frontiers | Frontiers in Food Science and Technology

TYPE Editorial
PUBLISHED 05 February 2026
DOI 10.3389/frfst.2025.1741722

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OPEN ACCESS

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RECEIVED 07 November 2025
ACCEPTED 15 December 2025
PUBLISHED 05 February 2026

CITATION
Banwo K, Gerhardt IR and Al Omari DZ (2026) Editorial: Importance and impacts of genetics in food production.
Front. Food Sci. Technol. 5:1741722.
doi: 10.3389/frfst.2025.1741722

Editorial: Importance and impacts of genetics in food production

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KEYWORDS

malnutrition, nutrition, food security, genetic resources, biotechnology

Editorial on the Research Topic
Importance and impacts of genetics in food production

Malnutrition is a significant challenge that affects the majority of people worldwide, particularly in areas where access to nutritious food is limited. Food insecurity persists in many nations where domestic production cannot adequately sustain communities. Addressing these issues is central to achieving lasting food security. Today, the global food system is at a crossroads. As the world faces converging challenges—climate change, population growth, nutritional imbalances, and the demand for sustainable production—genetics has become one of the central tools for transforming how food is produced, processed, and consumed. Recent advances in genetics have improved nutritional qualities and enhanced food security. There are, however, limitations to the synergy between components of malnutrition and food insecurity in food systems, which hinder their acceptability and adoption by consumers.

This Research Topic, *"Importance and Impacts of Genetics in Food Production,"* includes one review and three original research articles that comprehensively investigated biotechnological advancements in the enhancement of soybean oil for human health and applications in food industry, evaluation of nutritional and reduction in antinutritional factors in African yam bean (*Sphenostylis stenocarpa*) accessions grown in Togo, evaluation of pre-selected mandarin hybrids based on tolerance to *Alternaria* brow spot, physicochemical characteristics and acceptability, enhancement and comparative analysis of carcass traits and meat quality between Tibetan sheep and their three-way crossbred sheep. This Research Topic highlights how advances in plant and animal genetics are reshaping food systems toward greater resilience, quality, and innovation.

One clear example comes from Da Rosa et al., who reviewed soybean (*Glycine max* L. (Merr.) oil as the second most important vegetable oil with an output of 60.7 million tons after palm oil, categorizing soybean oil as the most widely consumed oil for human consumption. The authors reported soybean oil to be nutritional, with high functionality and flavour. Soybean oil possesses polyunsaturated fatty acids (PUFA) such as linoleic acid (LA) and α-linoleic acid (ALA), which are important for human health, such as cardiovascular protection and metabolic regulation. Genetic modification of soybean seeds during breeding, such as transgenes, RNA interference (RNAi), and gene editing, has been employed biotechnologically. These technologies enhanced crop productivity, conferred tolerance to stress (abiotic and biotic), promoted stability, enabled the meeting of market demand, and improved nutritional quality. The improvement of vegetable oils through genetic modification and functional genomics. The authors highlighted that biotechnological modification led to the development of soybean cultivars that possessed high oleic acid content, increased oxidative stability, and enhanced linoleic acid content, with low palmitic acid content, leading to the reduction in saturated fatty acid levels contributing to functional, nutritional, and healthier oils. These factors improved the oxidative stability for cooking at high temperatures and shelf-life stability. Such approaches show that genetic engineering is not merely an optional enhancement, but an essential pathway to aligning crop composition with health-conscious and environmentally responsible food markets. The study on genetically engineered soybeans demonstrates how RNA interference and gene-editing strategies have enabled the development of high-oleic cultivars with reduced palmitic acid content and improved oxidative stability, offering both nutritional and industrial advantages.

The exploration of underutilized genetic resources represents another frontier for food security and diversification. In the original paper, Palanga et al. evaluated 22 African yam bean (*Sphenostylis stenocarpa*) accessions/cultivars grown in Togo, identifying genotypes with superior nutritional, mineral, and antinutritional profiles. Their paper identified that many developing countries face the triple burden of malnutrition, characterized by undernutrition, micronutrient deficiencies, and being overweight. Micronutrient deficiencies with high rates of vitamin A deficiency occur among children below the age of five. Despite all these challenges, African yam bean (AYB) is a legume with important vital amino acids and protein comparable to a whole chicken egg. The authors provided information on the exploitation of this underutilized crop and its nutritional benefits. Several accessions reported for the AYB grown in Togo possess high protein, carbohydrates, fibre, vitamins, and minerals with low levels of antinutritional factors such as polyphenols, tannins, and phytates. They suggested that the nutritional content of the different accessions varied primarily due to their unique genetic makeup and place of origin. The protein content is more than Bambara groundnuts, Adzuki beans, Jack beans, Lima beans, and rice beans but less than that of Mung beans and wing beans in sub-Saharan Africa. All the accession of AYB possessed the nutritional qualities needed to combat malnutrition in Togo. These results underscore the role of genetic diversity in improving dietary quality while reinforcing local food systems. Here, genetics serves not only to "improve" crops but also to rediscover and valorize neglected species that can address contemporary food and nutrition challenges.

