Conserving crop landraces and wild relatives— on farms and in the wild

UNIVERSITY OF BIRMINGHAM

Conserving Crop Landraces and Wild Relative: Efficiency through networking

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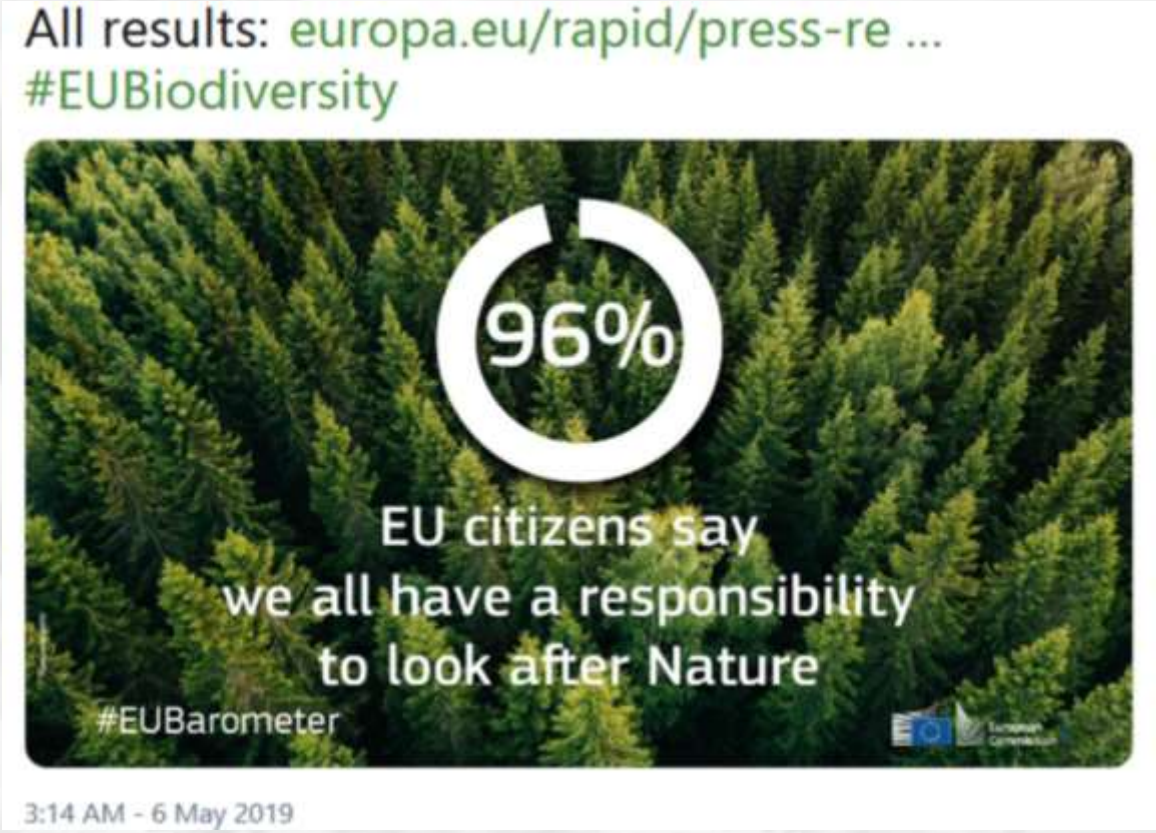
'Oxford Real Farming Conference (ORFC) 2020' workshop
9th Jan 2020, Oxford Town Hall, Oxford*, UK*

Talk objectives

1. Introduce ABD (CWR, LR) and the need for diversity
2. Systematic ABD planning global to regional to national
3. European ABD Networking



Agrobiodiversity

"Any genetic material of plant origin of actual or potential value for food and agriculture"
(FAO ITPGRFA 2001)

- Wild plant species with potential as trait donors to crops
  [crop wild relatives – CWR]
- Cultivated varieties of plant species
  [landraces/farmers' varieties – LR]

Agrobiodiversity

"PGRFA are the biological basis of world food security and, directly or indirectly, support the livelihoods of every person on earth"
(FAO CGRFA, 1996)

Provisioning ecosystem services

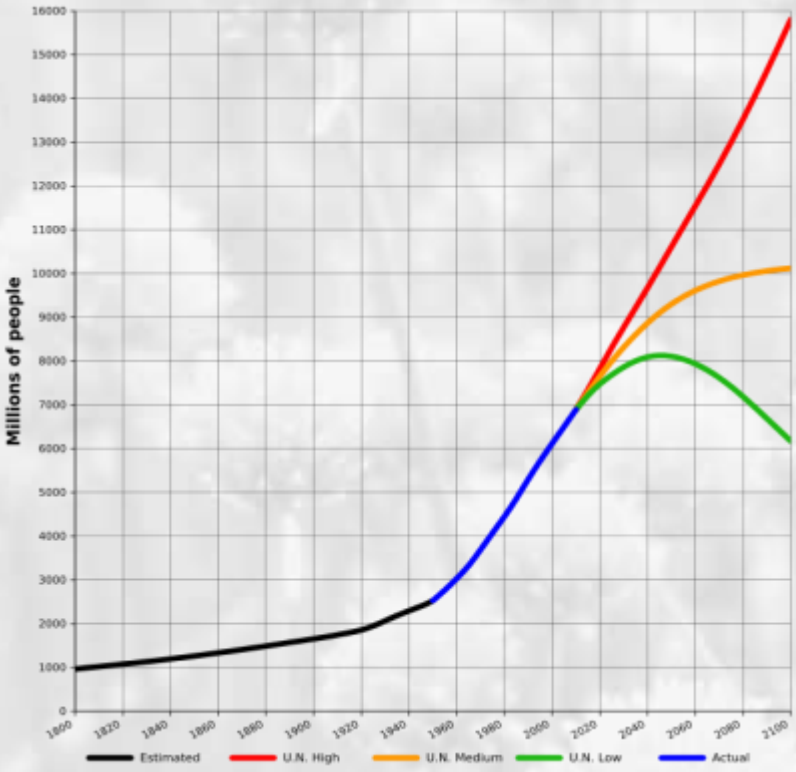
Agrobiodiversity

Imperative for greater use of both within and between species diversity in farming systems to provide sufficient options for the adaptation of crops as an insurance against climate variability

(IPCC, 2014)

Why actively conserve PGR now?

- 7.76 billion humans in 2020 (7/01/20)
- 9.6 billion humans by 2050 (UN, 2014)



16 billion

10 billion

6 billion

The human population is beyond the earth's carrying capacity?

