
*The Millennium Seed Bank
Partnership-safeguarding wild
plants for our future*

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Introduction & plant diversity
Seed Banking through the MSB
Partnership
Global Tree Seed Bank examples
Future priorities



The Royal Botanic Gardens, Kew



Image RBG Kew

330-acre
UNESCO World
Heritage Site in
West London
(Kew Gardens)

535-acre estate
in West Sussex
(Wakehurst)

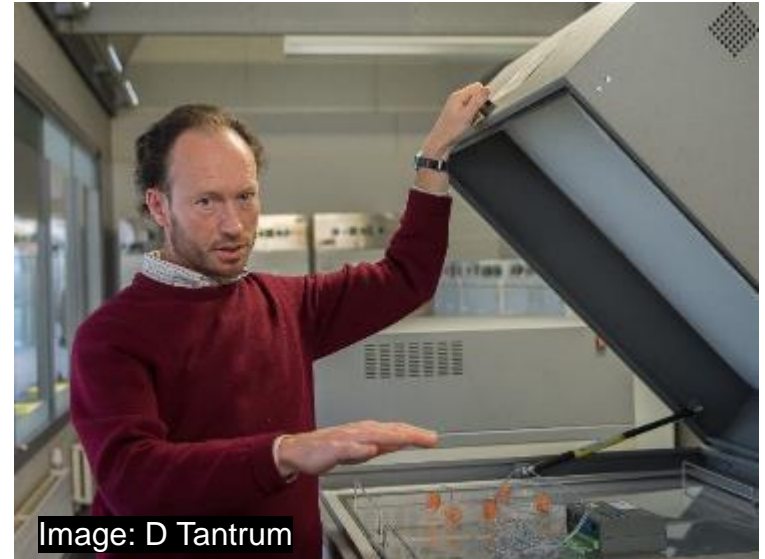


Image RBG Kew

Globally-significant science collections –
8.5m items: Herbarium, Seed, Fungi & plant DNA,
Living collections – c.30,000 plant species



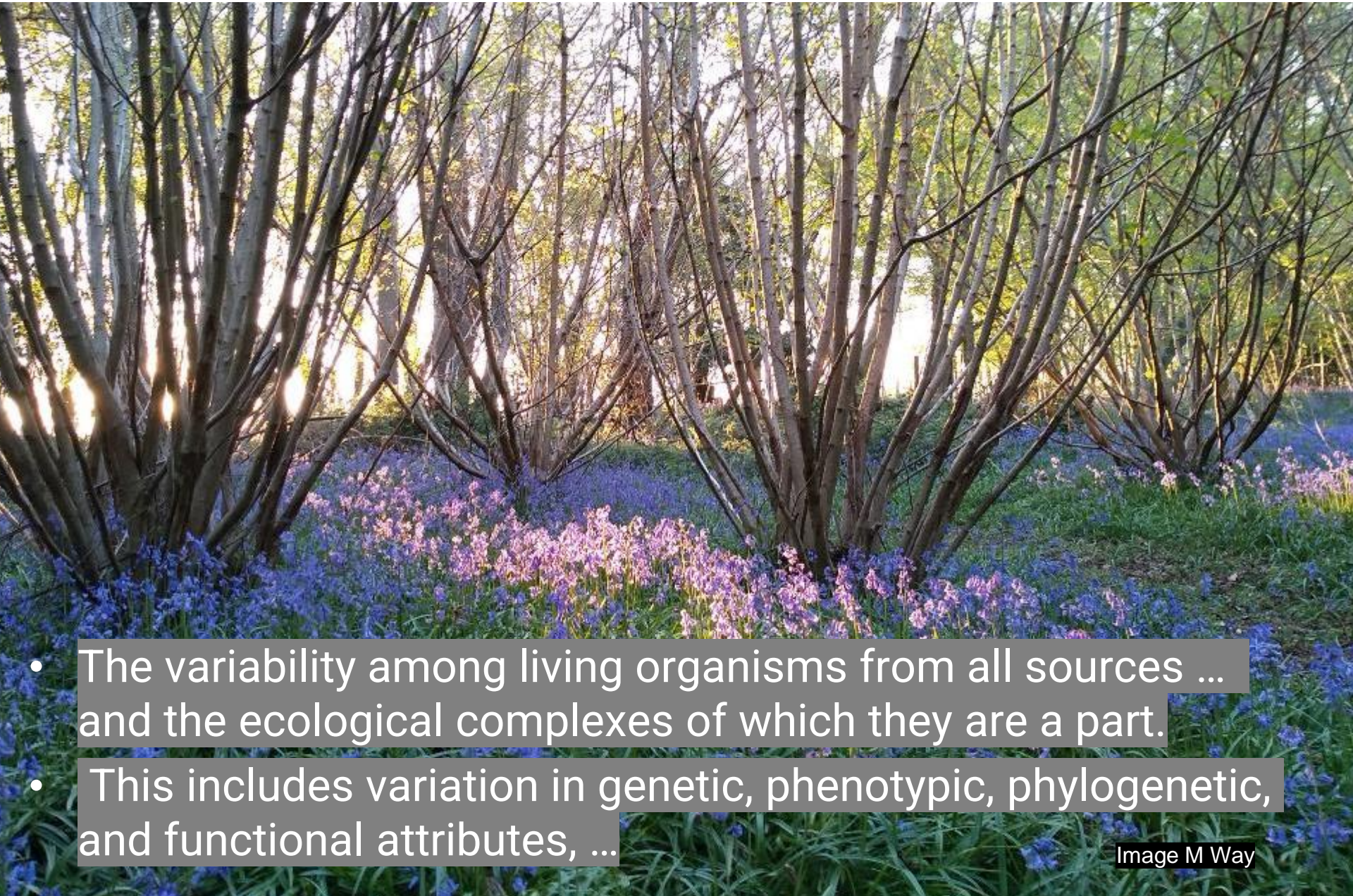
My Conservation Partnership role



- Strengthen partnerships
- Preserve species
- Restore habitats
- Build capacity
- Develop & share best practice

