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Brief History of Plant Breeding Open Access

Brief History of Plant Breeding (III): Evolution from Primitive Selection to Domestication

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Abstract This article explores the process from primitive selection to plant domestication and breeding. In ancient times, humans began to rely on plants as a source of food and practiced primitive selection to choose plants with beneficial traits for cultivation and reproduction. Over time, humans gradually realized the potential of breeding plants and developed conscious methods of domestication and breeding. This approach involved selecting plants with randomness and uncertainty, often referred to as domestication breeding or breeding 1.0. Domestication breeding has significant significance for agricultural development and food supply, driving human progress and agricultural advancements.
Keywords Variation populations; Phenotype selection; Breeding 2.0; Plant breeding

Plant breeding is an important milestone in the history of human civilization, marking the domestication and improvement of plants by humans. In ancient times, humans began to recognize the potential of plants and cultivated those with desirable traits through primitive selection. This process not only changed the plants themselves but also had profound impacts on human society and agricultural development (Leach, 2020).

Ancient humans lived in close proximity to the natural environment of plants. To survive and meet their needs, they started to notice certain plants with special characteristics, such as abundant fruits, edible seeds, or tuberous roots. These plants with beneficial traits were selected for cultivation and preservation, serving as sources of seeds for the next generation. Over time, this conscious selection led to the gradual accumulation of numerous favorable traits in plants.

As the practice of primitive selection evolved, humans began to explore more targeted methods of domestication and breeding. Milestones in the evolution of plant domestication, such as transplantation, division, stem cuttings, and grafting, marked important stages in human selection and improvement of plants. By applying these techniques, humans were able to propagate and improve plant varieties, meeting the growing demand for food and advancing agricultural development.

In this paper, we will explore the process and development of plant domestication, from primitive selection to more sophisticated methods. We will delve into key events and technologies at each stage, discussing their impacts and significance in plant breeding. By understanding this history of plant breeding, we can better comprehend the close relationship between humans and plants and the vital importance of plant breeding in human society.

1 Primitive Selection in Ancient Times

In ancient times, humans established a close relationship with plants, which became an essential part of human life. Humans relied on plants as a source of food, medicinal plants, and other essential items for daily living. This reliance prompted the practice of primitive selection, from unintentional accidental selection to purposeful directed selection, to obtain plants with greater edibility and beneficial traits.

Human understanding of plants can be traced back to approximately 2.6 to 2.5 million years ago to 12 000 years ago. Early humans observed and experimented, discovering that certain plants had better taste, higher nutritional value, or other beneficial characteristics. They selected and preserved these plants with beneficial traits, using their seeds or tubers as a source for the next generation (Fang, 2022). Over time, these beneficial traits accumulated and were passed on, leading to changes in plant populations.

Modern major food crops such as teff, maize, rice, wheat, legumes, bananas, and fiber-producing plants like hemp, flax, and cotton all originated from the prehistoric human selection and cultivation of wild primitive plants (Asano et al., 2011).

Archaeological and paleobiological studies provide specific evidence supporting the existence of primitive selection. Analysis of plant remains at ancient sites reveals that early humans deliberately selected and cultivated specific plants (Bai et al., 2021). Additionally, studies in genetics and plant morphology have also revealed that early humans engaged in conscious selection, altering the genetic traits of plants.

The existence and significance of primitive selection not only reveal the close relationship between humans and plants but also laid the foundation for later plant domestication. This process propelled the development of human society, providing a stable food source and having a profound impact on the rise of agriculture and civilizations. By studying the history and evidence of primitive selection, we can better understand the coevolutionary story of humans and plants.

2 Transition from Primitive Selection to Domestication Breeding

Early humans began to realize the potential of plant selection, marking the gradual transition from primitive selection to a conscious process of domestication breeding. With an improved understanding of plants and advancements in agricultural techniques, humans actively started to select and improve plants to obtain better crops and other useful plant varieties.

Through practical experience, humans gradually discovered that by choosing to cultivate plants with higher yields, larger fruits, or better adaptation to local environments, they could improve crop performance. This awareness drove the transition from primitive selection to domestication breeding. Humans began purposefully selecting and cultivating plants with beneficial traits to meet the ever-increasing food and other needs.

During this transitional process, plant cultivation and propagation techniques were gradually improved and applied. Humans learned to transplant plants, moving them from one location to another, which expanded the range of cultivation. Techniques such as root division and stem cuttings enabled more efficient plant propagation, rapidly increasing plant populations (Fang, 2023). Additionally, the emergence of grafting allowed for the combination of different plant varieties, further improving plant characteristics.

By depicting a timeline of these significant milestones, the transition from primitive selection to domestication breeding can be presented more clearly. The development of these techniques further propelled agricultural progress, increasing food production and quality, and laying the foundation for the prosperity and development of human society. The shift from primitive selection to domestication breeding marked the beginning of humans actively intervening in the evolutionary process of plants, establishing a solid basis for later breeding and agricultural advancements.

3 Progress and Impact of Domestication Breeding

Domestication breeding is a significant human achievement that has played a crucial role in the improvement and diversification of plant varieties. Through domestication breeding, humans can select and cultivate plant varieties with specific traits and advantages to meet various agricultural and economic needs (Leach, 2020). This is of great significance for increasing crop yields, adaptability, disease resistance, and nutritional value.

