Optimizing collections: efficiency

How can we make sure available capacity is optimally used?

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Optimizing collections: efficiency

Efficiency

- the extent to which time, effort or cost is well used for the intended task(s) or purpose(s)
  - reducing the unneeded expenditures of resources

Intended task of a genebank

- conserve diversity
  - long term conservation
- make diversity accessible
  - short–medium term utilisation

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Inefficient organizations generally disappear

- competitors take over
  - there is no competition in the genebank world
- funding agencies stop funding
  - genetic resources have to be conserved thus stopping funding is no option

Genebanks do not disappear despite inefficiency

- many genebanks are very ineffective and inefficient
  - CGIAR genebanks perform relatively well
- 'genebank standards' do not aim at efficiency

Optimizing collections: efficiency

Improving efficiency - three approaches

- reduce number of collections
  - coordination between organizations
- optimize number of accessions
  - find and eliminate redundancy and deficiency within and between collections
- reduce costs of operations
  - less operations by better planning
  - lower price per operation

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Reduce the number of collections by coordinating over institutions

- one needs to be able to rely on the quality of the other's operation
  - conservation, availability, continuity
  - construction with back-ups to guarantee availability
- often good option for smaller 'additional' collections
  - e.g. barley from CIMMYT to ICARDA?

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Reduce the number of collections by coordinating over institutions

- wheat: currently 170488 accessions in 69 collections in EURISCO of which 30 with <100 accessions
  - complete waste of capacity
- in 80-90's the IBPGR concept of crop mandates failed
  - National autonomy
- very few examples of bilateral exchange of collections
  - Dutch-German beet and potato collections

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Optimise the number of accessions by finding and eliminating redundancy and deficiencies within and between collections

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Optimise the number of accessions by finding and eliminating redundancy and deficiencies within and between collections

- definition of duplicate – not trivial
  - genetic identical samples only possible for homogeneous and homozygous accessions
- tracing and validating duplicates can be more expensive than maintaining them

Ref: van Treuren R, Magda A, Hoekstra R, van Hintum TJL (2004) Genetic and economic aspects of marker-assisted reduction of redundancy from a wild potato germplasm collection. *Genetic Resources and Crop Evolution 51*:277-290

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Optimise the number of accessions by finding and eliminating redundancy and deficiencies within and between collections

- global duplication in and between collections of most CGIAR crops is enormous (prob. >50%)
- what is duplication / redundancy ?
  - CGN study white cabbage (2007): genetic differences over regenerations are larger than those between accessions
    Ref: van Hintum TJL, van de Wiel CMM, Visser DL, van Treuren R, Vosman B (2007) The distribution of genetic diversity in a *Brassica oleracea* gene bank collection related to the effects on diversity of regeneration, as measured with AFLPs. *Theoretical and Applied Genetics 114*:777-786
- tracing duplication is difficult
  - GPG2 exercise (activity 3.3) showed the complexity of identifying duplication on the basis of passport data

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From an old CGN study

Ref: van Hintum TJL, Menting FBJ (2000) Barley genetic resources conservation - now and forever. Barley Genetics VIII - 8th International Barley Genetics Symposium:13-20

