Plant Genetic Resources
an introduction

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Plant Genetic Resources – an introduction

- lecture objectives
  - explain concepts in plant genetic resources (PGR) management
    - scope of PGR
    - origin of PGR & need to conserve it
    - current approaches in PGR management
    - the Dutch contribution

Plant Genetic Resources – an introduction

- scope: the concept of biodiversity
  - biodiversity viewed at different integration levels
    - within-species diversity (infraspecific diversity)
    - between-species diversity (interspecific diversity)
    - ecosystem diversity (from marine to desert)
  - also applicable to agro-biodiversity

Plant Genetic Resources – an introduction

- scope: the nature of agrobiodiversity
  - agro-biodiversity
    - all diversity related to agricultural production
  - various integration levels
    - within crop/animal diversity (including wild relatives)
    - between crop/animal diversity (farm level)
    - agro-ecosystems

Plant Genetic Resources – an introduction

- scope: the nature of agrobiodiversity
  - proximate and ultimate elements
    - direct production functions
      - crop and farm animal diversity
    - life-support functions
      - e.g. soil microbiome; pollinating insects and birds
    - no function - neutral species
      - adapted to agro-ecosystems but without production or life-support function
      - e.g. grassland birds

Plant Genetic Resources – an introduction

- scope: the nature of genetic resources
  - all genetic diversity of actual or potential use
    - agriculture
    - medicines
    - directly for food
  - different domains
    - plant genetic resources
    - animal genetic resources
    - forest genetic resources
    - aquatic genetic resources

adaptation to climate change
food and nutritional security

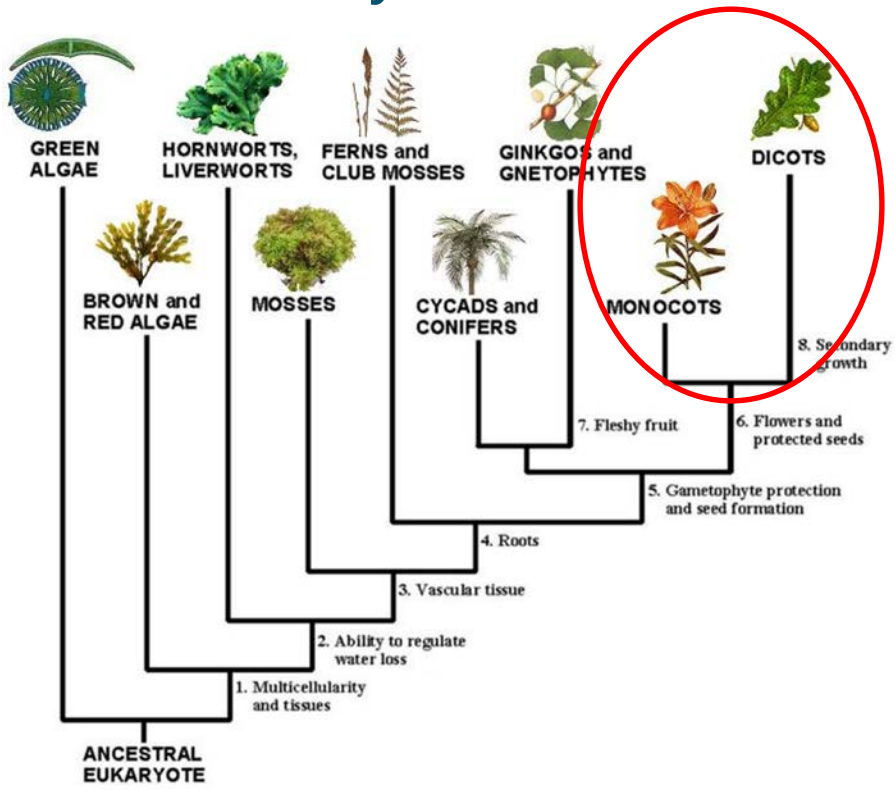
(Source: Luigi Guarino)

Plant Genetic Resources – an introduction

- let's start at the beginning
- timeline
  - big bang 13,700,000,000 year ago
  - earth 4,570,000,000 year ago
  - life 3,700,000,000 year ago
  - plants 425,000,000 year ago
  - TMRCA man/ape 7,000,000 year ago
  - agriculture 10,000 year ago
  - scientific plantbreeding 170 year ago
  - PGR management 60 year ago