- To feed the human population in 2050 we will require food supplies to increase by 60% globally, and 100% in developing countries (FAO, 2011)

Why actively conserve PGR now?
Climate change has changed the game

Climate change may reduce agricultural production by 2% each decade while demand increases 14%. Up to 40% of the world will develop unfamiliar climates by 2050 (IPCC, 2014)

M. sativa 2015 @ 12%

M. sativa 2020 @ 17.4%

M. sativa 2050 @ 2.3% of (Maxted & Phillips 2015)

Food insecurity and human malnourishment is going to be a real problem in our lifetimes

Indigenous PGR: Landraces

Highly threatened by

- No idea how many LR exist
- Landrace maintainers are old (> 65)
- Farmers grow for economic return
- Seed companies promoting modern cultivar

  replacement of LR
- No agency has direct responsibility
- No comprehensive inventory of LR

Scottish Landrace Protection Scheme (SLPS) launched by SASA in August 2006, small grain cereals, potatoes, forage grass and Shetland cabbage

Indigenous PGR: Crop Wild Relatives

Crop wild relatives are wild plant species that have indirect use derived from their relatively close genetic relationship to a crop

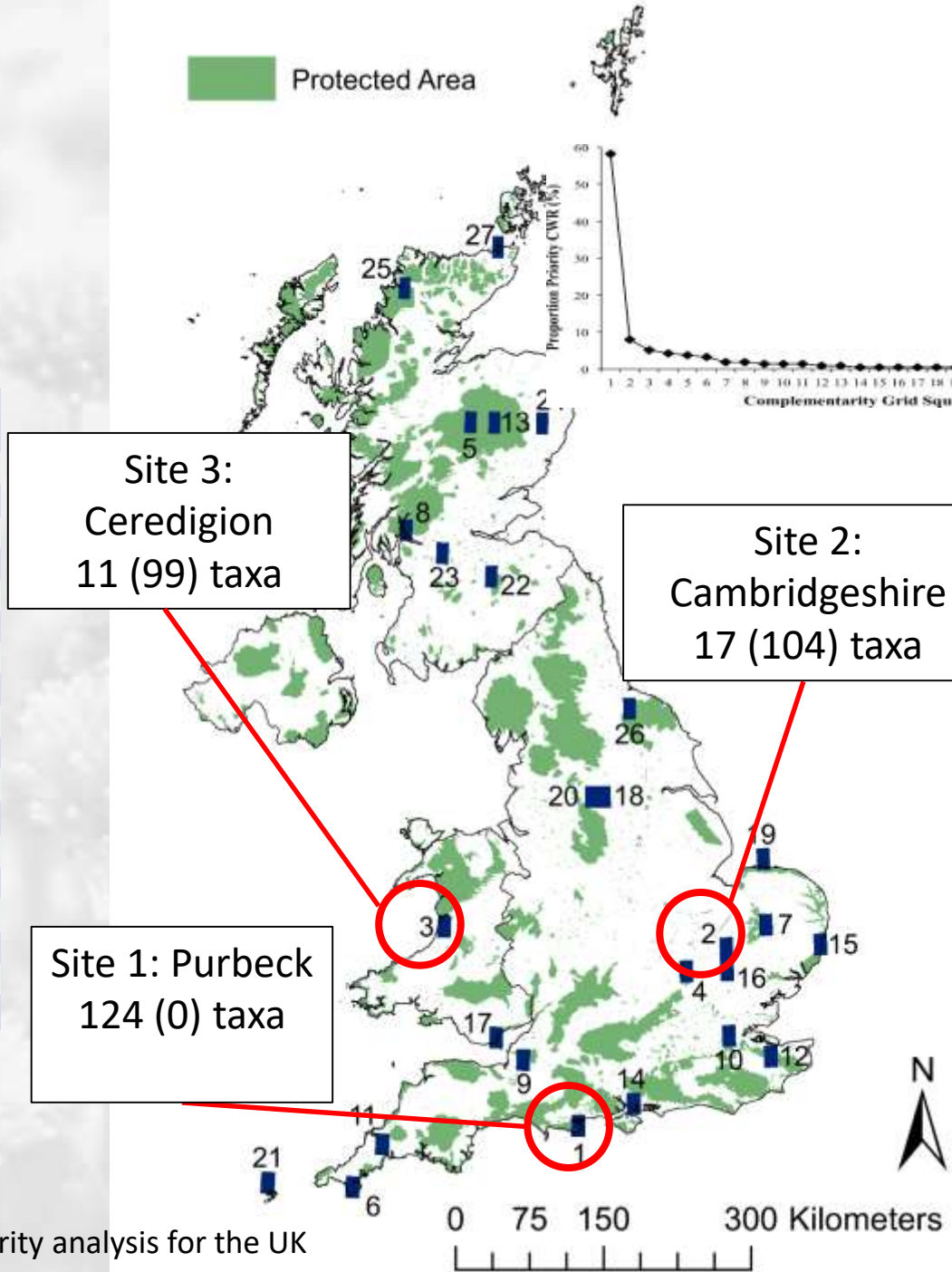
UK national CWR checklist contains 413 genera and 1955 species, although not all of these are native taxa (Maxted *et al.*, 2007)

Wild leek	Strawberry	Blackcurrant
Round headed leek	Least lettuce	Redcurrant
Creeping marshwort	Wild lettuce	Gooseberry
Field wormwood	Great lettuce	Dewberry
Wild asparagus	Sea pea	Cloudberry
Barberry	Perennial flax	Blackberry
Sea Beet	Rye Grass	Raspberry
Black Mustard	Apple (crab)	Shore dock
Wild Cabbage	Pennyroyal	Butcher's broom
Wild Turnip	Cherry	Elder
Interrupted brome	Sloe	Clovers
Hazelnut	Bilberry	Cocksfoot
Sea Kale	Cranberry	Crowberry
Wild Carrot		

Important CWR Areas for the UK

Table 1 Summary of inventory of 223 priority CWR in UK (N = Native, A = Archaeophyte, Neo = Neophyte)

Family	No. of genera	No. of species	No. of infra-specific taxa	Native status
Alliaceae	1	10	3	N; Neo
Amaranthaceae	3	13	1	N; A; Neo
Apiaceae	3	2	4	N
Asparagaceae	1	2		N; Neo
Asteraceae	2	5		N; A; Neo
Betulaceae	1	2		N; Neo
Brassicaceae	8	10	5	N; A; Neo
Ericaceae	1	6		N; Neo
Fabaceae	8	59	8	N; A; Neo
Fagaceae	1	1		Neo
Geraniaceae	1	3		N; A
Grossulariaceae	1	8		N; Neo
Juglandaceae	1	1		Neo
Linaceae	1	2	1	N
Moraceae	2	2		Neo
Poaceae	20	39	9	N; A; Neo
Rosaceae	6	27		N; Neo
Totals	61	192	31	



