AGRI MAGAZINE
(International E-Magazine for Agricultural Articles)
Volume: 03, Issue: 06 (June, 2026)
Available online at http://www.agrimagazine.in

Beyond Staple Crops: Strategies for Promoting Nutrient-Dense and Climate-Resilient Agricultural Systems

Ashutosh Sharma[1], Chander Mohan[2], Vikram Singh Gaur[3], Rajesh Kumar Singh[1], Ashutosh Singh[1], *Sharwan Kumar Shukla[1]

[1]RLB Central Agricultural University, Jhansi, U.P., India
[2]ICAR–IIMR, Regional Maize Station, Begusarai, Bihar, India
[3]College of Agriculture, Balaghat, JNKVV, Jabalpur, M.P., India
*Corresponding Author's email: sharwanshukla@gmail.com

Global agricultural systems are depends on crop like rice, wheat and maize to fulfil the food demand and caloric needs. Dependency on only three staple food crops contributed to homogenization, nutrient deficiencies, malnutrition, climatic degradation and highly vulnerability to climate change. Global food security is under risk for continuously increasing populations due to uncertain environmental conditions. To fulfil the global food and nutritional security in the era of climate change, high-value nutrient-dense crops like pulses, millets, legumes, minor fruits, nuts and indigenous vegetables offer viable solutions. These nutrient-dense crops enhance daily nutrient-intake, support agrobiodiversity, increase farm income, and reduce cultivation costs and demonstrating resilience to abiotic stresses like extreme heat and drought. In this article, authors has advocated for adaptation of nutrient-dense, diversified, and climate resilient crops to achieve durable food sustainability under adverse environmental conditions.

Keywords: Climate change, climate resilient, sustainable development, food security, nutrient-dense, crop diversification.

Introduction

Global agricultural production depends on limited staple food crops like rice, wheat and maize in most of the developing countries. In the mid of twentieth century, increasing agricultural productivity was essentially considered to combat food shortage, reducing hunger for rapidly increasing global populations. Revalorization of semi-dwarf crop cultivars of rice, wheat and maize, use of chemical fertilizers, development of irrigation infrastructure, and maximum price support towards government significantly increases food production to fulfil the national food demand (Fanzo, et al., 2020). Other than these staple crops, promotion of climate resilient, underutilized nutrient-dense crops may provide strength to the development of agricultural and nutritional sustainability for the increased global populations (Mir, et al., 2020).

Decadal monoculture farming system reduced crop diversification, and limited the cultivation of nutrient-dense crops like pulses, millets, climate resilient underutilized fruits and vegetables (Baldermann, et al., 2016). These imbalances have contributed to the persistence of hidden-hunger in various forms like micronutrient deficiency, obesity, and diet related diseases. Additionally, unprecedented climatic challenges including high temperature, drought, salinity, unpredictable rainfall and increased pathogen attack created pressure on agriculture production. These triple challenges (nutritional, environmental and economic) highlights quick transformation of fundamental agricultural policy. In coming future, global food security must not be ensure sufficient food production but also needed dietary quality, climatic sustainability as well as adaptation of climate change (Jagermeyr, et al., 2021). In the

era of climate change and nutritional crisis, diversified farming system through integration of climate resilient nutrient-dense crops has offering robust pathways to achieve long-term sustainability (Bianca, et al., 2023). Thus, refined policy in support to production, distribution, and consumption of diverse food must be create nutritional sensitive and resilient agricultural systems that rapidly contribute to accelerate ecological stability, rural development and improved public health.

Diversified Agricultural Systems

Diversified agricultural systems play important role in the nutritional security and sustainable agricultural development. In the changing climatic conditions, crop diversification provide a sustainable alternative to the staple crops through integration of diverse climate resilient nutrient-dense crops including millets, pulses, and neglected species of fruits and vegetables (Islam and Fraser, 2026). Furthermore, diversified agricultural systems enhance dietary diversity, strengthen farm income and minimize production risk. Promotion of these crops in the adverse environmental condition may also enhance agro-biodiversity, improve soil health and increase resilience to various climatic threats like drought, salinity and extreme temperature.

