

AGRIFRONTLINE

The Voice of Agriculture

Role of Millets, Pulses and Indigenous Crops in Climate-Resilient Food Systems

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1. Introduction

One of the biggest risks to the world's food systems is climate change, which exacerbates heat stress, droughts, floods, and soil degradation. A limited variety of crops, including rice, wheat, and maize, dominate conventional food systems, making them more susceptible to climatic fluctuations. In this regard, diversifying agriculture with millets, pulses, and native crops has become an essential tactic for creating food systems that are resilient to climate change. These crops are essential for future food and nutrition security because they have historically supported human populations in marginal environments and have special adaptive, nutritional, and ecological advantages.

The goal of climate-resilient food systems is to guarantee consistent food availability, accessibility, consumption, and sustainability in the face of climate shocks. By increasing agro-biodiversity, boosting soil health, lowering reliance on outside inputs, and giving vulnerable populations

access to nutrient-dense food, millets, pulses, and native crops help achieve these goals.

2. Millets as Climate-Resilient Cereals

2.1 Agro-ecological Adaptability

Small-seeded cereal crops, millets are suited to arid and semi-arid climates. Their superior water-use efficiency, deep and effective root systems, and brief growing cycles are all responsible for their resilience. Under rainfall conditions below 400 mm, where major cereals fail, many millets can yield economically. They are perfect crops in climate-change scenarios marked by heat waves and protracted dry spells because of their resistance to high temperatures and unpredictable rainfall. Additionally, millets do well on marginal lands with low soil fertility and little input. Their low need for pesticides and fertilizers lowers production costs and environmental impacts, making them appropriate for low-carbon and sustainable agriculture.

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2.2 Contribution to Nutritional Security

From a nutritional standpoint, millets are high in vitamins, minerals like iron, calcium, zinc, and magnesium, complex carbohydrates, dietary fiber, and essential amino acids. Because millets have a lower glycaemic index than refined cereals, they can help manage cardiovascular and diabetes conditions. They are even more crucial in treating food intolerances and lifestyle disorders because they are gluten-free. Millet-based diets can greatly improve nutritional outcomes, especially for women and children, in areas with hidden hunger and micronutrient deficiencies.

2.3 Environmental Sustainability

By increasing soil organic matter, conserving water, and lowering greenhouse gas emissions, millet farming helps to strengthen the environment. Millets produce fewer greenhouse gases and

require much less irrigation than rice and wheat. Their incorporation into crop rotations strengthens the stability of the agro-ecosystem by improving soil structure and disrupting pest and disease cycles.

2.4 Physiological and Agronomic Resilience

Millets are highly adapted to climatic stress due to the following characteristics:

- C4 photosynthetic pathway, which enhances water-use efficiency
- Deep and extensive root systems enabling moisture extraction from deeper soil layers
- Short life cycle, allowing escape from terminal drought
- High tolerance to temperature extremes
- Ability to grow in low-fertility and degraded soils

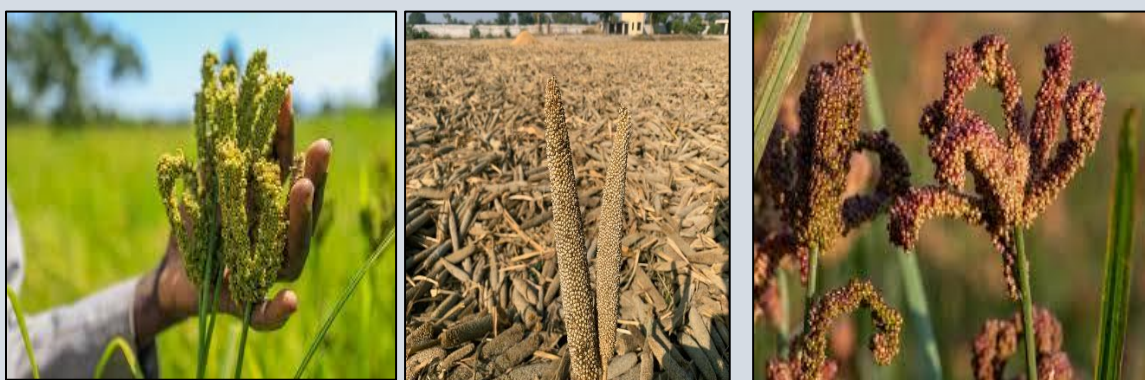


Figure 1: Millets cultivated under arid and semi-arid conditions demonstrate drought and heat tolerance

3. Pulses in Climate-Resilient Food Systems

3.1 Biological Nitrogen Fixation and Soil Health

Because of their capacity to fix atmospheric nitrogen through symbiotic relationships with rhizobia, pulses are essential to climate-resilient agriculture. This lowers production costs, lessens reliance on artificial nitrogen fertilizers, and reduces emissions of nitrous oxide. Pulses contribute to long-term soil health and productivity by increasing soil carbon sequestration, boosting microbial activity, and improving soil fertility.

3.2 Climate Adaptation and Resource Efficiency

Many pulse crops, including lentils, cowpeas, chickpeas, and pigeon peas, can withstand drought and thrive in rainfed environments. They can tolerate moisture stress because of their deep root systems and adaptable growth habits. Additionally, pulses require less water than cereals, which makes them appropriate for areas with limited water resources. Pulses are perfect intercroops or rotational crops in diversified farming systems, increasing the system's overall resistance to climate variability.

