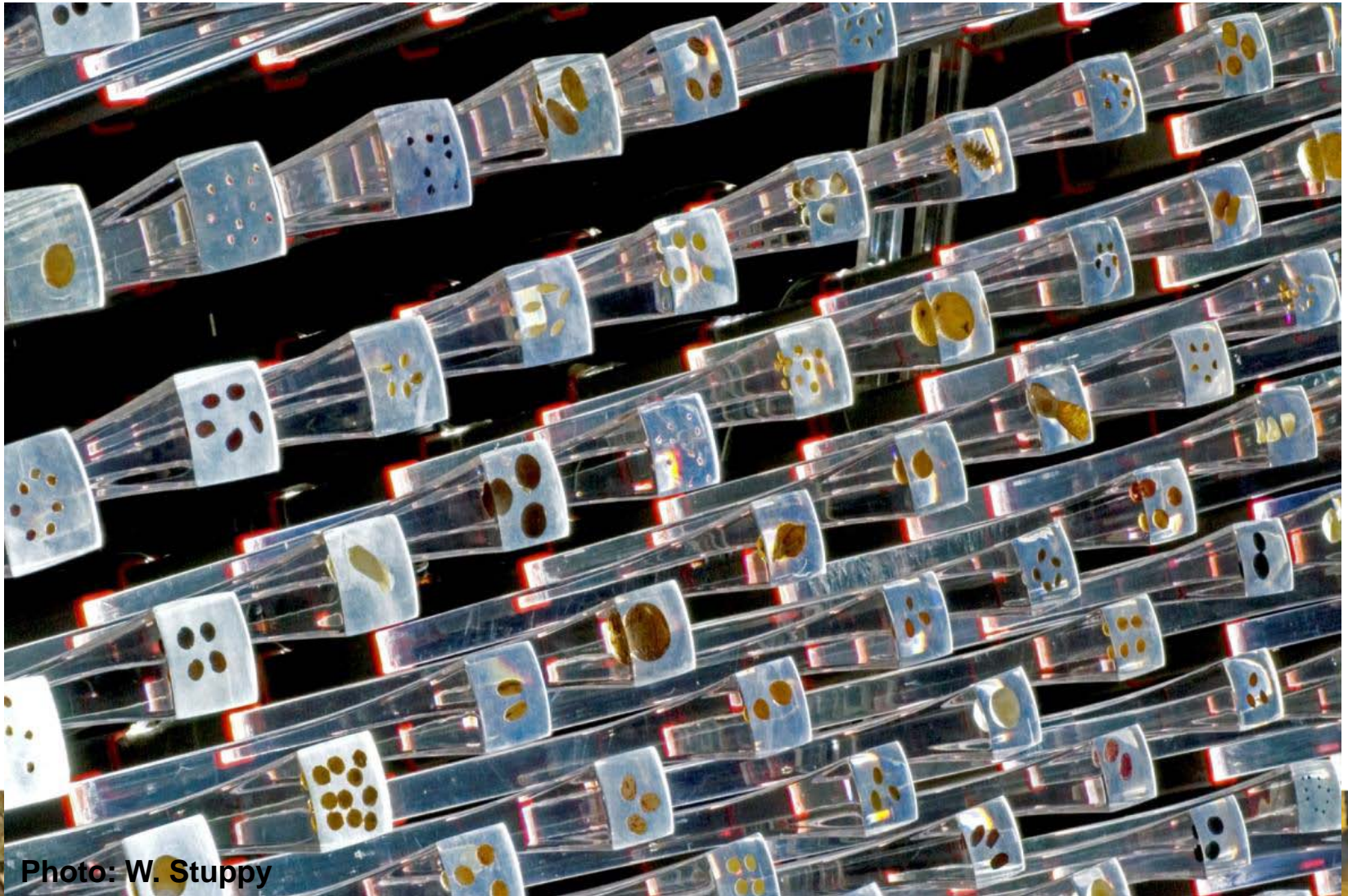


Photo: W. Stuppy

Millennium Seed Bank

- largest seed bank for wild species in the world
- non-crop species (>99% of plant diversity)
- active research methodology; seeds supplied for research and sustainable use



Photo: W. Stuppy



Millennium Seed Bank (1997-2009)



Funded by U.K. Lottery, corporate and private sponsors (£75m)



