

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



**Conserving plant diversity
for future generations**

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U

**Conserving Crop
Landraces and Wild
Relative: Efficiency
through networking**

B

Nigel Maxted

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

All results: [96%

EU citizens say
we all have a responsibility
to look after Nature

#EUBarometer

European Commission

The infographic features a circular gauge with a white needle pointing to 96% on a scale from 0 to 100. The background is a dense green forest. The text is overlaid on the forest image.](https://europa.eu/rapid/press-releases.htm?IP=1&IP2=0&IP3=0&IP4=0&IP5=0&IP6=0&IP7=0&IP8=0&IP9=0&IP10=0&IP11=0&IP12=0&IP13=0&IP14=0&IP15=0&IP16=0&IP17=0&IP18=0&IP19=0&IP20=0&IP21=0&IP22=0&IP23=0&IP24=0&IP25=0&IP26=0&IP27=0&IP28=0&IP29=0&IP30=0&IP31=0&IP32=0&IP33=0&IP34=0&IP35=0&IP36=0&IP37=0&IP38=0&IP39=0&IP40=0&IP41=0&IP42=0&IP43=0&IP44=0&IP45=0&IP46=0&IP47=0&IP48=0&IP49=0&IP50=0&IP51=0&IP52=0&IP53=0&IP54=0&IP55=0&IP56=0&IP57=0&IP58=0&IP59=0&IP60=0&IP61=0&IP62=0&IP63=0&IP64=0&IP65=0&IP66=0&IP67=0&IP68=0&IP69=0&IP70=0&IP71=0&IP72=0&IP73=0&IP74=0&IP75=0&IP76=0&IP77=0&IP78=0&IP79=0&IP80=0&IP81=0&IP82=0&IP83=0&IP84=0&IP85=0&IP86=0&IP87=0&IP88=0&IP89=0&IP90=0&IP91=0&IP92=0&IP93=0&IP94=0&IP95=0&IP96=0&IP97=0&IP98=0&IP99=0&IP100=0&IP101=0&IP102=0&IP103=0&IP104=0&IP105=0&IP106=0&IP107=0&IP108=0&IP109=0&IP110=0&IP111=0&IP112=0&IP113=0&IP114=0&IP115=0&IP116=0&IP117=0&IP118=0&IP119=0&IP120=0&IP121=0&IP122=0&IP123=0&IP124=0&IP125=0&IP126=0&IP127=0&IP128=0&IP129=0&IP130=0&IP131=0&IP132=0&IP133=0&IP134=0&IP135=0&IP136=0&IP137=0&IP138=0&IP139=0&IP140=0&IP141=0&IP142=0&IP143=0&IP144=0&IP145=0&IP146=0&IP147=0&IP148=0&IP149=0&IP150=0&IP151=0&IP152=0&IP153=0&IP154=0&IP155=0&IP156=0&IP157=0&IP158=0&IP159=0&IP160=0&IP161=0&IP162=0&IP163=0&IP164=0&IP165=0&IP166=0&IP167=0&IP168=0&IP169=0&IP170=0&IP171=0&IP172=0&IP173=0&IP174=0&IP175=0&IP176=0&IP177=0&IP178=0&IP179=0&IP180=0&IP181=0&IP182=0&IP183=0&IP184=0&IP185=0&IP186=0&IP187=0&IP188=0&IP189=0&IP190=0&IP191=0&IP192=0&IP193=0&IP194=0&IP195=0&IP196=0&IP197=0&IP198=0&IP199=0&IP200=0&IP201=0&IP202=0&IP203=0&IP204=0&IP205=0&IP206=0&IP207=0&IP208=0&IP209=0&IP210=0&IP211=0&IP212=0&IP213=0&IP214=0&IP215=0&IP216=0&IP217=0&IP218=0&IP219=0&IP220=0&IP221=0&IP222=0&IP223=0&IP224=0&IP225=0&IP226=0&IP227=0&IP228=0&IP229=0&IP230=0&IP231=0&IP232=0&IP233=0&IP234=0&IP235=0&IP236=0&IP237=0&IP238=0&IP239=0&IP240=0&IP241=0&IP242=0&IP243=0&IP244=0&IP245=0&IP246=0&IP247=0&IP248=0&IP249=0&IP250=0&IP251=0&IP252=0&IP253=0&IP254=0&IP255=0&IP256=0&IP257=0&IP258=0&IP259=0&IP260=0&IP261=0&IP262=0&IP263=0&IP264=0&IP265=0&IP266=0&IP267=0&IP268=0&IP269=0&IP270=0&IP271=0&IP272=0&IP273=0&IP274=0&IP275=0&IP276=0&IP277=0&IP278=0&IP279=0&IP280=0&IP281=0&IP282=0&IP283=0&IP284=0&IP285=0&IP286=0&IP287=0&IP288=0&IP289=0&IP290=0&IP291=0&IP292=0&IP293=0&IP294=0&IP295=0&IP296=0&IP297=0&IP298=0&IP299=0&IP300=0&IP301=0&IP302=0&IP303=0&IP304=0&IP305=0&IP306=0&IP307=0&IP308=0&IP309=0&IP310=0&IP311=0&IP312=0&IP313=0&IP314=0&IP315=0&IP316=0&IP317=0&IP318=0&IP319=0&IP320=0&IP321=0&IP322=0&IP323=0&IP324=0&IP325=0&IP326=0&IP327=0&IP328=0&IP329=0&IP330=0&IP331=0&IP332=0&IP333=0&IP334=0&IP335=0&IP336=0&IP337=0&IP338=0&IP339=0&IP340=0&IP341=0&IP342=0&IP343=0&IP344=0&IP345=0&IP346=0&IP347=0&IP348=0&IP349=0&IP350=0&IP351=0&IP352=0&IP353=0&IP354=0&IP355=0&IP356=0&IP357=0&IP358=0&IP359=0&IP360=0&IP361=0&IP362=0&IP363=0&IP364=0&IP365=0&IP366=0&IP367=0&IP368=0&IP369=0&IP370=0&IP371=0&IP372=0&IP373=0&IP374=0&IP375=0&IP376=0&IP377=0&IP378=0&IP379=0&IP380=0&IP381=0&IP382=0&IP383=0&IP384=0&IP385=0&IP386=0&IP387=0&IP388=0&IP389=0&IP390=0&IP391=0&IP392=0&IP393=0&IP394=0&IP395=0&IP396=0&IP397=0&IP398=0&IP399=0&IP400=0&IP401=0&IP402=0&IP403=0&IP404=0&IP405=0&IP406=0&IP407=0&IP408=0&IP409=0&IP410=0&IP411=0&IP412=0&IP413=0&IP414=0&IP415=0&IP416=0&IP417=0&IP418=0&IP419=0&IP420=0&IP421=0&IP422=0&IP423=0&IP424=0&IP425=0&IP426=0&IP427=0&IP428=0&IP429=0&IP430=0&IP431=0&IP432=0&IP433=0&IP434=0&IP435=0&IP436=0&IP437=0&IP438=0&IP439=0&IP440=0&IP441=0&IP442=0&IP443=0&IP444=0&IP445=0&IP446=0&IP447=0&IP448=0&IP449=0&IP450=0&IP451=0&IP452=0&IP453=0&IP454=0&IP455=0&IP456=0&IP457=0&IP458=0&IP459=0&IP460=0&IP461=0&IP462=0&IP463=0&IP464=0&IP465=0&IP466=0&IP467=0&IP468=0&IP469=0&IP470=0&IP471=0&IP472=0&IP473=0&IP474=0&IP475=0&IP476=0&IP477=0&IP478=0&IP479=0&IP480=0&IP481=0&IP482=0&IP483=0&IP484=0&IP485=0&IP486=0&IP487=0&IP488=0&IP489=0&IP490=0&IP491=0&IP492=0&IP493=0&IP494=0&IP495=0&IP496=0&IP497=0&IP498=0&IP499=0&IP500=0&IP501=0&IP502=0&IP503=0&IP504=0&IP505=0&IP506=0&IP507=0&IP508=0&IP509=0&IP510=0&IP511=0&IP512=0&IP513=0&IP514=0&IP515=0&IP516=0&IP517=0&IP518=0&IP519=0&IP520=0&IP521=0&IP522=0&IP523=0&IP524=0&IP525=0&IP526=0&IP527=0&IP528=0&IP529=0&IP530=0&IP531=0&IP532=0&IP533=0&IP534=0&IP535=0&IP536=0&IP537=0&IP538=0&IP539=0&IP540=0&IP541=0&IP542=0&IP543=0&IP544=0&IP545=0&IP546=0&IP547=0&IP548=0&IP549=0&IP550=0&IP551=0&IP552=0&IP553=0&IP554=0&IP555=0&IP556=0&IP557=0&IP558=0&IP559=0&IP560=0&IP561=0&IP562=0&IP563=0&IP564=0&IP565=0&IP566=0&IP567=0&IP568=0&IP569=0&IP570=0&IP571=0&IP572=0&IP573=0&IP574=0&IP575=0&IP576=0&IP577=0&IP578=0&IP579=0&IP580=0&IP581=0&IP582=0&IP583=0&IP584=0&IP585=0&IP586=0&IP587=0&IP588=0&IP589=0&IP590=0&IP591=0&IP592=0&IP593=0&IP594=0&IP595=0&IP596=0&IP597=0&IP598=0&IP599=0&IP600=0&IP601=0&IP602=0&IP603=0&IP604=0&IP605=0&IP606=0&IP607=0&IP608=0&IP609=0&IP610=0&IP611=0&IP612=0&IP613=0&IP614=0&IP615=0&IP616=0&IP617=0&IP618=0&IP619=0&IP620=0&IP621=0&IP622=0&IP623=0&IP624=0&IP625=0&IP626=0&IP627=0&IP628=0&IP629=0&IP630=0&IP631=0&IP632=0&IP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#EUBiodiversity</p></div><div data-bbox=)