Fruit breeding provides yet another perspective on the convergence between genetics and consumer preference. The evaluation of mandarin hybrids for Alternaria brown spot (ABS) tolerance, fruit quality, and sensory acceptability identified promising genotypes for future cultivation. This work highlights that genetics extends beyond yield improvement: it connects agricultural productivity with market expectations, sensory traits, and consumer satisfaction. Moura et al. selected novel Mandarin varieties to improve the fruit supply to address phytosanitary challenges in table citrus farming. The authors reported that the southeast region is the heart of mandarin production in Brazil, which accounts for 60.6% of the national output, where São Paulo is the leading producer of 34% of the general production. Diseases such as Alternaria Brown spot (ABS) and Greening (Huanglongbing) (HLB) negatively impact the citrus orchards in Brazil. Their study investigated three new hybrids based on the tolerance to ABS, physicochemical characteristics and general acceptability. All the hybrids were well accepted by the panelists. This acceptance in combination with the tolerance of these new genotypes to ABS opens up excellent prospects for sustainable citrus cultivation, which can reduce the application of pesticides, which can impact on the environment or have less impact on the environment.

Genetics is also transforming animal production systems. In the study on Tibetan sheep hybrids, candidate genes such as *CSRP3, ANKRD1*, and *PPARGC1A* were associated with growth performance, intramuscular fat content, and overall meat quality. Integrating genomic data with phenotypic and nutritional analyses reveals how breeding programs can simultaneously improve productivity and enhance the nutritional profile of animal-derived foods. The improvement of meat yield and nutritional quality of Tibetan sheep, Australian white and small-tailed Han rams introduced with Oura-type ewes of Tibetan sheep with genetic homogeneity was investigated by Qiao et al. The authors compared the growth conformation, meat quality, carcass traits, fatty acids and amino acids profiles, and ribonucleotide content of the two groups of lambs. The authors performed transcriptomics analysis to identify the candidate genes associated with muscle development and the quality of meat. The authors reported that the Tibetan three-way crossbred lambs possessed better growth performance than the Tibetan lambs at 5.5 months, which indicated that the crossbred lambs benefited from the hybridization, thereby improving the growth potential. The carcass traits were greatly enhanced because of the crossbreeding. The study identified significant fatty acids beneficial to humans, such as linoleic acids and α-linoleic acids. There was a significant increase in essential amino acids. The study identified differentially expressed genes (DEGs) and *longissimus thoracis et lumborum* (LTL) using transcriptomics analysis, which are associated with muscle development and improved flavour. The three-way crossbred lambs demonstrated superior growth performance, carcass traits and better meat quality. The authors suggested a further study on a longer-term feeding experiment with larger animal groups to explore the scientific investigation of the three-way cross-bred Tibetan lambs.

Taken together, these contributions illustrate three major dimensions of modern genetics in food production:

1. Nutritional and functional quality: optimizing fatty acid composition, protein content, micronutrients, and reducing antinutritional compounds;
2. Resilience and adaptation: harnessing genetic diversity for tolerance to stresses, diseases, and changing climates;
3. Integration from field to fork: aligning breeding goals with sensory quality, consumer acceptance, and market value.

From this perspective, genetics is not only a tool of the laboratory but also a driver of transformation across the food chain. It bridges disciplines, genomics, breeding, nutrition, biotechnology, and sensory science, and demands collaboration among scientists, farmers, industries, and policymakers. Looking ahead, emerging approaches such as pangenomics, precision gene editing, functional annotation of wild and landrace germplasm, and advanced phenotyping will accelerate our capacity to design crops and livestock that meet the nutritional, environmental, and economic demands of the twenty-first century. Ultimately, "Importance and Impacts of Genetics in Food Production" is not a narrow scientific field; it is a foundational pillar of sustainable food systems. The articles in this Research Topic invite readers to reflect on how genetic knowledge, when responsibly applied, can help build a future where nutrition, biodiversity, and innovation grow together.

Overall, the Research Topic emphasized the importance of genetic factors in enhancing food and agricultural production. Promotion and its sustainable use in the food systems are critical to food production. These genetic resources enhancement of the nutritional status of fruits and meat yields is vital for long-term food security and empowering human health.

Author contributions

KB: Writing – review and editing, Writing – original draft. IG: Writing – review and editing, Writing – original draft. DA: Writing – review and editing, Writing – original draft.

Funding

The author(s) declared that financial support was not received for this work and/or its publication.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author KB declared that they were an editorial board member of Frontiers at the time of submission. This had no impact on the peer review process and the final decision.

Generative AI statement

The author(s) declared that generative AI was used in the creation of this manuscript. AI was used to modify some written aspects of the editorial.

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