Fielder *et al.,* 2015

CWR complementarity analysis for the UK

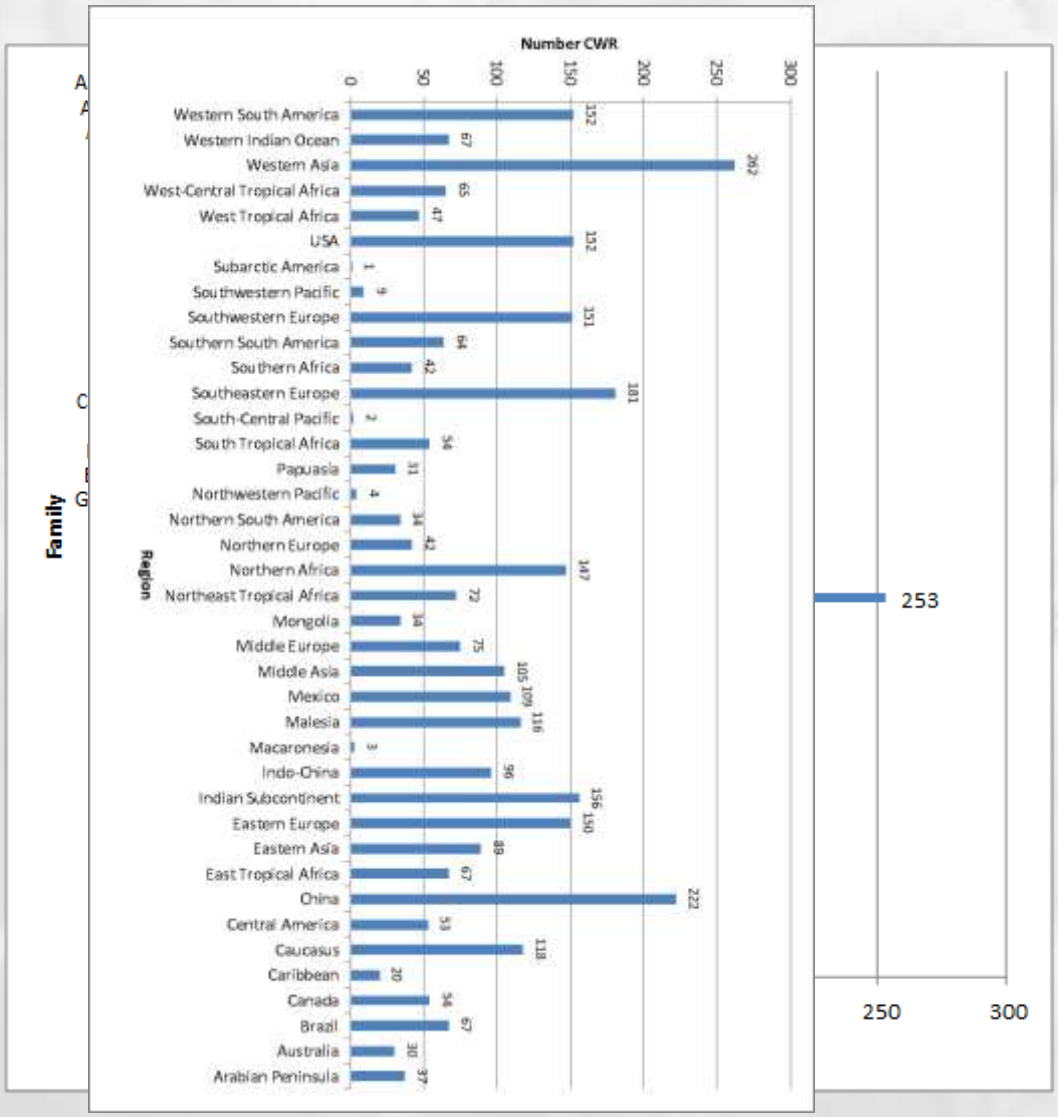
Global CWR Project

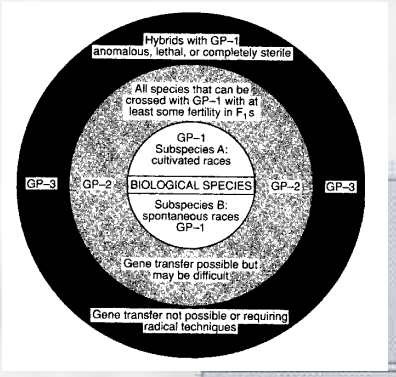
- Global Crop Diversity Trust, RBG, Kew, CIAT and UOB project with funding from Norwegian Gov. funding

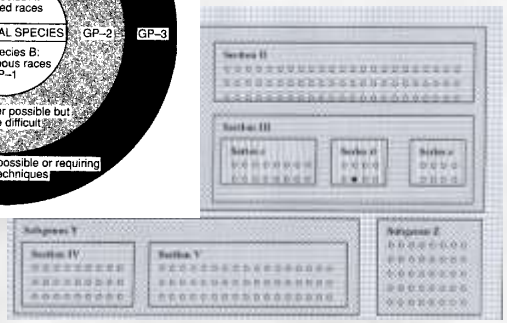
- Primarily use orientated, but *ex situ* collecting in first 5 years:

    1. List of gene pools and taxa to collect 92 genera with crops
    2. Ecogeographic data collection
    3. Gap analysis using Maxted *et al.* (2008) / Ramírez-Villegas *et al.* (2010) methodology
    4. Field collection
    5. *Ex situ* storage

Global Crop Diversity Trust: global *ex situ* CWR conservation







Harlan and de Wet Inventory

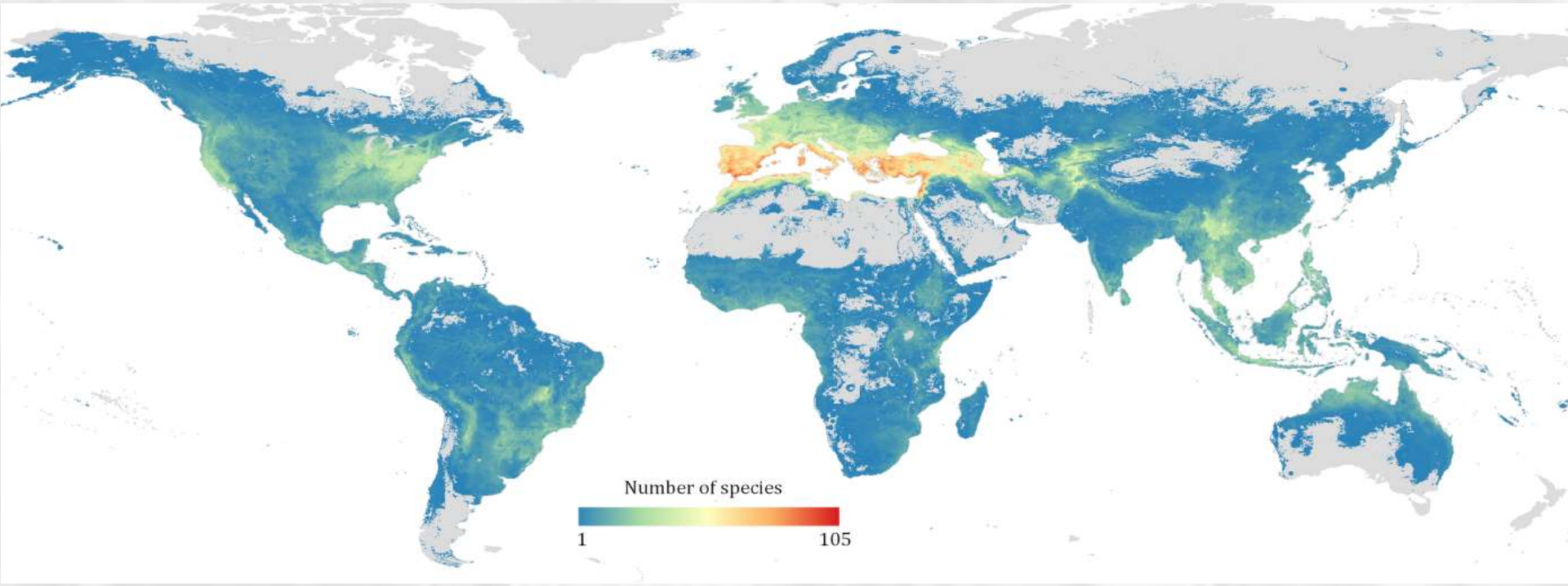
1,667 priority CWR taxa from 194 crops

- 37 families
- 109 genera
- 1,392 species
- 299 sub-specific taxa

Vincent *et al.* (2013)