3:14 AM - 6 May 2019

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

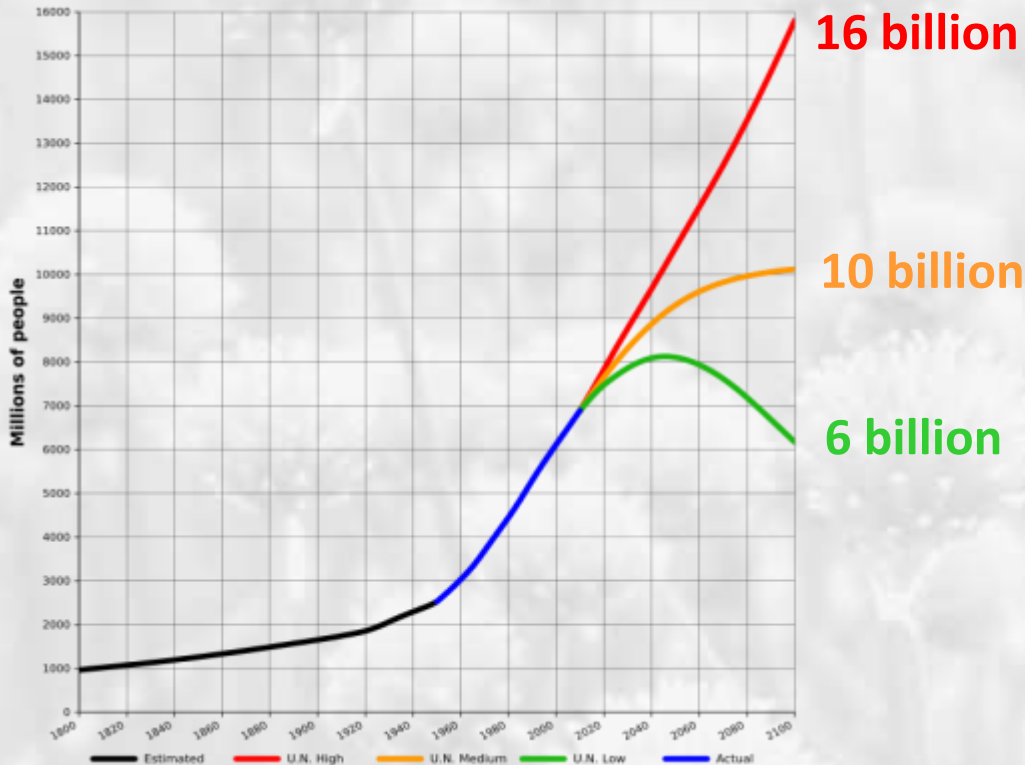
Imperative for greater use of both
within and between species
diversity in farming systems to
provide sufficient options for the
adaptation of crops as an insurance
against climate variability

(IPCC, 2014)



Why actively conserve PGR now?

