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Apple breeding in China

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In recent years, China's apple industry has developed rapidly. The cultivated area and regions for apples have gradually stabilized and become more concentrated, with a steady increase in production. China has become the world's largest apple producer[1,2], against the backdrop of global efforts to enhance sustainable fruit production[3]. Apple breeding research is a fundamental aspect of apple production, breeding new cultivars that exhibit durable resistance and exceptional fruit quality ('superior' cultivars) could significantly contribute to the sustainability of apple production[4]. Since its establishment in 2005, the National Apple Breeding Collaboration Group has achieved remarkable results in breeding work and played a huge role in promoting apple breeding in China. In 2007, the China Agriculture Research System-Apple was established, which systematically planned and coordinated breeding work nationwide, making apple breeding research more scientific and reasonable, and greatly improving breeding efficiency. A questionnaire survey was conducted among domestic institutions engaged in apple resource and breeding research to understand the institutions and personnel composition, crosses and seedlings, and statistics of breeding projects and funds.

Institutions and personnel composition engaged in research on apple resources and breeding

According to statistics from the National Apple Breeding Collaboration Group, the number of research institutions engaged in apple resource and breeding research in China has increased from 18 in 2008, to 26 in 2025 (Table 1). These institutions include Zhengzhou Fruit Research Institute, Chinese Academy of Agricultural Sciences; Liaoning Institute of Pomology; Northwest A&F University; Research Institue of Pomology, Chinese Academy of Agricultural Sciences, etc. The number of researchers has grown from 119 in 2008, to 178 in 2025, including 84 (47.19%) with doctoral degrees, and 75 (42.13%) with master's degrees. There are 118 people (66.29%) with senior professional titles, and 138 people (77.53%) were under the age of 50. The survey results show that research institutions in China focused on apple resources and breeding, and have developed a group of highly educated, young, well-structured, and professionally proficient scientific research teams.

Crosses and seedlings

In recent years, various breeding institutions have a large amount of breeding materials. According to the data provided by 26 institutions, by 2025, a total of 401,500 apple hybrid seedlings from 763 combinations are currently preserved in China, which is a significant increase compared to 450 combinations and 325,000 seedlings in 2008. On the basis of previous work, a total of 407 apple advanced selections have been selected so far, most of which remain under internal evaluation and have not yet entered wider regional trials or market release. Parental selection in apple breeding targets multiple traits, including organoleptic qualities, resistance to biotic and abiotic stresses, and storage properties, among others. The main hybrid parents include varieties from the 'Fuji', 'Gala', 'Golden Delicious', 'Honeycrisp', 'Saiwaihong', and 'Jin Hong', etc. In recent years, advanced selections and new varieties developed by various institutions, such as 'Qin Cui', 'Rui Xue', 'Lu Li', etc, are also frequently used as parents.

Statistics of breeding projects and funds

Statistics show that from 2023 to 2025, excluding the China Agriculture Research System-Apple project, there are a total of 76 projects related to apple resources and breeding across various institutions, with a total project budget of CNY 66.34 million. Among them, there are 12 projects under the National Key Research and Development Program of China, totaling CNY 12.66 million; 13 projects funded by the National Natural Science Foundation of China, totaling CNY 11.26 million; and 52 other projects, totaling CNY 37.62 million.

Opportunities and prospects

In recent years, China has made remarkable progress in apple breeding. A large number of new varieties have emerged, some of which have been promoted and applied in production. The number of seedlings has been increasing year by year, the number of research and development personnel has grown and their structure has been optimized, and the breeding funds have been stable. This will help to continuously produce new varieties. In the future, China's apple breeding work still needs to be further strengthened in the following aspects: First, multi-disciplinary and multi-institutional collaboration should be carried out. Currently, research is mainly focused on conventional breeding, while studies in social economics and molecular breeding are insufficient. For instance, molecular techniques like marker-assisted selection could be systematically integrated into conventional programs to accelerate the improvement of complex traits. Second, comprehensive and in-depth research should be carried out, especially emphasizing the comprehensive evaluation and innovation of germplasm resources, commercial evaluation of varieties, and consumer testing, etc. This necessitates establishing consensus on priority trait suites for evaluation, which may include market-driven and resilience-oriented characteristics. Third, it is necessary to attach importance

Table 1. Composition of research personnel involved in apple resource and breeding research.

