Rethinking Genebank Management –
some critical thoughts and new approaches

January 21st, 2021 – GROW webinar

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Centre for Genetic Resources, The Netherlands (CGN)

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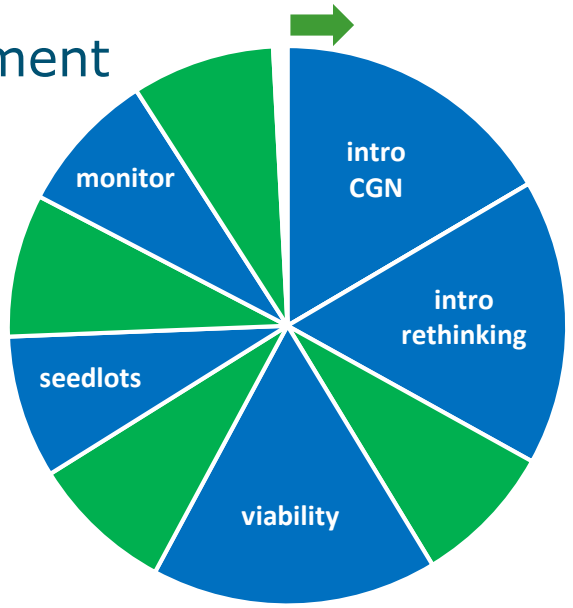
Rethinking Genebank Management

- overview webinar
  - short introduction CGN (10 min)
    - video
  - introduction rethinking genebank management (10 min)
  - viability monitoring (10 min)
  - principle seed lot management (5 min)
  - demo genebank monitor (5 min)



  - remaining 20 minutes used for discussion between the topics

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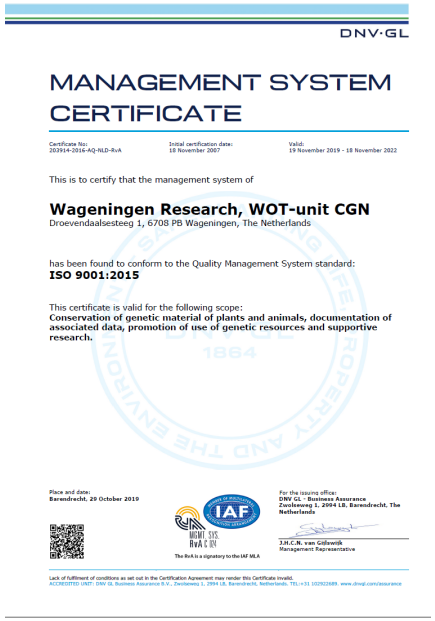
Short Introduction CGN

Short Introduction CGN

- Centre for Genetic Resources, The Netherlands (CGN)
  - Dutch GRC for plants, animals and forest
    - this workshop is about plant genetic resources (PGR)
      - 2021 budget CGN-PGR is ± € 2 mln, 10.5 fte
        66% funded by governmental genebank program
  - CGN-PGR manages *ex situ* genebank
    - 23437 accessions
      - focus on vegetables
    - active collaboration with users
      - plant breeding industry
      - research community
    - ISO 9001 quality management system
      - since 2004



DNV·GL

MANAGEMENT SYSTEM CERTIFICATE

Certificate No: 203914-2016-AQ-NLD-RvA
Initial certification date: 18 November 2007
Valid: 19 November 2019 - 18 November 2022

This is to certify that the management system of

Wageningen Research, WOT-unit CGN
Droevendaalsesteeg 1, 6708 PB Wageningen, The Netherlands

has been found to conform to the Quality Management System standard:
ISO 9001:2015

This certificate is valid for the following scope:
Conservation of genetic material of plants and animals, documentation of associated data, promotion of use of genetic resources and supportive research.

