

# TREES IN A CHANGING CLIMATE

## CONFERENCE FOR THE TREE AND FORESTRY SECTOR

University of Surrey, Guildford, UK

15 June 2005

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**Past-Chairman, British and Irish  
Hardwoods Improvement programme**

**Chairman, Marcus Wallenberg Prize  
Selection Committee**

# Implications and adaptations: species choice and timber production

- Definition of “climate” and sustainable development
- Traditional tree improvement
- Time relevance of research
- Recent technologies
- Variability and stability
- Site matching and future uncertainty

# Climate as defined

- **Physical (long-term, regional weather)**
- **Physical (rest of environment)**
- **Economic**
- **Social**
- **Managerial**
- **Institutional**

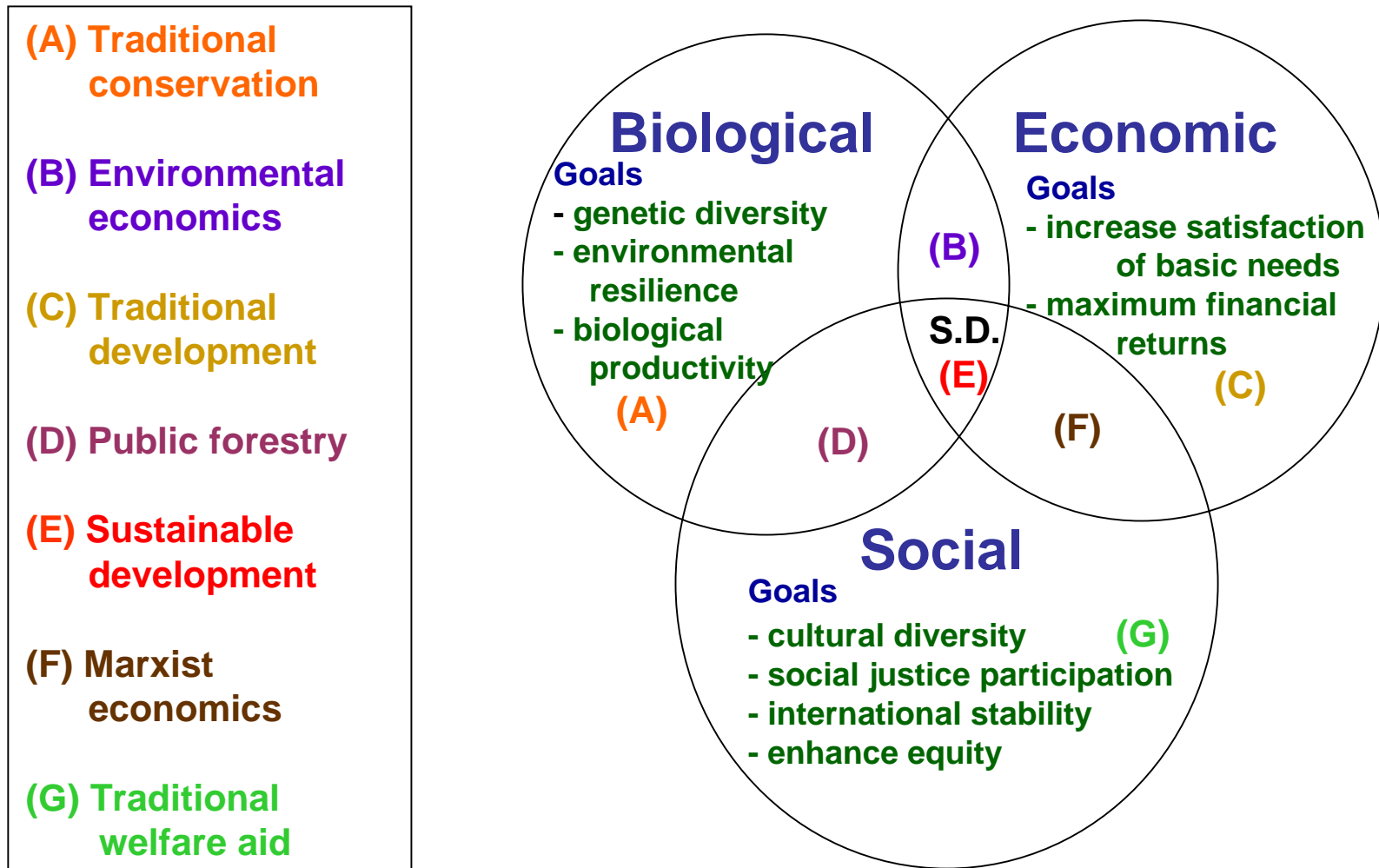
# Definition of **SUSTAINABLE DEVELOPMENT**

**Development involving changes in the production and/or distribution of desired goods and services which result, for a given target population, in an increase in welfare that can be sustained over time.**

**(FFSD Wkg. Pap.1, 1990, University of Minnesota)**

# SUSTAINABLE DEVELOPMENT

The integration of three spheres of resource use\*



From Hall, J.E. (1992) Doctoral thesis, Oxford Forestry Institute. \*Adapted from Barbier (1987)

