Priorities, Objectives and methods of oat breeding in China

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1. Oat breeding history in China
2. Oat genetic resources in China
3. Breeding objectives of breeding objectives
4. Oat breeding methods
5. Oat varieties released in China
6. Use of biotechnologies in oat breeding

- China initiated breeding activities in the 1960s
  - organizing the regional yield trail of naked oats in the northern area, particularly at Zhangjiakou in Hebei, and Wumeng in Inner Mongolia
  - Through such tests, Huabei l and Huabei 2 were selected and released into production. These varieties such as Sanfensan increased the yield of oats by 10-30% compared with local varieties

- In the mid 1960s, naked varieties were bred by the Yanbei Prefectual Agricultural Research Institute in Shanxi
  - Yanhonghao series by inter-varietal cross
  - Subsequently, hybridization became the main breeding method for new naked oat varieties

- From the 1970s, inter-specific crosses between *Avena sativa* and *Avena nuda* were carried out
  - New strains of naked oats were selected with shorter and thicker stems and greater lodging resistance than older varieties
  - The improved varieties had a yield potential of over 4,500 kg/ha under rich soil and adequate water conditions.

- For example
  - Yong 492, with a short plant stature and strong resistance to lodging, had an increased yield of 10-20% compared with Huabei 2. It was a variety suitable to growing in irrigated areas
  - Other later interspecific cross derivatives included Jingyan 2, Neiyan 4, Neiyan 5, Jinza 2, Wuyan 2, “578" and Jian 19.
  - The yields of these varieties were over 10% higher than those of the main local varieties.

- By 1980, inter-specific crosses between *Avena sativa* and *Avena nuda* made up 70-80% of total crosses.
  - Many varieties with good agronomic characters were developed; such as Tiegandali (7634-10-1), Variety 766-38-2-1, Neiyou 1 and Neiyou 2

- With the development of oat markets, many breeders focused on good quality varieties with high protein content and large grain in order to meet the needs for oat-flake processing.
  - A tetraploid oat germplasm, *A. magna*, from Morocco, with 32.4% protein content, 36.1g 1000-seed weight used in oat improvement
  - A number of naked oats varieties with 1000-grain weights of more than 30 g, such as Mengyan 7306

- At the same time, varieties with green stems at the maturity were developed for use as forage.
- In recent years, increased β-glucan content in grain has been a focus in oat breeding and a number of varieties such as Bayou 1 and Baiyan 2 were released by the Zhangjiakou PARI, and the Baicheng AAS, respectively

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- Since the 1950s, China has been making an effort to collect oat germplasm throughout the country. Up to now, more than 4,000 accessions of oats have been collected and conserved
  - 2,100 accessions of naked oats
  - 1,900 accessions of hulled oats
  - 70 accessions of wild oat species
- More than 60% of accessions are local varieties collected from farms

- The collection was characterized for major agronomic traits
  - Plant
  - Panicle
  - Seed

- Variations in germplasm
  - Short growing periods (generally 60-75 days),
  - Plant heights of 50-175 cm
  - Plant habits ranging from erect and semi-prostrate to prostrate
  - Very different panicle types and fertilities
  - 1000-grain weights ranging from 11-40 g
  - Protein contents ranged from 11.9-20.5%, and
  - β-glucan contents were from 2.5-7.5%

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- Major concerns in defining breeding objectives for oat in China
  - Different uses, both grain and fodder
  - in the different agro-ecological zones
  - major biotic and abiotic stresses
  - production conditions
  - growing in cool and high altitude mountain regions with a mixed system cropping and animal husbandry

- High yield
  - 10% higher
  - a good combination of yield components
    - spikes per unit
    - kernels per spike
    - 1000-grain weights

- High quality
  - high protein content (more than 17%)
  - β-glucan content, became a priority in order to meet the requirements of processing
  - green stems with high protein contents at maturity, and higher plant stature (over 120 cm).

- Resistance to diseases
  - Smut
  - Rust
  - BYDV
  - Aphids
- resistance to drought
  - Annul rainfall <300mm
  - Short of rain in in the early of growing season

- In rainfed areas
  - good tillering ability
  - both high grain and vegetative harvest indices
  - longer growing period, growing slowly at the seedling stage, fast grain-filling rates
  - taller plant heights, large spikes, well-developed root systems

- For irrigated conditions
  - Shorter growing times (90 days) and short statures (95-100 cm)
  - lodging resistance, uniform tillering with more florets and kernels
  - tolerance to high water and fertility conditions
  - a good combination of yield components (4.8-6.7 million spikes per hectare, 35-50 seeds per spike, and a 1000-grain weight of more than 20 g
  - Resistance or tolerance to Smut, rust, and BYDV diseases and aphids

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Systematic selection

- In early breeding efforts, Chinese breeders mainly improved landraces. Varieties collected from local farms in the 1950s were very different in terms of agronomic traits.
- Usually they selected superior individual plants from large populations of particular varieties and formed new populations with improved traits. This resulted in varieties such as Sanfensan and Huabei 1.