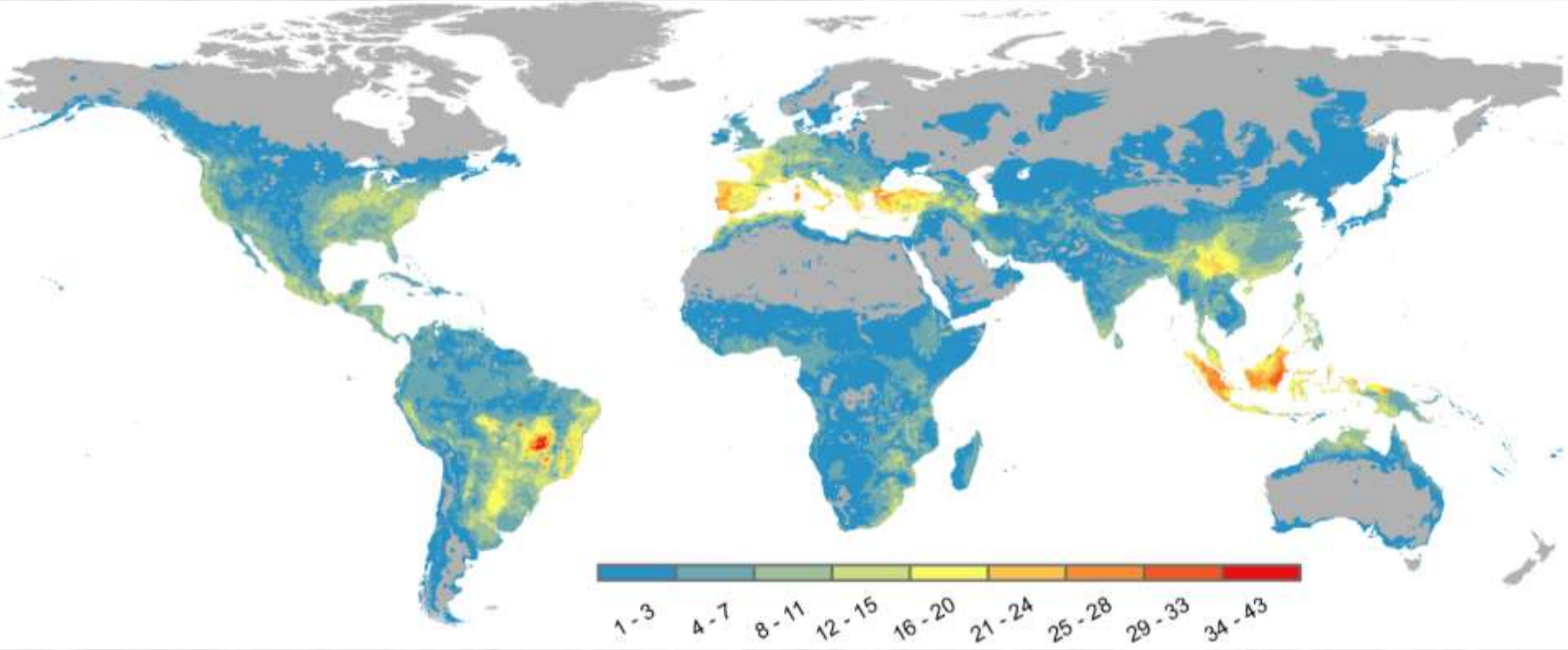
http://www.cwrdiversity.org/checklist/

Global CWR Conservation



Species richness map for the priority 1,394 CWR related to 194 crops at five arc minutes resolution (Vincent *et al.,* 2019).

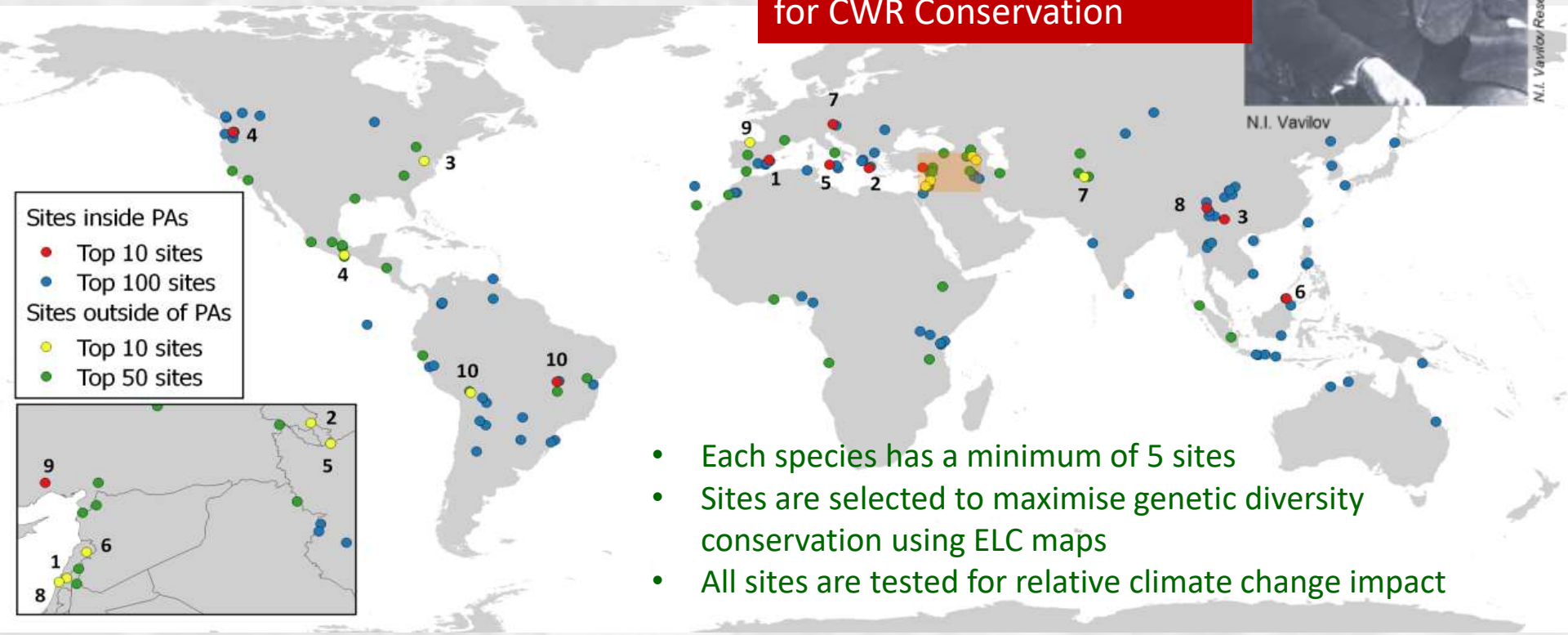
Global CWR Conservation



Global collecting hotspots for High Priority CWR for 1,026 CWR related to 81 crop gene pools (Castañeda-Álvarez *et al.*, 2016).