# Traditional tree introduction and breeding

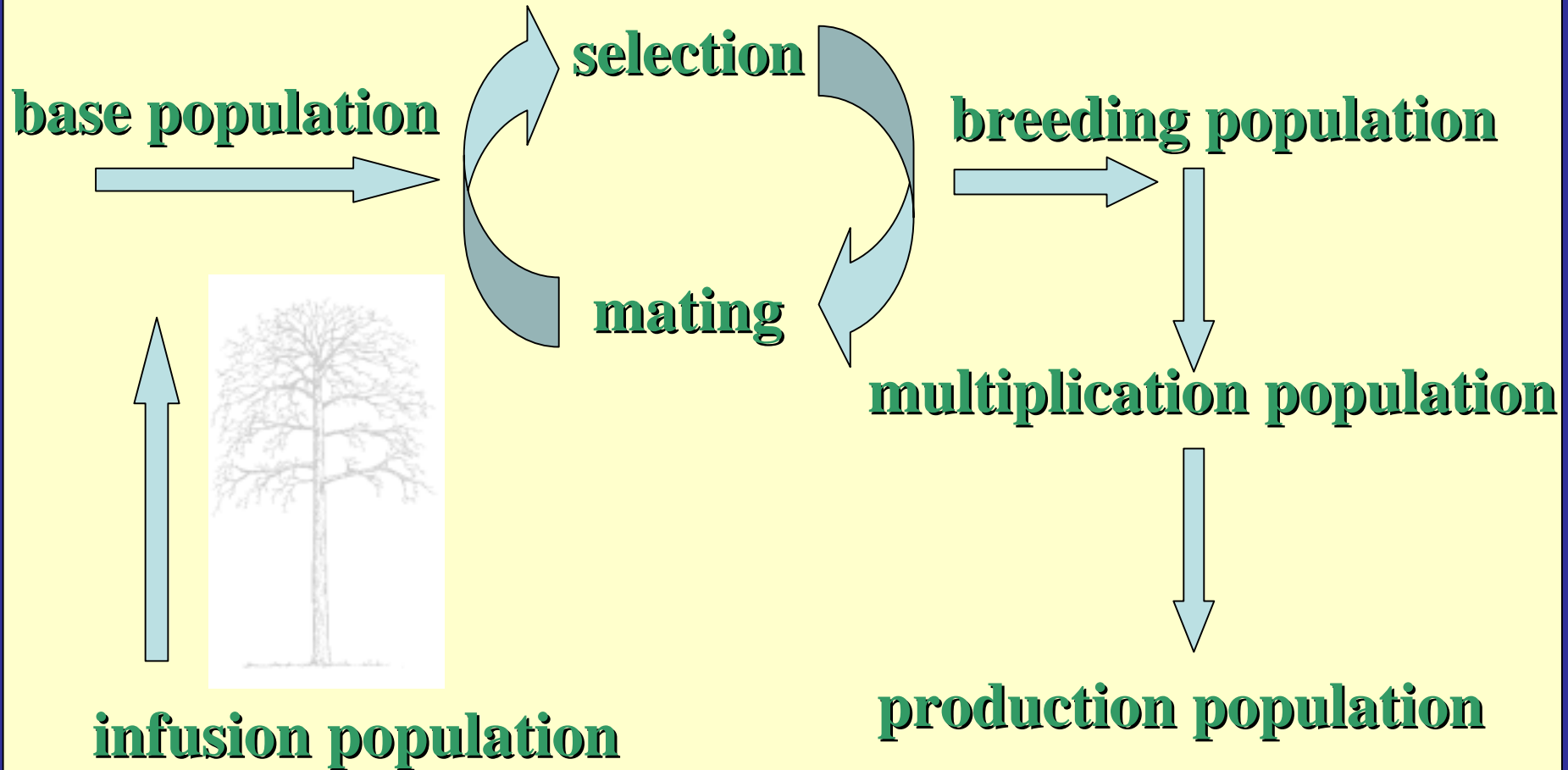
- **Species trials (several phases)**
- **Provenance trials (several phases)**
- **Pilot plantations**
- **Seed stands**
- **Commercial plantations**
- **Individual tree selection**
- **Seed orchards**
- **Progeny tests**
- **Controlled breeding**
- **Second-generation orchards**
- **Improved commercial plantations (seedling or clonal)**

# Benefits of tree improvement

- ❖ **aids commercial viability while maintaining amenity and conservation values;**
- ❖ **encourages better silviculture;**
- ❖ **marketability improved;**
- ❖ **a more diverse range of timber products;**
- ❖ **confidence in planting stock encourages further tree planting.**