Place and date:
Barendrecht, 29 October 2019

For the issuing office:
DNV GL - Business Assurance
Zwolseweg 1, 2994 LB, Barendrecht, The Netherlands

J.H.C.N. van Gilswijk
Management Representative

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Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.
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Short Introduction CGN

- Centre for Genetic Resources, The Netherlands (CGN)
  - CGN-PGR is involved in other PGR related activities
    - support NL on-farm actors
    - promotion CWR conservation to nature conservation
    - policy development
      - ITPGRFA
      - ABS & DSI debate
    - international collaboration
      - ECPGR
      - Crop Trust

Short Introduction CGN

- Centre for Genetic Resources, The Netherlands (CGN)
  - as good as its staff

Noor Bas
Curator / Communicatie

Dione Bouchaut
Curator

Martin Brink
Beleidsmedewerker

Willem van Dooijeweert
Curator

Liesbeth de Groot
Curator / Zaadbeheer

Jarinka Heijink
Beleidsmedewerker / communicatie

Theo van Hintum
Afdelingshoofd / Onderzoeker

Roel Hoekstra
Curator / Documentatie

Chris Kik
Hoofdcurator / Verzamelaar

Rik Lievers
Curator

Frank Menting
Documentatie / Communicatie

Rob van Treuren
Curator / Onderzoeker

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Short Introduction CGN

https://youtu.be/PGlpiMkhBGY

The Issues

Rethinking Genebank Management

- introduction
  - genebanks arose organically
    - working collections for research and breeding grew
    - logistics became complicated due to size and use
    - legal and phytosanitary issues arose
  - genebank management has become a complicated discipline

how would we set up a genebank from scratch?
- objective: conserve PGR and make it available
- funding is always the major limiting factor

Rethinking Genebank Management

- genebank issues that could be re-thought
  - composition of the collection
    - what diversity to sample?
    - duplicate or complement other collections?
    - focus on cultivated or on CWR, and within these groups?
    - how much to invest to obtain material?
  - composition of the accessions
    - single lines or populations
      - splitting for self pollinators?
    - bulked accessions
      - bulking for cross pollinators?

Genetic Resources and Crop Evolution **43:** 343–349, 1996.

Reduction of duplication in a *Brassica oleracea* germplasm collection

Th.J.L. van Hintum, I.W. Boukema & D.L. Visser
Centre for Plant Breeding and Reproduction Research (CPRO-DLO), Centre for Genetic Resources The Netherlands, P.O. Box 16, 6700 AA Wageningen, The Netherlands

Received 7 March 1995; accepted in revised form 6 September 1995

Key words: duplication, bulking, *Brassica oleracea*, Brussels sprouts, white cabbage, genetic resources, isozymes

Summary

To reduce the number of accessions in the *Brassica oleracea* collection of the Centre for Genetic Resources The Netherlands (CGN) groups of accessions were bulked. Accessions in a group were selections from the same landrace or old variety, and were chosen, with the help of crop experts, on the basis of their history and morphology.

Rethinking Genebank Management

- genebank issues that could be re-thought
  - conservation method
    - clones or seeds or pollen or DNA
      - e.g. apple or potato
    - technical set-up
      - what temperature for seed storage?
      - small freezers or freezer rooms?

  - regeneration method
    - large numbers of accessions or high genetic integrity?
      - investment needed to maintain genetic integrity (during regeneration) can not be spend on increasing the collection size
  - viability monitoring
    - large numbers of accessions or high security?

Rethinking Genebank Management

- genebank issues that could be re-thought
  - availability
    - how can (/should?) use be promoted?
    - what user groups should be targeted?
    - what conditions for access are applied?
    - what service level is targeted?
      - access to information / core selectors / bio-informatics interfaces
      - user consultancy
      - phytosanitary and import permits, non-GMO statements
  - quality management
    - invest in quality management?
    - what system and to what level of detail?

Rethinking Genebank Management

- genebank issues that could be re-thought
  - automation
    - image recognition
    - material storage
  - monitoring regeneration
    - high-throughput techniques
  - integration bioinformatics
    - optimisation collection composition
    - selection material for use
  - integration *in situ* actors
    - become a true genetic resources centre

Rethinking Genebank Management

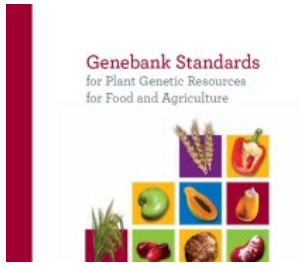
- messages
  - genebank management decisions are arbitrary
    - funding is limiting factor
    - pro's and con's of decisions should be clear
      - sometimes more research is needed
    - community consensus is difficult
      - optimal decision depends on purposes of genebank
      - genebank standards support collaboration