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



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%
(Maxted & Phillips 2015)



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)

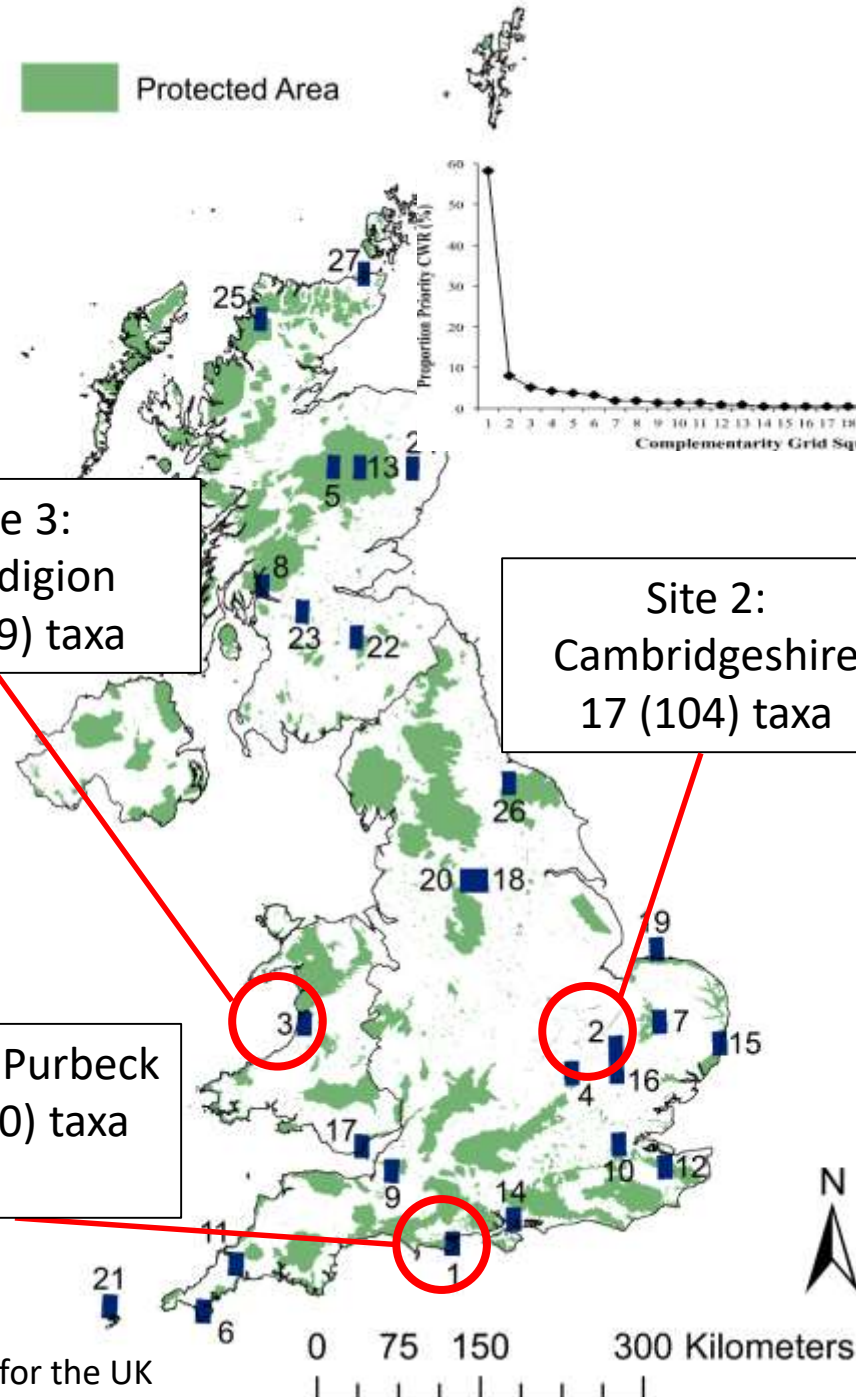
Wild leek	Strawberry	Blackcurrant
Round headed leek	Least lettuce	Redcurrant
Creeping marshwort	Wild lettuce	Gooseberry
Field wormwood	Great lettuce	Dewberry
Wild asparagus	Sea pea	Cloudberry
Barberry	Perennial flax	Blackberry
Sea Beet	Rye Grass	Raspberry
Black Mustard	Apple (crab)	Shore dock
Wild Cabbage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



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	

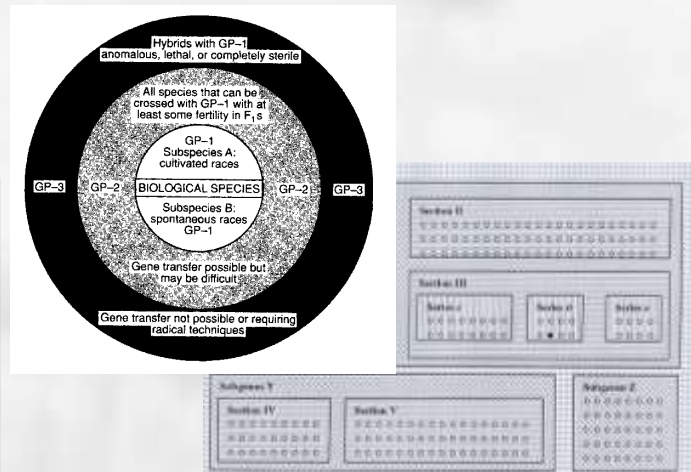
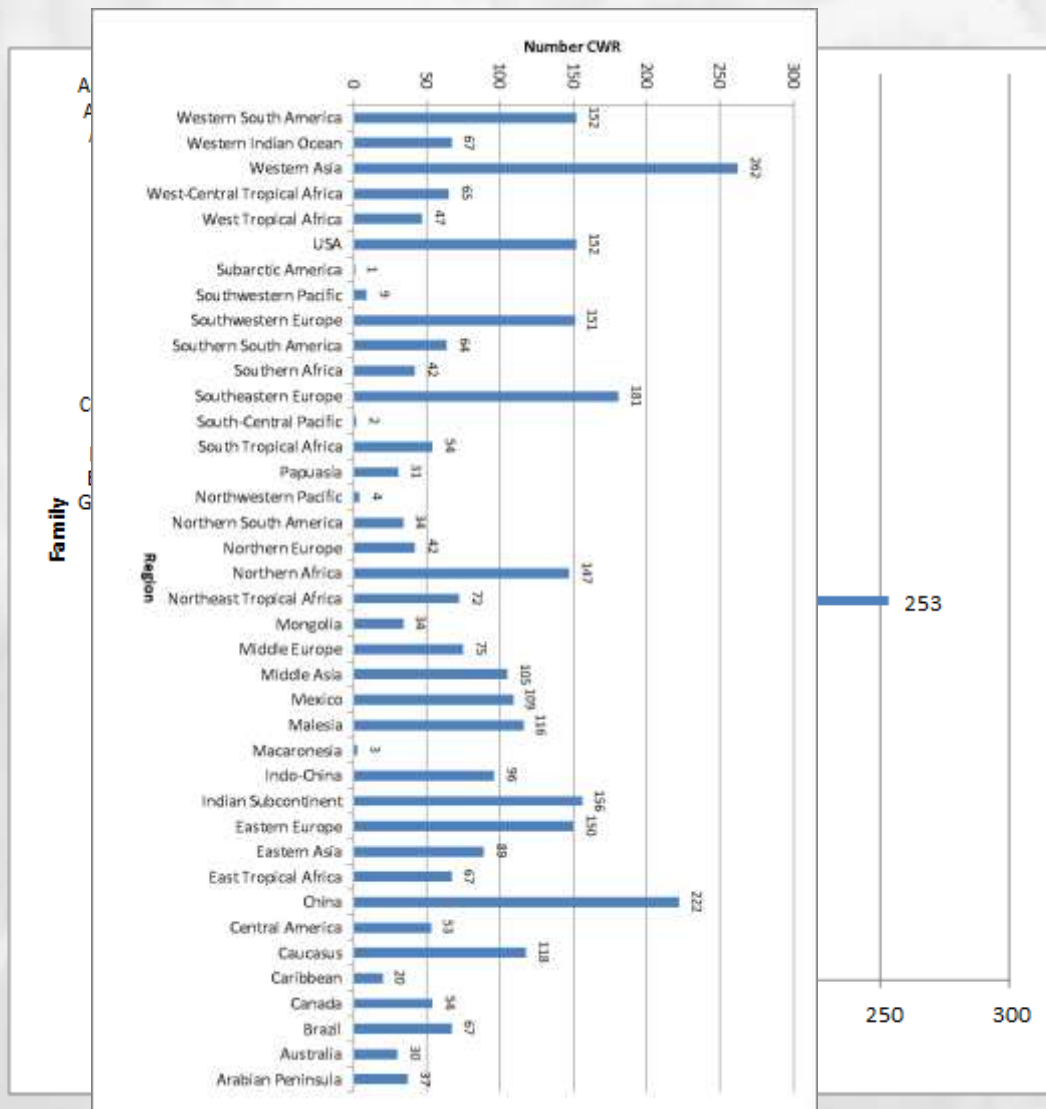