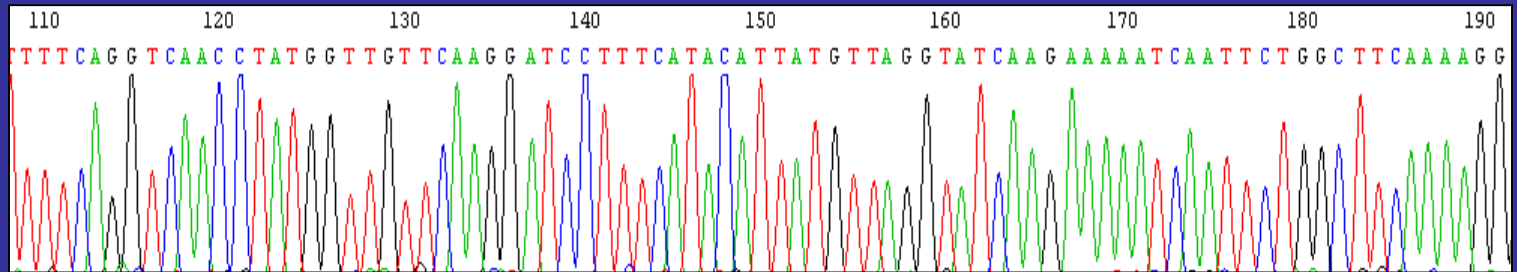


# Tree breeding cycle



# Time relevance of research

- **Results lag**
- **Juvenile-mature correlations**
- **Climate change rate**



CONTIGS

CLOWING

QTL

Engineering

CDNA(PtCelA)  
CDNA(PtCelA)

CBD

Gene

CONSTRUCT

BT

ESTP

Promoter

Synthase

TRANSGENIC

RAPD

Cellulose

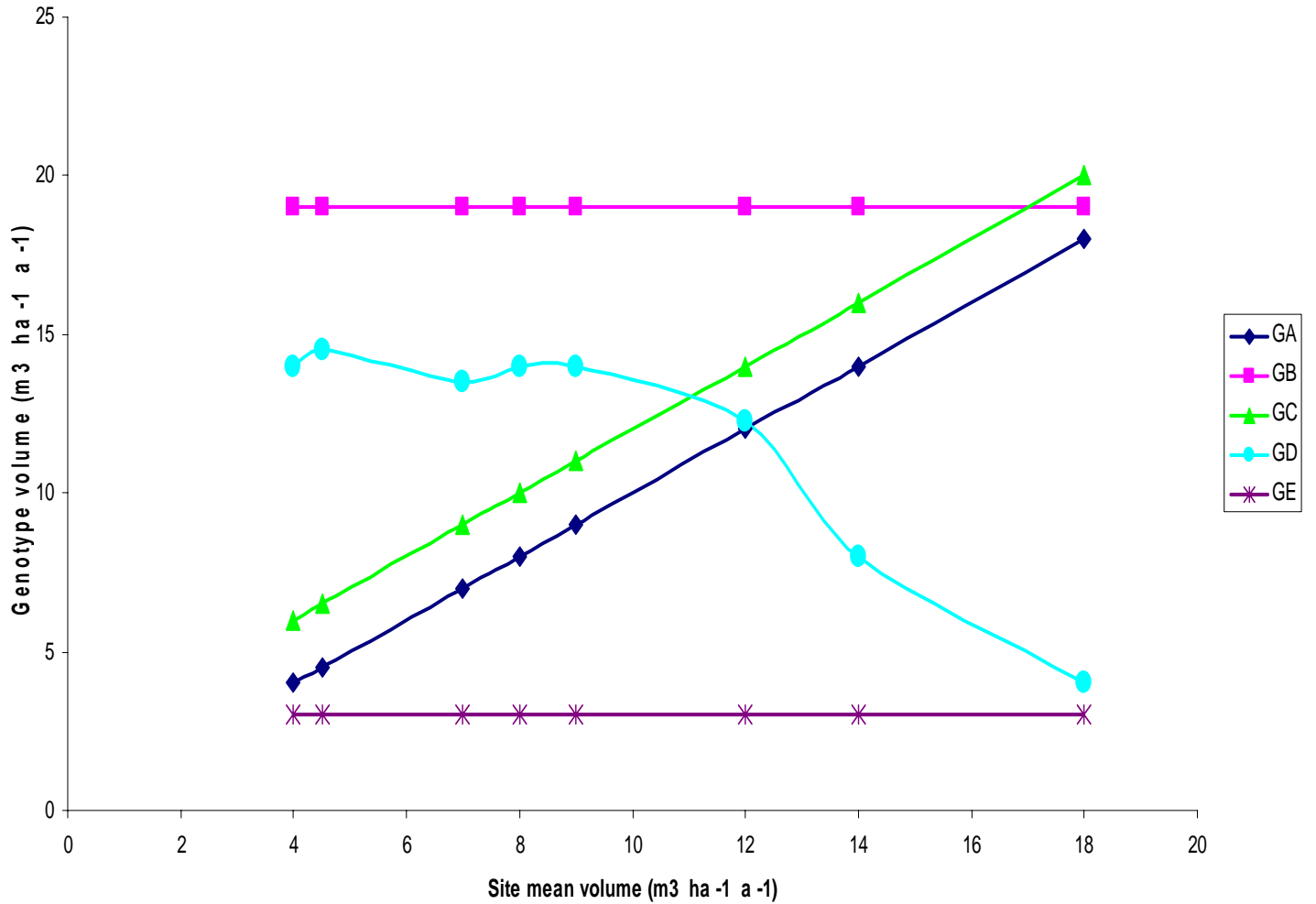
Lignin

Agrobacterium

Domain

DNA

# Genotype-Environment Interaction



# Genotype-environment interaction: performance vs. stability

Perform.      Stability      GEI Contribn

- **A.** Average      Average      n/a
- **B.** V. high      High      High
- **C.** Above ave.      Low      Low
- **D.** Average      Moderate      High
- **E.** V. low      High      High