Plant Genetic Resources – an introduction

- let's start at the beginning
- start of biodiversity: evolution



Plant Genetic Resources – an introduction

- origin of crop plant genetic diversity
  - farmers domesticating crops since c. 10,000 years
    - selection adapted phenotypes from wild populations
    - in ‘centers of origin’
    - result: landraces

Plant Genetic Resources – an introduction

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Plant Genetic Resources – an introduction

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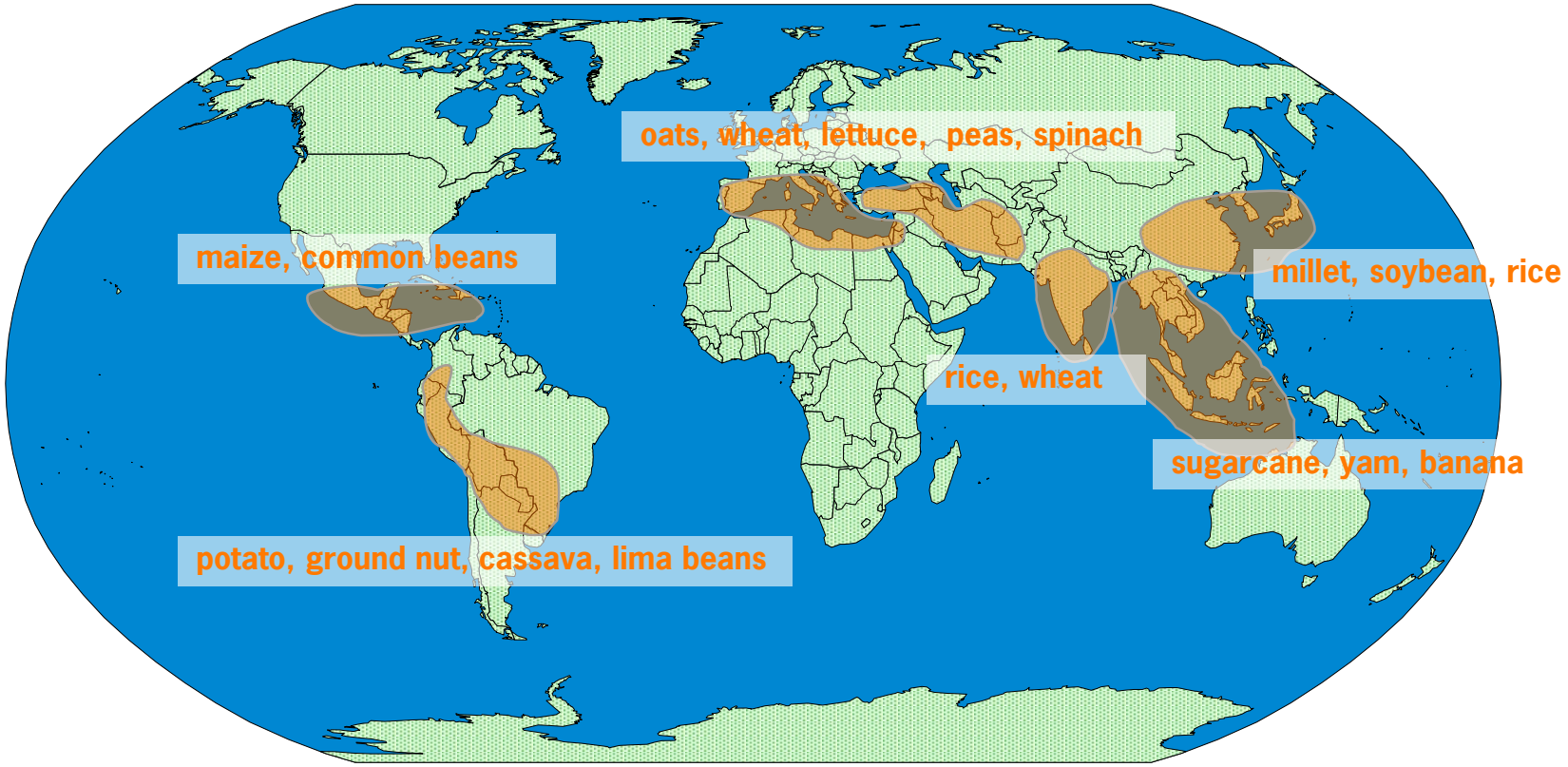
    - Vaviliov's centres of origin