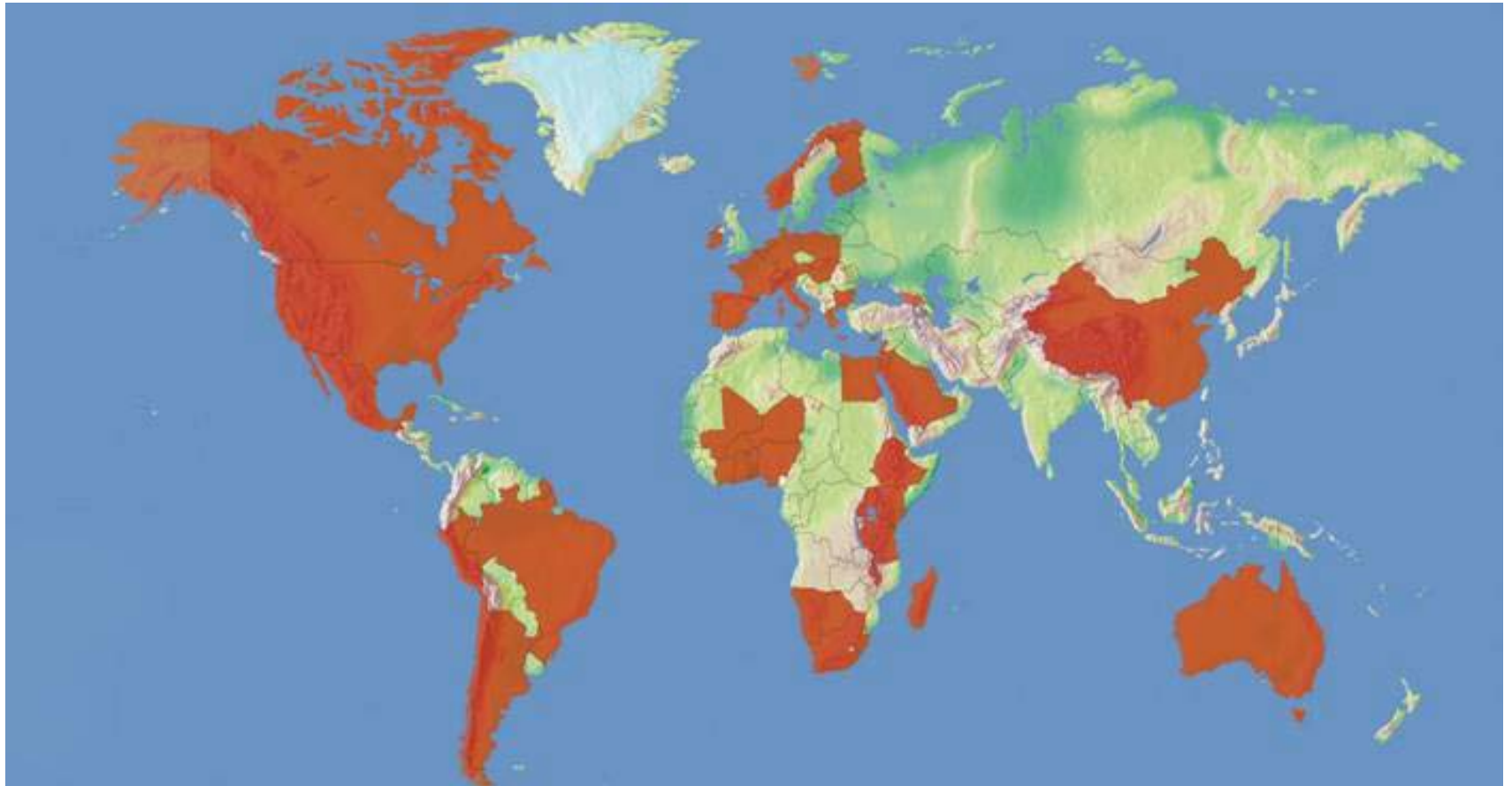
Phase 1 (1997-2000): Collect U.K. native flora and build Millennium Seed Bank