# Site-genotype matching

## Traditional “homoclimal comparison”

- Long term naturally matched origins
- Newly naturally matched origins

## Modelling

- UK CIP
- French
- Australian

# Contrasts

- **S.D. Economic vs. non-market benefits**
- **Conservation vs. production**
- **Quantity vs. quality**
- **Hardwoods vs. softwoods**
- **Indigenous vs. exotic**
- **Natural vs. derived provenance**
- **Planting vs. natural regeneration**



# British Isles Population

*Data from the UK Census 2001 and the Central Statistics Office, Republic of Ireland 2002*

- **United Kingdom**  
**59,647,790**
- **England** 49,138,831
- **Scotland** 5,064,200
- **Wales** 2,903,085
- **Northern Ireland**  
**1,685,267**
- **Republic of Ireland**  
**3,458,479**



# British Isles: land area

- England 243,000 km<sup>2</sup>  
(93,000 m<sup>2</sup>)
- Scotland 78,772 km<sup>2</sup>  
(30,418 m<sup>2</sup>)
- Wales 20,761 km<sup>2</sup>  
(8,019 m<sup>2</sup>)
- Northern Ireland 14,160 km<sup>2</sup>  
(5,467 m<sup>2</sup>)
- Republic of Ireland 70,280 km<sup>2</sup>  
(27,133 m<sup>2</sup>)



**All woodland  
(‘000s hectares in 2003)**

<b><u>Country</u></b>	<b><u>Conifers</u></b>	<b><u>Broadleaves</u></b>	<b><u>Total woodland</u></b>
<b>England</b>	<b>372</b>	<b>739</b>	<b>1,110</b>
<b>Wales</b>	<b>163</b>	<b>123</b>	<b>285</b>
<b>Scotland</b>	<b>1,052</b>	<b>275</b>	<b>1,327</b>
<b>Great Britain</b>	<b>1,586</b>	<b>1,136</b>	<b>2,722</b>

## Non-Forestry Commission area of woodland (‘000s hectares in 2003)

<u>Country</u>	<u>Conifers</u>	<u>Broadleaves</u>	<u>Total woodland</u>
England	216	687	904
Wales	64	112	176
Scotland	607	250	857
Great Britain	887	1,049	1,936

# Forests and woodland

- Existing plantations (1.9m hectares)
- Existing naturally regenerated forest (0.8m hectares)
- Restocking 2003-04 (12,000 hectares broadleaves)
- Newly planted forest 2003-04 (9,000 hectares broadleaves; 4,000 hectares conifers)

# Wood production

- **Actual 2002 (GB)**
  - Hardwoods 0.69m m<sup>3</sup>
  - Softwoods 9.24m m<sup>3</sup>
- **Prediction 2017-21(GB)**
  - Hardwoods 1.0m m<sup>3</sup>
  - Softwoods 15.5m m<sup>3</sup>
- **UK imports of wood and wood products 2002**  
48.6m m<sup>3</sup>
- **UK exports of wood and wood products 2002**  
9.4m m<sup>3</sup>
- **Total apparent consumption 46.6m m<sup>3</sup>**

# Projection for wood production (‘000s m<sup>3</sup> overbark standing)

<u>Year</u>	<u>Conifers</u>			<u>Broad leaves</u>	<u>Total</u>
	<u>FC</u>	<u>Non-FC</u>	<u>Total</u>		
2002–06	5,130	5,750	10,870	1,000	11,870
2007–11	5,980	7,080	13,060	1,000	14,060
2012–16	6,240	8,200	14,450	1,000	15,450
2017–21	6,850	8,630	15,480	1,000	16,480