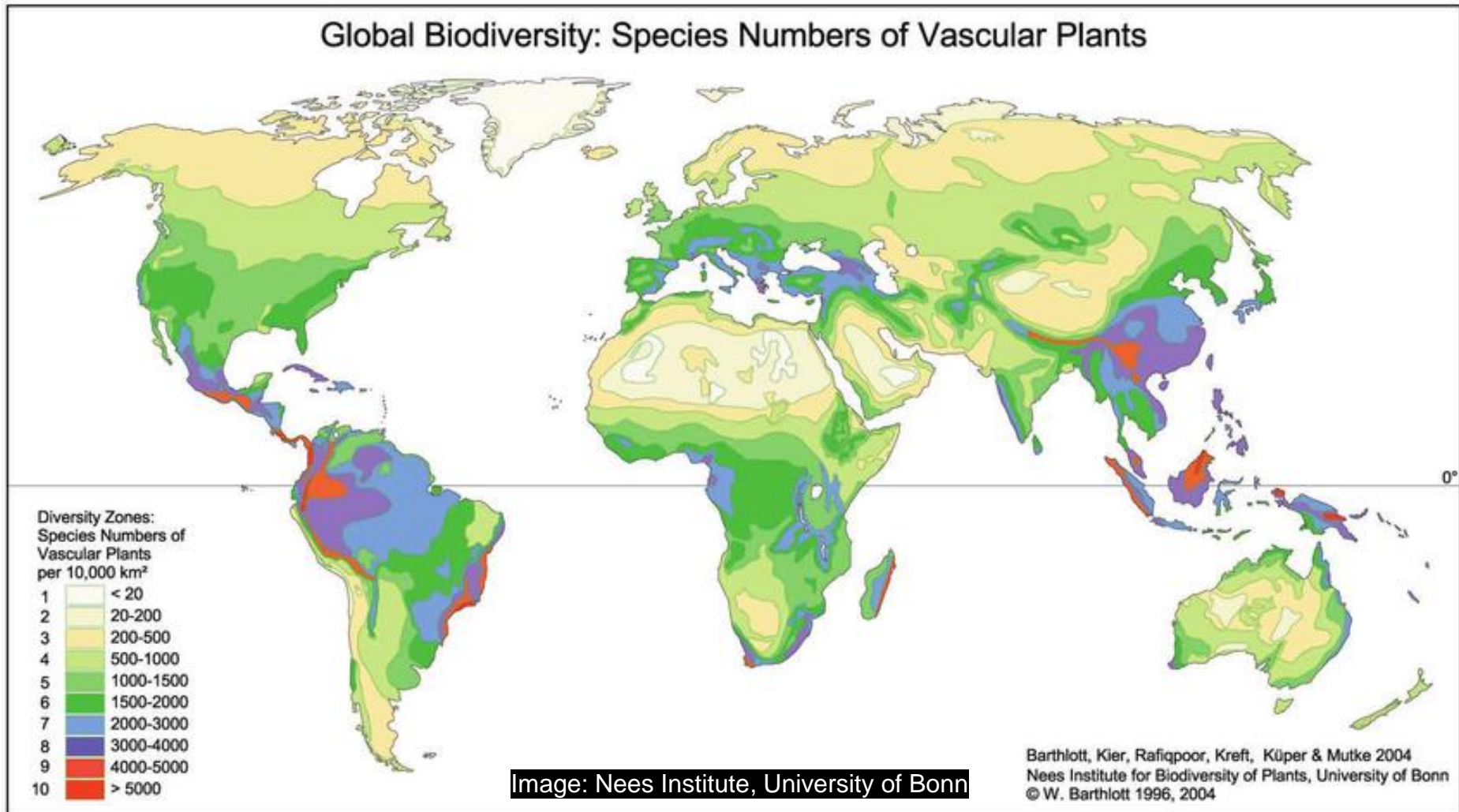


What is Biodiversity?



- The variability among living organisms from all sources ... and the ecological complexes of which they are a part.
- This includes variation in genetic, phenotypic, phylogenetic, and functional attributes, ...

Global Plant Diversity



391,000 vascular plant species

Threats to Biodiversity



The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is the intergovernmental body which assesses the state of biodiversity and of the ecosystem services it provides to society, in response to requests from decision makers.

- 8 million: total estimated number of animal and plant species on Earth (including 5.5 million insect species)
- Up to 1 million: species threatened with extinction, many within decades
- 25%: average proportion of species threatened with extinction
- 70%: increase since 1970 in numbers of invasive alien species across 21 countries with detailed records

What is driving these changes?

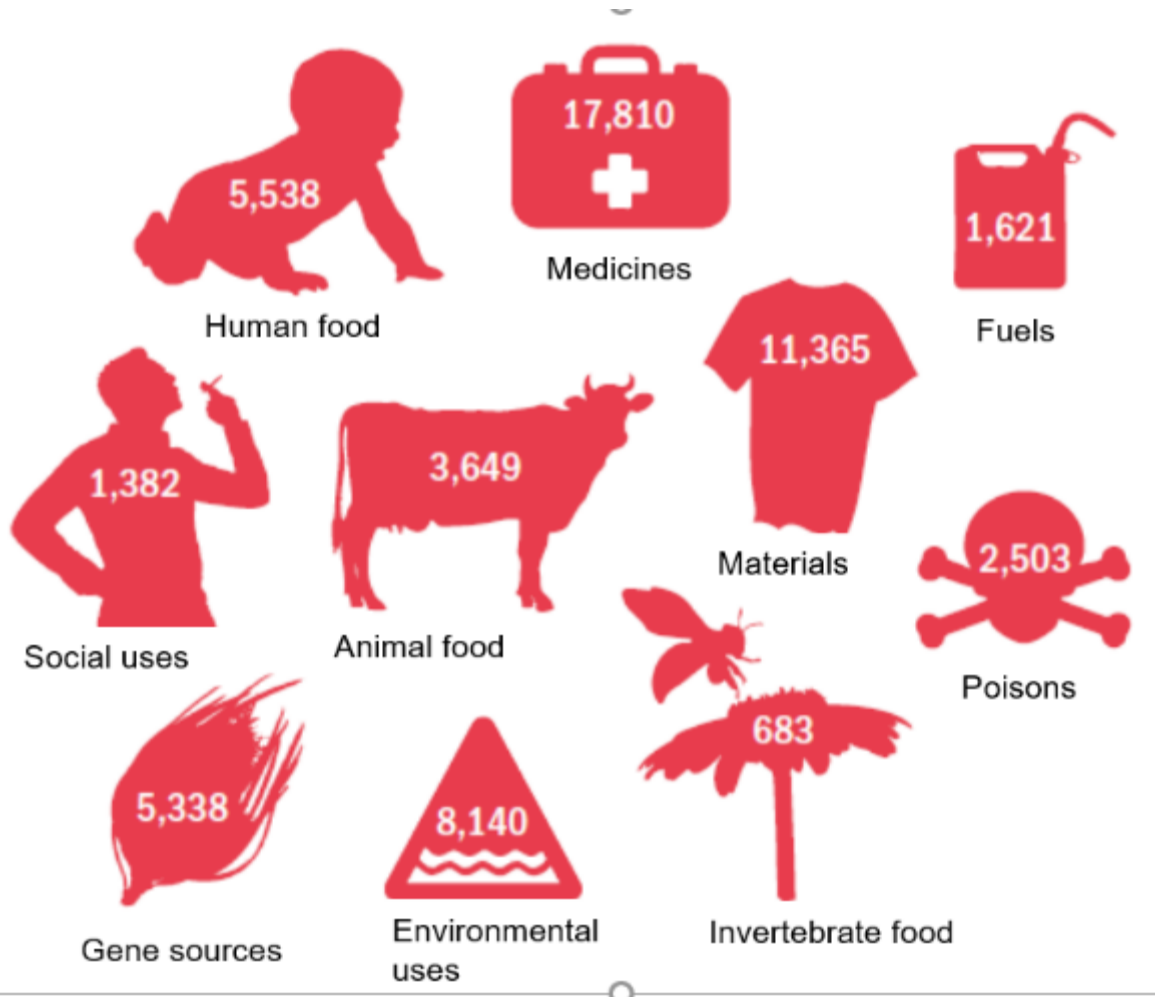
the five direct drivers of change in nature *with the largest relative global impacts* are:

- (1) changes in land and sea use;
- (2) direct exploitation of organisms;
- (3) climate change;
- (4) pollution and
- (5) invasive alien species.