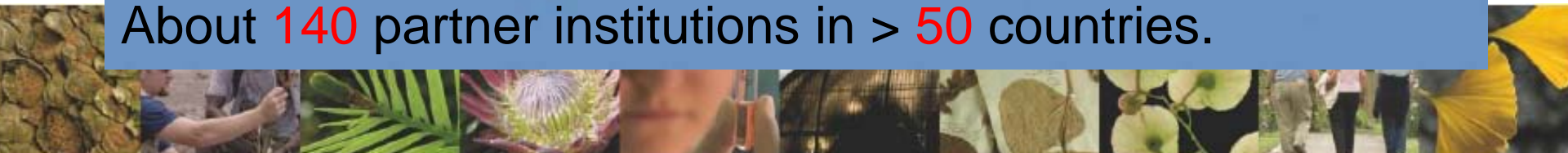
Phase 2 (2001-2009): International Programme: Build partnerships worldwide; conserve 10% of the world's plant species



Millennium Seed Bank (1997-2009) Global network of partnerships



About **140** partner institutions in **> 50** countries.





Millennium Seed Bank (1997-2009) Global network of partnerships

Bilateral cooperation, technology transfer and benefit-sharing
Facilities & equipment supported



Millennium Seed Bank

- Ownership
- Intellectual Property
- Consent
- Activities
- Notification of transfer
- Benefit sharing
- Non-commercialisation
- Transfer to third parties

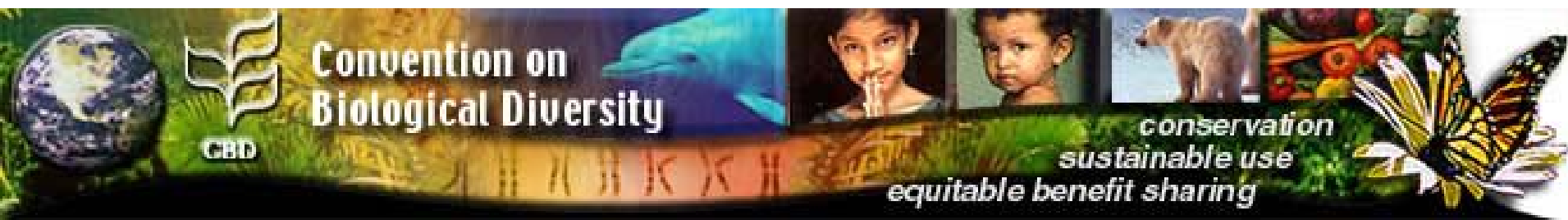


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ITPGRFA





Millennium Seed Bank Partnership (2010-2020)



Target 1: Secure in safe storage **25%** (75,000) of the world's orthodox plant species by **2020**

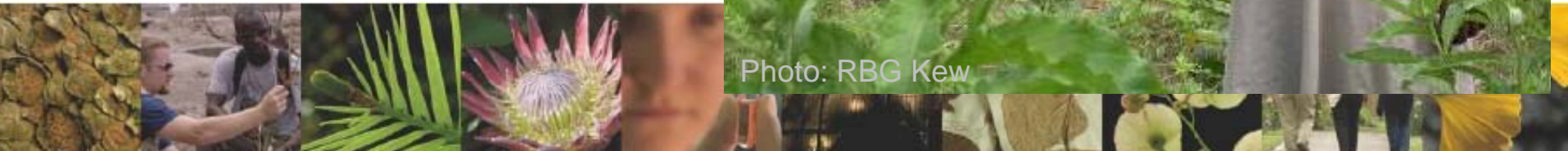
Target 2: Enable **innovation, adaptation** and **resilience** in agriculture, horticulture, forestry and habitat restoration.






Millennium Seed Bank Partnership (2010-2020)

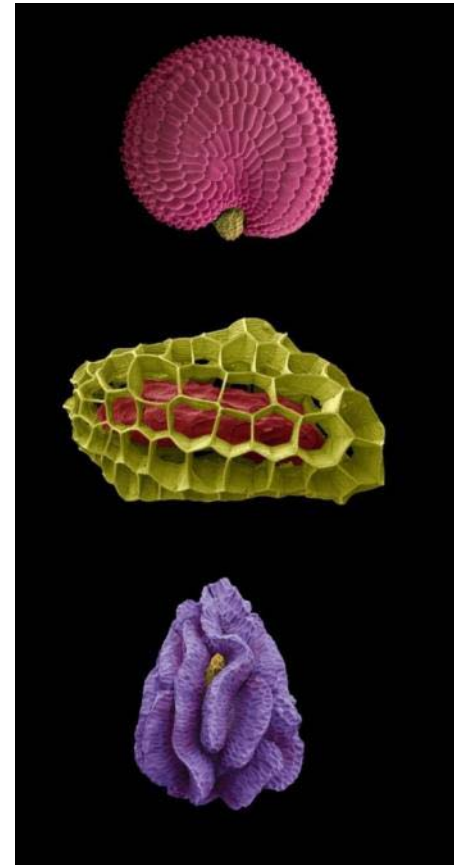
Purpose

“To combat potentially catastrophic threats to human wellbeing by safeguarding wild plant diversity and enabling its sustainable utilisation through global partnership.”