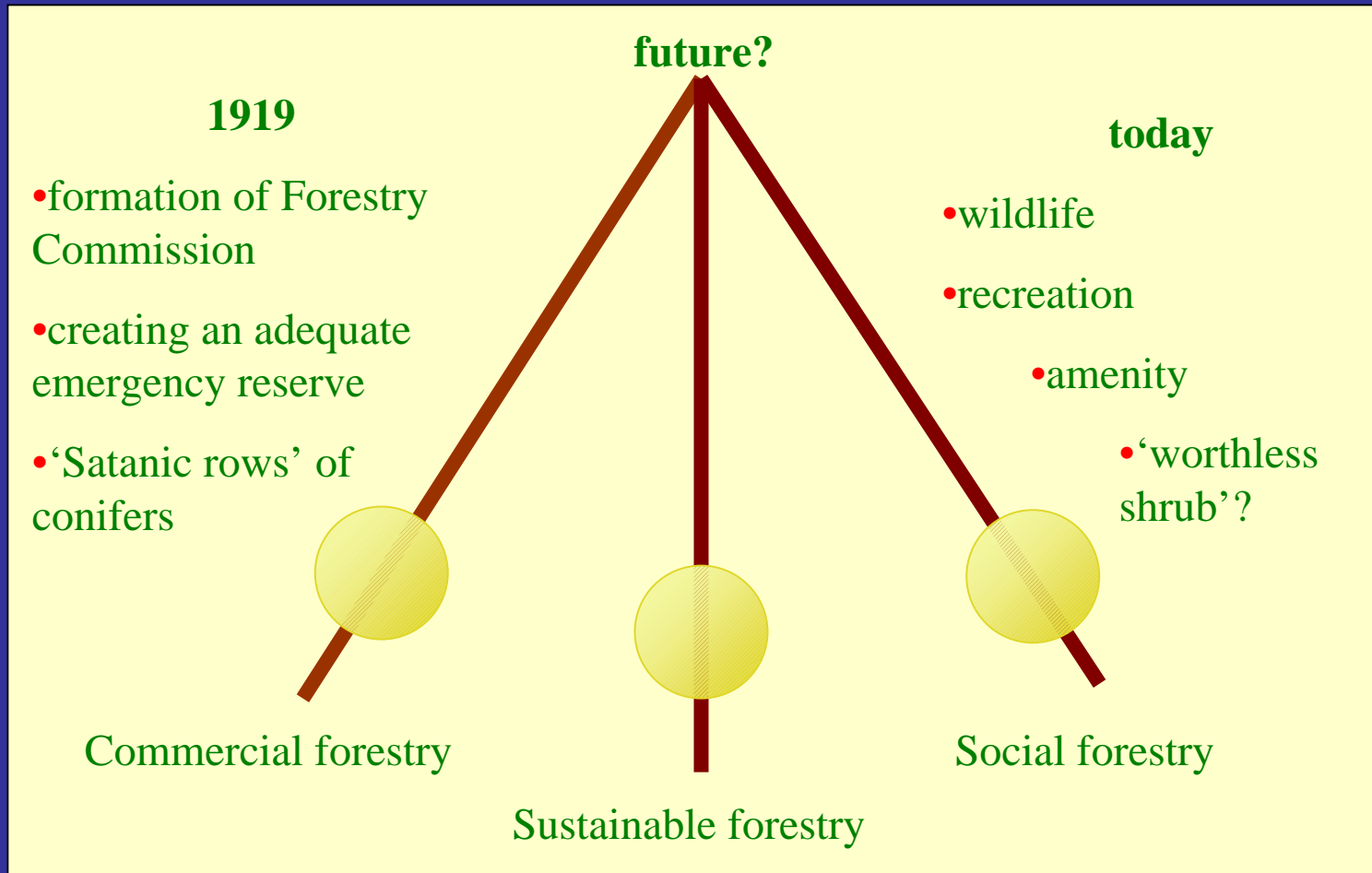
# CONSERVATION

**The management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations.**

**World Conservation Strategy, IUCN 1980**



# Changing Forestry Policy



# Quantity vs. quality; examples of characteristics

## Quantity

Height

Diameter

Taper

Straightness

Resistance to pests

Tolerance of environ.  