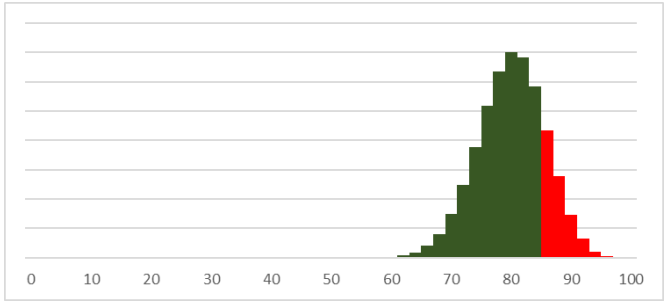
  - whatever decisions taken – they need to be implemented correctly
    - quality management is the tool

Viability Monitoring

Viability Monitoring

- to assure the quality of the seeds viability needs to be monitored
  - FAO (2014) standards have been defined
    - initial value > 85 %
    - threshold for regeneration = 85%
      - or lower depending on the species or specific accessions of initial viability
    - Nseeds = ?
      - "dependent upon the size of the accession but should be maximized to achieve statistical certainty; however, the sample size should be minimized to avoid wasting seed"





sampling effects:
if true germination = 80%, N_{seeds} = 50, then 19.0% of the tests will result in values over 85%

Viability Monitoring

- previous CGN viability monitoring protocol
  - germination tested by ISTA certified labs
    - following ISTA protocols but 200 instead of 400 seed
  - reliability appeared very low
    - based on 5-10% blind doubles
    - too many wrong decisions were made
      - to regenerate – shortened generation span and unnecessary costs
      - not to regenerate – risk of loosing the accession
- other genebanks appear to all do it in their own ways
  - based on a small inventory

    van Dooijeweert, W., Menting, F. (2018) Procedures for Germination in Genetic Resources Conservation. CGN Internal Report. 33p. (available on request)