Target 1: Conserving plant diversity

-  Higher level taxonomic sampling strategy (mean = two collections per taxon)
-  Purpose. Long term conservation (**200 years +**); understanding seed biology (storage behaviour, longevity, dormancy, germination etc.)
-  Currently **>40,000** species in MSBP seed banks **>5 billion** seeds in total



Target 1: Conserving plant diversity

- Endangered
- Endemic
- Economic



Target 1: Conserving plant diversity

- Dryland
- Island
- Coastal
- Mountains



Target 2: Enabling innovation and adaptation

Sampling strategy, multi-provenance collections, maximising genetic diversity and adaptive potential.

Purpose: use in the landscape in the short to medium term.

Multiple projects supporting agriculture, forestry, horticulture and restoration



Habitat restoration: UK Native Seed Hub

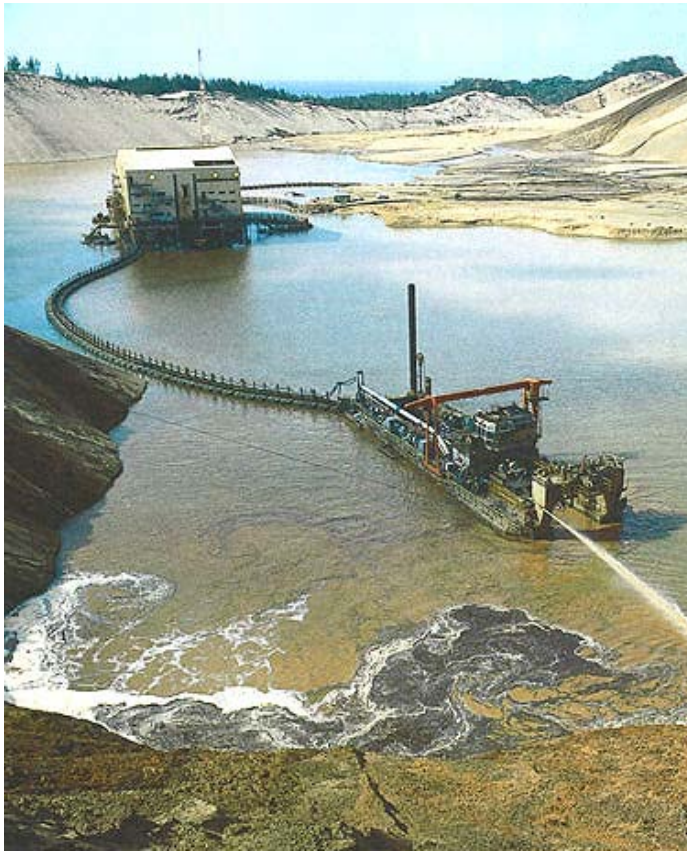
UK native seed companies offer a limited range of species, seed quality is often poor (unregulated).

MSB supports UK commercial companies and restoration practitioners with:

- advice on seed collecting, processing and storage to improve seed quality
- high quality material of rare and threatened species



Habitat restoration: Mining activities



**Bauxite mining
(Australia, Madagascar)**



MILLENNIUM
SEED BANK
PARTNERSHIP

Kew

Habitat restoration: Mining activities - reforestation



Habitat restoration: Mining activities - reforestation



Habitat restoration: Mining activities - reforestation





‘Mango model’

Nutritional benefits

Phenology

Low input

Better adapted

More sustainable

Existing market

Existing knowledge

But technical impediments



Ecosystem services

Forest Landscape Africa

A pan-African technical consortium delivering sustainable agroforestry, utility forestry and forest restoration on the ground

Who we are

Facilitating organisations providing technical support and coordination: World Agroforestry Centre (ICRAF); Forest and Landscape Denmark (FLD); Millennium Seed Bank Partnership (MSBP); UN Food and Agriculture Organisation (FAO); United Nations Environment Programme (UNEP).