features

Phenology

## Quality

Density

Fibre dimensions

Ring pattern

Grain/Split/Shake

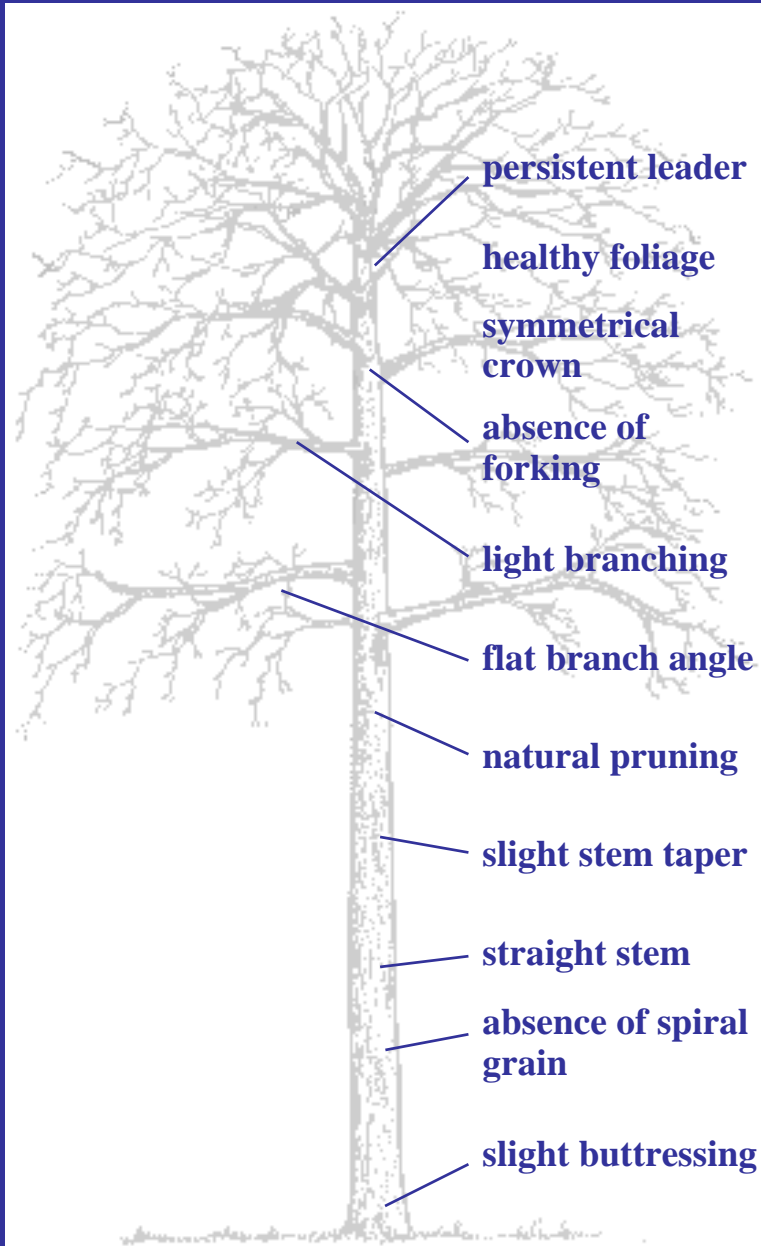
Lignin

Cellulose

Extractives

Decay resistance

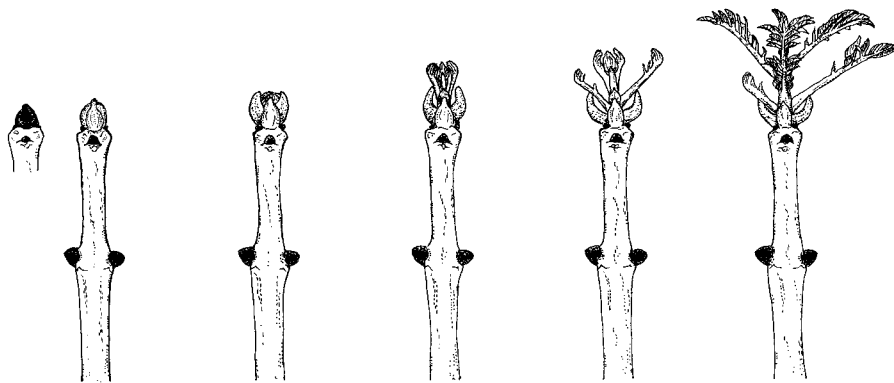
# The perfect plus tree



# Desirable traits...

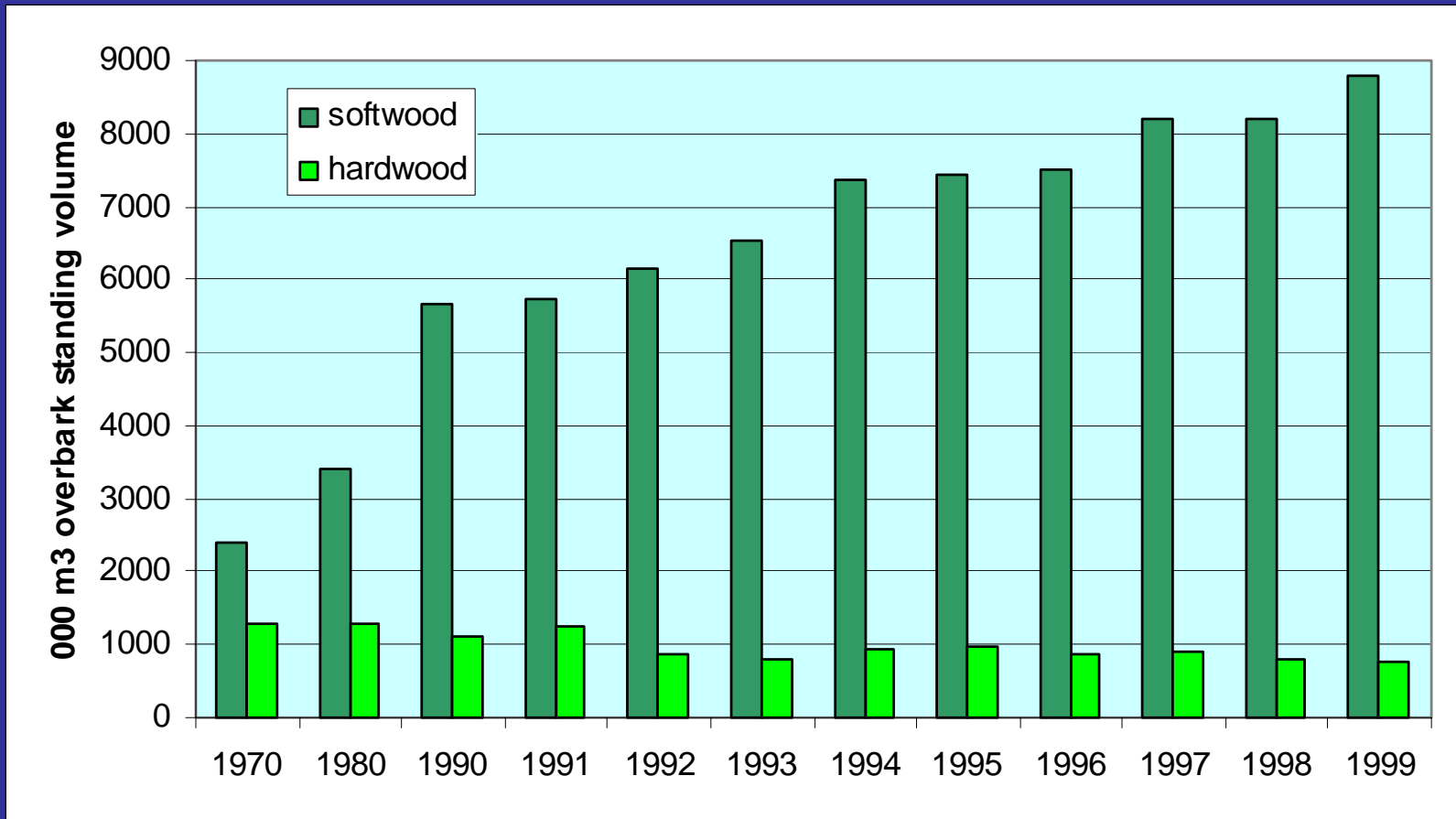
## late leaf-burst in frost-sensitive species