3.3 Nutritional and Livelihood Benefits

High-quality plant protein, dietary fiber, and vital micronutrients can all be found in

pulses at reasonable prices. They are essential for increasing dietary diversity, especially in low-income and vegetarian populations. By distributing risk and giving smallholder farmers more market opportunities, pulse cultivation improves farm income stability.

Nutritional content in 100 gms of dry Grain	Protein (in gms)		Carbohydrates (in gms)		Fat (in gms)		Minerals (in mg)		Fiber (in gms)		Calcium (in mg)		Phosphorus (in mg)		Iron (in mg)		Energy (in KCal)		Thiamine (in mg)		Niacin (in mg)	
Foxtail	12.3	60.2	4.3	4	6.7	31	290	2.8	351	0.59	3.2											
Little	7.7	67	4.7	1.7	7.6	17	220	9.3	329	0.3	3.2											
Kodo	8.3	65.9	1.4	2.6	5.2	35	188	1.7	353	0.15	2											
Proso	12.5	70.4	1.1	1.9	5.2	8	206	2.9	354	0.41	4.5											
Barnyard	6.2	65.5	4.8	3.7	13.6	22	280	18.6	300	0.33	4.2											
Sorghum	10.4	70.7	3.1	1.2	2	25	222	5.4	329	0.38	4.3											
Pearl	11.8	67	4.8	2.2	2.3	42	240	11	363	0.38	2.8											
Finger	7.3	72	1.3	2.7	3.6	344	283	3.9	336	0.42	1.1											
Paddy Rice	6.8	78.2	0.5	0.6	1	33	160	1.8	362	0.41	4.3											
Wheat	11.8	71.2	1.5	1.5	2	30	306	3.5	348	0.41	5.1											
Quinoa	14	64	6	*	7	36	457	4.6	368	0.36	*											

Compiled from a study published by the National Institute for Nutrition, Hyderabad and other sources for Quinoa.

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4. Indigenous and Traditional Crops: Hidden Assets for Resilience

4.1 Genetic Diversity and Climate Adaptation

Centuries of natural and farmer-led selection have shaped the rich genetic diversity of indigenous crops, including underutilized species and traditional landraces. Inherent resistance to regional stressors like salinity, drought, pests, and illnesses is provided by this diversity. Traditional rice landraces, minor millets, tubers, and leafy vegetables are examples of crops that have evolved to thrive in particular agroclimatic conditions, making them priceless genetic resources for climate adaptation.

4.2 Cultural and Ecological Significance

Local food cultures and traditional knowledge systems are intricately linked to indigenous crops. Their production promotes agro-ecological farming methods that prioritize mixed crops, organic inputs, and biodiversity. Pollination, nutrient cycling, and natural pest control are among the ecosystem services that these systems improve.

4.3 Role in Food Sovereignty

Communities can increase their food sovereignty and lessen their reliance on outside inputs and international supply

chains by supporting local crops. This is especially crucial when local food systems act as a safety net for vulnerable populations during climate-related disruptions.

5. Indigenous Crops: Preserving Agro-Biodiversity and Cultural Heritage

Indigenous crops include traditional landraces and underutilised species such as minor millets, indigenous tubers, oilseeds, leafy vegetables, and pseudo-cereals.



Figure 2 Indigenous crops cultivated in traditional mixed farming systems enhance biodiversity

6. Synergistic Role in Climate-Resilient Food Systems

Comparative Role of Millets, Pulses, and Indigenous Crops

Parameter	Millets	Pulses	Indigenous Crops
Water requirement	Very low	Low	Very low
Climate tolerance	Drought, heat	Drought, variable rainfall	Multi-stress tolerance
Soil fertility role	Improve structure	Nitrogen fixation	Organic matter enhancement
Nutritional value	High fiber, minerals	High protein	Diverse micronutrients

Input requirement	Minimal	Low	Very low
Suitability for marginal lands	High	High	Very high
Contribution to biodiversity	Moderate	High	Very high
GHG mitigation potential	High	Very high	High

7. Policy, Research, and Development Perspectives

Millets, pulses, and native crops continue to be underutilized in mainstream agricultural policies and research agendas despite their enormous potential. To increase their contribution to climate-resilient food systems, they must:

- Development of effective post-harvest processing and value-addition technologies
- Increased funding for breeding programs centered on yield stability and climate tolerance
- Incorporation of these crops into public food distribution, nutrition, and school feeding programs
- Awareness campaigns to encourage consumer acceptance and dietary diversification

Scaling up resilient cropping systems and guaranteeing fair benefits for farmers and consumers require institutional frameworks and supportive policies.

8. Conclusion

Climate-resilient food systems must include millets, pulses, and native crops. They are strategic crops for tackling the interconnected problems of climate change, food insecurity, and malnutrition because of their agronomic resilience, nutritional richness, ecological sustainability, and socioeconomic advantages. Food systems can be transformed into resilient, inclusive, and sustainable frameworks that can withstand future climate uncertainties by revitalizing these crops through research, policy support, and consumer awareness.

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