Plant Genetic Resources – an introduction

- Vaviliov's centres of origin



Plant Genetic Resources – an introduction

- travelling crop genetic diversity
  - domesticates traveled with peoples
    - into newly populated areas
    - replacing original human population
  - domesticates were adopted in new regions
    - brought by traders
    - adapted by resident populations
  - domesticates were collected through dedicated missions

Plant Genetic Resources – an introduction

- result: mutual interdependence
  - cassava, maize, groundnut, beans
    - domesticated in Americas, staple crops in SSA
  - sorghum and millets
    - domesticated in SSA, major crops in South Asia and Latin America
  - Brazil
    - half of food calories from rice, wheat

      maize (all from elsewhere)

Plant Genetic Resources – an introduction

- origin of crop plant genetic diversity
  - since c. 1850 crop genetic diversity disappears due to monocultures and habitat destruction
    - scientific plant breeding based on Mendel and de Vries
    - urbanization, desertification, climate change
    - result: genetic erosion

Plant Genetic Resources – an introduction

- PGR needs to be conserved
  - genetic erosion: from many crops to few staple crops
    - improved varieties yield better
    - underutilized and marginalised crops poorly researched
    - commercial varieties promoted by government policies

Plant Genetic Resources – an introduction

- PGR needs to be conserved
  - genetic erosion: replacement of local varieties by bred cultivars
    - anecdotal evidence
      - home gardens of Korea: 26% remained between 1985/1993
      - wheat in China: 10,000 varieties in 1949, 1000 varieties in 1970's
      - maize in Mexico: 20% of local varieties in 1930 remain
      - USA crops: 86% of apple varieties lost, 95% of cabbage, 91% of maize, 81% of tomato

Plant Genetic Resources – an introduction

- PGR needs to be conserved
  - historical developments: genetic vulnerability
    - examples of vulnerability
      - late blight pandemic in potato: 1.5 million casualties in Ireland in 1840s
      - new maize leaf blight destroyed >15% of US maize crop in 1970
      - shoot fly and Karnal blunt severe epidemics in wheat in India in 1970s
      - banana and black sigatoka

Plant Genetic Resources – an introduction

- PGR needs to be conserved
  - the importance of genetic diversity is increasing dramatically
    - increased farmers and consumers demands
    - global population growth
    - climate change

Plant Genetic Resources – an introduction

- PGR needs to be conserved
  - historical developments: the cry for conservation
    - 1950s: breeders issued warnings
    - 1968 - 1972: FAO technical conferences
    - 1970 - now: conservation an issue
      - Sustainable Development Goal 2.5

Plant Genetic Resources – an introduction

- PGR needs to be conserved
  - *ex situ* – in genebanks
  - *in situ* – in nature reserves
  - *on-farm* – in 'traditional' farming systems

Plant Genetic Resources – an introduction

- PGR management activities in Europe
  - *ex situ*
    - ca. 1.4 million accessions in 400 public holdings
      - in principle available
    - documentation centralised in EURISCO
    - quality of management varies
  - on-farm (landraces)
    - very many NGO's with various sizes and backgrounds
      - representing local farmers and hobby growers
    - generally poor management and restricted access
    - strong public awareness activities
  - *in situ* (crop wild relatives)
    - based on national legislation and nature protection
    - hardly accessible