Viability Monitoring

source: Hintum & Treuren (2012) PGRCU 10:134

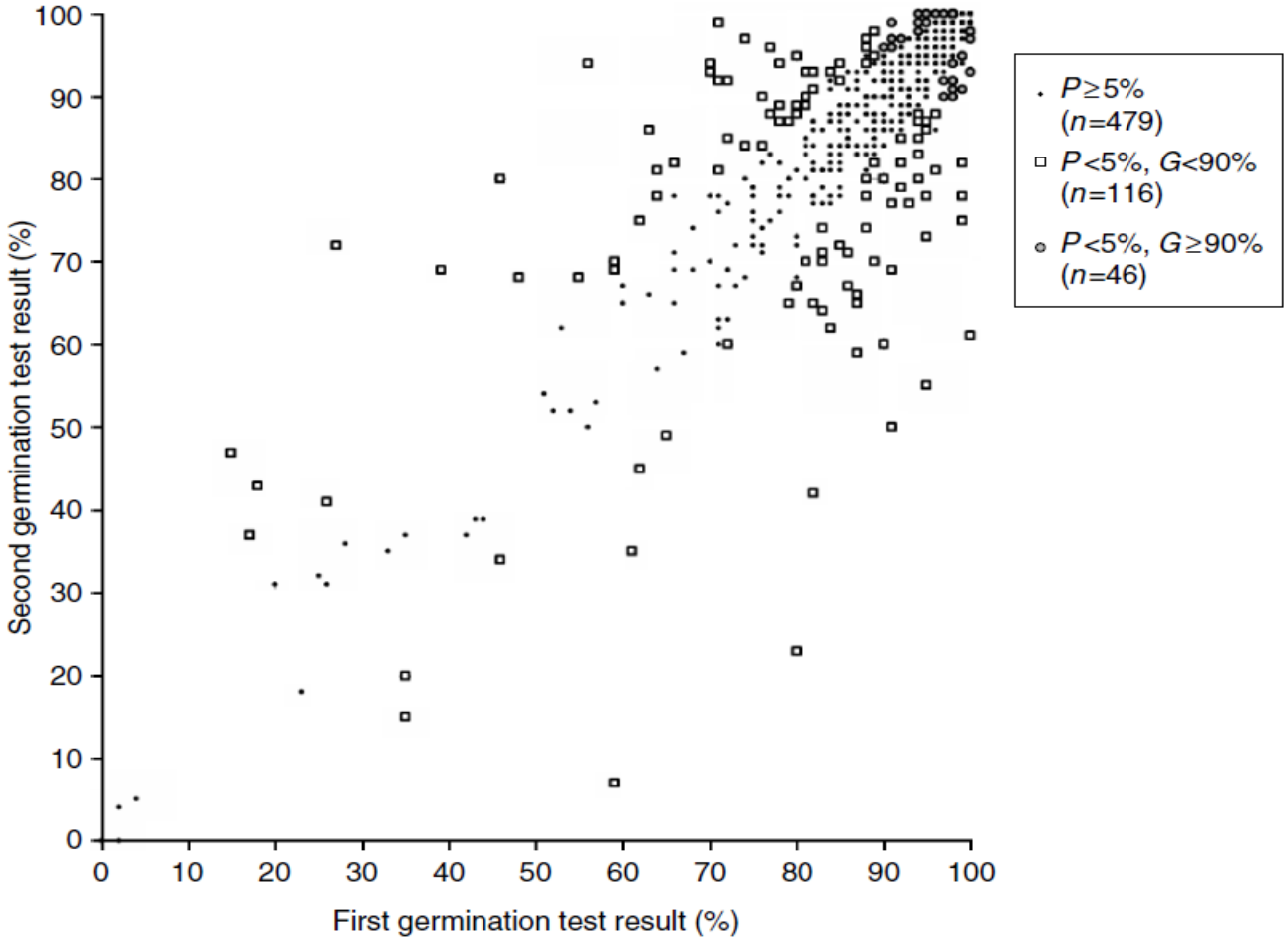


Fig. 1. Germination control tests of 641 seed lots. *P* indicates the probability of the results by chance alone, while *n* represents the number of included pairs. For data points with $P < 5\%$, a distinction is made for germination values (*G*) lesser than 90% and values $\geq 90\%$.

Viability Monitoring

- grey zone between germinating and not germinating
  - lettuce

  - melon

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Viability Monitoring

- new viability monitoring protocol
  - still apply same viability thresholds
    - complying to FAO genebank standards
  - wait 25 years after tested successful regeneration
    - based on Treuren et al (2013)
  - determine quality of seeds the way you think best
    - use following scale
      1. very good, no worry, wait another 10 years (20 for small cereals)
      2. good enough, but pay closer attention, test within few years
      3. dubious, regenerate within few years
      4. bad, regenerate as soon as possible
  - further development of protocol is possible
    - blind doubles are being tested to determine repeatability
    - fate of 'bad seedlings' needs to be determined

Seed Lot Management

Seed Lot Management

- many genebanks maintain various seed-lots per accession
  - necessary complexity ?

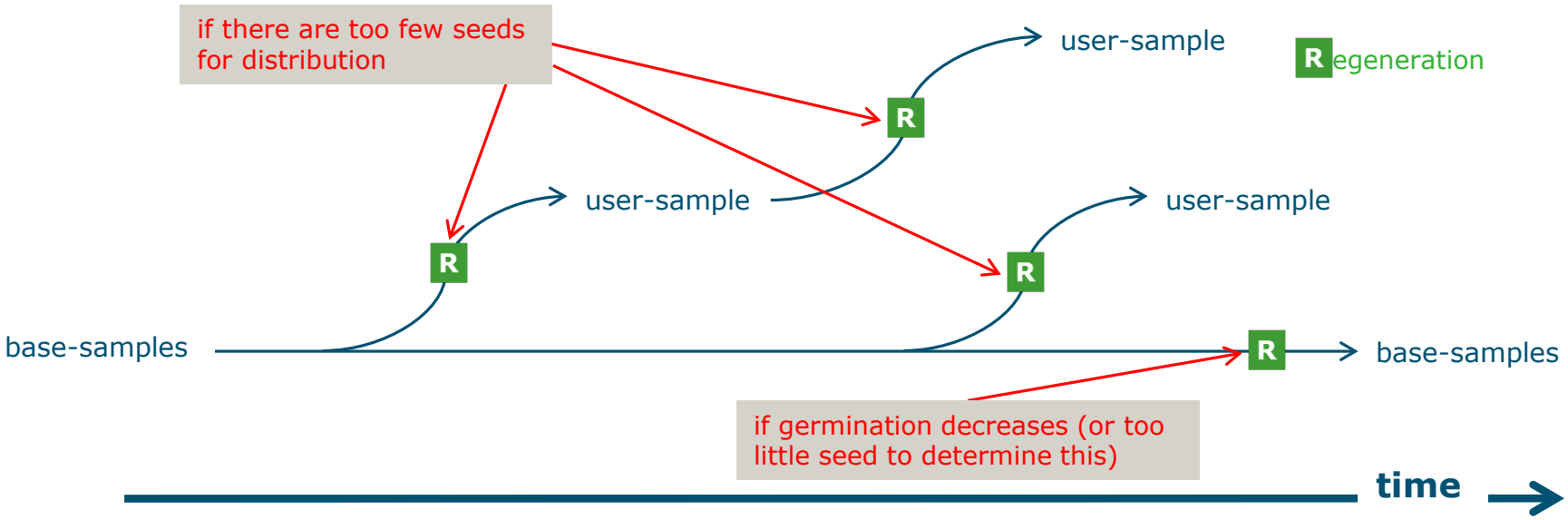
- seed-lots serve two conflicting purposes
  - prolong generation span of material
    - every regeneration (rejuvenation) threatens genetic integrity
      - human error, genetic drift ($N_e < \infty$), natural selection, etc.
  - always have seed available for distribution
    - seed stocks run out and need regeneration (multiplication)