Results from IPBES
Global Assessment (2019)

Importance of plants



31,128 species with documented human use (State of the worlds plants 2016)

List now extended to 40,000 plant species (Diazgranados et al 2020)

Economic value of useful plants
US\$30-40 trillion per annum

Managing biodiversity *in situ*

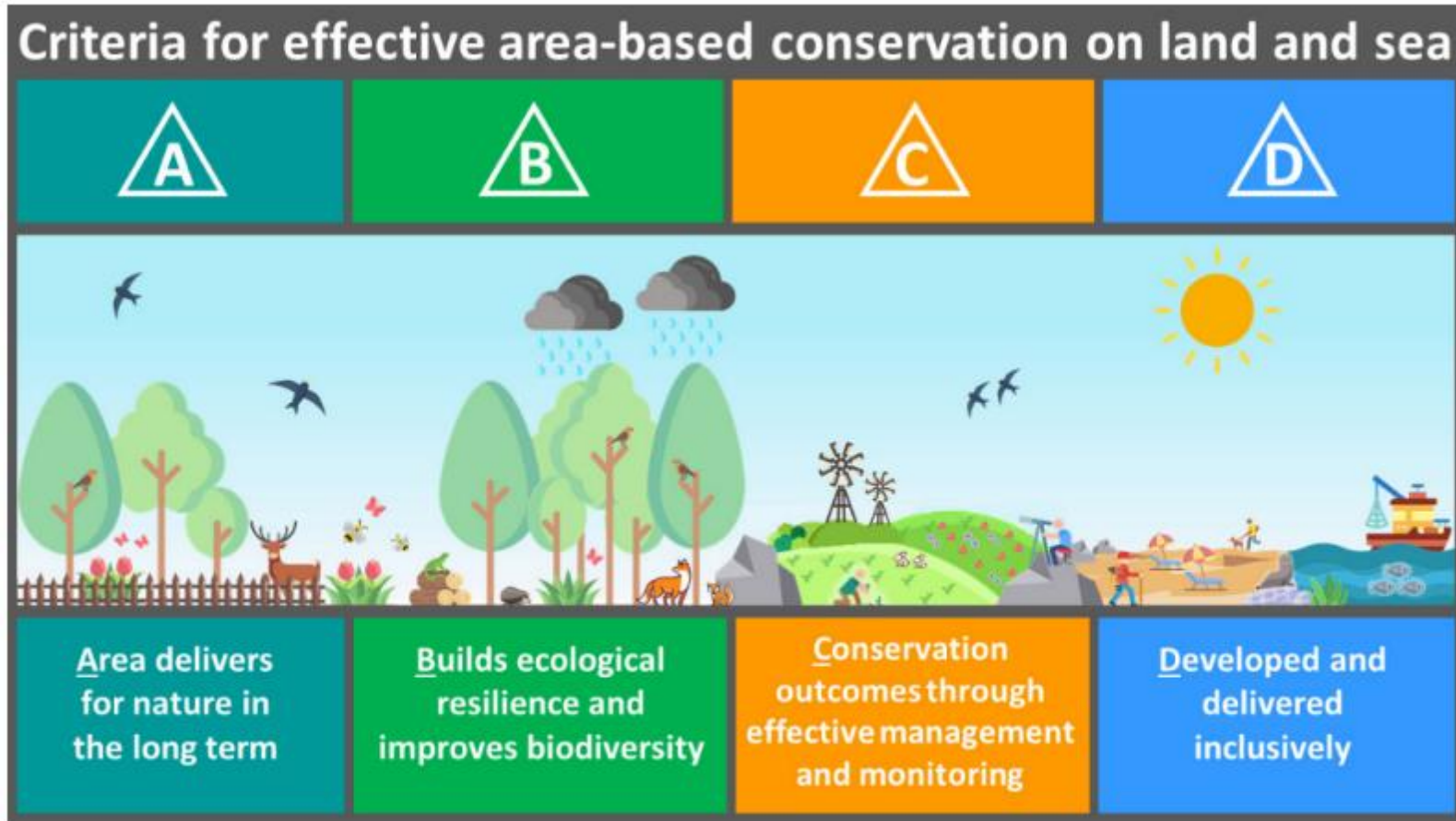
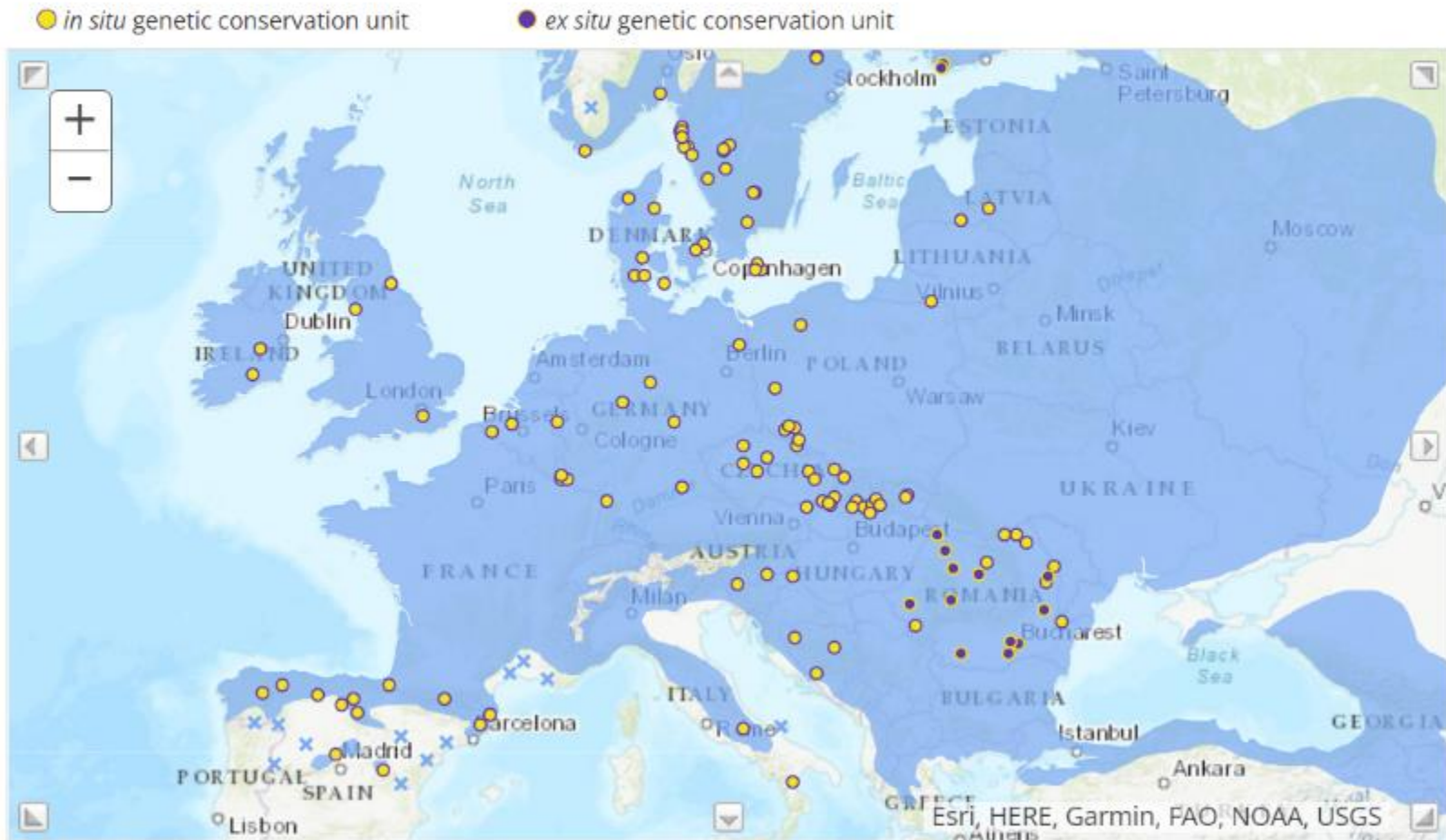