Domestication breeding has far-reaching effects on agricultural development and food supply. By domestication breeding, humans can improve crop yields and quality, increase food supply, and meet the growing demand of the population. Continuously improved crop varieties can adapt to different soil and climate conditions, enhance stress tolerance, and thus reduce the risk of crop damage due to adverse conditions.

The impact and evolution of domestication breeding on human society and civilization are also noteworthy. The development of domestication breeding gradually transformed human societies from nomadic lifestyles to settled agricultural communities. The advancement of agriculture provided stable food supply, created conditions for economic prosperity and social organization. Furthermore, domestication breeding also promoted advancements in science and technology. Through understanding and application of plant genetic traits, humans continuously improved breeding methods and techniques, driving the development and innovation of modern agriculture.

The importance of domestication breeding in improving and diversifying plant species extends beyond the realm of agriculture. Many plant varieties are not only used for food and agricultural production but also for medicine, fibers, construction materials, and energy. Domestication breeding has provided humanity with rich plant resources, meeting diverse needs, and propelling the development of human society.

In conclusion, domestication breeding is the culmination of human wisdom and creativity, with profound impacts on plant improvement, agricultural development, and the evolution of human society and civilization. It embodies the long-standing and successful partnership between humans and plants, providing us with abundant food and resources, and laying the foundation for a sustainable future.

4 Contemporary Significance and Future Prospects of Plant Breeding

Contemporary plant breeding has been continuously evolving from the foundation of primitive selection and domestication breeding and plays a significant role in various fields. By combining traditional breeding methods with emerging techniques such as gene editing and genetic improvement, modern plant breeding has accelerated the process of selecting new varieties, achieving remarkable results in improving crop yield, disease resistance, and adaptability (Schlegel, 2014).

Plant breeding holds enormous potential in addressing current food demand and sustainable development. With the continuous growth of the global population and challenges posed by environmental changes, ensuring stable food supply and sustainable agricultural production have become increasingly critical. Plant breeding can enhance crop production efficiency and quality by cultivating high-yield, high-nutritional-value, and adaptable varieties, reducing reliance on land, water resources, and chemical pesticides, and promoting the development of sustainable agriculture.

However, plant breeding faces several challenges and future directions. These include the need to address climate change and biodiversity conservation, improve breeding efficiency and precision, overcome time and resource limitations in traditional breeding, and foster collaboration between public and private sectors. Moreover, exploring and harnessing plant genetic resources, promoting agricultural sustainability, and developing innovative varieties that meet future demands are also essential future directions for plant breeding (Gepts, 2002).

In the future, we can expect that plant breeding will continue to advance, utilizing advanced techniques and global collaborative networks to enhance the sustainability and resilience of agricultural production. By gaining a better understanding of plant genomes, optimizing breeding strategies, and disseminating new varieties, plant breeding will become a critical field in achieving global food security, nutritional improvement, and environmental sustainability.

In conclusion, contemporary plant breeding, building upon the legacy and development of primitive selection and domestication breeding, provides effective solutions to address current food demand and sustainable development challenges. The future of plant breeding will encounter numerous challenges but also presents tremendous opportunities and potential. Through ongoing innovation and international cooperation, we have the confidence to address these challenges and provide better food security and sustainable development for human society.

5 Conclusion

From ancient primitive selection to the evolution of domestication breeding, plant breeding has been driving the development of human agriculture and food supply. Primitive selection emerged as a result of mutual dependence between humans and plants, as early humans observed and chose plants with beneficial traits for cultivation and propagation, gradually domesticating many crops and ensuring reliable food supply (Curry, 2016). Over time, humans became increasingly aware of the potential for plant breeding and developed conscious methods of domestication breeding, leading to further diversification of plant varieties and improvement in crop yield and quality. This method, now known as primitive breeding, was defined as "Breeding 1.0," characterized by selection with randomness and uncertainty (Wallace et al., 2018).

Plant breeding holds great significance for agricultural development and food supply. Through domestication breeding, wild plants have been tamed and improved into cultivated plants or varieties adapted to different environments and production requirements, enhancing crop yield, quality, and resistance. This not only provides abundant food sources for humans but also drives the progress of human society and civilization.

However, we also face challenges. Climate change, biodiversity loss, resource constraints, and other issues exert pressure on agriculture and food production (Ceccarelli et al., 2010). In response to these challenges, humans have continuously explored new breeding technologies and methods based on primitive breeding. Gregor Mendel's laws of inheritance and hybridization marked the watershed between primitive and modern breeding, ushering in the era of Breeding 2.0 (Wallace et al., 2018), commonly known as conventional breeding or traditional breeding. This approach mainly involves human use of hybridization to create variation and select plant varieties with desirable traits, featuring a certain level of certainty and directionality in the selection process. At the same time, emerging breeding technologies such as gene editing and genetic improvement offer us more possibilities, enabling more precise breeding of new varieties to meet future demands, enhance crop yield and adaptability, reduce resource dependencies, and promote sustainable agriculture development.

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