Seed Lot Management

- CGN uses two types of seed-lots
  - base-seed-lots and user-seed-lots
  - every accession has a base-seed-lot
    - consisting of user-, regeneration-, germination- and rest-samples
      - viability is monitored
      - regenerated when viability drops or base-seed (for viability testing) runs out
  - some frequently used accessions have user-seed-lot
    - consisting of only user-samples
      - initial viability testing
      - no viability monitoring
      - not used for creating new base seed lots

Seed Lot Management

- CGN uses two types of seed-lots
  - base-seed-lots and user-seed-lots



Demo Genebank Monitor

Demo Genebank Monitor

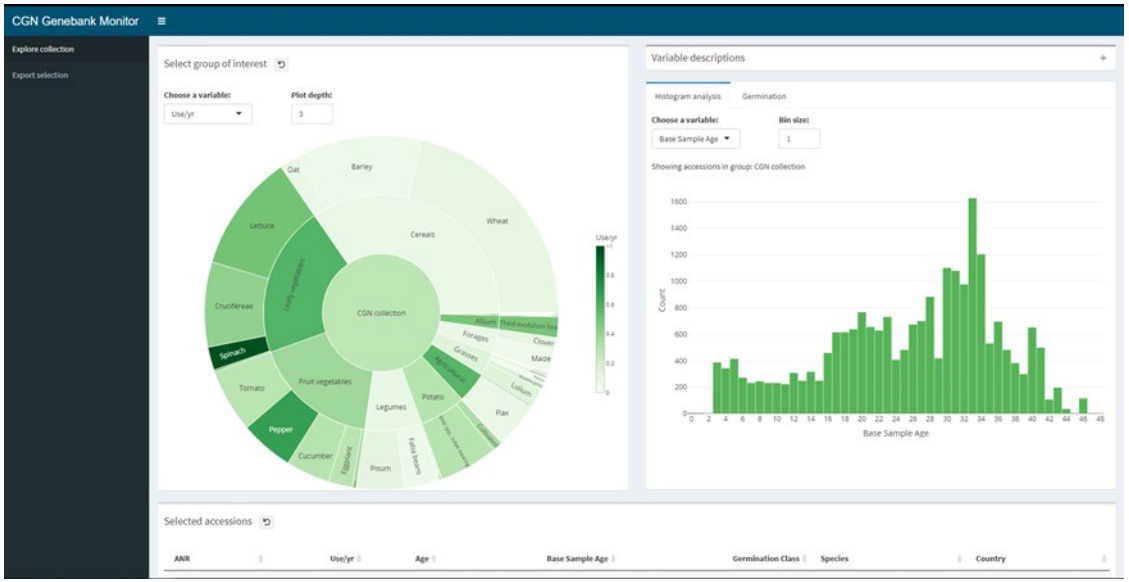
- genebank managers / curators need overview of their collection to make management decisions
  - composition
  - use
  - traits
  - seed age

- databases are often far from accessible
  - standard reports are not sufficient
  - more complex questions are difficult to answer

Demo Genebank Monitor

- genebank monitor is based on
  - diversity tree of the collection
  - basic accession-based statistics

- prototype



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Demo Genebank Monitor

- prototype genebank monitor
  - available at https://cgn-monitor.shinyapps.io/monitor/
  - intended to convey idea of genebank management tool
    - software (R-package Shiny) possibly not the best
    - presented data very limited

we need concepts, knowledge, platforms and tools to professionalize genebank management

Thank you for your attention !

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