Figure 6.1 Criteria for effective area-based conservation that support nature's recovery.

Bailey et al. (2022). *Protected Areas and Nature Recovery. Achieving the goal to protect 30% of UK land and seas for nature by 2030*. London, UK.

Image: British Ecological Society CC BY 4.0

Conserving genetic diversity *in situ*



Genetic Conservation Units reported for common ash
Fraxinus excelsior

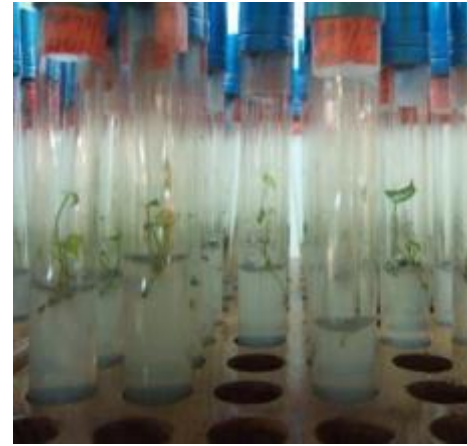
Preserving genetic diversity *ex situ*



Seed bank



Cryopreservation



In vitro tissue culture



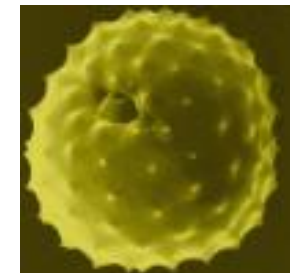
Botanic gardens



Field gene banks



DNA bank



Pollen bank

Millennium Seed Bank



Royal Botanic Gardens
Kew

Kew's Millennium Seed Bank currently holds 98,002 seed collections of 39,992 species from 190 countries and territories (04-May-2022)



Viewing the Seed Cleaning Lab.



One of six 50m² -20°C cold rooms in the underground vault



Four glasshouse chambers sit above study bedrooms for scientific visitors

Images RBG Kew

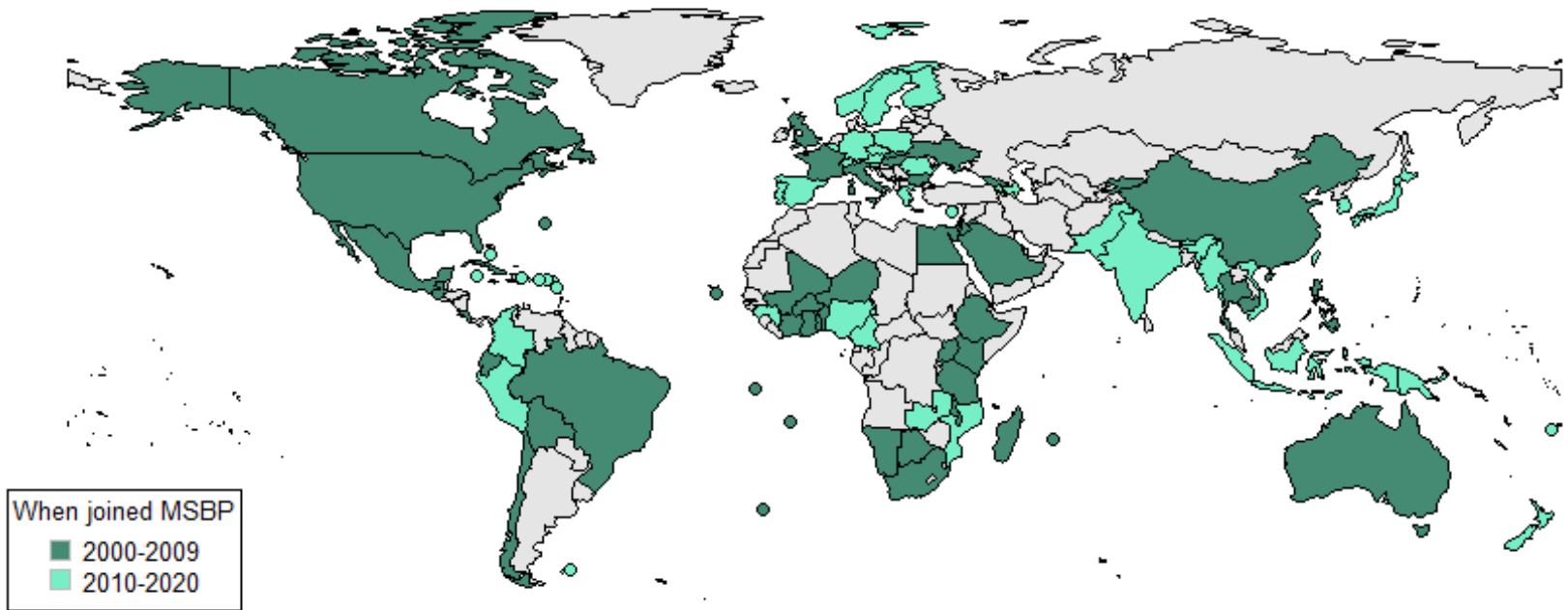
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Millennium Seed Bank Partnership

Founded on Bilateral cooperation, technology transfer & benefit-sharing

MSBP partners 2000-2020



MSBP Seed Conservation Standards



To be recognised as a **global resource** and satisfy the needs of anticipated users of collections and associated data, MSB Partnership seed collections must be of **high quality**.