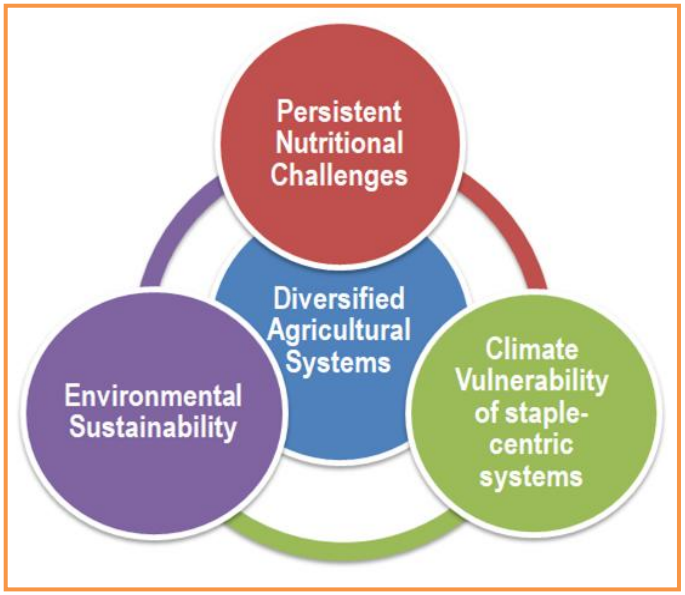

Figure-1: Diversified Agricultural Systems to Enhance Nutritional Security and Climate-resilience

Persistent Nutritional Challenges: Food security is the challenging issue for continuously increasing population because of the dependency on few staple crops. Many populations suffer from hidden hunger due to deficiency of essential minerals and vitamins in their daily diet. Common nutritional challenges include iron deficiency anemia, vitamin A deficiency, zinc deficiency, protein-energy malnutrition, and inadequate consumption of fruits and vegetables. While staple grains such as rice, wheat, and maize are important sources of energy, they often lack adequate levels of key micronutrients. Increasing the production, availability, and consumption of nutrient-dense crops can address these deficiencies, improve dietary quality, and contribute to better public health and long-term food and nutrition security (Wood, et al., 2018).

Climate Vulnerability of Staple-Centric Systems: Limited numbers of major crops increases the vulnerability of agricultural systems to climatic and economic shocks. Climatic threats like drought, heat, and water scarcity intensifying risk on the crops like rice and wheat and increasing the incidence of disease and pests on these crops. Further prolonged monoculture practices of these staple crops negatively contribute to fertility declining, soil degradation and reduced ecosystem health. Long-term challenges of such practices significantly undermine the food production and farmers livelihoods. Therefore, integration of diversified agricultural systems is very essential to spreading the risk across diverse crops and production cycles (Fanzo, et al, 2020). Diversified agricultural systems significantly contribute to the enhancement of resilience, improve resource use efficiency and enable farmers to better adaptation of the changing environmental conditions for maintaining long-term agricultural sustainability and nutritional security.

Environmental Sustainability: Promotion of diversified agricultural systems play vital role in the development of environmental sustainability. Integration of wider variety of crops, farmers can improve soil health, biodiversity, and nutrient cycle (Hunter, et al., 2017). Additionally, diversified farming systems reduce the dependency of chemicals, fertilizers,

and lowering the cultivations costs. It can significantly contribute in the reduction of the emission of greenhouse gas by resource efficiency and carbon sequestration.

Nutrient-Dense and Climate-Resilient Crops

Traditional and indigenous crops like millets, neglected legumes, pulses and underutilized vegetables and fruits are rich in nutrition and resilient of climate change. These crops are able to thrive in adverse environmental conditions and provide essential minerals, vitamins, proteins and antioxidants. Cultivation of these crops require fewer inputs and are able to survive in unfavourable conditions like drought, heat, poor soil making them most suitable for strengthening food security and enhancing agricultural resilience (Baldermann, et al., 2016).

Table-1: Nutrient-Dense and Climate-Resilient Crops for Sustainable Food Systems

Crops	Nutritional Attributes	Climate Resilience	Security
Pearl millet, Finger millet, Foxtail millet, Sorghum,	Rich in iron, zinc, calcium, dietary fiber, antioxidants, and complex carbohydrates	Tolerant to drought, heat, and salinity; perform under low-input conditions	Improve dietary quality, enhance climate-smart agriculture, and support sustainable food systems
Chickpea, Pigeon pea, Lentil, Mung bean, Cowpea, Common bean	High-quality protein, dietary fiber, iron, zinc, and other micronutrients	Adapted to diverse agroecological conditions; require relatively low external inputs	Reduce protein and micronutrient deficiencies, improve soil by biological nitrogen fixation
Faba bean, Winged bean, Ivy gourd, Spine gourd, Amaranth, Moringa, Taro,	Rich in vitamins, minerals, antioxidants, dietary fiber, and bioactive compounds	Adapted drought, suitable for marginal lands with limited inputs	Enhance dietary diversity, conserve agrobiodiversity, and promote resilient agricultural systems
Bael, Jamun, Aonla, Tamarind, Karonda, Wood apple, Ber	Excellent sources of vitamins, minerals, antioxidants, and phytochemicals	Growing under adverse climatic conditions with lower production costs	Improve micronutrient intake, support immune, contribute to agricultural sustainability