Global CWR Conservation

A PROPOSAL:
NI Vavilov Global Network
for CWR Conservation

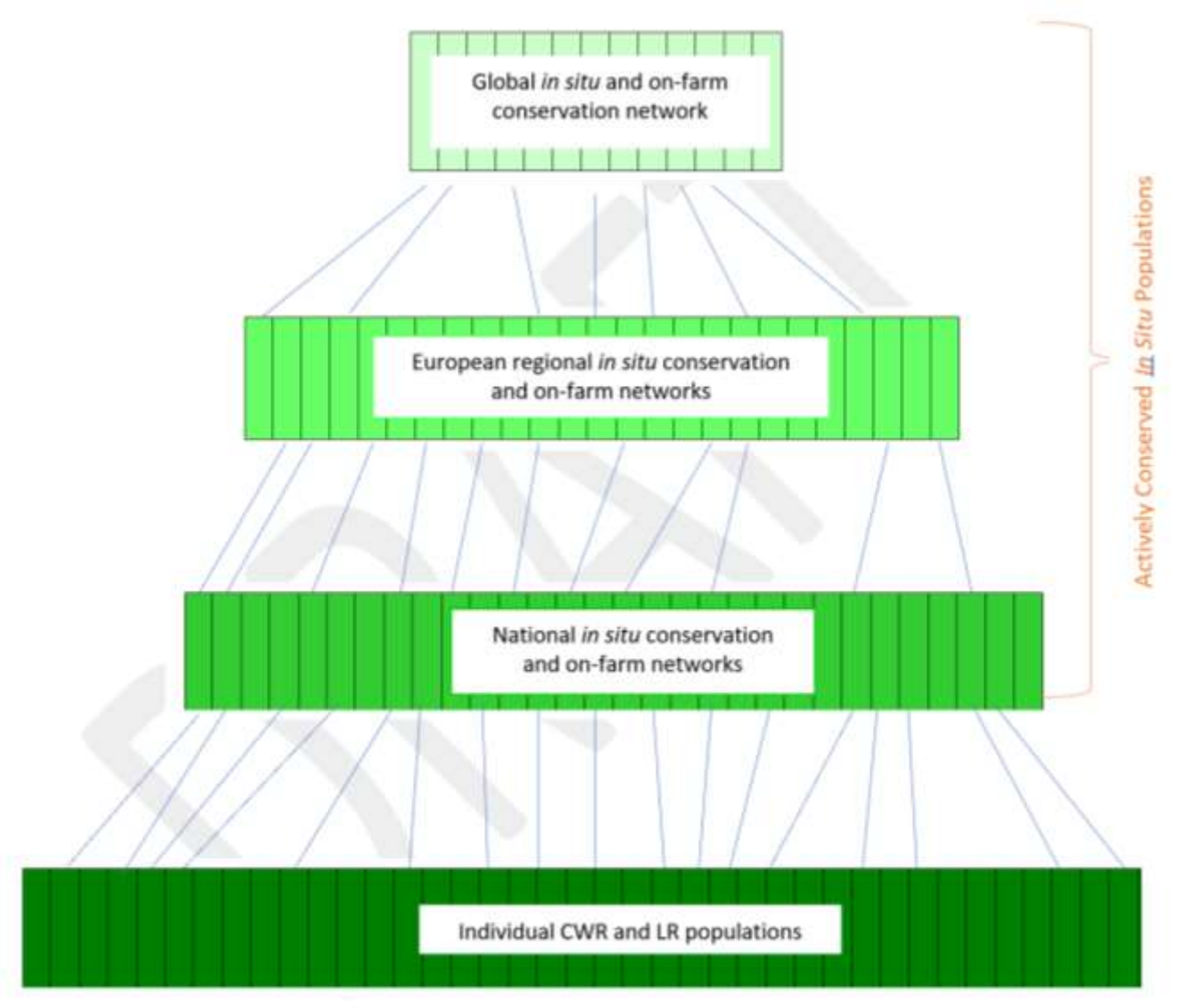


- Each species has a minimum of 5 sites
- Sites are selected to maximise genetic diversity conservation using ELC maps
- All sites are tested for relative climate change impact

Top 150 sites for global *in situ* CWR conservation (100xPA and 50xnon-PA), with magnification on the Fertile Crescent and Caucasus (Vincent *et al.,* 2019).