- The standards provide a **framework** to recognise **Millennium Seed Bank Partnership Collections**
- The standards assure users of the **utility of the collections** and also provide a basis for **technology transfer** amongst partners and **capacity development** within the MSBP network as a whole.



MSBP Seed Conservation Standards

Collecting



Processing



Storage and duplication



Viability monitoring



Data management



Distribution

The MSB Seed List




Seed Bank Management




Prioritisation and targeting

ROSACEAE


Malus sylvestris Mill.
European crab apple




Habit



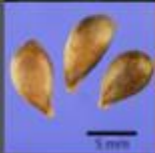

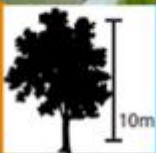


Fruit




Leaf



Flower

April - May



July - October

ROSACEAE

Malus sylvestris Mill.
European crab apple

Gene Pool 2 of Apple - *Malus domestica* Borkh.





Small tree with low-domed crown; usually one sided; dense twisting branches.


Height: to 10 m
Diameter: 0.3-1 m

Leaves: Elliptic, abruptly acuminate, cuneate or rounded, slightly oblique, crenate-serrate; deep green above, whitish green and pubescent beneath. 5-6 x 3-4 cm. Petiole 2.5 cm grooved,


densely pubescent, dark crimson towards base.
Bark: Dark brown, deeply and finely cracked into small square plates.
Flowers: With leaves in late May, white, faintly pink.
Fruit: Nearly globular, 2.5 x 2.8 cm depressed each end, glossy pale green speckled with large white spots, flushed or speckled red in autumn.
Seeds: 5 - 15 per fruit.

Malus sylvestris can be easily confused with 'escaped' domestic orchard apples:

| <i>Malus sylvestris</i> | Domestic apple |
|---|---|
| Whiter flowers and fruit up to 2.8cm | Pinker flowers and larger fruit |
|  |  |
|  |  |



Distribution of *M. sylvestris* in Ireland



Collecting gaps

Distribution: Found throughout Europe
Habitat: In broadleaved woods and on plains, scrub and hedges, especially in oak woods, found on varying soil types.
Altitude: up to 1400m.

Why Collect Crop Wild Relatives?

- New crop varieties needed for new climates, pests, diseases
- Breeding takes time and cannot be taken for granted
- Untapped diversity/adaptive characteristics in CWR
- CWR under-collected, unevaluated, unavailable (30% absent)
- CWR at risk of extinction (up to 20% threatened)



Image RBG Kew

Forest clearance in Malaysia for oil palm



sputniknews.com/

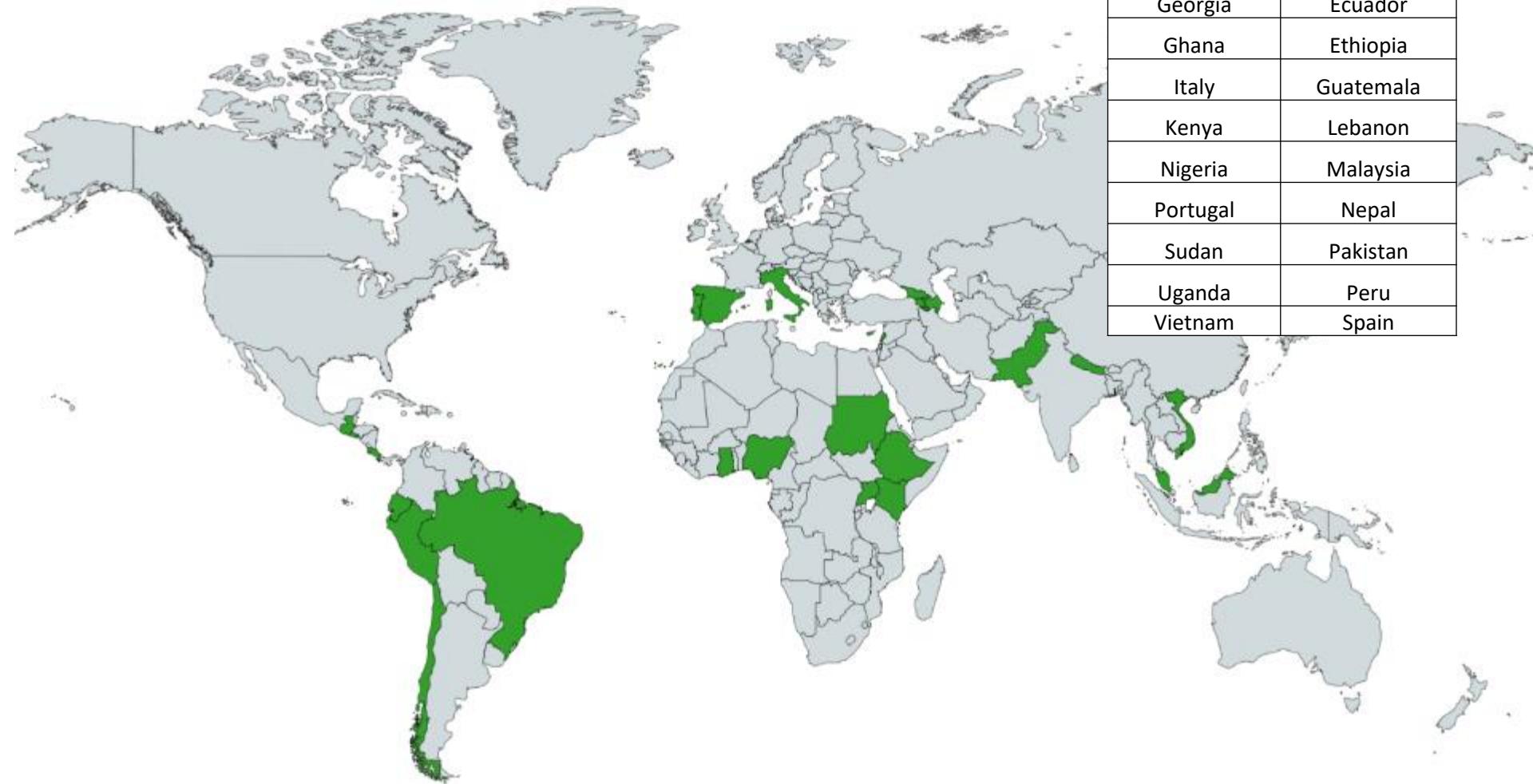


<http://ec.europa.eu/>

Adapting Agriculture to Climate Change Project



CWR project countries



| | |
|------------|------------|
| Armenia | Brazil |
| Azerbaijan | Chile |
| Cyprus | Costa Rica |
| Georgia | Ecuador |
| Ghana | Ethiopia |
| Italy | Guatemala |
| Kenya | Lebanon |
| Nigeria | Malaysia |
| Portugal | Nepal |
| Sudan | Pakistan |
| Uganda | Peru |
| Vietnam | Spain |



