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Utility of Underutilized Crops in the Era of Climate Change for Nutritional Security and Sustainable Development

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Climate change poses a significant threat to global food systems by adversely affecting crop productivity, nutritional quality and livelihood security. Rising temperatures, erratic rainfall patterns, soil degradation and an increasing frequency of extreme weather events have heightened the vulnerability of conventional agricultural systems. In this context, underutilized and neglected crops often referred to as orphan, minor or traditional crops, offer considerable potential to enhance nutritional security and promote sustainable development. These crops are generally resilient to harsh climatic conditions, require fewer external inputs and possess superior nutritional profiles. Despite these advantages, they remain marginalized in agricultural research, policy frameworks and food markets. This review examines the role of underutilized crops in addressing climate change challenges, improving nutritional outcomes, supporting smallholder livelihoods and ensuring sustainable agricultural development. Emphasis is placed on their agronomic resilience, nutritional value, socio-economic benefits and contribution to agro-biodiversity.

Keywords: Underutilized crops, Climate change, Nutritional security, Sustainable agriculture, Agro-biodiversity, Food systems

Introduction

Global agriculture is facing unprecedented challenges due to climate change, rapid population growth and the depletion of natural resources. Modern food systems rely heavily on a narrow range of staple crops such as rice, wheat and maize, making them increasingly vulnerable to environmental stresses. Climate change has intensified droughts, floods, salinity intrusion, pest infestations and disease outbreaks, resulting in yield instability and rising food insecurity, particularly in developing countries.

Underutilized crops including millets, pseudo-cereals, indigenous legumes, roots, tubers and traditional leafy vegetables have historically supported local food systems but have been neglected due to agricultural modernization and commercialization. These crops are well adapted to marginal environments and possess inherent tolerance to climatic extremes. Reviving and integrating underutilized crops into mainstream agricultural systems can play a crucial role in enhancing climate resilience, achieving nutritional security and advancing sustainable development goals.

Underutilized Crops and Climate Resilience

Underutilized crops are naturally adapted to diverse agro-ecological conditions, including drought-prone, saline and low-fertility soils. Crops such as sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*), finger millet (*Eleusine coracana*), cowpea (*Vigna unguiculata*),

adzuki bean (*Vigna angularis*) and quinoa (*Chenopodium quinoa*) exhibit high tolerance to heat and water stress. Their deep root systems, efficient water-use mechanisms and relatively short growth cycles make them particularly suitable for climate-stressed environments.

Moreover, these crops require fewer external inputs such as chemical fertilizers and pesticides, thereby reducing greenhouse gas emissions and environmental pollution. Integrating underutilized crops into diversified farming systems enhances resilience by minimizing dependence on climate-sensitive major cereals.