Delivery organisations carrying out afforestation on the ground: forestry research institutes, forestry departments and national tree seed centres from 12 African countries: Botswana, Burkina Faso, Ethiopia, Ghana, Kenya, Madagascar, Mali, Malawi, Mozambique, Nigeria, Tanzania and Uganda.



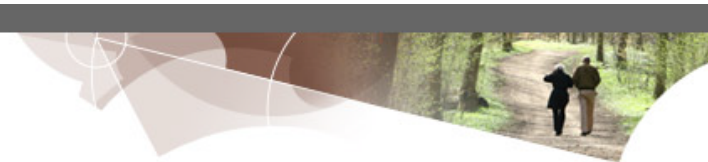
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UNIVERSITY OF COPENHAGEN



Forest & Landscape
Faculty of Life Sciences





Ecosystem services

Sahelian Great Green Wall Project

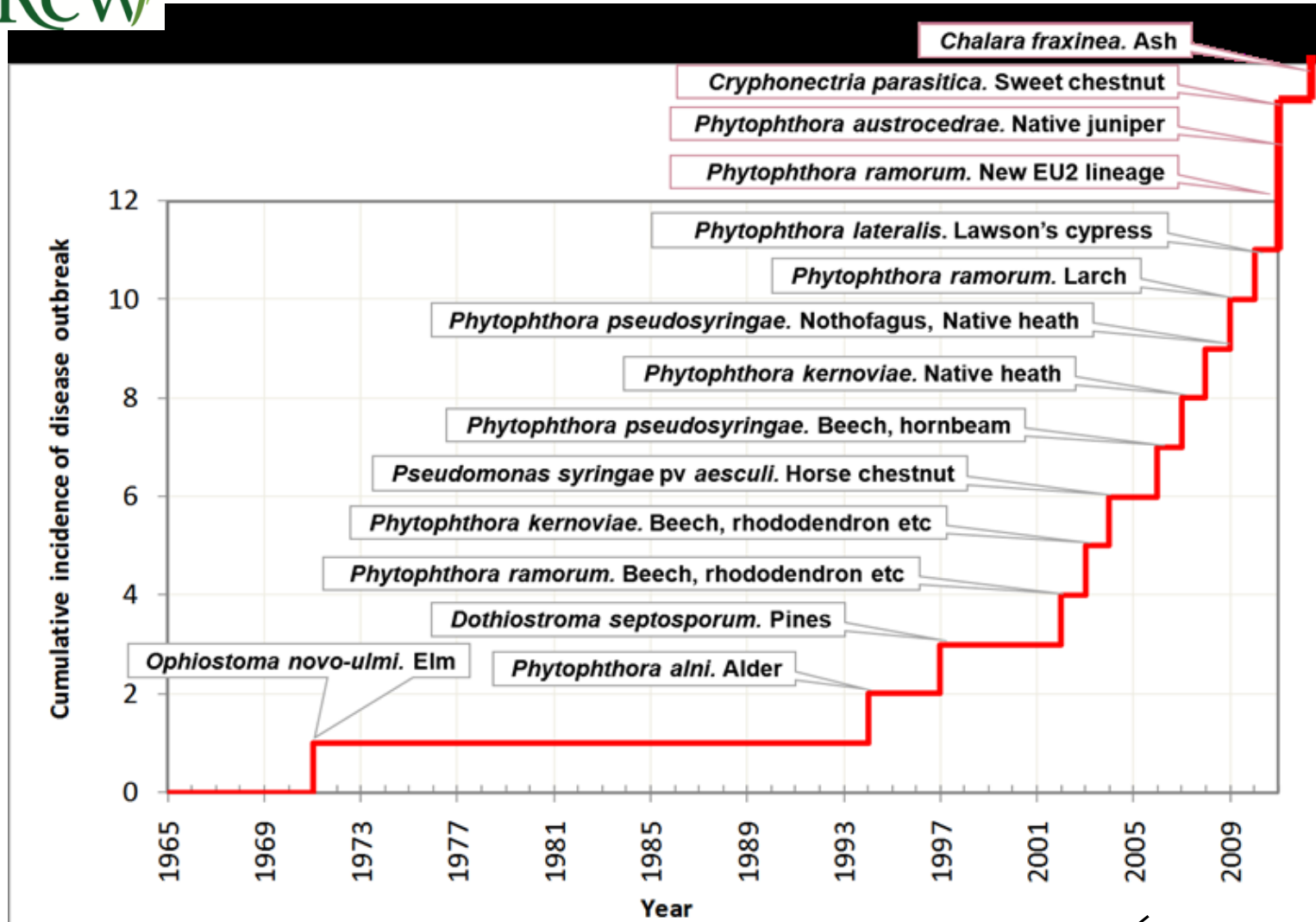