Cut test to assess
early seed formation
in *Mutisia* sp, Peru



Collecting seed
at 4500m
southern Peru



Post-collection
Lebanon



Drying room of the MSB
15°C, 15% RH

Seed banking equipment



Quality Storage containers

Once dry, seed is stored in sealed containers to keep it dry.



Cold room storage at -20°C



- Viability is tested after banking, and periodically every 10-20 years.
- Germination Incubators provide more than 30 combinations of conditions
- Protocols are shared with partners and online



Images RBG Kew

- supplied seed to 280 researchers since 2012,
- including 2650 collections sent to crop breeders for climate change adaptation.

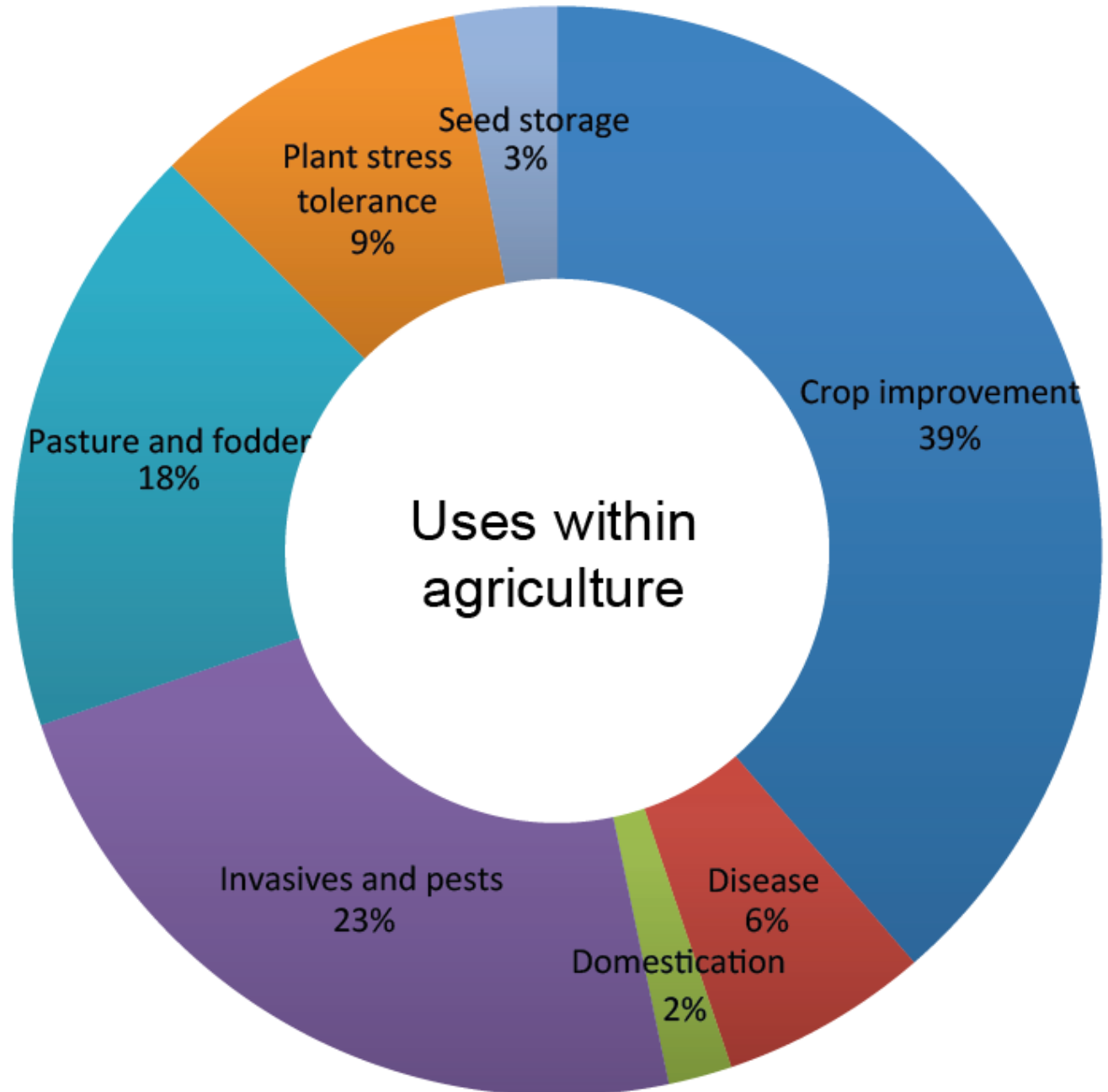
Example: CABI biological control for Japanese Knotweed

- MSB supplied seeds of 21 native species to CABI for testing
- MSB collections saved CABI, 1 year of research time
- LSE estimated value of MSB support £27 - £121m

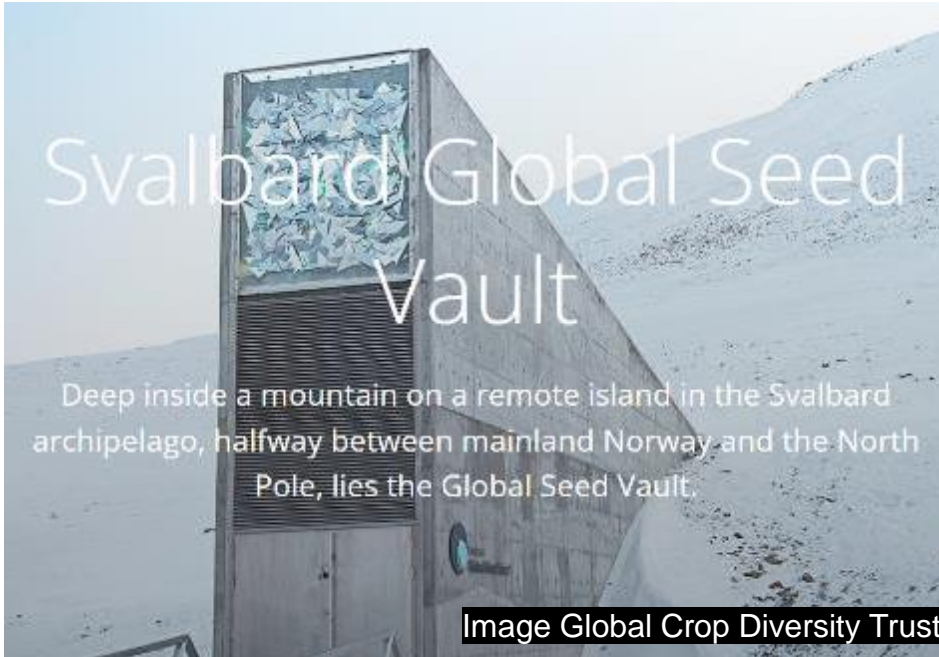


MSB
example:

How are
MSB seed
collections
used by
the
Agriculture
sector?