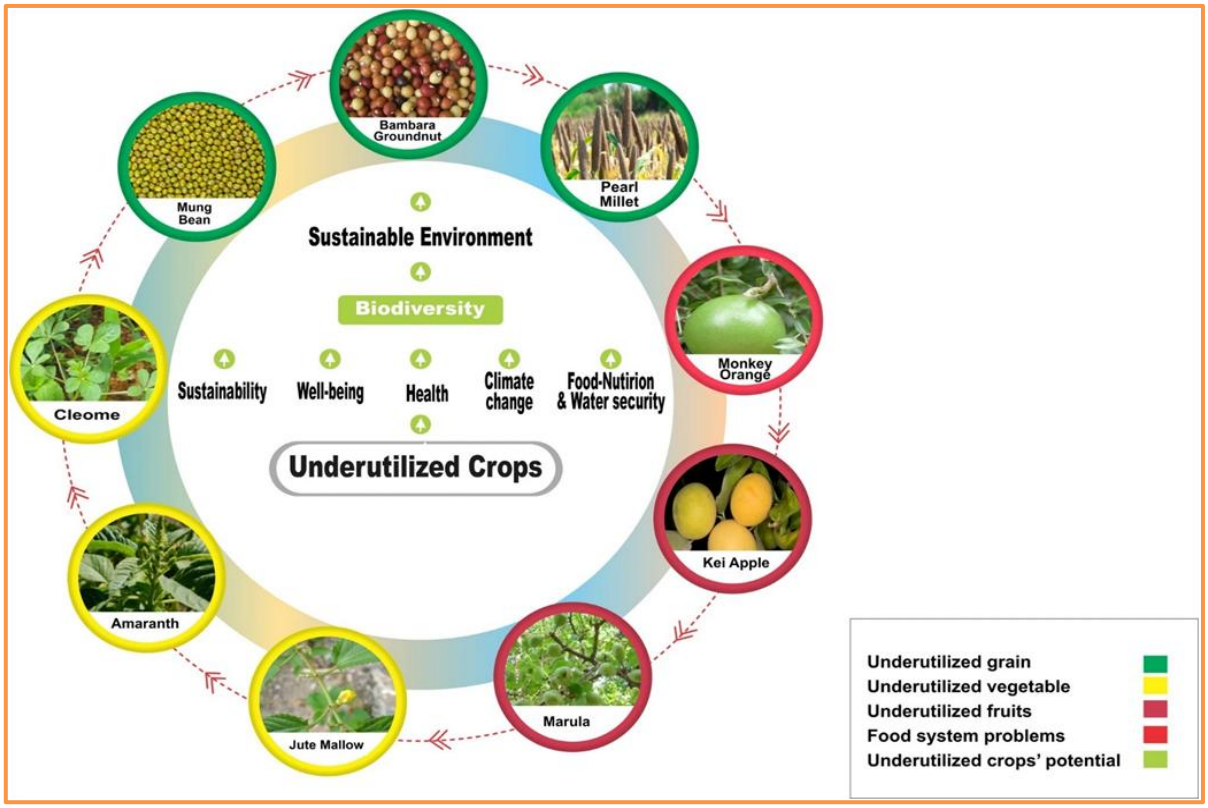

Figure 1. Schematic presentation of underutilized crops' potential to transform the food system under climate change, illustrating pathways to food, nutrition, and water security (adapted from Grovermann *et al.*, 2025).

Contribution to Nutritional Security

A major advantage of underutilized crops lies in their superior nutritional composition. Many of these crops are rich sources of protein, dietary fiber, essential vitamins, minerals and bioactive compounds. Millets are known for their high iron and calcium content, while indigenous legumes including cowpea and adzuki bean are excellent sources of plant-based protein, iron and dietary fiber.

Table 1. Nutritional comparison of selected underutilized crops and major cereals (per 100 g, approximate values)

Crop	Protein (g)	Dietary fiber (g)	Iron (mg)	Calcium (mg)
Rice (polished)	6.8	0.2	0.7	10
Wheat	11.8	1.2	3.5	34
Finger millet	7.3	3.6	3.9	344
Pearl millet	11.6	1.3	8.0	42
Sorghum	10.4	2.7	4.1	25
Cowpea	24.0	6.3	8.3	110
Adzuki bean	20.0	7.3	5.0	66

Source: Saleh et al. (2013); Upadhyaya & Vetriventhan (2018); FAO (2019); Kumar et al. (2023).

The table highlights the nutritional superiority of underutilized crops over major cereals, particularly in terms of protein, iron, calcium and dietary fiber. Adzuki bean, an important but underutilized legume in many regions, demonstrates high protein and fiber content, reinforcing its role in improving dietary quality and combating micronutrient deficiencies.

Role in Sustainable Development

Underutilized crops contribute to sustainable development by supporting environmental sustainability, economic viability and social equity. Their cultivation enhances agro-biodiversity, which is essential for ecosystem stability and long-term food security. Diverse cropping systems improve soil health, reduce pest and disease pressure and enhance carbon sequestration. From an economic perspective, underutilized crops provide livelihood opportunities for smallholder and marginal farmers by lowering input costs and increasing resilience to climate risks. Many of these crops hold cultural significance and local market relevance. Value addition through processing, branding and niche markets can further enhance farmer incomes while preserving indigenous knowledge systems.

Challenges Limiting Adoption

Despite their substantial potential, underutilized crops face multiple constraints, including limited research investment, lack of improved varieties, weak seed systems, insufficient extension services and poor market access. Policy support and subsidies continue to favor major cereals, reducing incentives for diversification. Consumer awareness regarding the nutritional and environmental benefits of underutilized crops also remains limited.

Evidence from Field Experiences

The integration of underutilized crops into climate-smart agricultural systems has demonstrated improved yield stability under drought and heat stress, enhanced dietary diversity and reduced vulnerability of farming communities. Regions promoting millets, cowpea and adzuki bean have shown better adaptation to climatic variability and improved nutrition outcomes.

