## PGR Management in the 21st Century Crop Wild Relatives:

#### climate change and niche modelling

Rob van Treuren 21 June 2017





Centre for Genetic Resources, The Netherlands (CGN)

- Terms & abbreviations
  - Crop wild relatives (CWR)
    - Wild ancestor of the domesticated plant,

or another closely related taxon

• Climate change (CC)



- Change in global or regional climate patterns from mid to late 20<sup>th</sup> century onwards attributed largely to increased levels of greenhouse gasses
- Species distribution modelling (SDM)
  - Process of using computer algorithms to predict the distribution of species on the basis of their known distribution



#### Background

- CWR are important to plant breeding and thus global food security
- CWR are mainly conserved in situ
  - CC threatens the continued existence of these CWR
  - Access to CWR is very limited in situ





## Example: resistances for tomato

Root-knot nematode from L. peruvianum

Verticillium from L. pimpinellifolium

ToMV from L. peruvianum

TYLCV from L. chilense

TSWV from L. peruvianum

Cladosporium from L. pimpinellifolium

Stemphilium from L. pimpinellifolium

Fusarium o.l. from *L. pimpinellifolium* 





# **Example: resistances for lettuce**

Bremia lactucae genes from L. sativa, L. serriola, L. saligna en L. virosa

LMV from L. sativa or L. serriola

BWYV from *L. sativa* 

Nasonovia from L. virosa

Root lice from L. sativa

Potato aphid from L. serriola

Corky root from L. serriola



## CGN collecting expeditions of CWR

- 2008 spinach: Tajikistan & Uzbekistan
- 2009 leek: Greece
- 2011 spinach: Armenia, Azerbaijan & Georgia
- 2012 asparagus: Armenia & Azerbaijan
- 2013 lettuce: Armenia & Azerbaijan
- 2015 carrot: Kirgizia & Uzbekistan







- CWR in the Netherlands now and in the future
  - What CWR exist in the Netherlands?
  - What is the current and future level of threat?
  - How can conservation be improved?



Inventory of CWR in the Netherlands

- Step 1: determine economically most important crops for agri- and horticulture in the Netherlands and in the world
  - Data from FAO, CBS/LEI, variety lists
  - Result: 207 crops
- Step 2: determine the CWR of these crops
  - Data from 'FLORON Verspreidingsatlas'
  - Species of same genus as crop
  - Crossability with crop species



Crop group	Common	Red list	Total
Cereals	18	5	23
Vegetables	34	17	51
Fruits	20	4	24
Oil crops	9		9
Herbs	5	4	9
Leguminous crops	15	7	22
Sugar crops	1		1
Others	59	16	75
Total	161	53	214



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Inventory of CWR in the Netherlands

- Step 3: collect detailed distribution data for Red List species
  - In collaboration with FLORON
  - Data from 2000-2015
  - Occurence per km square
  - Coverage National Ecological Network
  - Occurence in protected areas by
    - national organisations (SBB and NM)





Geen EHS

EHS

Atriplex laciniata (35) Carum verticillatum (2) Chenopodium bonus-henricus (7) Chenopodium chenopodioides (6) Chenopodium vulvaria (8) Medicago polymorpha (13) Erucastrum gallicum (245) Lathvrus japonicus (23) Lepidium graminifolium (39) Poa chaixii (7) Rubus saxatilis (1) Scorzonera humilis (22) Trifolium ornithopodioides (5) Valerianella rimosa (8) Allium carinatum (14) Lathyrus linifolius (17) Petroselinum segetum (12) Trifolium subterraneum (15) Valerianella dentata (13) Vicia tetrasperma subsp. gracilis (16) Apium repens (35) Fragaria moschata (8) Vaccinium uliginosum (27) Vicia tenuifolia (14) Asparagus officinalis subsp. prostratus (166) Lathyrus aphaca (26) Trifolium scabrum (44) Salsola tragus (60) Trifolium micranthum (37) Alopecurus bulbosus (29) Atriplex pedunculata (24) Carum carvi (140) Mentha pulegium (82) Avena fatua (371) Bromus secalinus (52) Valerianella carinata (48) Chenopodium murale (126) Trifolium striatum (117) Trifolium medium (128) Apium graveolens (304) Vicia lathyroides (562) Hordeum marinum (62) Mentha suaveolens (182) Lepidium campestre (177) Lathyrus palustris (280) Allium oleraceum (220) Pimpinella saxifraga (727) Apium inundatum (180) Bromus racemosus (187) Medicago falcata (580) Atriplex portulacoides (551) Fragaria vesca (1279) Linum catharticum (790) 350

#### Scorzonera humilis L.

Kleine schorseneer



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100 150 250 300 200

50

Change in average temperature (1986-2005 to 2081-2100)



Change in average precipitation (1986-2005 to 2081-2100)



Optimistic scenario (RCP2.6)

Pessimistic scenario (RCP8.5)



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- Species distribution modelling
  - Prediction of species distribution based on known distribution



- 	°C	<u>Temperature</u> variables		Max temperature of warmest month Min temperature of coldest month Mean temperature of wettest quarter Temperature seasonality	
من من	mm	<u>Precipitation</u> variables		Precipitation of driest month Precipitation seasonality Precipitation of wettest quarter	*5x5 km *Corr≤ 0.7
4 *		<u>Soil</u> variables	-   -	pH Organic carbon	



