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Climate Smart Farming with Native Millets

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Introduction

Climate-smart farming integrates sustainable agricultural practices to enhance productivity while mitigating climate change impacts and adapting to its effects. Native millets, with their inherent resilience, are key to this approach. Millets are ancient grains renowned for their nutritional value and are often referred to as miracle crops due to their numerous health benefits.Millets are small-seeded annual grasses cultivated as grain crops, primarily on marginal lands in dry temperate, subtropical, and tropical regions. Encouraging millet cultivation can solve global challenges related to climate, water scarcity, and under nutrition.

As one of the first domesticated food plants, the earliest evidence of millet cultivation dates back to the Indus civilization around 3000 BC. Millets are now grown in 131 countries and serve as a traditional staple for 590 million people in Asia and Africa.Global millet production totals 98 million tonnes, with sorghum accounting for 63% of this amount, while pearl millet contributes 24% (Yadav*et al.,* 2024). In 2021-22 leading millet-producing states in India are Rajasthan, Maharashtra, Karnatakaand Uttar Pradesh (IDI, 2023).

While India has achieved self-sufficiency in food grain production, nutritional security remains a challenge, with many unable to afford nutritious food. Millets, being highly nutritious, offer a viable solution. They include major millets like Sorghum, Finger millet, and Pearl millet, and minor millets such as Foxtail millet, Proso millet, Kodo millet, Barnyard millet, Little millet, and Brown top millet.

Cropping systems:

Millet-based cropping systems are highly adaptable and can be effectively integrated into diverse farming models, with their crop residues serving as valuable fodder for livestock.Millets enhance biodiversity and are traditionally cultivated for soil conservation. Farmers often grow six to twenty different crops simultaneously. In India, millet cropping systems are diverse and vary based on regional climates, soil types, and agricultural practices. Here are some notable millet cropping systems:

1. **Dryland Farming Systems:** Rajasthan: Millets like Pearl Millet (Bajra) are commonly grown in dry and arid regions. Crops are often intercropped with pulses or oilseeds to maximize land use and improve soil fertility.

   Dakkani Plateau: Millet crops such as Finger Millet (Ragi) and Pearl Millet are cultivated alongside legumes and other drought-resistant crops.

2. **Mixed Cropping Systems:** Southern India: In states like Karnataka and Tamil Nadu, Finger Millet (Ragi), Foxtail Millet, and Little Millet are grown in mixed cropping systems with pulses, oilseeds, and other cereals. This approach helps in maintaining soil fertility and reducing pest incidence.

3. **Integrated Farming Systems:** Himalayan Region: The Barahnaja cropping system involves growing up to 12 different crops, including various millets, along with pulses and oilseeds. This system supports soil conservation and biodiversity.

   North-Eastern States: In states like Manipur and Mizoram, millets are grown in conjunction with vegeta-

Krishi Netra
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bles and legumes in a diversified cropping system that enhances food security and soil health.

4. **Traditional Systems:** Central India: Millets such as Pearl Millet and Sorghum are cultivated in traditional systems that integrate them with other staple crops like pulses and legumes.

5. **Conservative Agriculture Systems:** Madhya Pradesh and Maharashtra: Conservation agriculture practices are employed with millets to promote soil health and water conservation, often incorporating crop residues as mulch.

Water use efficiency of millets: Millet cultivation is highly water-efficient, requiring only a fraction of the water needed for other crops.

Crop	(Rainfall requirement (mm
Sugarcane	2200 – 2000
Banana	2200 – 2000
Paddy	1300 – 1200
Chilli	600
Cotton	650 – 600
Groundnut	500 – 450
Sorghum	500 – 400
Pearl Millet	400 – 350
Finger Millet	400 – 350
Pulses	350 – 300
Sesame	350 – 300

*Rani *et al.,* 2020

Millets require minimal water, thriving with rainfall between 200 mm and 500 mm.For instance, while growing one kilogram of grain typically requires 4000 litres of water, whereas millets need significantly less, making them an excellent choice for sustainable agriculture.

Soil Adaptability: Millets thrive in various soil conditions, including low-quality, acidic, and alkaline soils, where paddy cultivation is impractical. Pearl millet can grow in sandy soils, making it suitable for regions like Rajasthan, while finger millet adapts well to alkaline soils. Barnyard millet can be cultivated in almost any soil type. Additionally, farmers often use millets as intercrops to enhance soil fertility. They are resilient in climates with less than 500 mm of annual rainfall, making them ideal for drought-prone areas like Rajasthan and DakkaniPeethaBhumi.

Nutrient Content: Millets are nutrient-dense, surpassing rice and wheat in several aspects. They are high in fiber, protein, and essential minerals like calcium and iron. Finger millet, for example, contains 30 times more calcium than rice. Millets also provide significant amounts of micronutrients, such as beta-carotene, typically found only in supplements. Given their superior nutritional profile, millets are a valuable alternative to rice and wheat, addressing malnutrition for millions.