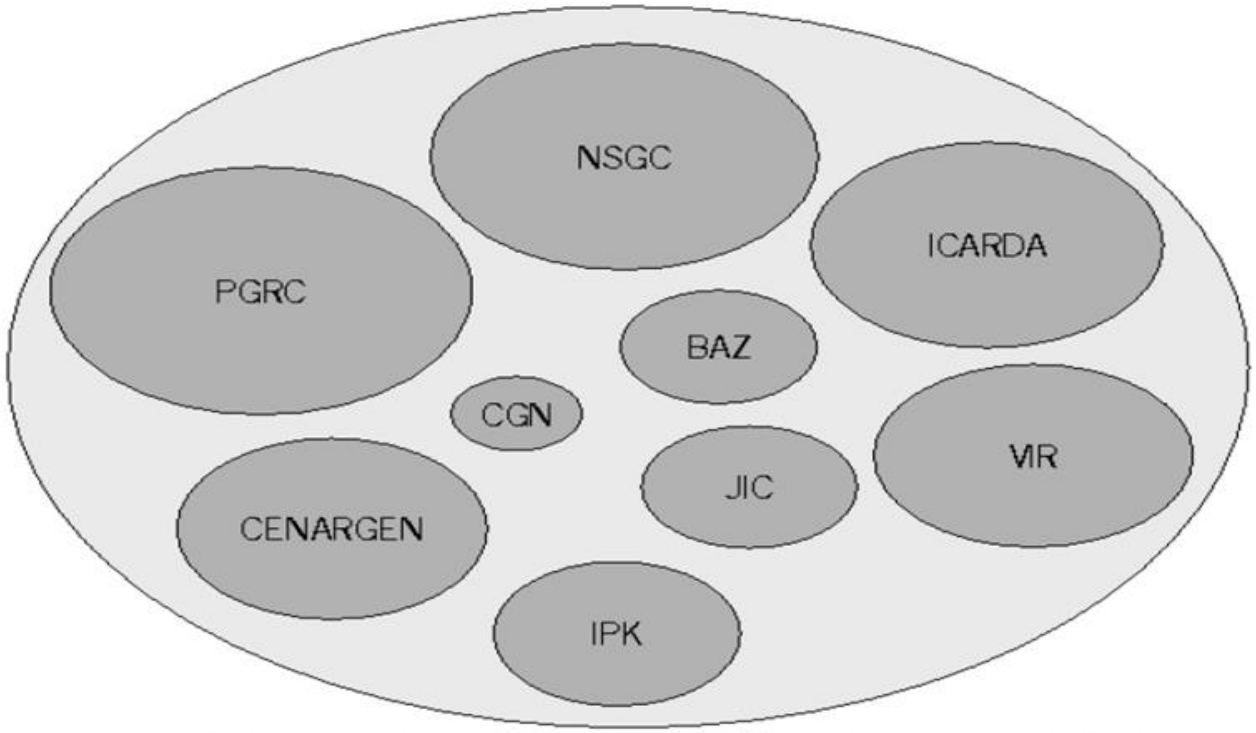

Figure 1. Graphical representation of the cultivated barley collections included in the study. Sizes of ellipses are proportional to the number of accessions, the large ellipse in the back represents the world barley holding.

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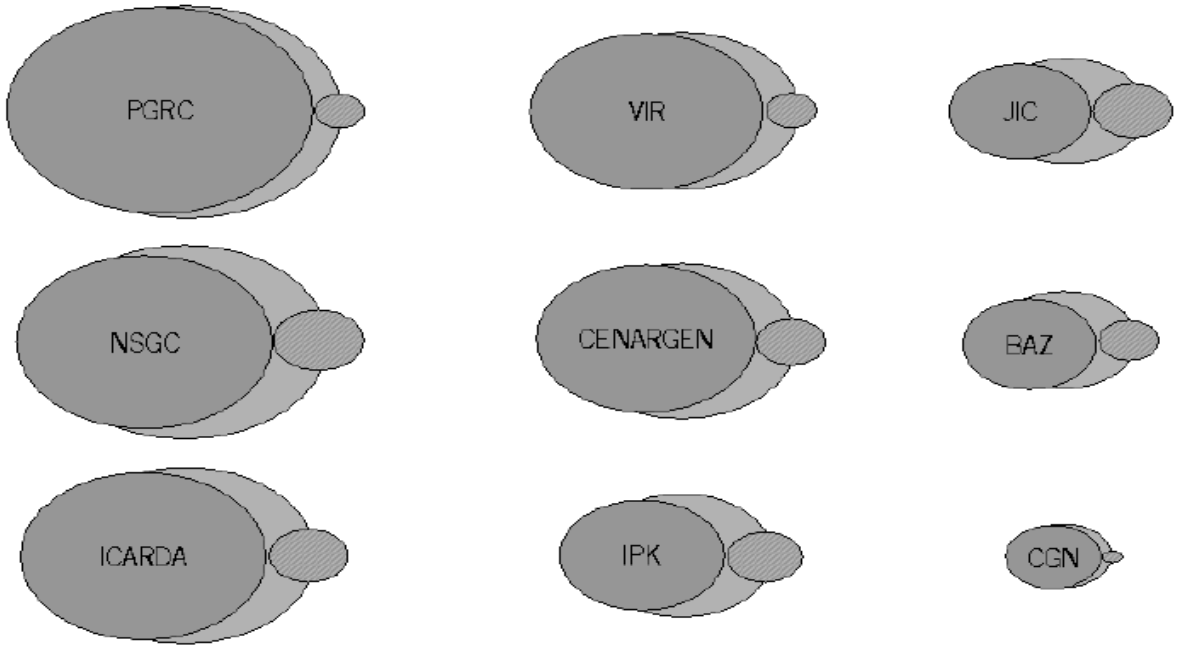