Community-based pilot programmes with an emphasis on indigenous species in Mali, Burkina Faso and Niger (pilot).

£1 million secured
<http://www.thegef.org/gef/great-green-wall>



Adaptation: biosecurity



Adaptation: biosecurity

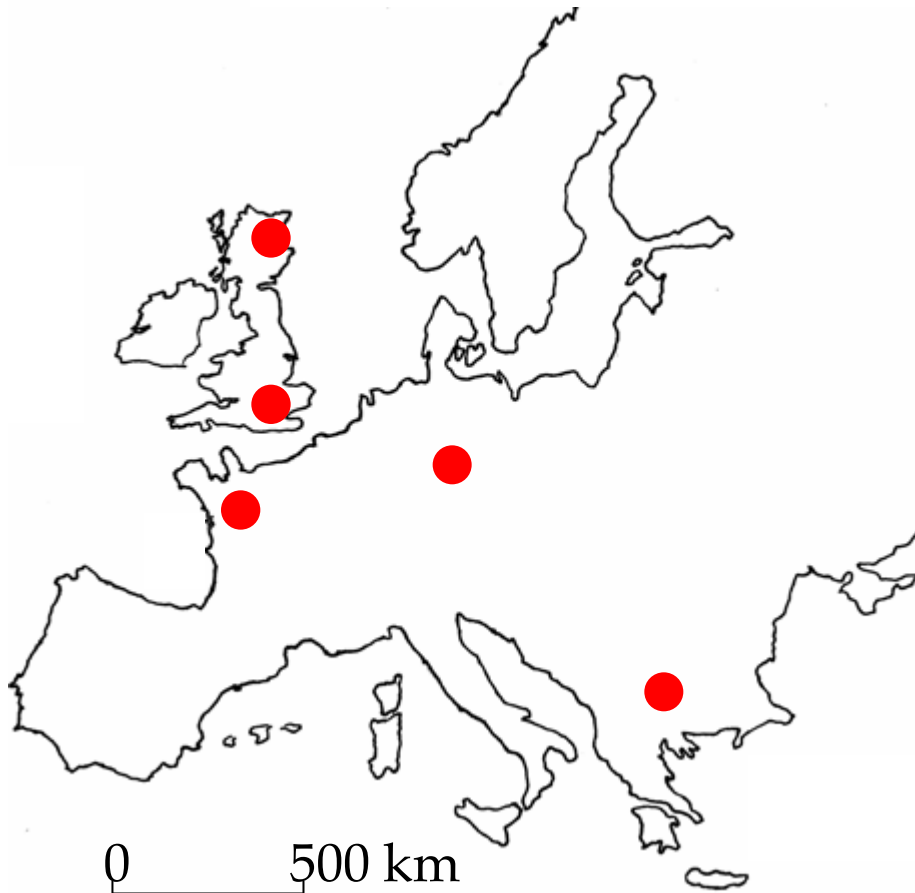


Kew and Forest Research are establishing the UK's first genetically comprehensive National Tree Seed Collection.

- Tree seeds will be used for:
- Screening for disease/pest resistance
 - Development of biological/chemical controls
 - Screening for tolerance to climate and soils
 - Re-introduction of diversity to the landscape

