Oat Genetic Resources in Finland

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Oat is one of the main cereal crop in Finland

Second biggest crop after barley

- In year 2015: 306 500 hectares, yield 980 million kg
- In year 2016: 332 000 hectares

Known for high quality including high protein content, high hectoliter weight, thin cover, purity, pale color

- Early, healthy, reliable yield

Use:

- Feed in the farm (33%)
- Feed industry (18%)
- Food industry (7%)
- Seeds (6%)
- Export (32%)
- Energy (4%)

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Landraces

- Until the early 1900-century, oat cultivation was based on landraces
  - majority assumed to be black-covered in Finland.
- Landraces disappeared rapidly from active cultivation, when scientific cultivar breeding started.

Landraces in cultivation in Finland (%)

Year	1902	1921	1930	1955
Winter wheat	100	100	~60-70	0,7
Spring wheat	100	94,3	~5	0,1
Barley	100	69,8	~25	1,0
Oats	100	33,8	~5-10	0,2
Winter rye	100	100	~70-80	18,0

Table by M. Heinonen, Luke

International concern about loosing genetic diversity of the crop plants, and domestic animals woke as late as 1960's.

Early cultivar breeding

- The first cultivars were mainly selections made from the Nordic and Northern-European early cultivars.
- Swedish cultivars, especially Kultasade (Gold Rain, Guldregn) released in 1903 and Kultasade II in1928 were cultivated in large areas in Finland.
- Landraces collected around Finland in 1920's and were widely used as crossing parents in cultivar breeding.
  - For example: cv. Kytö (released in 1925), was a cross between Finnish landrace (Ta 091) and cv. Kultasade,
    - landrace contributed earliness and better yield production in the Norther conditions (Ulvinen, 2004).
  - Especially two Finnish landrace can be identified, which have largely affected to the background of the Finnish oat cultivars (Saastamoinen, 2000).
- Important crossing material was obtained also from the Northern parts of America, and East, like cv. Pendek from Siperian origin.

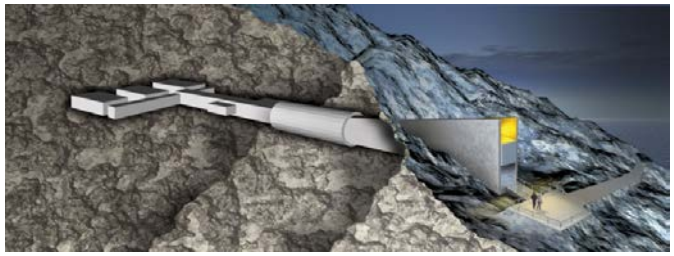
Today

- Today, 46 oat cultivars have been accepted to the Finnish national list of plant varieties, two of them naked type.
- Majority of them are cultivars of the Finnish company Boreal Plant Breeding Ltd. In addition, also cultivars bred in Sweden, Norway and Germany are in the list.
- In addition, black-hulled oat Heljä is accepted as conservation variety

Finnish seed material in NordGen

- NordGen – the Nordic Genetic Resource Center – conserve seeds of the cultivated plants for food and agriculture for all Nordic countries.
  - Active collection locates in Alnarp, Sweden
  - In total 30 000 unique seed accession

- NordGen collection includes 142 oat accessions of Finnish origin.
- In total, 1017 *Avena* acc, of which some CWR's (*A. sterilis, strigosa, fatua, nuda, byzantina, barbata, brevis, abyssinica*)
  - Set of oat samples was recently repatriated from the Vavilov Research Institute, showing the great importance of co-operation between the gene banks.
- Safety duplicated in the Svalbard Global Seed Vault.



Oat has potential for greater significance in feed and especially in the food sector.

- Different type of food products have been developed and their healthy effects and functional properties are promoted.
  - Yogurt, milk, ice cream, biscuits and snacks, bread, mysli and oatmeal, and newest pulled oat, which is kind of vegetarian meat by Gold&Green Foods.
- Targeted breeding for special aims could potentially increase oat use and productizing.

  - Like breeding it even more suitable coeliac patients (pure oat products)

    o variation shown in the protein faction patterns of individuals of old landraces (Ahokas & Manninen 2000, Gen.Res. Crop Evol.)

  – Other health promoting factors

    o landrace varying in fatty acid ratio (V:16/C:18) and residual grain protein pattern (Ahokas & Manninen, 2000, Gen. Res. Crop Evol.)

Oat gene pool is narrow

- Nordic oat gene pool is shown to be narrow (He & Bjørnstad, 2012). Where to get genetic variation for breeding?

- There is still work to be done to evaluate the characteristics of the existing Avena sativa cultivars, landraces and preserved breeding lines.
- In addition, large gene pool of other *Avena* species is available. Several of them are easily crossed with cultivated oat, like *A. sterilis* known to been used as a source of disease tolerances.

Wild *Avena* relatives have potential

- Axel Diederichsen yesturday noted, that important PGR's have been found from all ploidy levels.

- Igor Loskutov referred Al tolerant *A. sterilis* acc., and interesting variation in biochemical content, fatty acid composition and fusarium resistance measured in wild *Avena* species.