- Inventory of CWR in the Netherlands
  - Step 4: predict distribution of CWR under two CC scenarios
    - In collaboration with Naturalis
    - Initially Red List species
    - Using SDM with panel of 3 models
    - Predictions for 2070
    - Projected distribution in the Netherlands and Europe



- Inventory of CWR in the Netherlands
  - Step 4: predict distribution of CWR under two CC scenarios
    - Latitudinal shifts





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#### Inventory of CWR in the Netherlands

• Step 4: predict distribution of CWR under two CC scienarios



Valerianella rimosa Geoorde veldsla

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Unrestricted dispersal



-100

-75

-50

-25

25

0

50

75

100

No dispersal





Inventory of CWR in the Netherlands

- Step 5: prioritize for conservation
- Six factors with equal weights
  - Crop relationship
  - Trend in the Netherlands since 1950
  - Existence in large protected NL populations
  - Conservation status in neighbouring countries
  - Effect of CC in the Netherlands
  - Effect of CC in the European region



Species	Crop relationship	T rend in The Netherlands since 1950	Large protected Dutch populations	Conservation status in neighbouring regions	Effects of climate change in The Netherlands	Effects of climate change in the European region	Overall priority
Chenopodium bonus- henricus	3	5	5	3	5	5	4.3
Fragaria moschata	3	5	4	3	5	5	4.2
Atriplex pedunculata	1	5	3	4	5	5	3.8
Apium repens	1	5	4	5	4	3	3.7
Erucastrum gallicum	4	4	5	1	4	4	3.7
Poa chaixii	1	4	5	3	5	4	3.7
Asparagus officinalis subsp. prostratus	4	3	4	4	4	2	3.5
Carum carvi	1	5	3	3	4	4	3.3
Rubus saxatilis	1	5	5	1	5	3	3.3
Allium carinatum	1	1	4	5	4	4	3.2
Carum verticillatum	1	5	5	4	1	3	3.2
Medicago falcata	5	3	1	1	5	4	3.2
Scorzonera humilis	1	4	5	3	2	4	3.2
Apium graveolens	1	5	2	3	4	3	3.0
Atriplex laciniata	1	4	5	3	3	2	3.0
Chenopodium vulvaria	1	4	5	4	2	2	3.0
Lathyrus japonicus	1	1	5	3	5	3	3.0
Vaccinium uliginosum	1	3	4	2	5	3	3.0
Valerianella dentata	1	5	4	3	2	3	3.0
Valerianella rimosa	1	5	5	4	1	2	3.0
Avena fatua	5	3	3	1	2	3	2.8
Hordeum marinum	3	5	1	4	2	2	2.8
Lathyrus linifolius	1	5	4	2	2	3	2.8

Grote bo	saardbei
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**Brave Hendrik** 

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Inventory of CWR in the Netherlands

- Step 6: develop policy for protection
  - Objectives
    - Improve security CWR
    - Make material available for research and breeding
    - Raise (public) awareness
  - Establish contact with protecting agencies
    - Bilateral communication
    - Publications and presentations for communities



- Inventory of CWR in the Netherlands
  - Step 6: develop policy for protection
    - Development website: CWRnl
      - Results of the inventory
      - Information on CWR species
      - Links to protected areas
      - Effects CC





#### Crop Wild Relatives (CWRs) in Nederland

Cultuurgewassen produceren het grootste deel van ons dagelijks voedsel. Wilde plantensoorten die verwant zijn aan cultuurgewassen worden vaak aangeduid met de Engelse term 'crop wild relatives'. CWRs vorme een belangrijke born van nuttige eigenschappen, die door middel van kruisingen in cultuurgewassen kunnen worden ingebracht. Nieuwe eigenschappen in cultuurgewassen zijn noodzakelijk voor de voedselzekerheid wanneer door veranderde omstandigheden, bijvoorbeeld ten gevolge van klimaahverandering, de huidige voedselproductie in gevaar komt. Het is dan ook uitenst belangrijk dat CWRs behouden blijven. Door factoren als milieuvervuiling, verstedelijking en klimaatverandering is het voortbestaan van veel wilde plantensoorten echter onzeker. Voor de economisch meest belangrijkste landen tuinbouwgewassen worden op CWRnI de resultaten getoond van een inventarisatie van CWRs die in Nederland voorkomen.

#### • Publications

Van Treuren (2016) Wilde verwanten van voedselgewassen: het behouden waard! Planten 3: 4-5.

Aguirre-Gutiérrez J, van Treuren R, Hoekstra R, van Hintum TJL (2017) Crop wild relatives range shifts and conservation in Europe under climate change. Divers & Distrib 00: 1-12. <u>https://doi.org/10.1111/ddi.12573</u>

Van Treuren R, Hoekstra R, van Hintum TJL (submitted) ) Inventory and prioritization for the conservation of crop wild relatives in The Netherlands under climate change. Biological Conservation.



Inventory of CWR in the Netherlands

- Future activities
  - SDM for 161 non Red List CWR
  - Meta analysis all 214 CWR
  - Translation CWRnl in English
  - Strategic note on the conservation of CWR

in the Netherlands for policy makers