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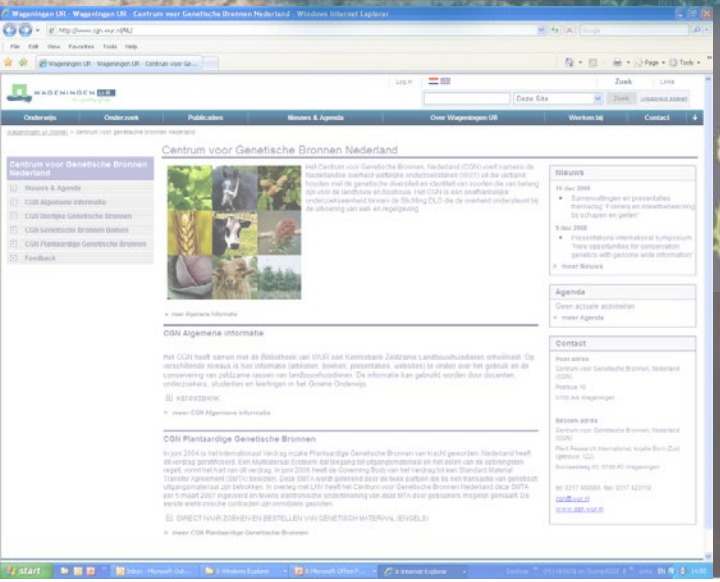

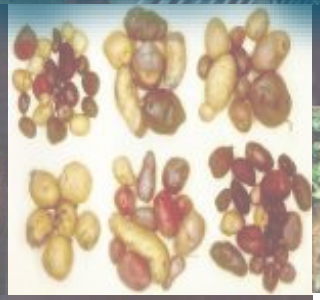

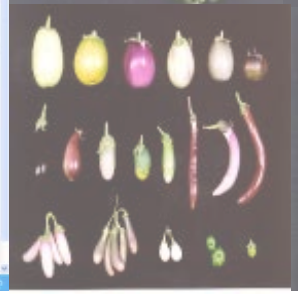

WAGENINGEN UR
For quality of life

Plant Genetic Resources – an introduction

- CGN-PGR activities
  - genebank with seed collections
    - focus on vegetables
    - user orientation & quality management
  - support on–farm and *in situ* activities in NL
  - policy development and advice
    - National Focal Point on Access and Benefit Sharing
  - methodological research
    - seed storage behaviour
    - species niche modelling
    - interface genomics – genebank management

Plant Genetic Resources – an introduction

- CGN-PGR collections
  - 25 crop collections with 22,828 accessions
    - originating from more than 100 countries
    - focus on vegetable crops and potato
    - focus on small numbers of high quality

Plant Genetic Resources – an introduction

- CGN-PGR collections
  - 25 crop collections with 22,828 accessions

CGN collections (March 6th, 2017)

lettuce	2401	wheat	4909
potato	1468	barley	2666
tomato	1330	flax	952
onion	428	pea	1010
spinach	468		
pepper	1032	*other crops*	3444
cucumber	926		
cabbage etc.	1791	*TOTAL*	22828

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- CGN-PGR seed management
  - conditions
    - T= -20°C
    - w= 6-8%
  - germination is being monitored
    - cvs & landraces: > 80%
    - wild species: > 60%

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- CGN-PGR seed management
  - all material is
    - duplicated in collegue genebank
    - triplicated in Svalbard ‘Global Seed Vault’

Plant Genetic Resources – an introduction

- CGN-PGR documentation
  - the value of PGR is a function of the available information
  - all information is available on-line
    - on-line search and order functionallity
    - www.wur.nl/cgn

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- one more thing
  - access and exchange
    - from the concept of heritage of mankind (FAO International Undertaking) to the concept of national sovereignty (CBD)
    - from free exchange to heavily regulated exchange
    - genetic resources as a source of national income
      - the myth of the ‘green gold’

Plant Genetic Resources – an introduction

- one more thing
  - complicating factors
    - intellectual property rights limit access to improved germplasm
      - in particular patent rights
    - sovereign rights limit access to farmers' varieties and wild relatives
      - Convention on Biological Diversity (1992)
      - Global Plan of Action on PGRFA (1996)
      - International Treaty on PGRFA (2001)
      - Nagoya Protocol on Access and Benefit Sharing (2010)

Plant Genetic Resources – an introduction

- further reading
  - Five Continents, Vavilov
    - travel reports collecting missions
  - Crops and Man, J. Harlan
    - domestication
  - Guns, Germs and Steel, J. Diamond
    - human societies as a result of food production
  - FAO State of the World on PGRFA, FAO
    - detailed information on global PGR

Thank you for your attention