Global CWR Project

- 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

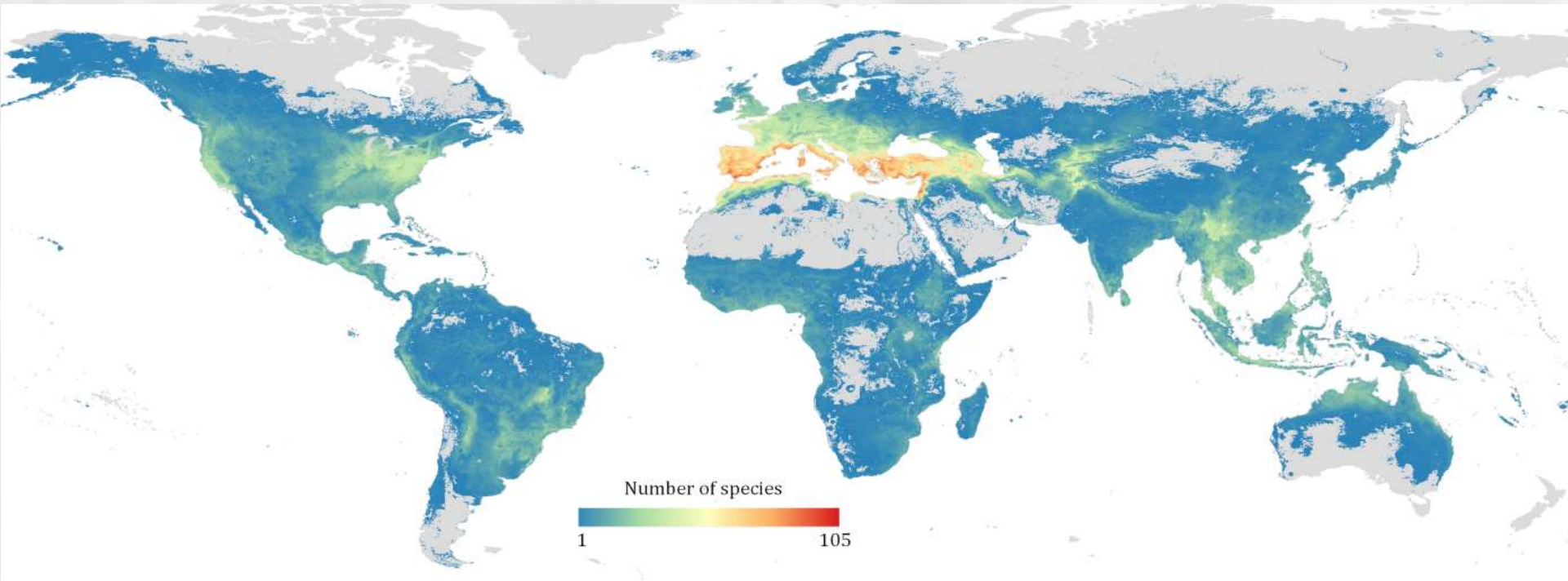
1,667 priority CWR taxa from 194 crops

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

Vincent *et al.* (2013)

