Available online at
http://currentagriculturetrends.vitalbiotech.org/

ISSN (E): 2583 – 1933

Curr. Agri.Tren.:e- Newsletter, (2026) *5*(6), 25-30

Current Agriculture Trends: *e-Newsletter*

Article ID: 650

Genomic Exploitation of High-value Potential Crops to Enhance Nutritional Security and Agricultural Sustainability

Chander Mohan[1], Vikram Singh Gaur[2], Sajan Kumar[3], Ashutosh Sharma[3], Ashutosh Singh[3], Anshuman Singh[4]

[1]ICAR–IIMR, Regional Maize Research, Begusarai, Bihar, India
[2]College of Agriculture, Balaghat, JNKVV, Jabalpur, M.P., India
[3]RLB Central Agricultural University, Jhansi, U.P., India
[4]ICAR–Indian Agricultural Statistical Research Institute, New Delhi

*Corresponding Author
Anshuman Singh*

Article History
Received: 03.06.2026
Revised: 08.06.2026
Accepted: 13.06.2026

INTRODUCTION

Global agricultural production facing multiple challenges due to degradation of natural resources, loss of biodiversity, deforestation, and malnutrition among in increasing population. Continuous increase in temperature, decreasing soil fertility, flood, uncertainty of rainfall, and drought are threatening crop productivity and food security (Tseng et al., 2020). Additionally, micronutrient deficiencies and malnutrition are continuously affecting millions of peoples across the world due unavailability of nutritious diet. Thus, agricultural sustainability and nutritional security necessitates exploration of crops suitable for cultivation in the era of climate change and capable to support nutritional demand.

In ancient era, when irrigation, chemical, fertilizers and other crop cultivation facilities was not commercialized underutilized crops were grown by the peoples. Cultivation of these crops as completely based on natural resources. Most of the underutilized crops are drought and heat stress tolerant and their cultivation was depends on rain water, ponds and rivers based irrigation systems. Some underutilized crops seasonally grow in the forest and wasteland having high nutritive value was consumed by local communities (Dwivedi, et al., 2023). Now days, these crops have opportunity of commercial cultivation in the scenario of climate change for sustainable agricultural development.

ISSN (E): 2583 – 1933

Potential crops are unexploited underutilized crops having high biochemical profile. Most of the underutilized crops are not in the main stream of cultivation but have potential of cultivation to enhance nutritional security and agricultural sustainability. These crops are nutrient-dense and climate resilient. In the era of climate change and malnutrition, unexploited crops may provide strength to the continuously increasing global populations. Priority based collection, characterization and genomic exploitation may provide opportunities to researchers for indentifying nutrient-dense and climate resilient potential crop genotypes for proper cultivation. Recent advancement in genomic science such as high-throughput genotyping and phenotyping are highly useful to speed-up the screening of underutilized crops at early stage (Abberton et al., 2022). Additionally, nutritional profiling of these crops may also essential part of the genetic exploitation to understand the availability of nutrients in the particular genotypes of the underutilized crops for development of future breeding strategy. In some underutilized crops like faba bean, millets, Ivy gourd, spine gourd, sponge gourd etc., attempts have been made by researchers for screening of potential germplasm. In this article, authors have explored the importance of high-value, nutrient-dense underutilized crops for future farming.

However, some neglected crops often termed as underutilized crops gained attention sue to unique nutritional and agronomical attributes. Most of the underutilized crops are richest source of vitamins, proteins, fibers, antioxidants and minerals making them for improving food quality and nutritional sustainability (Chivenge, et al., 2015). Furthermore, neglected crops having more tolerance to extreme heat, drought, and salinity may enabling them to thrive in the variable environments with limited cultivation inputs. Some underutilized crops naturally occur in the wasteland and forest area and have consumed by rural communities for nutritional and medicinal benefits. After commercialization of semi-dwarf high yielding cereal crops leading to neglecting numerous crops (Chankaew et al., 2022). Due to inadequate research, proper characterization and limited breeding efforts and weak market linkages have further restricted the commercial cultivation of underutilized crops.

Recent advancements in genomic tools and techniques like high-throughput genotyping, genome sequencing, high-throughput phenotyping and marker-aided selection enables to identifying gene of interest, assessment of genetic diversity and improvement of genotypes with stress tolerance and enhanced nutritional quality. Additionally, collection, characterization, conservation and nutritional profiling along with genomic exploitation enables to development of climate smart and nutrient-dense cultivars of underutilized crops. Thus, integration of genomic approaches with traditional agricultural knowledge open the door the promoting high-value potential crops to achieve durable nutritional security and long-term agricultural sustainability for the increasing global population.