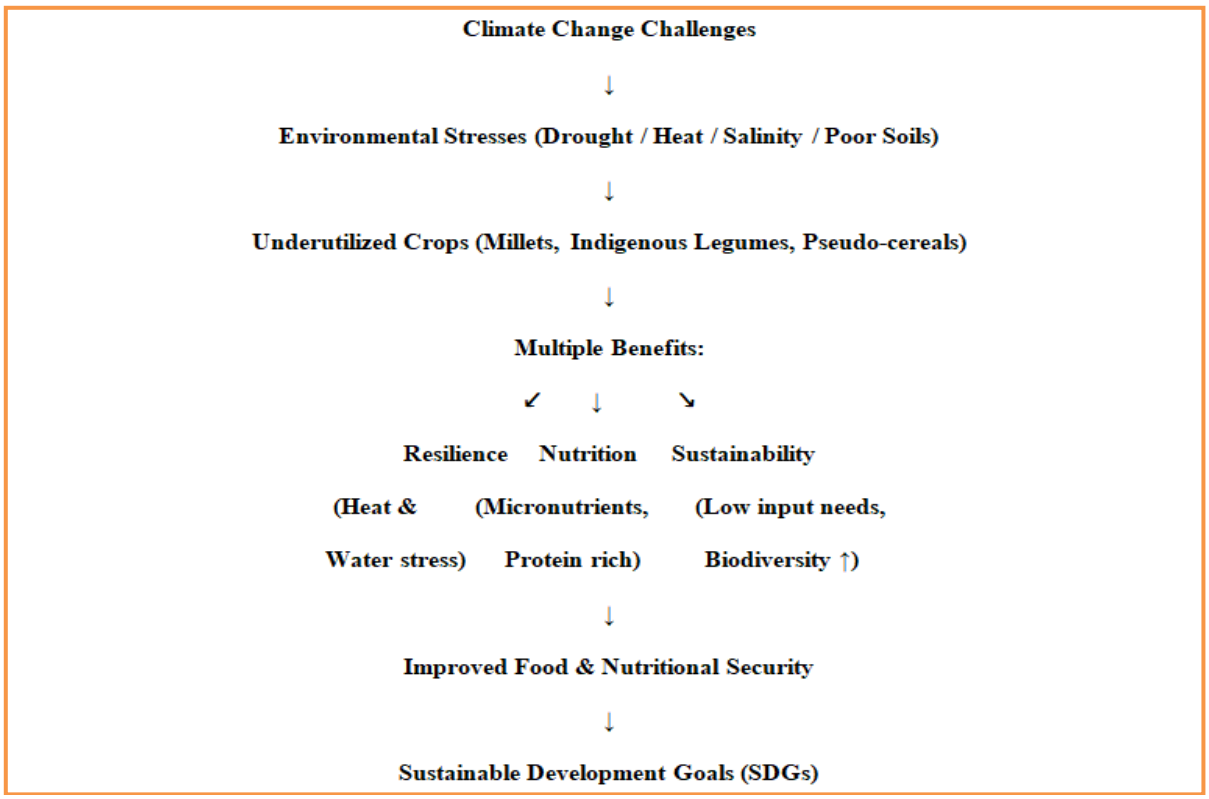

Figure 2. Underutilized crops offer a systemic response to climate change by enhancing resilience, nutrition and sustainability.
(Adapted from Padulosi et al. (2013) and Kumar et al. (2023).)

Future Directions

Future efforts should focus on mainstreaming underutilized crops through:

- Development of high-yielding, climate-resilient varieties
- Strengthening seed systems and extension services
- Promoting value addition, processing technologies and market integration
- Inclusion of underutilized crops in national food and nutrition programs
- Enhancing consumer awareness and dietary diversification

Participatory and interdisciplinary approaches will be critical for sustainable adoption.

Conclusion

Underutilized crops, including millets and indigenous legumes, represent viable solutions to the intertwined challenges of climate change, nutritional insecurity and unsustainable agriculture. Their resilience to environmental stresses, superior nutritional composition and contribution to agro-biodiversity make them indispensable components of future food systems. Strategic policy interventions, strengthened research support and market development are essential to unlock their full potential and ensure a resilient and nutritious food future.

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