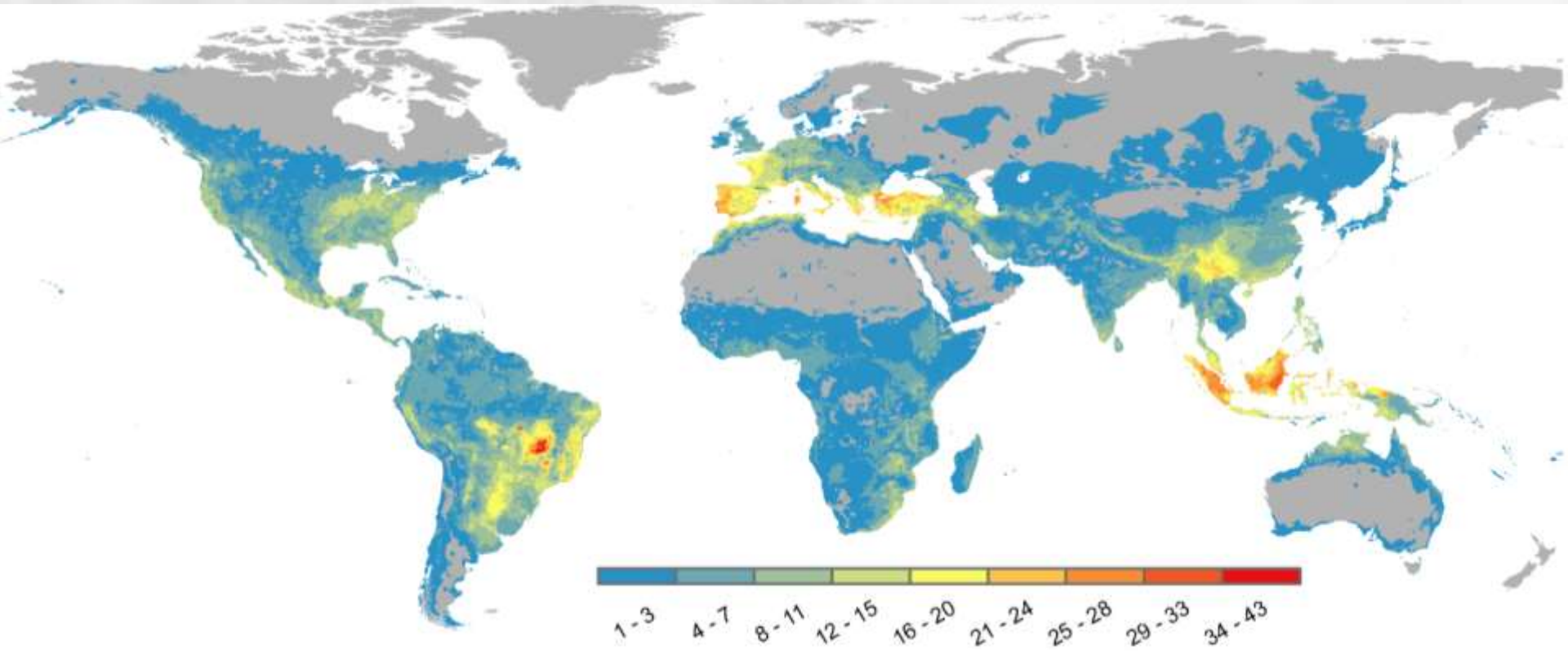
<http://www.cwrdiversity.org/checklist/>

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).