Crops	(Protein (g	(Fiber (g	(Minerals (g	(Iron (mg	(Calcium (mg
Sorghum	10	4	1.6	2.6	54
Pearl millet	10.6	1.3	2.3	16.9	38
Finger millet	7.3	3.6	2.7	3.9	344

Krishi Netra
ISSN : 3048-5207

Foxtail millet	12.3	8	3.3	2.8	31
Little millet	7.7	7.6	1.5	9.3	17
Kodo millet	8.3	9	2.6	0.5	27
Barnyard millet	11.2	10.1	4.4	15.2	11
Proso millet	12.5	2.2	1.9	0.8	14
Browntop millet	11.5	12.5	4.2	0.65	0.01
Paddy	6.8	0.2	0.6	0.7	10
Wheat	11.8	1.2	1.5	5.3	41

*ICAR-IIMR, 2023. www.millets.res.in

Fertilizer Use: Millets can be grown in hilly areas without chemical fertilizers, relying instead on organic fertilizers like farmyard manure and vermicompost. Techniques such as using panchagavya and jeevamrutham allow farmers to maintain control over their agricultural practices while promoting sustainable farming.

Pest Management: Under favourable climatic conditions, millets grown in traditional soils are less prone to pests, eliminating the need for special pesticides. Foxtail millet is particularly effective in keeping pulses like green gram pest-free.Millets can be stored without the need for any specialized pesticides.

Weather Resilience: Millets can withstand climate changes, such as decreased rainfall, high temperatures, and water scarcity. While wheat crops fail with a 2°C temperature rise and rice cultivation releases methane, contributing to climate change, millets thrive under these conditions.Millets can be cultivated even as temperatures rise by 2-5°C.

Multi-Benefits: Millets not only ensure food security but also offer nutritional benefits, animal feed, health improvements, and environmental protection. Sorghum and pearl millet are commonly used as animal feed. Millets have a low glycaemic index, are gluten-free, help control blood sugar, improve digestive health, promote anti-aging, prevent cardiovascular diseases, detoxify the body, and prevent type 2 diabetes

1. Drought tolerance: Native millets such as Pearl Millet, Finger Millet, and Foxtail Millet are highly drought-resistant. Their deep root systems allow them to access moisture from lower soil layers, making them ideal for regions with irregular rainfall and prolonged dry periods.

2. Water use efficiency: Millets require significantly less water compared to traditional cereals like rice and wheat. For example, Pearl Millet and Finger Millet need only about 350-400 mm of water, whereas rice requires 1200-1300 mm. This water efficiency is crucial in areas experiencing water scarcity.

3. Soil health: Millets contribute to soil health through their extensive root systems, which help in preventing soil erosion and improving soil structure. They also enhance soil organic matter when crop residues are used as mulch or incorporated into the soil, further supporting soil fertility.

4. Low carbon footprint: Millets have a lower carbon footprint compared to high-water-demand crops. They produce fewer greenhouse gases during cultivation and require minimal external inputs, reducing the overall environmental impact of farming.

5. Biodiversity enhancement: Native millets can be grown in diverse cropping systems, including mixed and intercropping systems. This practice promotes agricultural biodiversity, which enhances ecosystem resilience and reduces the risk of pest and disease outbreaks.

6. Nutritional security: Native millets are nutrient-dense, providing essential vitamins, minerals, and antioxidants. They are particularly rich in calcium, iron, and dietary fibre, contributing to improved nutritional

Krishi Netra
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security for vulnerable populations.

7. Adaptation to extreme weather: Native millets can adapt to extreme weather conditions, including high temperatures and irregular rainfall patterns. Their ability to complete their growth cycle quickly allows them to withstand short-term climatic stresses.

8. Economic viability: By growing native millets, farmers can diversify their income sources. Millets often require lower inputs and have lower production costs compared to other cereals, providing a more stable economic return.

Interspersed Millets:

Millet cultivation has declined by 44% from 1966 to 2006 due to social changes, lack of government support, non-availability of loans, and lack of insurance for millet farmers. If this trend continues, millets may become a staple crop again in the next 50 years.

Strategies for strengthening climate-smart millet farming

- **Seed selection and variety improvement:** Choose drought-resistant and climate-adapted millet varieties for better yield and resilience.
- **Seed bank establishment and storage:** Creating controlled environments for preserving millet seeds to ensure their viability and reuse.
- **Integrated pest management:** Use sustainable pest management practices to reduce reliance on chemical pesticides.
- **Soil conservation practices:** Implement conservation tillage and cover cropping to maintain soil health and reduce erosion.
- **Water management:** Adopt efficient water use practices, such as rainwater harvesting and drip irrigation, where applicable.

Native millets offer a promising solution for climate-smart agriculture, addressing both environmental and socio-economic challenges while enhancing food security and sustainability.

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