Cross breeding

- Cross breeding was popularly used in developing oat varieties after the 1960s.
- Inter-varietal crosses
- Inter-specific crosses

Irradiation treatment

- Gamma rays are mainly used as irradiation agent. In general, the proper radiation dose of Gamma rays should be 15,000-25,000 Roentgen Unit and the dosage rate 100-150 Roentgen Unit per minute.
- Varieties Yanhong 3, Fuza 2 and naked variety “1809” were selected following gamma ray treatments of 15,000-25,000 Roentgen units at 100-150 units/min.

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Major varieties released in recent year

- Bayou series, No.1-13
- Jizhangyou series
- Baiyan series, No. 1-11
- Mengyan series
- Dingyou series

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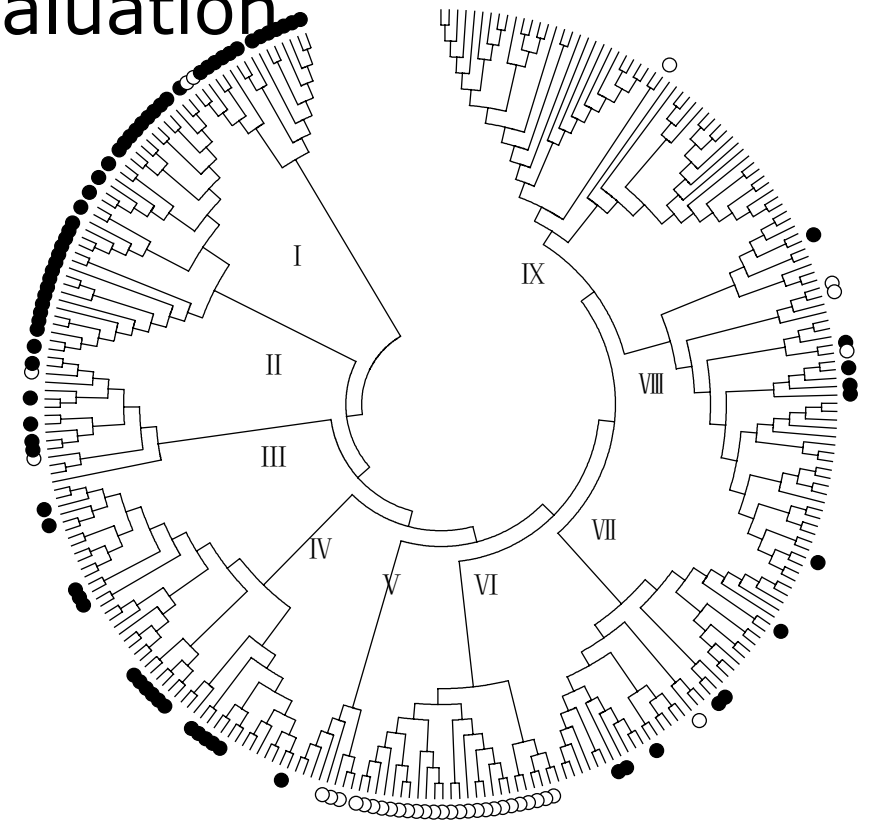
Use of biotechnology in oat breeding

- Germplasm evaluation

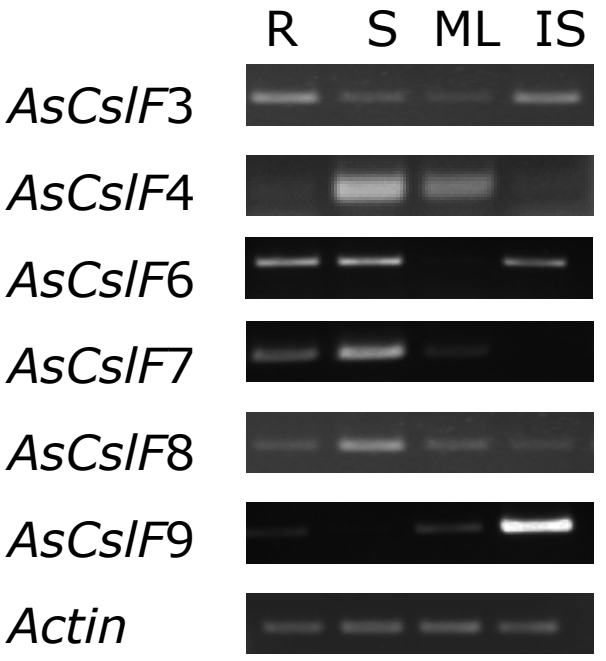


●Domestic cultivars; ○Exotic accessions; Domestic landraces are unsigned

Fig. Clustering of 281 Naked accessions by neighbor-joining analysis

Use of biotechnology in oat breeding

- Identifying genes of useful traits
  - *β-glucan synthase gene, designated AsCSLH, and its genomic DNA sequence were cloned from the oat landrace Xiayoumai*



R: Root; S: Stem;

ML: Mature Leaf;

IS: Immature Seed

- Molecular assistant selection
  - Identified a SNP closely linked with β-glucan content
  - It can used as a marker for selecting high β-glucan content

Thank you!