A unique opportunity

Building blocks of the European Network: A network of networks



Maxted *et al.*, 2015

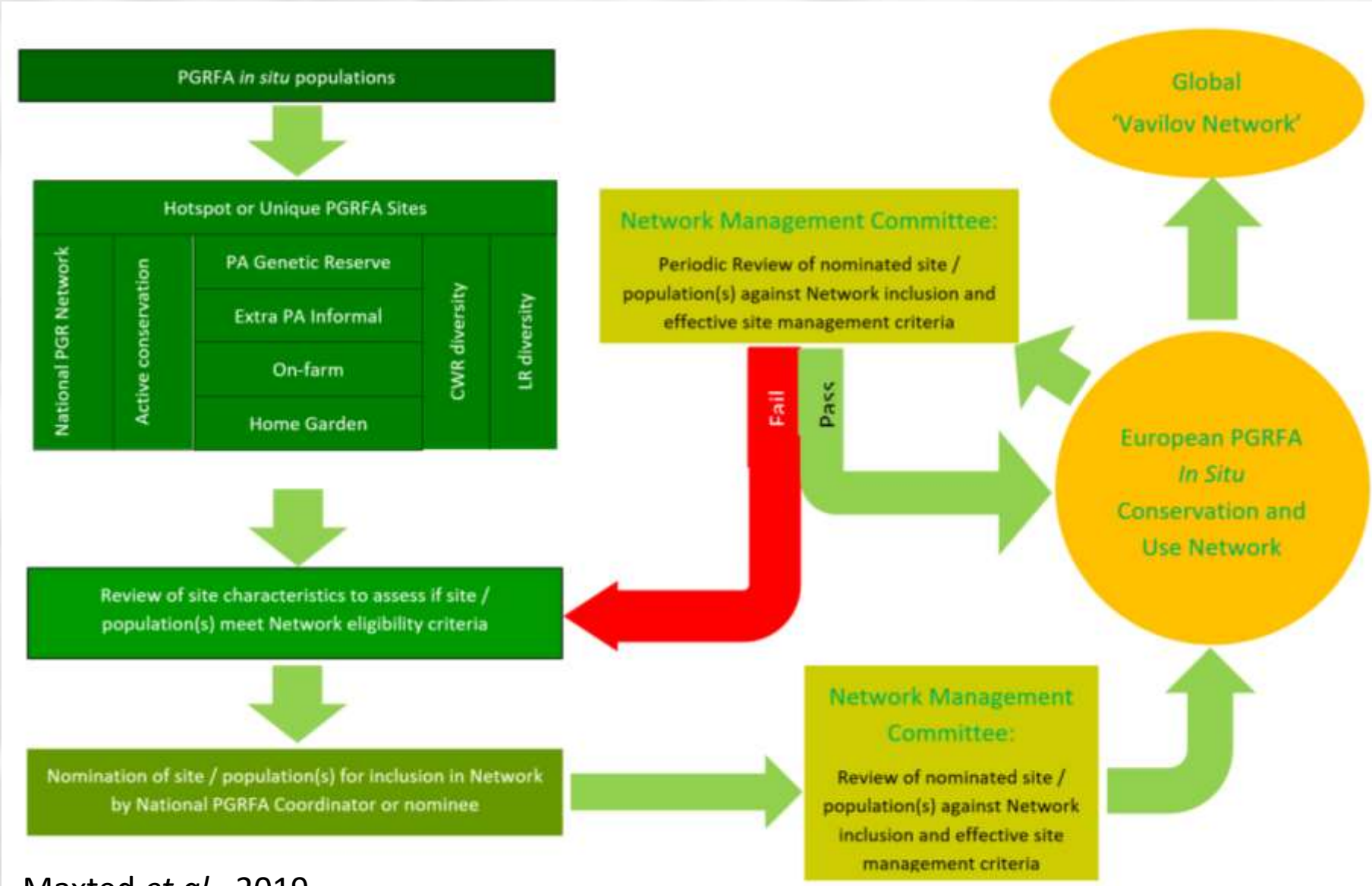
Building blocks of the European Network: Functions of the European Network

To be sustainable the Network must work, fulfil its functions:

- Enhanced conservation and sustainable use
- Facilitated coordination
- Enhanced partnerships
- Facilitated access to and exchange of conserved resource and information
- Benefits to local communities

As good as gene banks

Establishing the European Network: Site / population identification/nomination process

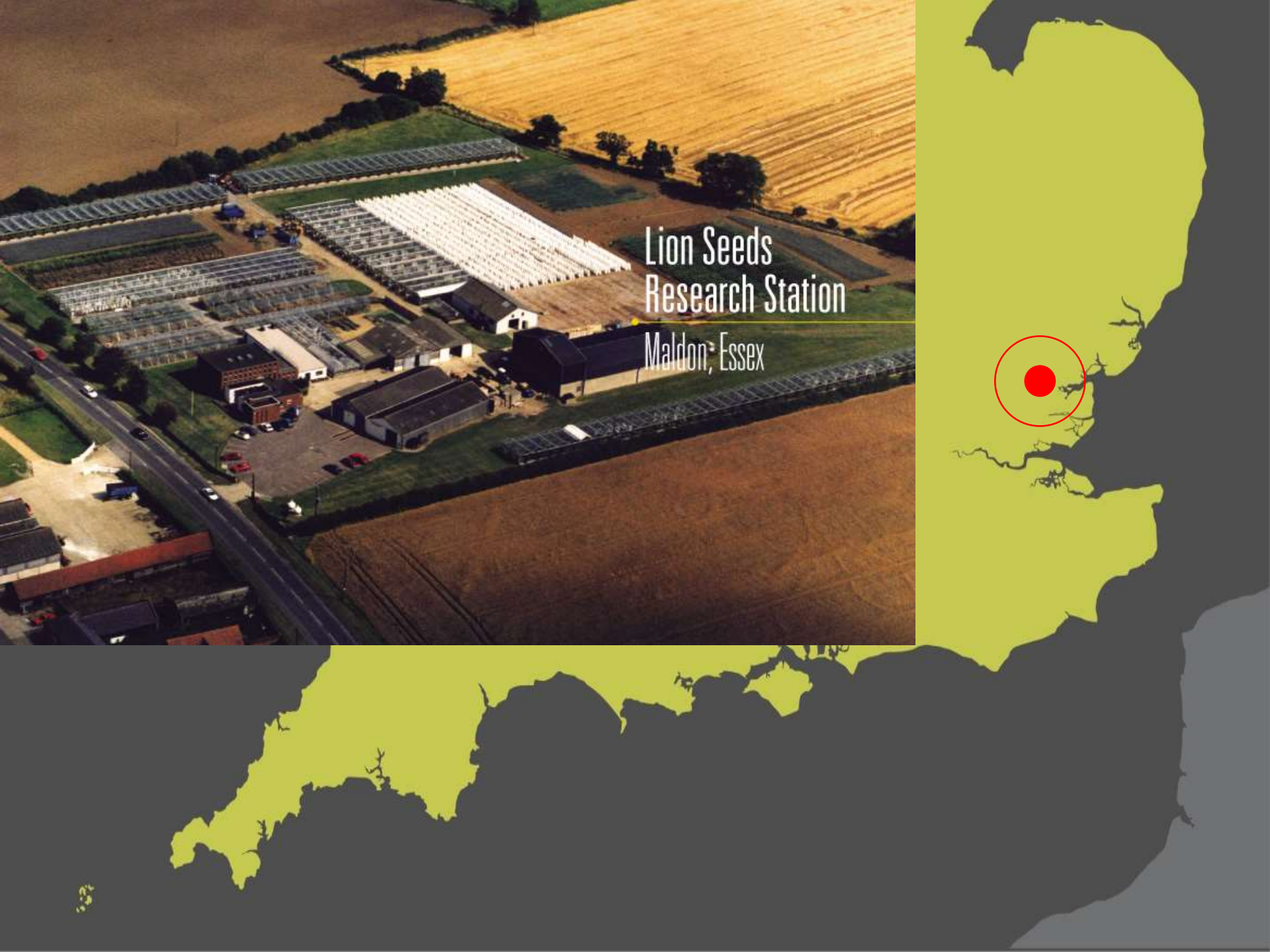


Maxted *et al*., 2019

Establishing the European Network: Benefit of Network membership

- The prestige of belonging to an international community of appreciation and concern for the value of PGR diversity
- Assistance with facilitated access and ABS to the conserved resources for sustainable use
- Assistance with identifying, preserving and promoting CWR and on-farm conservation
- Emergency assistance to mitigate the impact of sudden threats on CWR / LR populations
- Financial assistance for heritage conservation projects from a variety of sources
- Advice on population management and development of added value and enhanced value chains to help sustain populations