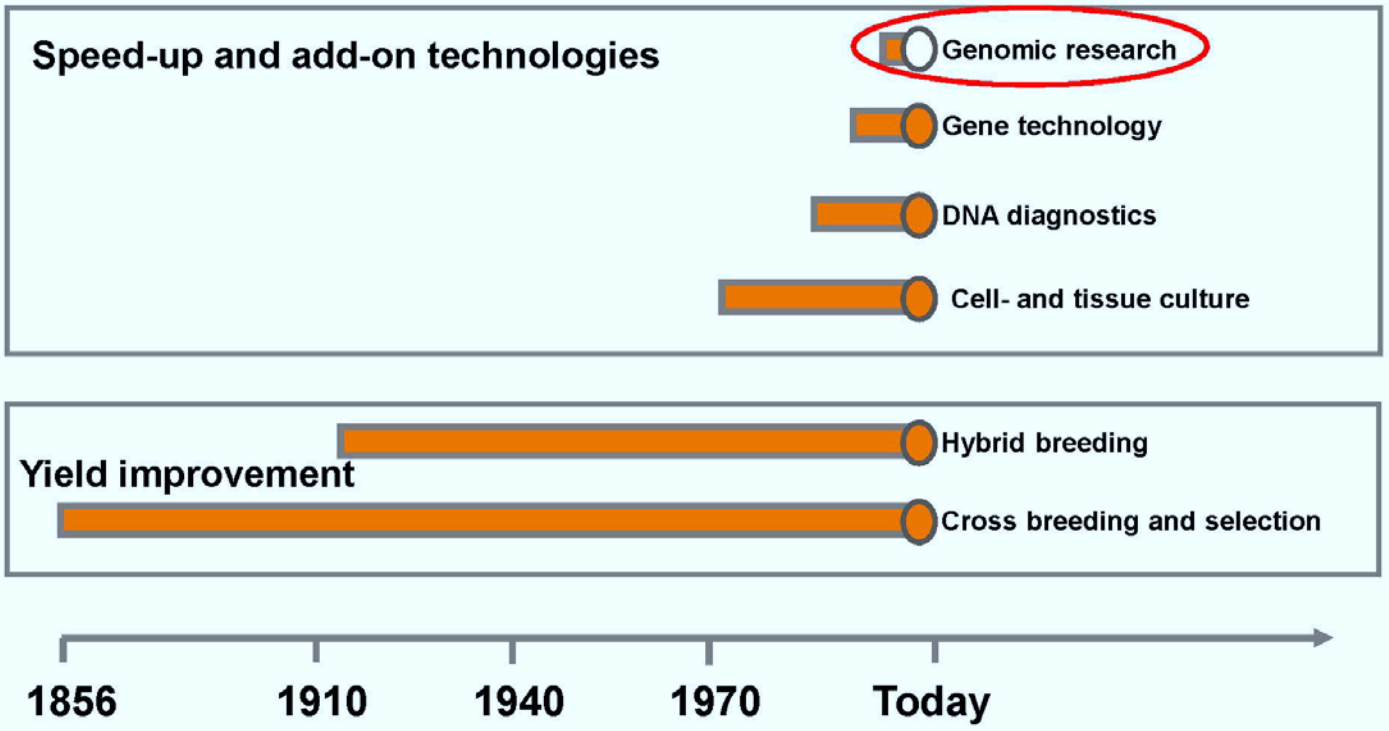
- Diploid *A. strigosa* for cultivation (2009 new cultivar released in Germany) and it's use as cover oat in Brasil (Marcelo Pachero).

- Also Polish group (Sylwia Okon et al) raported potential sources for resistance of fungal diseases powdery mildew and crown rust in *A. sterilis* genotypes.

Wild *Avena* relatives have potential

- Hannu Ahokas has reported (2000) introgressive fertile hexaploid oat plant
  - from the *Avena abyssinica* (AABB) x *A. sativa* (AACCDD) cross.
  - Stable hexaploid line obtained from colchicine-produced decaploid hybrid after several generations of selection
  - Differencies measured at least in the grain protein fractions and lipids comparing to the either or both parents. Early maturing.

Innovations in plant breeding



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Utilization of PGR by assisted pre-breeding

Although genome of hexaploid oat is big (11 300 000 000 bp)

- Improved genomic tools are providing possibilities for
    - mining and identifying valuable alleles and
    - detect them in the crossing/backcrossing progeny individuals
        - by using marker assisted selection of single selected alleles or via genome wide observation.

- With these tools, time-consuming and laborous pre-breeding programmes could be enhanced.
- Moreover: homozygous DH-lines are produced from *A. sterilis* by anther culture
    - fixes the genotype
    - simplifies genetic analyses.
    - succesful at least in genotypes CAV 2648, CAV 1191, CAV 2941, CW 533, 16.

Refs: Kiviharju & al. 1998. Agric Food Sci Finld, 7:409-422..

Kiviharju et al. 1999, Plant Cell Rep, 18:582-588.

Cultivar breeders are looking for practical tools

- Breeders are looking for clear practical benefits for cultivar breeding, and that should be the aim for PGR conservation, evaluation and research in the long run as well.
- This is achieved by
  - increasing knowledge and understanding of the genetics and inheritance of the important breeding traits,
  - joint evaluation efforts and
  - continuing development of genomics tools to be more efficient and cheaper to use
  - and development of the breeding methods

Continuous research is essential, to ensure constant improvement in cultivar breeding programmes and to get all available genetic potential in use.

Thank you!

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