	Research institute	Total N	PhD	Master's degree	Age < 50	Age < 40	Senior title
1	Zhengzhou Fruit Research Institute, Chinese Academy of Agricultural Sciences	4	3	1	4	2	4
2	Liaoning Institute of Pomology	10	3	5	6	4	5
3	Northwest A&F University	23	21	1	17	10	21
4	Research Institue of Pomology, Chinese Academy of Agricultural Sciences	7	6	1	6	5	5
5	Changli Institute of Fruit Research, Hebei Academy of Agriculture and Forestry Sciences	11	2	6	9	4	7
6	Shanxi Agricultural University/ Shanxi Academy of Agricultural Sciences, Pomology Institute	9	3	4	7	1	5
7	China Agricultural University	13	13	0	10	8	12
8	Qingdao Agricultural University	8	8	0	4	3	7
9	Shenyang Agricultural University	3	3	0	3	2	2
10	Institute of Fruit And Floricultrue Research Gansu Academy of Agricultural Sciences	4	0	2	2	1	3
11	Jilin Academy of Agricultural Sciences (Northeast Agricultural Research Center of China)	4	0	3	4	2	2
12	Institute of Horticultural of Yunnan Academy of Agricultural Sciences	3	0	3	3	2	3
13	Qingdao Academy of Agricultural Sciences	5	3	1	3	1	4
14	Yantai Academy of Agricultural Sciences	8	1	7	8	4	4
15	Tianshui Research Institute of Pomology	2	0	2	1	0	2
16	Shandong Institute of Pomology	8	7	1	6	5	4
17	Shijiazhuang Institute of Pomology, Hebei Academy of Agriculture and Forestry Sciences	9	1	3	5	1	6
18	Mudanjiang Branch of Heilongjiang Academy of Agricultural Sciences	6	1	5	4	2	4
19	Hebei Agricultural University	4	4	0	3	2	3
20	Horticulture Research Institute, Sichuan Academy of Agricultural Sciences	4	4	0	3	1	3
21	Shangqiu Academy of Agriculture and Forestry Sciences	6	0	6	5	4	2
22	Weihai Academy of Agricultural Sciences	6	0	5	5	5	1
23	Yili Kazak Autonomous Prefecture Academy of Forestry Sciences	8	0	8	8	7	2
24	Dalian Institute of Agricultural Sciences	5	0	5	5	0	3
25	Tongliao Forestry and Grassland Research Institute	3	0	2	2	2	2
26	Institute of Rural Revitalization Science and Technology, Heilongjiang Academy of Agricultural Sciences	5	1	4	5	3	2
Total		178	84	75	138	81	118

to fundamental work, such as evaluating traits and standardizing observation data, to facilitate future intelligent breeding.

Author contributions

The authors confirm their contributions to the paper as follows: study conception and design: Han X, Zhang C; data collection: Han X, Ma S; draft manuscript preparation: Han X, Ma S, Kang L; final manuscript preparation: Cong P, Han X, Zhang C. All authors reviewed the results and approved the final version of the manuscript.

Data availability

The data is sourced from institutions in China engaged in research on apple resources and breeding.

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Conflict of interest

The authors declare that they have no conflict of interest.

Dates

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References

[1] Liu D, Xu J, Li X, Zhang F, et al. 2024. Green production of apples delivers environmental and economic benefits in China. *Plant Communications* 5:101006

[2] Zhao B, Liu Q, Luo L, Zhou H, Zhang X, et al. 2025. Suppression of *MdPRP6* enhances adaptation of apple plants to long-term drought. *Physiologia Plantarum* 177:e70099

[3] De Mori G, Cipriani G. 2023. Marker-assisted selection in breeding for fruit trait improvement: a review. *International Journal of Molecular Sciences* 24:8984

[4] Luo F, Evans K, Norelli JL, Zhang Z, Peace C, et al. 2020. Prospects for achieving durable disease resistance with elite fruit quality in apple breeding. *Tree Genetics & Genomes* 16:21