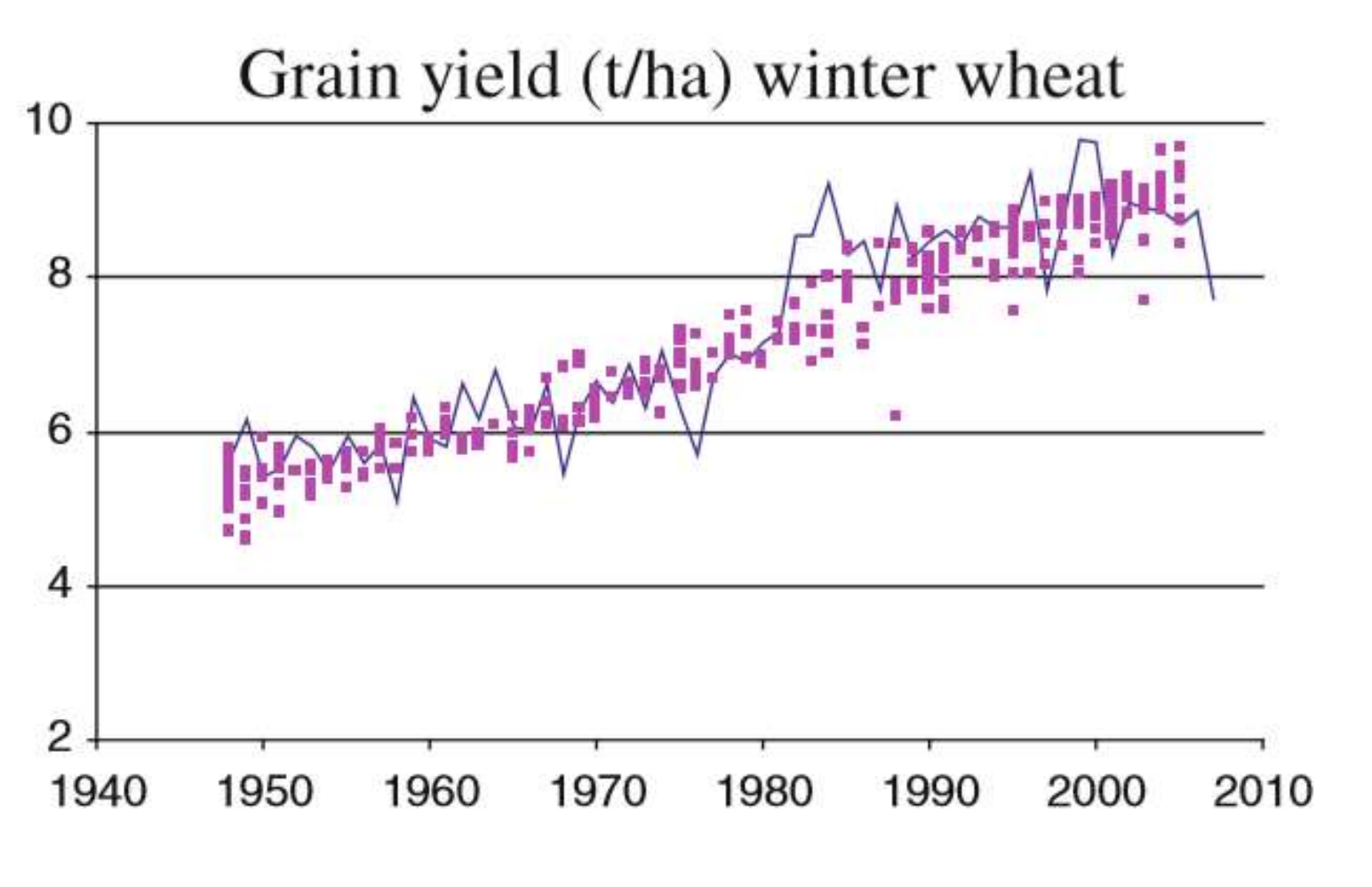
Conserving crop landraces and wild relatives— on farms and in the wild

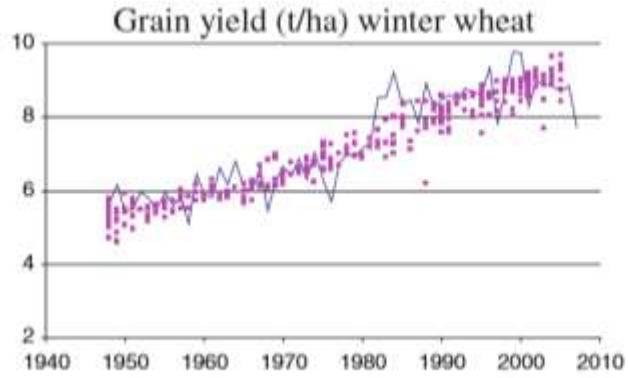

Lion Seeds
Research Station
Maldon, Essex

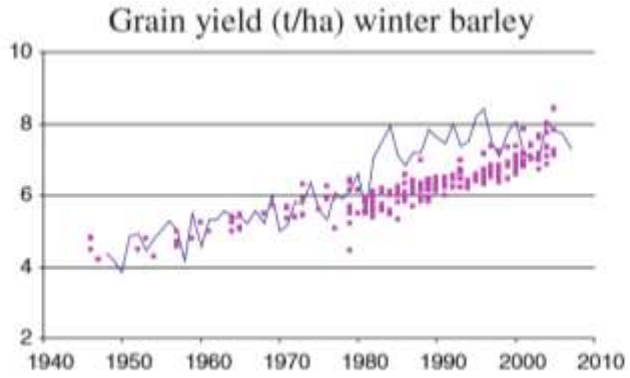
Reanalyses of the historical series of UK variety trials to quantify the contributions of genetic and environmental factors to trends and variability in yield over time

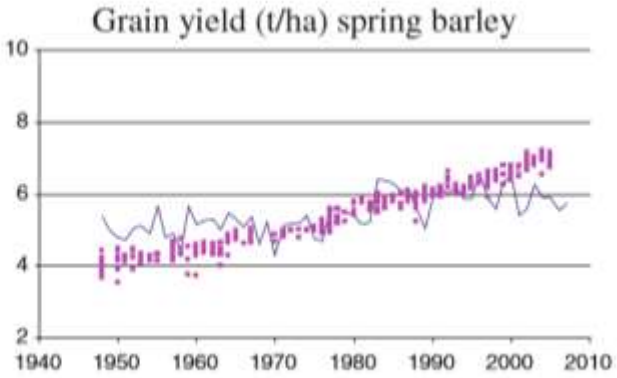
I. Mackay • A. Horwell • J. Garner • J. White • J. McKee • H. Philpott

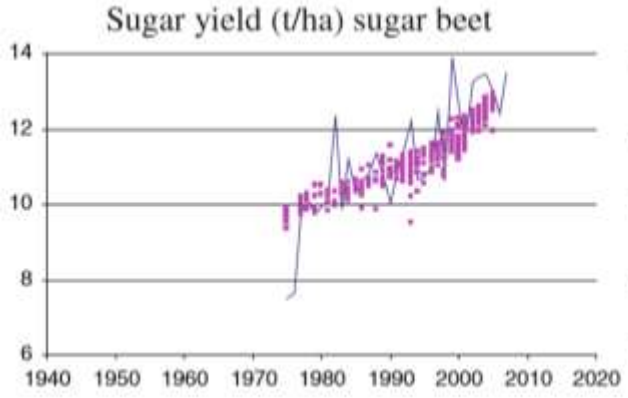
Theoretical and Applied Genetics 122(1): 225-238, September 2011