The other global seed bank you may have heard about ...



The Svalbard Global Seed Vault provides insurance against loss of crop diversity held in 1700 traditional genebanks around the world.

- Opened Feb. 2008
- Run by the Ministry of Agriculture and Food on behalf of the Kingdom of Norway
- Capacity to store 4.5 million seed samples



MILLENNIUM SEEDBANK
PARTNERSHIP
DATA WAREHOUSE

The Millennium Seed Bank Partnership

LATEST NEWS September 2016 monthly refresh complete! New data now available

The Millennium Seed Bank Partnership represents the largest and most ambitious ex situ plant conservation initiative in the world. Today, more than 20% of our plant species are faced with the threat of extinction. The MSBP is a worldwide partnership aiming to save plants most at risk and most useful for the future. The network of partners now spans 60 countries with some 120 actively participating institutions. Together we have already secured more than 10% of the world's wild plant species in seed banks across this network.

Which data are available?

Data available depends entirely on the policies of each participating MSB partner. Data falls into three main categories:

Seed accession data: Default data includes Donor seed bank accession numbers; locality and collector; sampling methodology; verified identification; and an estimate of seed quantities.

Germination test data: Any associated germination test data of the above accessions can be offered through the MSBP Data Warehouse. This includes information on all germination tests carried out on material thus far duplicated to the Millennium Seed Bank.

Georeferenced data: Non-sensitive species may include geographic co-ordinates data that can be mapped in the Data Warehouse using the built-in BRAHMS online mapping tools. Publication of co-ordinates data is at partners' discretion.



Images RBG Kew



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Conserving tree genetic diversity- Brewer Spruce



Conserving tree genetic diversity- Brewer Spruce





Conserving tree genetic diversity- Brewer Spruce



Royal Botanic Gardens
Kew

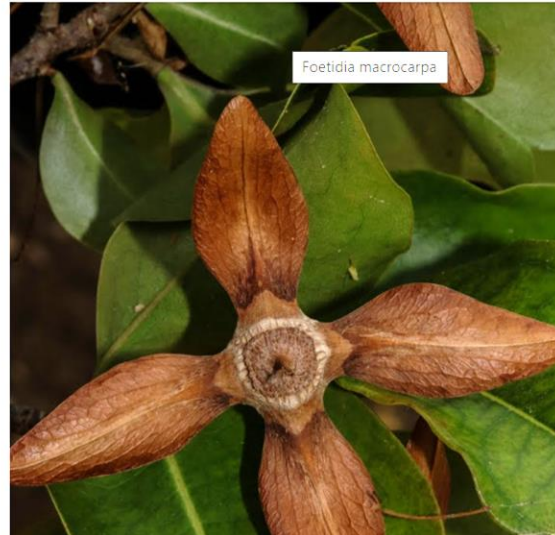


Distribution of Brewer
Spruce

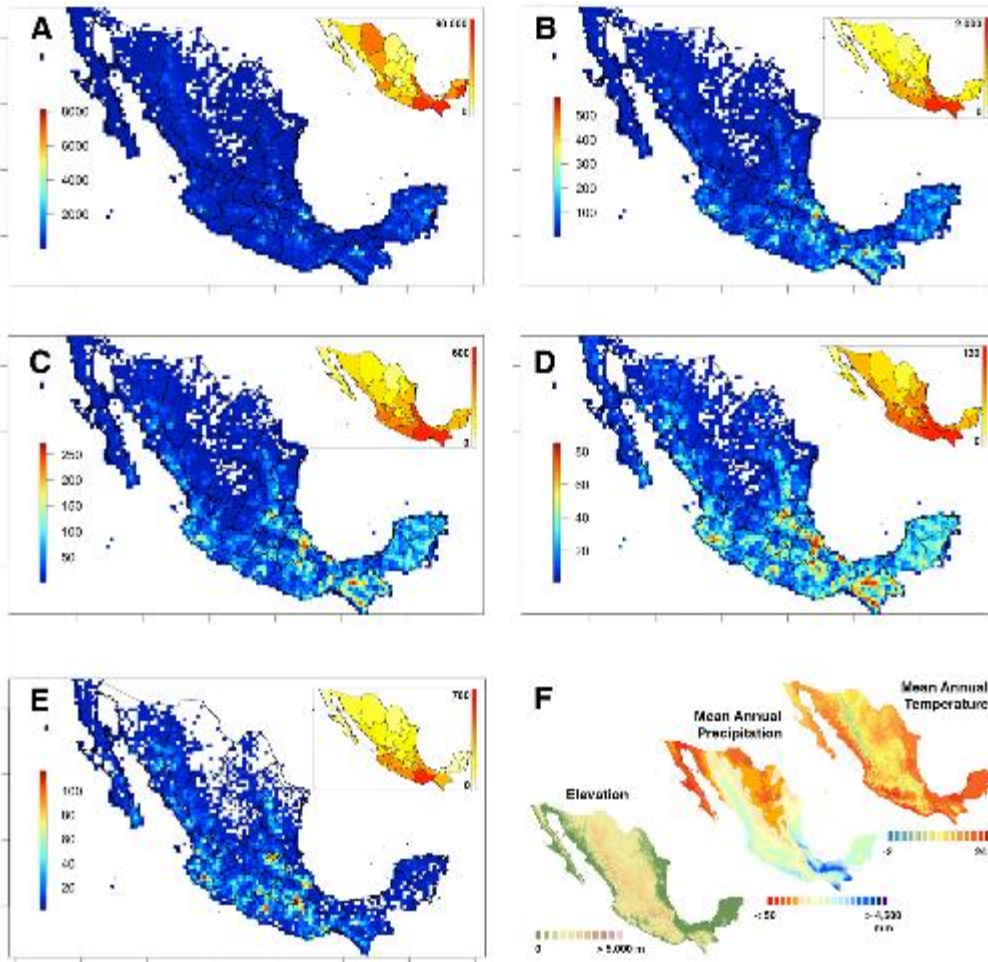
Picea breweriana

Oregon & California

Madagascar



- *Dalbergia baronii* (Rosewood) a tree vulnerable to over exploitation of its valuable timber.
- *Foetidia macrocarpa*. Vulnerable due to logging. From dry and subhumid forests
- *Abrahamia deflexa*. Threatened due to the loss of its dry forest habitat.