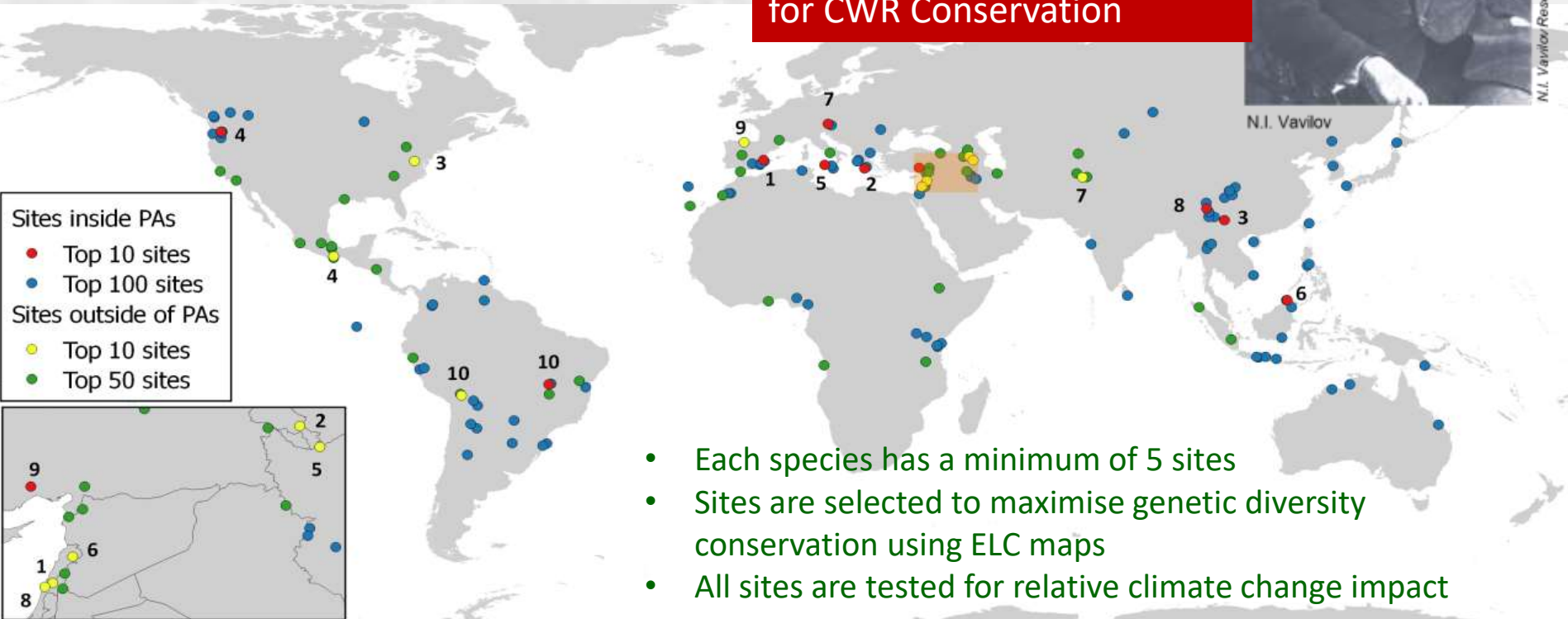
Global CWR Conservation

A PROPOSAL:
NI Vavilov Global Network
for CWR Conservation



N.I. Vavilov/Research Institute of Plant Industry

N.I. Vavilov



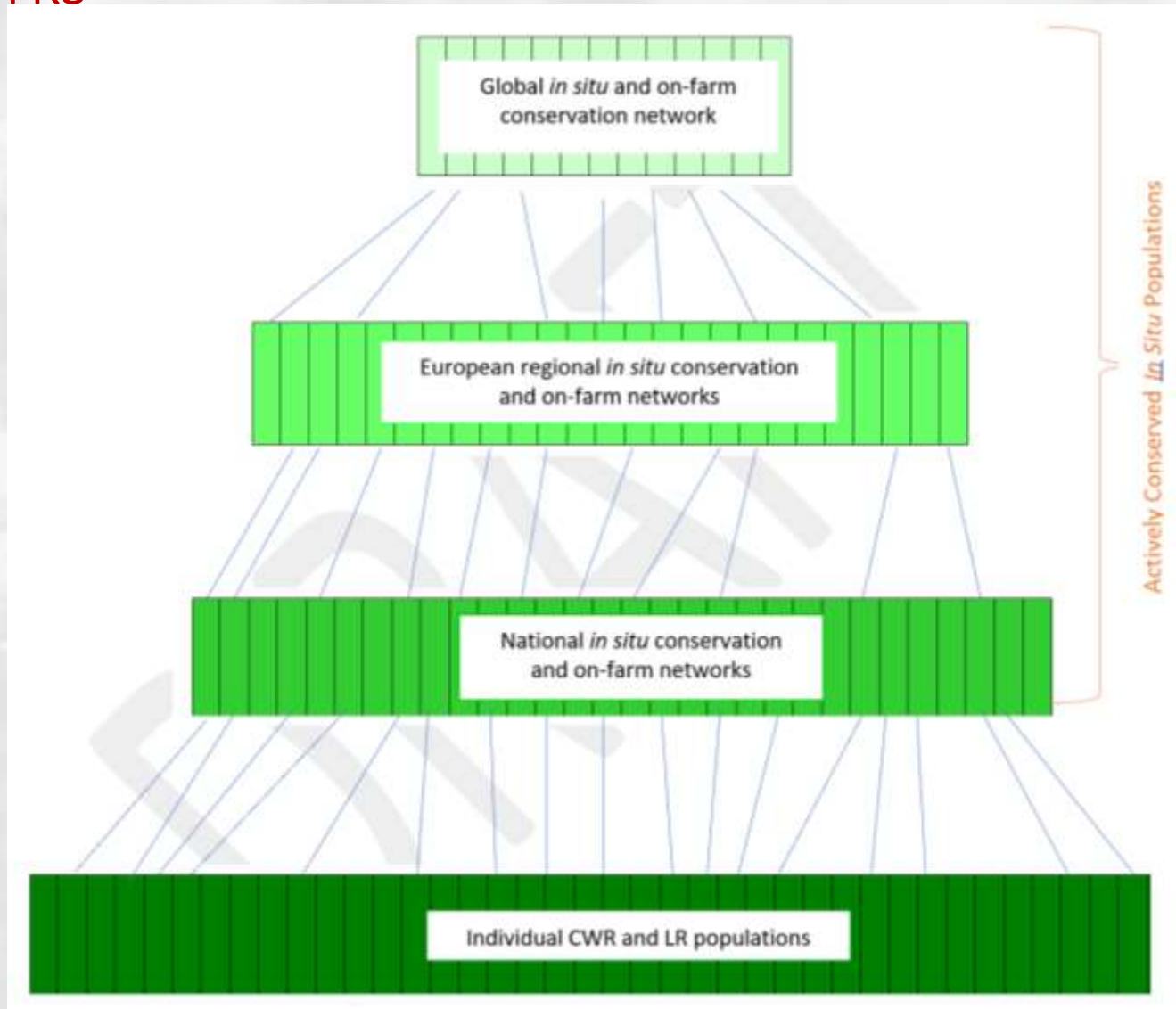
- Each species has a minimum of 5 sites
- Sites are selected to maximise genetic diversity conservation using ELC maps
- All sites are tested for relative climate change impact

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



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

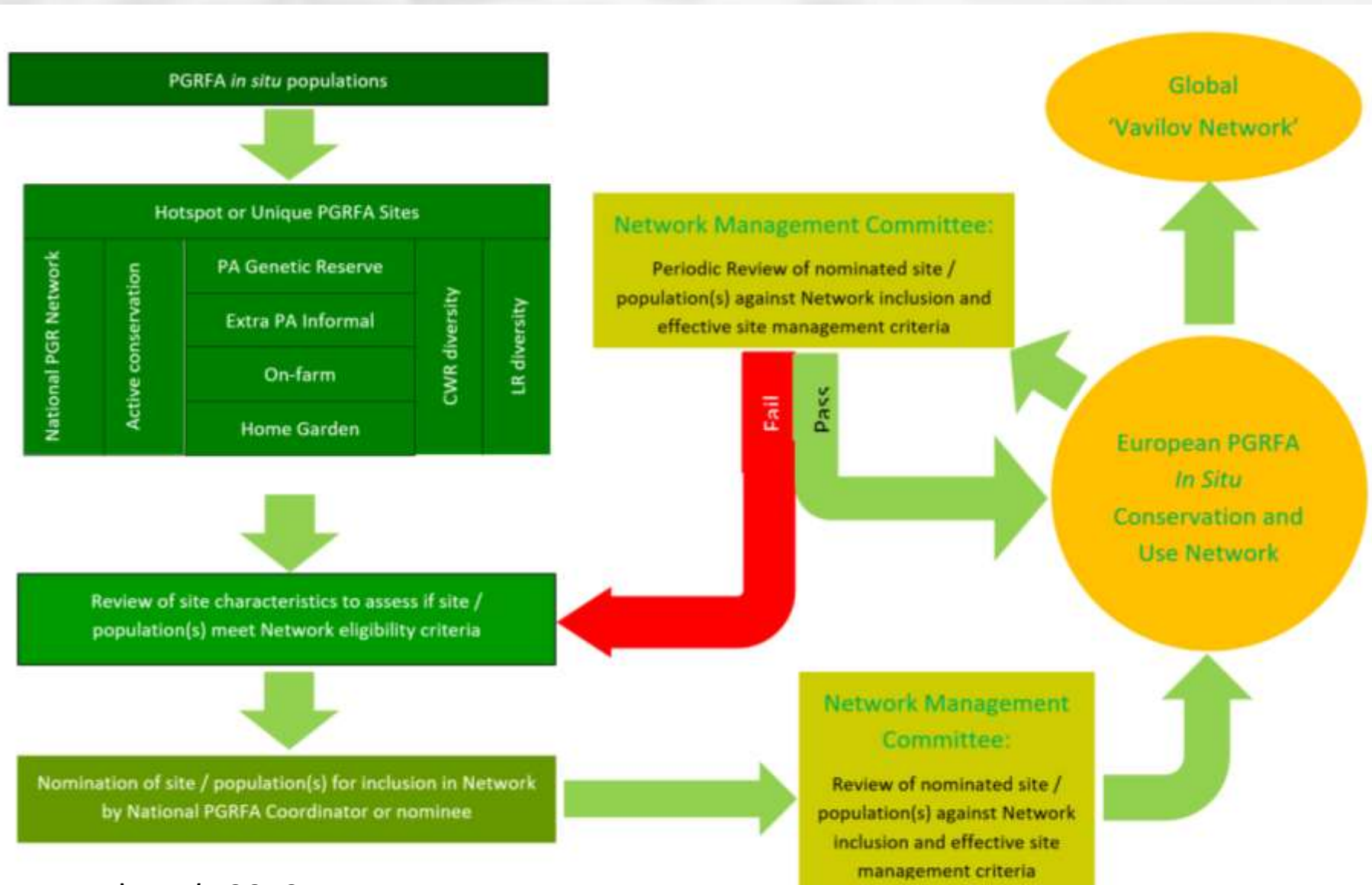
To be sustainable the Network must work, fulfil its functions:

- 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



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



**Conserving plant diversity
for future generations**

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Lion Seeds
Research Station
Maldon, Essex

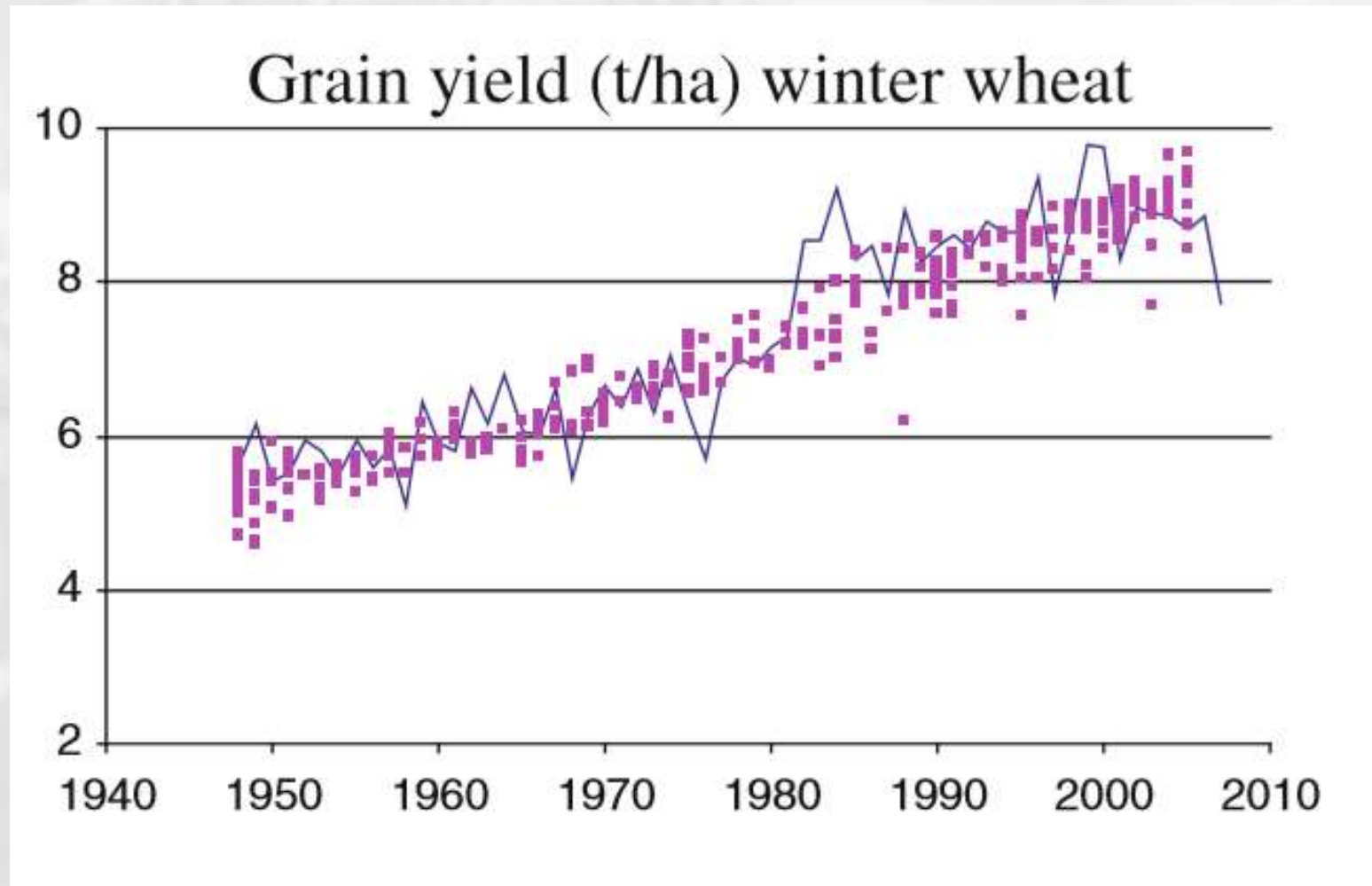


Reanalyses of the historical series of UK variety trials to quantify the contributions of genetic and environmental factors to trends and variability in yield over time

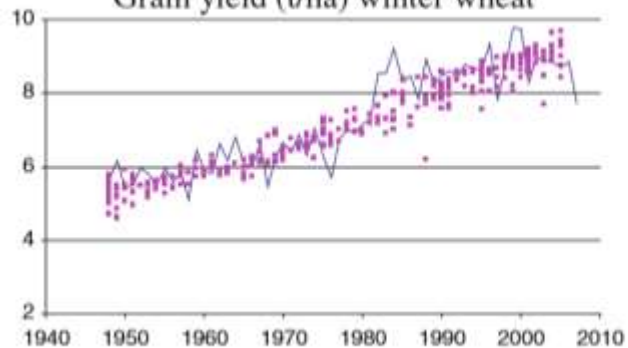
I. Mackay • A. Horwell • J. Garner • J. White • J. McKee • H. Philpott



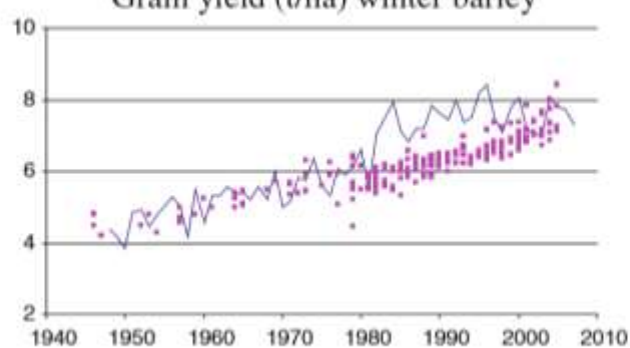
Theoretical and Applied Genetics 122(1): 225-238, September 2011