Figure 2. Graphical representation of internal redundancy in the cultivated barley collections included in the study. Ellipses in the back represent the size of the complete collections, the ones in the front give the distinct and the redundant (hatched) accessions respectively.

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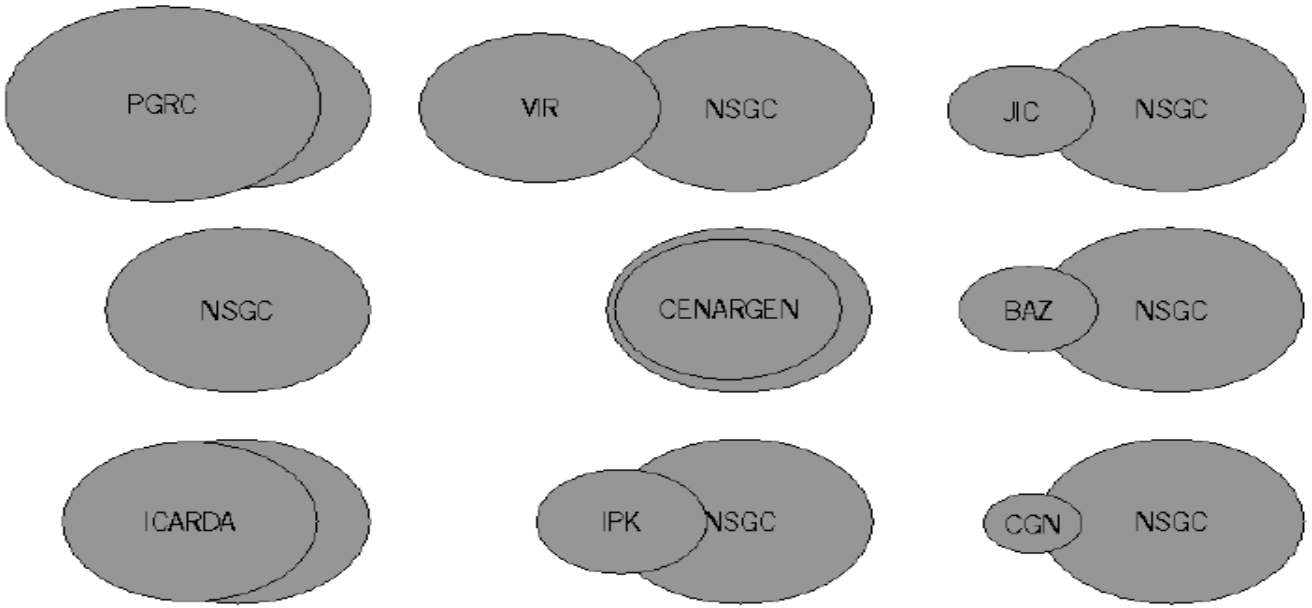

Figure 3. Graphical representation of the estimated overlap of the cultivated barley collections included in the study with the NSGC (after removal of internal redundancy).