Spatial density and richness of trees from Mexico: A) density of records; B) species richness; C) genera richness; D) family richness; and E) richness of endemic species. Smaller maps (A-E) show the same statistics calculated by Mexican state (Spatial analyses by M. Diazgranados Cadelo, RBG Kew).

DOI: [10.7717/peerj.9898](https://doi.org/10.7717/peerj.9898)

UK National Tree Seed Project

Aim: to collect, store and make available a collection of all UK tree seeds, representing the full genetic diversity of the UK's tree populations.



Taxus baccata

Image: RBG Kew

Image: RBG Kew





Survey of Ash in woodland



Vegetative cuttings of Ash
for propagation



A Strategy for UK Forest Genetic Resources:

protecting the UK's unique diversity
of trees and shrubs

Helping to identify and protect genetic diversity of trees
Needed for expansion and resilience of UK woodlands & forests

Ten Golden Rules for Reforestation



Royal Botanic Gardens
Kew

Received: 25 August 2020

Accepted: 13 October 2020

DOI: 10.1111/gcb.15498

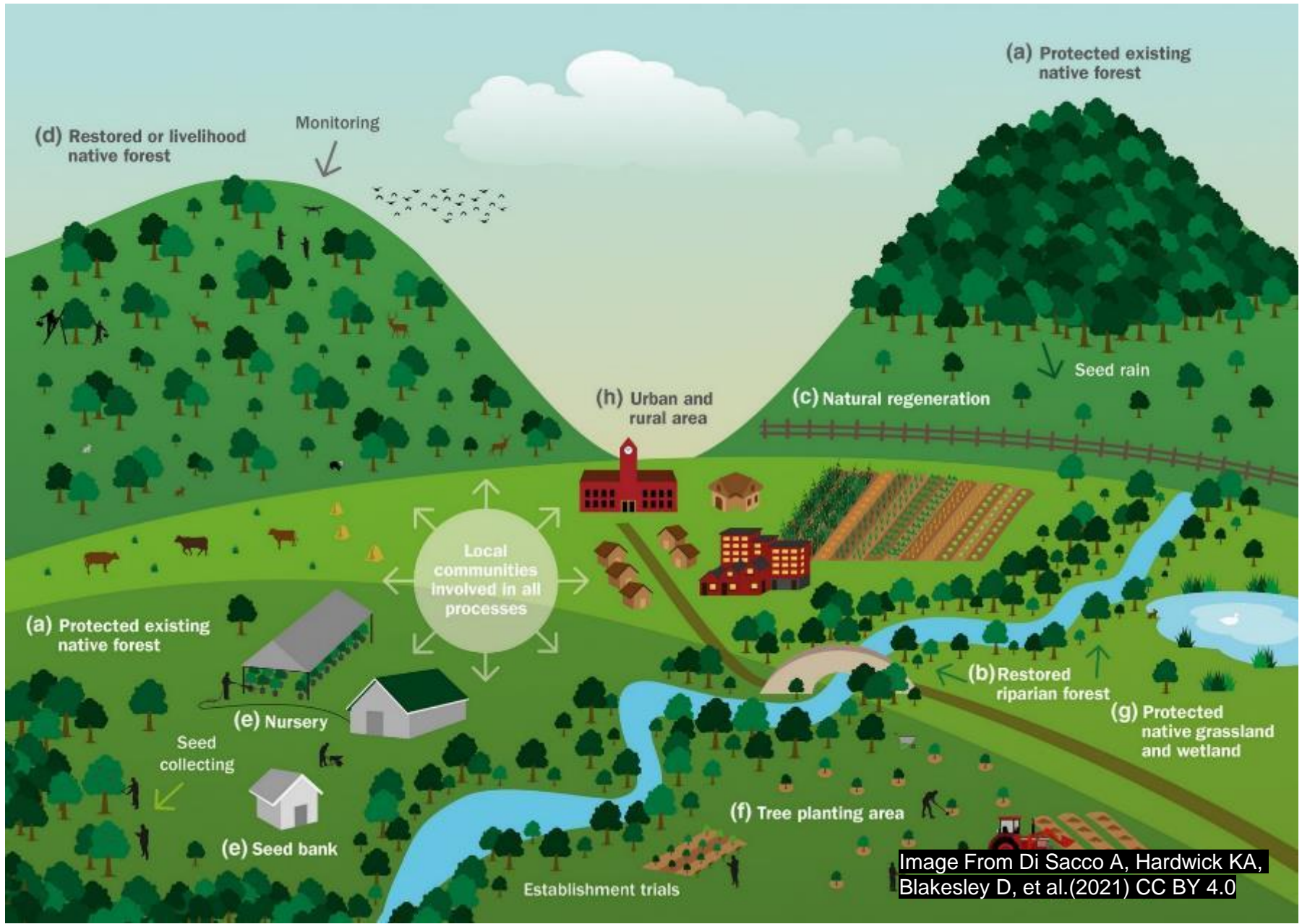
GCB REVIEWS

Global Change Biology
WILEY

Ten golden rules for reforestation to optimize carbon sequestration, biodiversity recovery and livelihood benefits

(1) Protect existing forest first; (2) Work together; (3) Aim to maximize biodiversity recovery to meet multiple goals; (4) Select appropriate areas for restoration; (5) Use natural regeneration wherever possible; (6) Select species to maximize biodiversity; (7) Use resilient plant material with appropriate genetic variability and provenance); (8) Plan ahead for infrastructure, capacity and seed supply; (9) Learn by doing; and (10) Make it pay.

Ten Golden Rules: how could this work?



MSB Partners including

- UNAM, CONAFOR, Pronatura (Mexico)
- US Forest Service, Center for Plant Conservation (USA)
- INIA, (Chile)
- Global Crop Diversity Trust

Funders of programmes including

- Garfield Weston Foundation
- People's Postcode Lottery

Kew colleagues contributing data and images including Alice Hudson, Chris Cockel, Solofo Rakotoarisoa

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Future Priorities- a personal view

Address the global challenge of simultaneously:

1. avoiding dangerous climate change,
2. halting and reversing dramatic biodiversity loss,
3. and meeting the food and other needs of a growing global human population



Future Priorities- a personal view

What is the role for our sector (Seedbanks, Botanic Gardens, and Plant & Fungal Science) right now?

- **Identify the most important plant areas worldwide**
- **Strengthen ex situ protection of threatened and useful species.**
- **Inform transformational policies through robust research**
- **Mobilise expertise, plants and communities for nature recovery efforts**