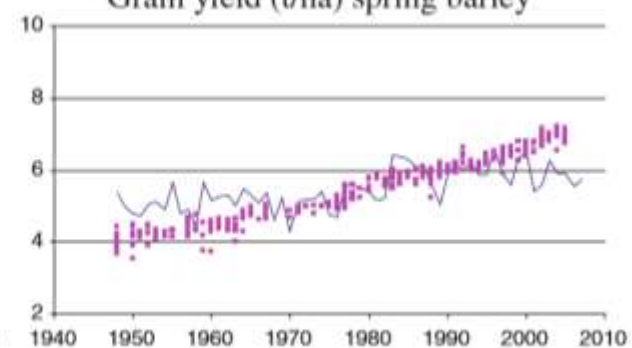
Grain yield (t/ha) winter wheat



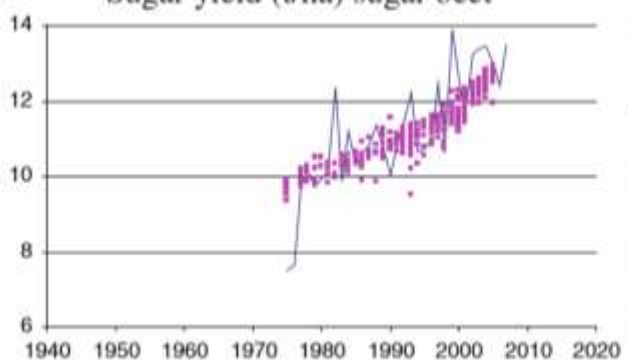
Grain yield (t/ha) winter barley



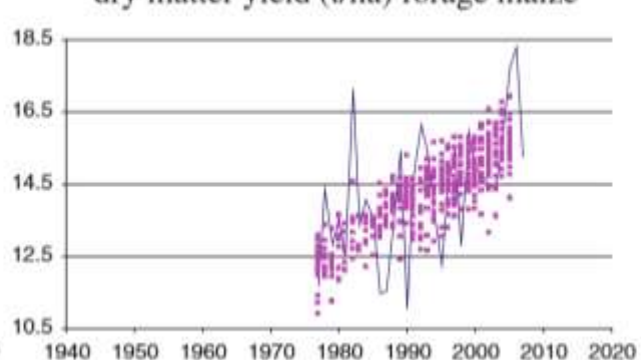
Grain yield (t/ha) spring barley



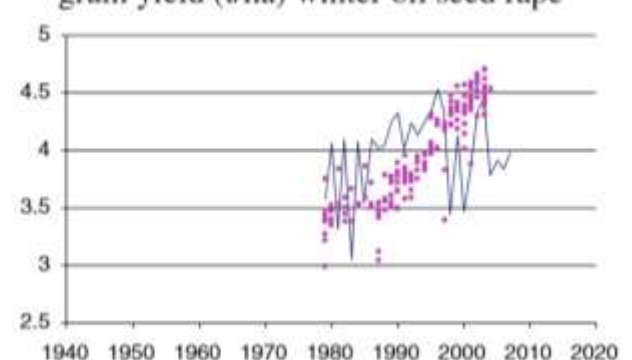
Sugar yield (t/ha) sugar beet



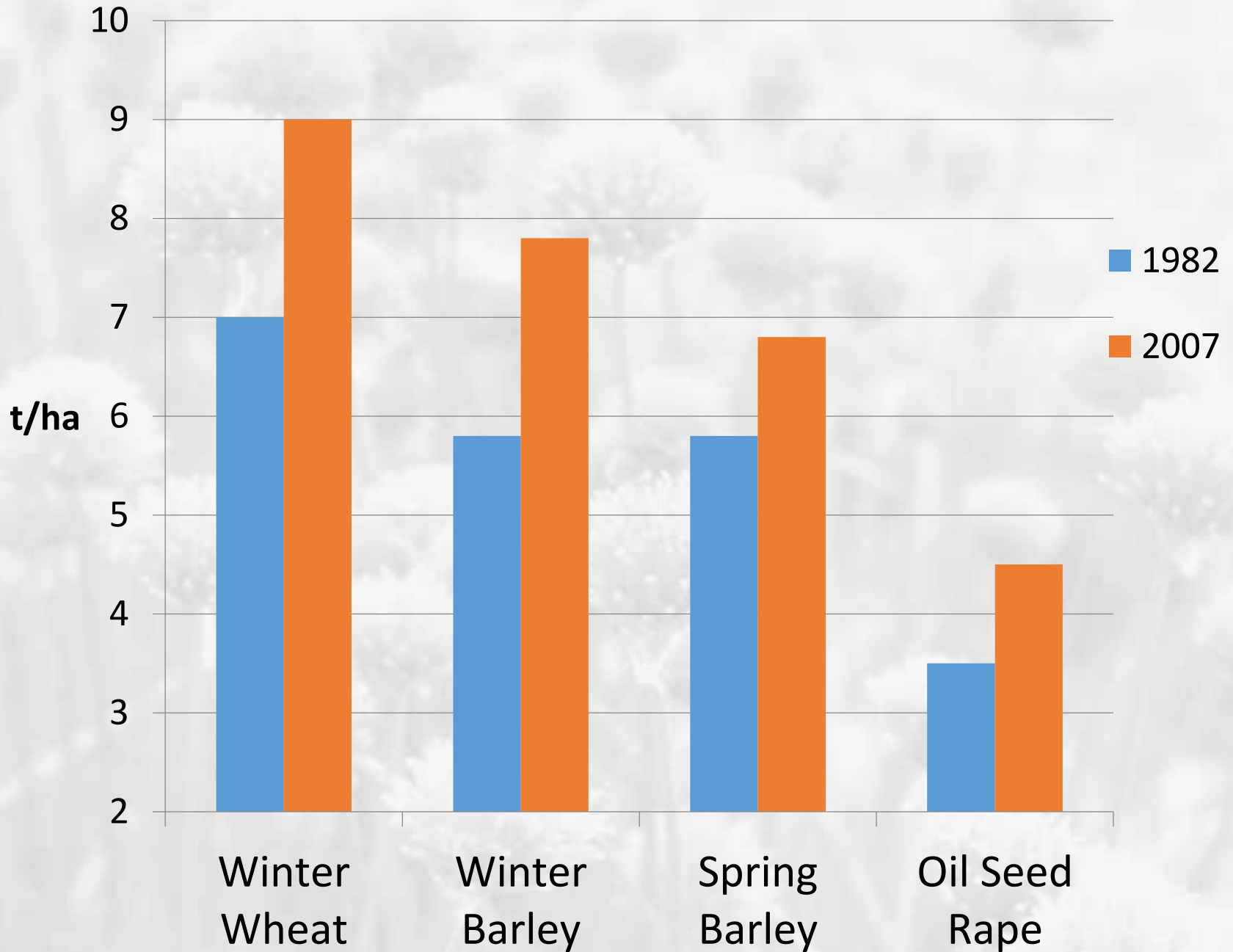
dry matter yield (t/ha) forage maize



grain yield (t/ha) winter oil seed rape



Average yield of varieties in trial



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