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Editorial: Speed breeding systems for food

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Editorial on the Research Topic
Speed breeding systems for food

Sustainable food production systems hold great promise for addressing the global challenges of food security and environmental sustainability. This Research Topic centers around food systems that incorporate speed breeding technologies, vertical hydroponics, and data-driven smart sensor applications.

Speed breeding technologies enable the rapid generation of new plant varieties, accelerating crop development with desired traits, such as pest resistance, drought tolerance, high nutritional value, and high productivity. Achieved through advanced genetics, artificial lighting, and controlled environments, these techniques allow multiple generations of plants to be grown and harvested in a single year, surpassing the typical one to two generations of traditional field-based breeding. By analyzing specific crop genomes using molecular markers, breeders can identify and characterize genetic variation. This knowledge helps select desirable traits, such as pest or disease resistance and improved yield. Marker-assisted selection (MAS) and genomic selection (GS) are groundbreaking methods that enhance the efficiency and accuracy of trait selection. MAS identifies desirable traits early in the breeding process, while GS predicts plant performance before growth, accelerating breeding. These techniques have significantly improved breeding efficiency, allowing for the development of new varieties and breeds in less time.

Vertical hydroponics, which uses nutrient-rich water instead of soil, enables higher yields per unit of land, efficient resource utilization, and year-round production, while data-driven smart sensors optimize growing conditions and automate processes like nutrient delivery and harvest.

Eleven articles were published in this Research Topic, authored by experts from different disciplines. The first study was by Choi et al. on the development of a speed breeding protocol for pepper (*Capsicum annuum*) by controlling the photoperiod and light quality. The authors revealed that the combined influence of Epp and FR light affects flowering gene expression in pepper plants, providing valuable insight into the potential of the speed breeding system to expedite genetic research by reducing generation time. The submission by Tetreault et al. was a hypothesis and theory article that defined the integration of recirculating aquaculture systems (RAS) with hydroponic cropping systems (HCS) into a single system with shared water treatment units.

A review on "Genomics-assisted speed breeding for crop improvement: present and future" by Ćeran et al. provided an overview of current research on speed breeding in crops. They covered various aspects of the manipulation of different environmental factors in speed breeding. The authors provided a summary of developed speed breeding protocols for main crops and discussed the possibilities of integrating speed breeding with genomic approaches. The current status and challenges of speed breeding and future perspectives in breeding were also reviewed. In the article "Efficient regeneration of *in vitro* derived plants and genetic fidelity assessment of *Phalaenopsis* orchid" by Sarmah et al. the authors successfully developed a simple and rapid regeneration protocol for *Phalaenopsis* by using flower stalk nodes as explants, which resulted in a high frequency of plantlets in a short period of time. The integrity of the micropropagated clones created *in vitro* and the genetic maintenance of the mother plant were confirmed by DNA fingerprinting, contributing to the advancement of reliable and efficient micropropagation methods. The study "*Genomic analysis and identification of potential duplicate accessions in Burkina Faso cassava germplasm based on single nucleotide polymorphism*" by Soro et al. showed high genetic diversity and complex genetic structure within cassava accessions grown in Burkina Faso using molecular markers. The study "*Development of portfolio management tools in crop breeding programs: a case study of cassava in sub-Saharan Africa*" by Egesi et al. presented pilot work on cassava to improve varietal development that is efficient, effective, and delivers higher genetic gain. The authors proposed the transformation of cassava breeding programs by developing guiding, flexible, and adaptive tools for portfolio management. A deeper understanding of the genetic diversity within the cassava population, transformation of breeding programs, and speed breeding could provide resources to advance its breeding by improving disease resistance, climate change adaptation, and other critical factors necessary to ensure food security in sub-Saharan Africa. Anshori et al. developed an innovative and effective approach for selecting F3 transgressive segregants in cayenne pepper populations using a semi-objective-based selection index that includes canopy width, fruit weight, and yield.

Nhamo et al. addressed resource-poor farmers residing in many marginal areas by promoting the adoption of multi-cropping, rainwater harvesting, and soil conservation techniques using underutilized indigenous crops like Bambara groundnut. Cepková et al. reviewed current information on quinoa's genetic resources, focusing on the variability of economically important traits like yield and bioactive compound content, including protein and amino acid composition, under different growing conditions. They also discussed how variety and environmental factors, such as elevated temperatures, high salinity, and extreme weather, can negatively impact the growth, productivity, and nutritional content of quinoa. Luo et al. assessed the impact of soybean breeding on phosphorus (P) and nitrogen (N) utilization efficiency by increasing their partitioning to pods. They concluded that soybean breeding improved the agronomic efficiency of P fertilizer and P and N utilization efficiency. Increased partitioning to pods and decreased partitioning to stems contributed to these improvements by reducing the demand for P and N. However, while P supply increased nutrient accumulation, it reduced P utilization efficiency. These findings highlight the importance of appropriate resource allocation among plant organs and efficient P management to improve nutrient utilization and reduce fertilizer requirements. Armengot et al. evaluated the yield performance of four locally-selected cacao clones, four widely-used international clones, and four full-sib families in a long-term trial in Bolivia. The cacao trees in monocultures had higher yields than those in agroforestry systems, with no differences observed between conventional and organic management. On average, the local clones had two and five times higher yields than the international clones and full-sib families, respectively.

This special edition Research Topic sheds light on sustainable food production systems from plants, which offer promising alternatives to conventional agriculture, delivering high yields, efficient resource utilization, and reduced environmental impact. Speed breeding has the potential to revolutionize plant breeding, accelerating the development of new crop varieties and contributing to food security by increasing productivity and resilience. The integration of innovative technologies and data-driven approaches will further advance these systems, and make them more accessible for widespread adoption.

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KP: Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Formal analysis, Conceptualization. MC: Writing – review & editing, Writing – original draft, Resources.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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