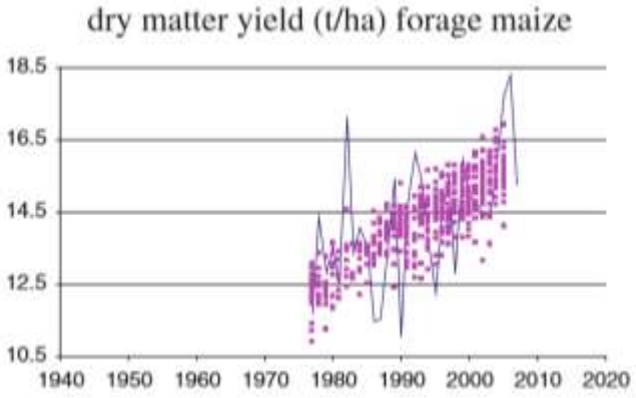


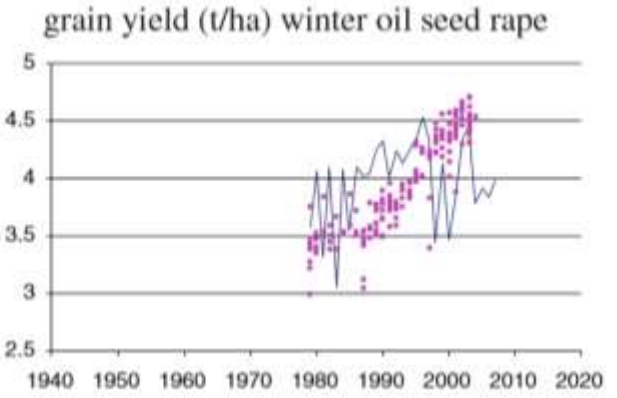

Grain yield (t/ha) winter wheat
10
8
6
4
2
1940 1950 1960 1970 1980 1990 2000 2010

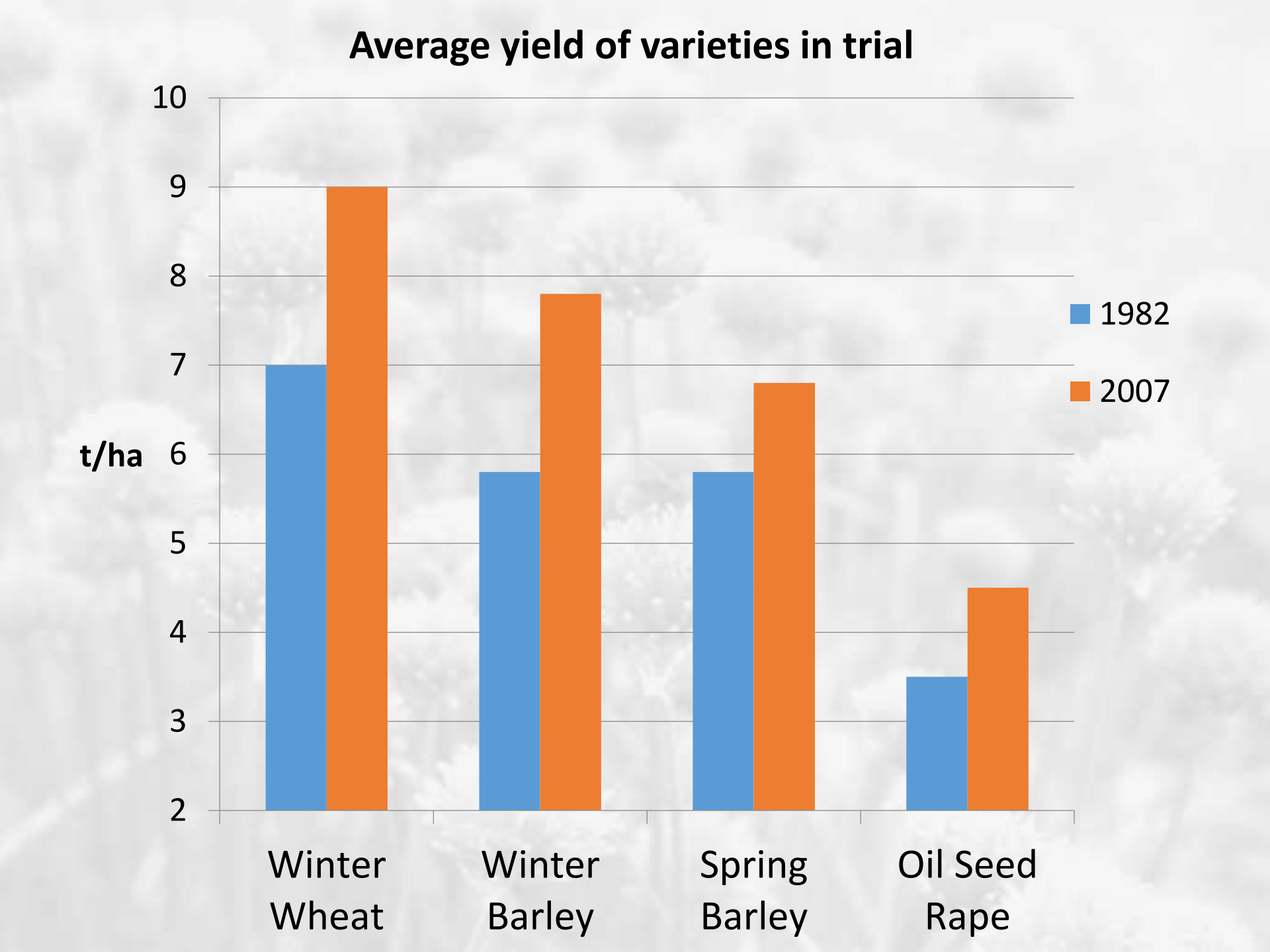

Grain yield (t/ha) winter barley
10
8
6
4
2
1940 1950 1960 1970 1980 1990 2000 2010


Grain yield (t/ha) spring barley
10
8
6
4
2
1940 1950 1960 1970 1980 1990 2000 2010


Sugar yield (t/ha) sugar beet
14
12
10
8
6
1940 1950 1960 1970 1980 1990 2000 2010 2020


dry matter yield (t/ha) forage maize
18.5
16.5
14.5
12.5
10.5
1940 1950 1960 1970 1980 1990 2000 2010 2020


grain yield (t/ha) winter oil seed rape
5
4.5
4
3.5
3
2.5
1940 1950 1960 1970 1980 1990 2000 2010 2020


Average yield of varieties in trial
10
9
8
7
6
5
4
3
2
t/ha
1982
2007
Winter Wheat
Winter Barley
Spring Barley
Oil Seed Rape

Conserving crop landraces and wild relatives— on farms and in the wild

Irish Seed Savers

Irish Seed Savers

Protecting Ireland's food crop heritage for future generations.

Conserving crop landraces and wild relatives— on farms and in the wild