2. Importance of High-Value Potential Crops

High-value potential crops are often called as underutilized crops or neglected crops. These crop species having exceptional nutritional, medicinal, ecological and sustainable value but remain underexploited due to lack of genomic exploitation. Most of the underutilized crops have been identified and have ability to contribute nutritional security and agricultural sustainability in diverse environmental situations (Aditya et al., 2019). The significant importances to exploit these high-value underutilized crops are briefly explained here.

Figure 1: High-value potential crops in nutritional and agricultural sustainability

2.1. Nutritional Significance:

Underutilized crops have significant contribution to the global nutritional security, agricultural sustainability and climate resilience. Most of the underutilized crops have higher nutritional profile than stable food crops and known for richest source of vitamins, minerals, proteins, antioxidants, dietary fibers and essential bioactive compounds. Addition of these crops in daily diet can help to addressing micronutrient deficiencies and malnutrition.

2.2. Importance in Agricultural Sustainability: Underutilized crops thrive in hardy environment and have ability to contribute agricultural sustainability in the era of climate change. These crops require minimum inputs of cultivation like fertilizers, pesticides, irrigation water making them most suitable for low input farming. Some underutilized crops have ability to thrive in marginal, degraded and low land may reduce the pressure on productive agricultural areas.

2.3. Resilience to environmental Stresses: Most of the underutilized crops exhibited natural potential to tolerate the abiotic threats like drought, extreme heat, salinity and pathogen attack enabling them sustainable crop production under changing climatic conditions.

2.4. Nutritional Security through Underutilized Crops: Micronutrient deficiency and hidden hunger globally affect millions of people. Integration of underutilized crops and their processed products in the daily diet offer a promising solution due to their higher nutritional value. For example protein rich underutilized legumes like winged and faba bean, horse gram and Bambara ground nut provide sufficient amino acids essential for proper growth and development (Venn and Mann, 2004).. Other underutilized crops like millets are the potent source of micronutrients would help to prevent anemia, calcium and other immune deficiencies. Thus, integration of these crops into food systems promotes nutritional quality.

3. Genomic Approaches for Crop Improvement

In last decades, rapid advancement in science and technology including genomic research has transformed crop improved strategy. Genomic science precisely enables identification, characterization and transformation of desirable genes into underutilized crops for development of cultivars for commercial cultivation (Laosatit et al., 2022). Additionally, whole genome sequencing provides comprehensive information of gene structure, and their organization facilitates identification of gene of interest and stress-responsive pathways. Therefore, genomic research play crucial role in build-up foundation for improvement of high-value underutilized crops. Some of the modern genomic platforms provide strength to the improvement of underutilized crops is mentioned in the table1.

Table 1: Modern Genomic Tools and Their Applications in Crop Improvement

Approach	Advantages	Applications	Benefits
High-Throughput Genotyping	Rapid screening of germplasm using molecular markers	Genetic diversity, trait-mapping	Precision breeding.
High-Throughput Phenotyping	Uses imaging platforms to measure traits in field and controlled environments.	High yield, stress tolerance, Nutri-dense lines	Generates large-scale datasets for selection efficiency
Genome-Wide Association Studies	Statistical associations between genetic markers and traits	Discovery loci controlling yield, quality, resilience	Accelerates gene discovery
Marker-Assisted Selection	Uses molecular markers for early plant selection	Selection of plants with desirable genes	Reduces breeding time and costs
Genomic Selection	Genome-wide markers to predict breeding values for complex trait	Traits improvement by multiple genes.	Enhances selection/ breeding programs

4. Nutritional Profiling and Biofortification

Nutritional profiling provides basic information of the nutritional status of underutilized crops to build-up biofortification strategy. Nutritional profiling of these crops also play important role in the genomic exploitation of crops with enhanced nutritional profile (Owino et al., 2022). Assessment of the essential nutritional parameters like mineral composition, protein content, vitamin concentration, amino acid composition, antioxidant activity, dietary fiber etc. may enabling the identification and selection of promising lines of underutilized crops. Development of high yielding underutilized crops with high nutritional profile is very essential for addressing micronutrient deficiency and malnutrition. Techniques like genomic-assisted breeding and genome-editing tools may enable the further biofortification strategy with aim to increase nutritional value.

5. Success Stories in Genomic Exploitation

Some underutilized crops like faba bean, millets, Ivy gourd, spine gourd, sponge gourd, winged bean etc. have been already targeted for genomic exploitation to enhance nutritional security and agricultural sustainability are elaborated in table2 as success stories.