- ❖ late-spring frosts in UK a major problem for some species
- ❖ ash and walnut particularly prone
- ❖ flushing is highly heritable in these species
- ❖ selection & breeding for this trait has never been carried out!



# Hardwoods vs. softwoods

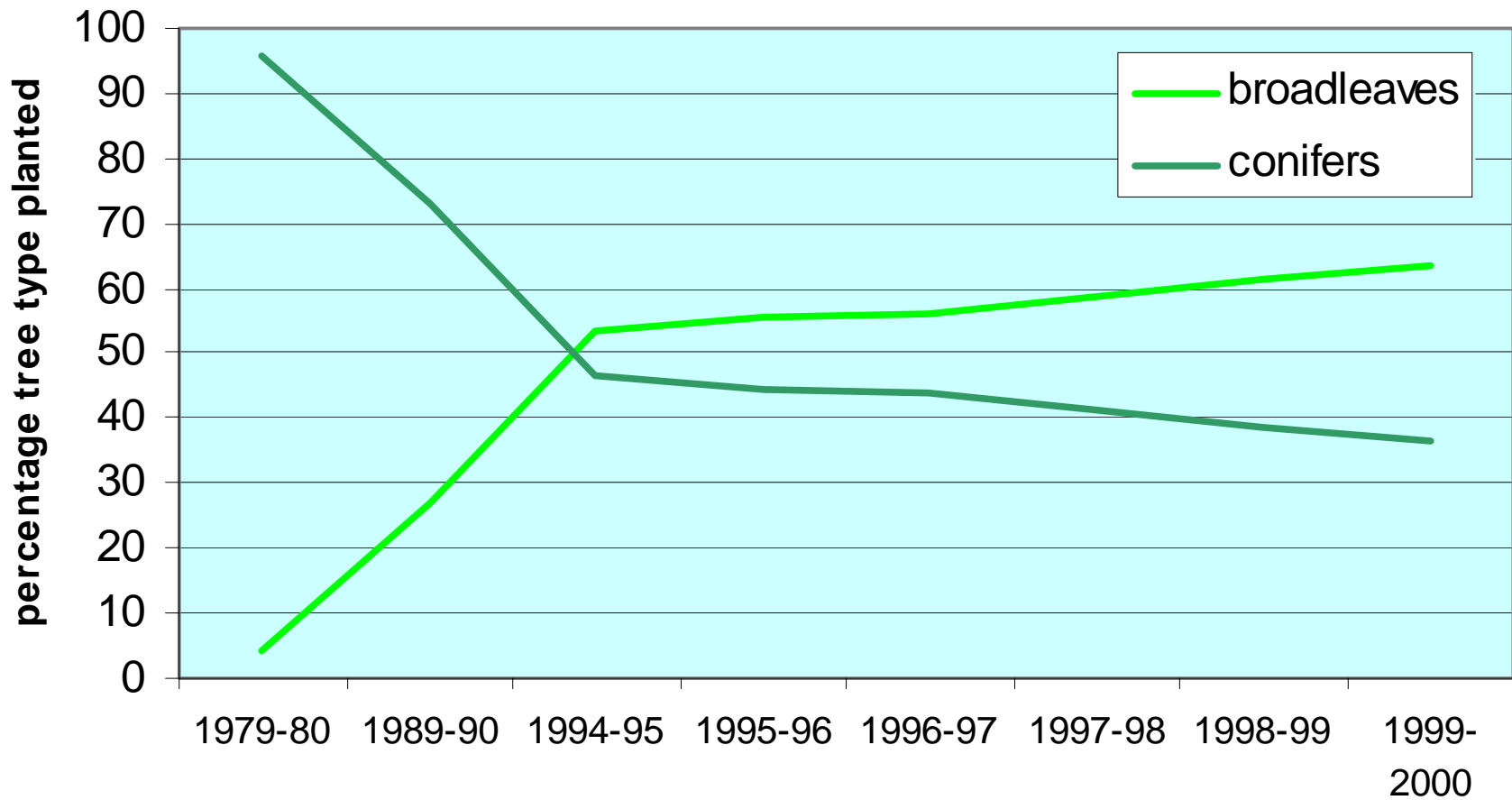
## Total UK wood production (1970-1999)