Millets: Millets are recognized as super food because of its exceptional nutritional value and ability to survive in adverse climatic conditions. Most of the millet crop species are able to tolerate in drought, heat, and salinity making them to most suitable for climate-smart agriculture. Some millet cultivars like pearl millet, finger millet, foxtail millet, and sorghum contribute to sustainable food system because of the availability of essential minerals including iron, zinc, calcium, dietary fiber, and antioxidants.

Pulses and Legumes: Legumes are the calorie rich and nutrient-dense crops having high quality protein, fibers and essential micronutrients like zinc, iron. Daily intake of pulses reduces prevalence of micronutrient and protein deficiency and significantly contributes to improved nutrition and support to healthier body growth. Other than nutritional benefits, pulses also contribute to sustainable agricultural development by increasing soil fertility by natural nitrogen fixation. Thus integration of pulses in crop production system may reduces the consumption of chemical fertilizers and enhance food security system.

Indigenous and Underutilized Crops: High-value indigenous neglected crops like faba bean, ivy gourd, sponge gourd, winged bean, quinoa, spine gourd, amaranth, moringa, taro, bambara groundnut exhibited strongest adaptive traits under changing climatic conditions make them valuable for sustainable agricultural development. These crops are able to thrive

in harsh environmental conditions and require limited inputs for cultivation. Additionally, these crops have high nutritional value like rich in micronutrients, antioxidants and dietary fiber. Promoting their cultivation and consumption can enhance dietary diversity, improve food security, and support agricultural biodiversity.

Neglected Fruits: Some neglected fruit crops have potential to enhance nutritional quality because of the availability of essential minerals, vitamins, and antioxidants making them to useful in prevention of micronutrient deficiencies and support immune health. Most of the neglected fruit crops are able to survive in harsh environmental conditions requires, less cost of cultivation and gives higher economic returns per hectare compared to many staple crops. Therefore, promotion of these crops provides strength to the nutritional security and agricultural sustainability.

Climate Resilience through Diversification

Diversification by integration multiple crops, diverse crop cultivars, and low costs farming practices plays crucial role in the development of climate resilience. Development of climate resilience though agricultural diversification significantly reduces the dependency on single crop and spread risk in diverse production cycle (Bianca, et al., 2023). Such type of diversification practices marking crop production less vulnerable to climatic socks including, extreme temperature, flood, drought, heatwaves and pathogen outbreaks. Additionally, diversified agricultural systems also accelerates soil health, water-intake efficiency and ecosystem sustainability enabling better standing to changing climatic conditions.

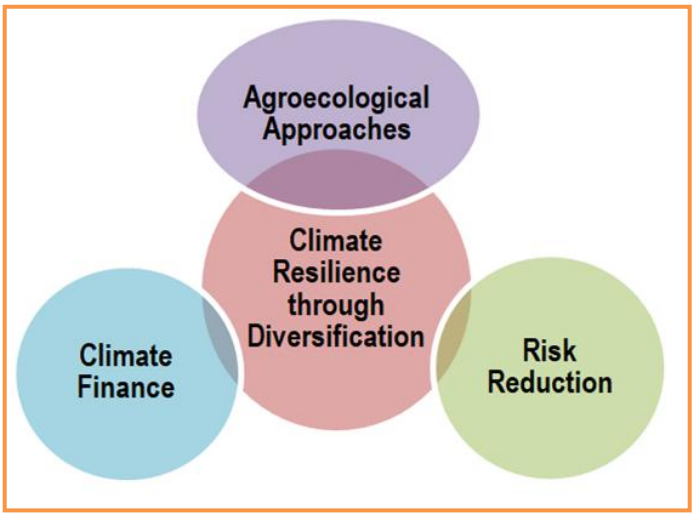

Figure-2: Role of Crop Diversification on Climate Resilience

Risk Reduction: In the era of climate change, diversified agricultural systems increase production stability by reducing cultivation costs and resilience. Multilayered cropping or multiple cropping pattern may also expose to production salability by reducing the effect of climatic variability like drought and flood. Mixed farming systems are also more resilient, often recovering faster after climatic shocks due to ecological balance and resource complementarities, ensuring more consistent agricultural performance.