Table 2: Genomic Exploitation of Underutilized and Nutritionally Important Crops**.**

Crop	Key Successes	Traits Improved	Outcome
Faba Bean	Identification of diverse germplasm using DNA markers	High protein content, tolerance to stress	Nutritional security and Resiliency
Millets	Identification of genes linked to traits	Nutrient-dense, stress tolerance, higher yield	Climate resilience, enhanced productivity
Ivy Gourd	Germplasm characterization	High vitamin, micronutrient content,	Varietal development with enhanced nutritional value
Spine Gourd	Genetic diversity, sex identification	Fruit quality, high yield, stress tolerance	Commercial cultivation with adaptability
Sponge Gourd	Molecular characterization to identify elite genotypes	Improved cultivation traits	Wider cultivation and sustainable production

6. Challenges in Genomic Exploitation of Underutilized Crops

Underutilized crops have potential to enhance climate resilience, nutritional security and sustainable crop production. Most of the underutilized crops possesses essential nutrients and have potential to thrive under unfavourable climatic conditions. Limited research and development of these potential crops are the major constrains of the widespread of these crops. Further, some potential crops have limited genomic resources like lack of reference genome and molecular markers, unavailability of genetic data base etc. restricting their strategic improvement. Additionally, low consumer awareness, limited value chain, limited cultivation and lack of proper procession further discourage commercial cultivation of these crops. Some underutilized crops have efficient seeds and quality planting materials also limits their cultivation. These challenges can be addressed by strategic research, varietal development and marker integration. Thus, genomic research and market development and supportive policies may unlock the potential of the commercialization of high-value potential crops.

7. Future Prospects

Neglected crops have gaining importance as valuable resources of nutritional security, climate resiliency and agricultural sustainability. In future, genetic improvement and commercialization of underutilized crops depends on strategic integration of genomic technologies with traditional agricultural knowledge. Recent advancement in genomic tools like genome editing, omic approaches, artificial intelligence and speed breeding offers to researchers for identification, characterization, and development of high-value climate resilient underutilized crop cultivars. Genomic approaches can also enhance nutritional quality, yield potential and adaptation to continuously changing climates. Realizing the importance of underutilized crops, cooperative efforts by researchers, policymakers, farmers, and stakeholders significantly contribute to long-term agricultural sustainability and nutritional security.

CONCLUSION

High-value potential crops explored untapped resource for addressing the climate change and global nutritional security. Adaptability of these crop species to marginal climatic conditions and wonderful nutritional profile enable to making them highly suitable for agricultural sustainability and nutritional security. Therefore, proper collection, characterization, evaluation, nutritional profiling, genomic exploitation for gene mining of these neglected crops can unlock their potential. Recent advancement in genomic science and technology like high-throughput genotyping, phenotyping, genome sequencing, and genomic-assisted breeding provide strength for accelerating their improvement. In the era of climate change and malnutrition, strategic breeding and commercialization of high-value potential crops will play vital role in addressing nutritional security and agricultural sustainability for future generations of the globe.

REFERENCES

Abberton, M., Paliwal, R., Faloye, B., Marimagne, T., Moriam, A., Oyatomi, O. (2022). Indigenous african orphan legumes: Potential for food and nutrition security in SSA. *Front. Sustain. Food Syst.*6, 83. 10.3389

Aditya, J.P., Bhartiya, A., Chahota, R.K., Joshi, D., Chandra, N., Kant, L., et al. (2019). Ancient orphan legume horse gram: A potential food and forage crop of future. *Planta.*250, 891–909

Chankaew, S., Sriwichai, S., Rakvong, T., Monkham, T., Sanitchon, J., Tangphatsornruang, S., et al. (2022). The first genetic linkage map of winged bean [*Psophocarpus tetragonolobus* (L.) DC.] and QTL mapping for flower-pod-and seed-related traits. *Plants (Basel)* 11, 500.

Chivenge, P., Mabhaudhi, T., Modi, A.T., Mafongoya, P. (2015). The Potential Role of Neglected and Underutilised Crop Species as Future Crops under Water Scarce Conditions in Sub-Saharan Africa. *Int. J. Environ. Res. Public. Health*. 26;12(6):5685-711.

Dwivedi, S.L., Chapman, M.A., Abberton, M.T., Akpojotor, U.L., Ortiz, R. (2023). Exploiting genetic and genomic resources to enhance productivity and abiotic stress adaptation of underutilized pulses. *Front. Genet.* 14:1193780.

Laosatit, K., Amkul, K., Chankaew, S., Somta, P. (2022). Molecular genetic diversity of winged bean gene pool in Thailand assessed by SSR markers. *Hort. Plant J.*8, 81–88.

Owino, V., Kumwenda, C., Ekesa, B., Parker, M.E., Ewoldt, L., Roos, N., et al. (2022). The impact of climate change on food systems, diet quality, nutrition, and health outcomes: A narrative review. *Front. Clim.*4, 941842.

Tseng, M., Roel, A., Deambrosi, E., Zorrilla, G., Riccetto, S., Pittelkow, C. (2020). Towards actionable research frameworks for sustainable intensification in high-yielding rice systems. *Sci. Rep.* 10 (1), 9975.

Venn, B.J. and Mann, J.I. (2004). Cereal grains, legumes and diabetes. *Eur. J. Clin. Nutr.*58, 1443–1461.