*Original data sourced from Forestry Commission statistics*

# New planting in the UK by tree type

## 1979-2000



*Original data sourced from Forestry Commission statistics*

# Technical and economic constraints on hardwood production in the UK

## For broadleaves, on average:

- ❖ lower timber revenues than conifers
- ❖ higher cost of suitable land
- ❖ more costly management during establishment
- ❖ lack of expertise and training in broadleaved management
- ❖ marketing difficulties (lack of supply consistency, poor quality of existing resource, lack of development of home markets)

## Co-ordinating forestry research and industry

- ❖ *Promoting research into provenance testing, selection, and breeding*
- ❖ *Supporting the establishment of trials*
- ❖ *Development of technologies to aid rapid multiplication*
- ❖ *Promoting the use of improved material*
- ❖ *Education, publicity, fund raising and lobbying to further the above aims*



# Organisations participating in B.I.H.I.P.

## COMMERCIAL

Landowners

Nurseries

## RESEARCH

Universities

Forest Research (FC)

Coillte (Eire)

Northern Ireland Forest Service

Northmoor Trust

Horticulture Research International

## FUNDING

Forestry Commission

DEFRA

Forest Service

Woodland Heritage

Royal Forestry Society

Northmoor Trust

Leverhulme Trust

# Why 'improve' trees?

## The current situation

- ❖ concern over genetic quality of planting stock
- ❖ lack of knowledge about provenance choice
- ❖ indiscriminate use of foreign origin planting stock
- ❖ low priority afforded to broadleaved tree improvement
- ❖ rudimentary advice on genetic conservation

*Inadequate provision of genetics research and advice undermines all aspects of sustainable forestry and potentially hampers the delivery of UK forestry strategy*

*Ultimately may limit the potential for producing high quality hardwood timber*

# BIHIP Working Groups



Ash



Birch



Cherry



Oak



Sweet chestnut



Sycamore



Walnut

# INDIGENOUS vs.EXOTIC

European Community's 1993 guideline  
*"native species & local provenances should  
be preferred where appropriate".*

Forest certification & timber labeling  
standards require action to conserve  
genetic diversity & to use local provenances

But what is indigenous and local?



Local genotypes assumed to be well adapted to local conditions

Should seed come from

the same wood?

the same

watershed?

the same county?

How *local* should a seed source be?

- scale of local adaptation
- geographic? ecological?

How precise can climate predictions be?

# Extent of adaptation?

Influenced by balance between  
*selection*

- degree of environmental differences between sites
- time/no of generations occupied site

*gene flow*

- extensive gene flow counteracts selection
- gene flow much more extensive in trees than herbaceous plants

## UK hardwood species adaptation

- extent of local adaptation of British tree populations in doubt
- planting of native broadleaves in Britain continues
- demand for certified sourced seed increases



# What is important?

- maintain historical patterns of diversity?
- ensure future adaptive potential?
- optimise current production?
- avoid inbreeding?

Precautionary Principle?

# Need to maintain genetic variation

- adaptation to changing environments
- viability of populations in short term
  - seed production
  - inbreeding depression
- direct use of genetic resources





# Looking Forward...

- ❖ Better communication between FC and stakeholders
- ❖ Encourage local FC officers to assist BIHIP and promote its ideals
- ❖ Consistency of approach between different conservancies
- ❖ Need to promote education in all sectors of the forest industry
- ❖ BIHIP to develop regional programmes
- ❖ Evidence for regional diversity needs to be reviewed for all economic hardwood species
- ❖ Genetic conservation research programme should be linked to provenance testing
- ❖ Need to develop 'horses for courses' (both trees and policies)
- ❖ Identification, support and management of registered seed stands

# Forest research costs by subject

<i>Subject</i>	<i>2000 £m</i>	<i>Subject</i>	<i>2003 £m</i>
Silviculture	4.3	Resources/silviculture	5.8
Environment	3.7	Environment	3.6
Biotic damage	2.7	Protection	3.2
Tropical	2.6	Wood use/processing	2.8
Genetics/tree impr.	2.1	Tropical	2.4
Mensuration/inventory	2.0	Conservation/biodiversity	2.1
Tree biology	1.4	Tree impr./genomics	1.6
Wood science	1.4	Tree biology	0.7
Socio-economics	1.0	Planting	0.6
Harvesting	0.6	Recreation/participation	0.5
		Arboriculture	0.06

# Acknowledgements

- BIHIP – Peter Savill and Gabriel Hemery
- ECI – Pam Berry
- Green College – Kristina Plenderleith
- OFI – Janet Stewart and David Boshier
- RHS - for invitation