Agroecological Approaches: Sustainable agroecological practices like crop rotation, intercropping, agroforestry, integrated insect, pest and diastase management plays important role in the formulation of durable strategy for development of conservation agricultural system. Standardized agroecological approaches improve soil health, resource use efficiency and significantly reduce the dependency of chemical inputs in crop production (Herrero, et al., 2017). Particularly, crop rotation and intercropping provide strength to break the pest and pathogen cycle, whereas agroforestry system may enhances ecosystem services.

Climate Finance: Climate finance and subsidy by government for diversified farming pattern may enable the resilience and productivity under changing environmental conditions. Further investment also needed to promotion of traditional and indigenous crop cultivars able to adopt in local climatic conditions may significantly contribute to food security and agricultural sustainability (Bodirsky, et al., 2020). In drought-prone area, sustainable and efficient water management practices like watershed development, conservation and restoration of natural water and water reservoir may also provide strength to agricultural sustainability.

Conclusion

Creating agricultural systems that nourish global populations, sustain ecosystem and withstand climatic socks like high temperature, drought, and soil salinity is more essential in coming future. Promotion of only staple food crops like rice, wheat and maize are inadequate to addressing contemporary challenges like malnutrition, environmental degradation, and climate change. Integration of nutrient-dense and climate resilient system provide strength to achieve long-term nutritional security, ecological sustainability and climatic adaptation. Additionally, investment in research, public procurement, farmer support, processing industry and market development can reshape future food systems.

References

1. Baldermann, S., Blagojevic, L., Frede, K., Klopsch, R., Neugart, S., Neumann, A., Ngwene, B., Norkeweit, J., Schro¨ ter, D., Schro¨ ter, A. (2016). Are neglected plants the food for the future? *Crit. Rev. Plant Sci.* 35, 106–119.
2. Bianca, C., Jonas, J., Alex Ruane, C., Jessica, F. (2023). Rising to the challenge: Producing and sustaining a nutrient-dense and climate-resilient food basket for all. *One Earth*, 6 (11) 1143-1446.
3. Bodirsky, B.L., Dietrich, J.P., Martinelli, E. (2020). The ongoing nutrition transition thwarts long-term targets for food security, public health and environmental protection. *Sci Rep* 10, 19778.
4. Fanzo, J., Haddad, L., McLaren, R., Marshall, Q., Davis, C., Herforth, A., Jones, A., Beal, T., Tschirley, D., Bellows, A. (2020). The Food Systems Dashboard is a new tool to inform better food policy. *Nat. Food* 1, 243–246.
5. Herrero, M., Thornton, P.K., Power, B., Bogard, J.R., Remans, R., Fritz, S., Gerber, J.S., Nelson, G., See, L., Waha, K. (2017). Farming and the geography of nutrient production for human use: a transdisciplinary analysis. *Lancet Planet. Health* 1, e33–e42.
6. Hunter, M.C., Ssmith, R.G., Schipanski, M.E., Atwood, L.W., Mortensen, D.A. (2017). Agriculture in 2050: recalibrating targets for sustainable intensification. *BioScience* 67, 386–391.
7. Islam, M.M. and Fraser. E.D.G. (2026). "Climate-Resilient Agri-Food Systems (CRAFS): A Review of Approaches and Outcomes of Agri-Food Systems." *Sustainable Development* 1–16.
8. Jagermeyr, J., Muller, C., Ruane, A.C., Elliott, J., Balkovic, J., Castillo, O., Faye, B., Foster, I., Folberth, C., Franke, J.A., et al. (2021). Climate impacts on global agriculture emerge earlier in new generation of climate and crop models. *Nat. Food 2*, 873–885.
9. Mir, R.R., Rustgi, S., Zhang, YM. (2020). Multi-faceted approaches for breeding nutrient-dense, disease-resistant, and climate-resilient crop varieties for food and nutritional security. *Heredity* 128, 387–390.
10. Wood, S.A., Smith, M.R., Fanzo, J., Remans, R., DeFries, R.S. (2018). Trade and the equitability of global food nutrient distribution. *Nat. Sustain*. 1, 34–37.