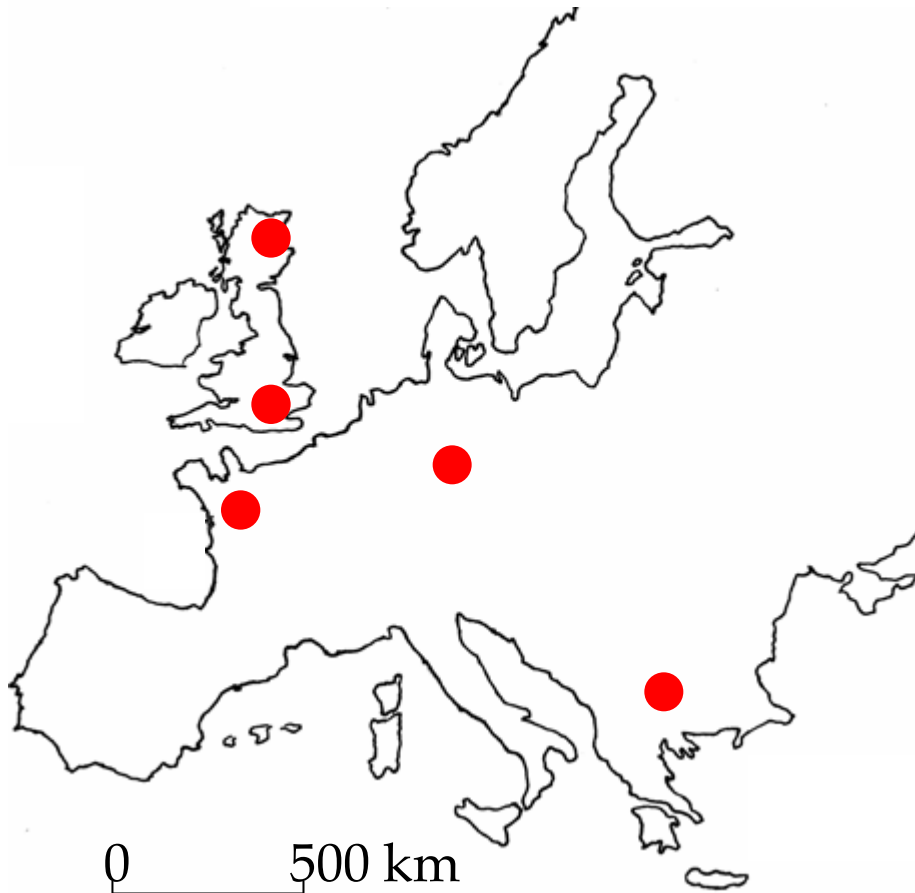
Adaptation: predicting impacts

Aesculus hippocastanum



Adaptation: predicting impacts

Aesculus hippocastanum



Location (19° Lat)	Average October air temperature (°C)	
	Max.	Min.
Scotland	17.1	0.1
England	19.5	-1.8
Poland	20.8	-1.3
France	23.8	-2.2
Greece	29.7	10.5



Challenges



<http://kelsocameraclub.co.uk>

Challenges: seed availability

We recently identified **1,624** species available through ICRAF's Tree Seed Supplier Directory

<http://www.worldagroforestrycentre.org/Sites-old/TreeDBS/tssd/treesd.htm>

However, of the 30 suppliers identified only 7 responded to requests. Once contact had been made, we requested **633** listed species.

Eventually we were able to secure only **218** unique species.



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Challenges: data and provenance

When we checked the names of ca. **600** tree/shrub species available through the Tree Seed Supplier Directory against The Plant List, **48%** of these names were not valid.

When the correct names were compared with the MSB's accessions, it was found that **25%** of the species were already in the MSB.

Other provenance data: wild/cultivated (**48%**); date of collection (**88%**); country of origin (**100%**); region of origin (**65%**); precise locality (**14%**)



Challenges: seed quality

Unregulated industry

Preliminary results:

High eRH for most of the
collections (60-85%)

Canadian supplier (public)

30% failure

Australian supplier (private)

79% failure





Challenges: technical questions lead to new research

- What is the frequency of species with desiccation sensitive seeds in the world's flora, and how does it vary with habitat?
- What are the roles of genes, proteins and metabolites in seed ageing and survival?
- Which species have seed traits to cope with stress under future climate change scenarios?
- Which metabolites in seeds contribute to both nutritional and functional traits?
- How can tropical forest species be conserved *ex situ*?
- How can orthodox seed lifespan be extended?
- Are dormancy classes valid, and can they be defined genetically?

Conclusion

Our role is to enable human innovation, adaptation and resilience.

Our role is primarily in providing plant-based solutions to the environmental challenges that we all face.



Conclusion

There is no technological reason why any plant species should become extinct....





Vielen Dank!
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