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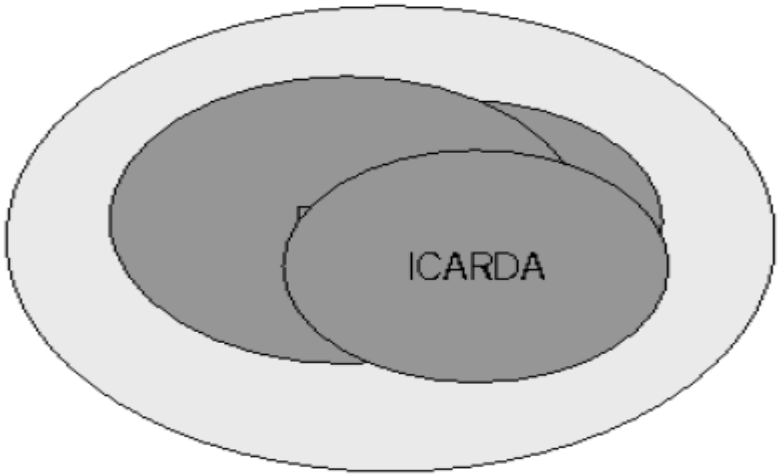

Figure 4. Graphical representation of the estimated overlap of the NSGC (back), PGRC (middle) and ICARDA (front) cultivated barley collections, after removal of internal redundancy. The large ellipse represents the size of the combined complete collections.

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Optimise the number of accessions by finding and eliminating redundancy and deficiencies within and between collections

- tracing and validating duplication can be expensive
  - CGN study on wild potato (2004): even in an expensive potato collection, tracing duplicates with AFLP markers is not economically feasible; validating is !
    Ref: van Treuren R, Magda A, Hoekstra R, van Hintum TJL (2004) Genetic and economic aspects of marker-assisted reduction of redundancy from a wild potato germplasm collection. Genetic Resources and Crop Evolution 51:277-290
  - in a clonal collection is will always be economically feasible
- eliminating redundancy between collections involves similar criteria as reducing the number of collections

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Optimise the number of accessions by finding and eliminating redundancy and deficiencies within and between collections

Ref: van Treuren R, Engels JMM, Hoekstra R, van Hintum TJL (2009) Optimization of the composition of crop collections for *ex situ* conservation. *Plant Genetic Resources: Characterisation and Utilisation 7*:185-193

- redundancy = extent to which a collection contains over-representation as compared to the 'optimal composition' given the capacity of the collection
  - redundancy: too many accessions from Ecuador
  - deficiency: too few from Guatemala

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Optimal composition

- procedure to define optimal collection
  1. define population structure of gene pool in terms of hierarchy, describing subsets (‘groups’)
     - e.g. ‘genepool: cultivated and wild’
  2. distribute the total number of accessions that a collection ideally may contain (‘capacity’)
     - e.g. ‘two third cultivated and one third wild’
  3. optimize the diversity within the groups
     - concentrate of ‘end-groups’
     - e.g. ‘select the three most diverse *L. viminea* from western Armenia’

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Optimal composition

- example from analysis of wild potato in European collections

	CGN collection			EU collection		
Series	Actual	Optimal	Surplus	Actual	Optimal	Surplus
Yungasensa	185	153	32	296	330	−34
Megistacroloba	198	77	121	229	165	64
Cuneolata	73	15	58	73	33	40
Conicibaccata	44	107	−63	64	231	−167
Tuberosa[a]	845	613	232	1125	1322	−197
Acaulia[b]	403	215	188	641	463	178
Longipedicellata	42	215	−173	202	463	−261
Demissa[c]	13	123	−110	54	264	−210
Total	1803	1518	285	2684	3271	−587

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Reduce costs of operations

- less operations by better planning
  - reduce number of regenerations
    - size of stored and distributed samples
    - guiding requests
    - assuring requests are serious
  - reduce number of required germination tests
    - group representation
    - postpone first ‘check-test’
- lower price per operation
  - outsourcing, while guaranteeing quality

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Meanwhile in Europe

- AEGIS: A European Genebank Integrated System

  - an attempt to create a 'virtual' genebank in Europe
    - currently: 43 associate member institutions from 18 countries
    - quality management system AQUAS in preparation
    - compilation European Collection on-going

Optimizing collections: efficiency

Incentives for increasing efficiency

- limited funds for an important objective
  - high efficiency = little waste = maximal outputs
  - public money = moral duty
- funding agency requires it
  - enforcement problem
- decreasing funding
  - less money – where can savings be made?

Disincentives for increasing efficiency

- higher efficiency ⟶ lower budget