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Millets, Medicinals, and Nutrition Sovereignty

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Abstract

India is at a critical point where traditional crops, such as millet and medicinal plants, can pave the way towards ecological resilience, sustainable development, and nutritional sovereignty. This chapter discusses how indigenous medicines and millets can help resolve challenges such as malnutrition, climate change, and agricultural distress. Millets were once a cornerstone of the Indian diet; however, the Green Revolution has sidelined these crops. The exceptional nutritional profile of millets suggests that they can be a solution to increasing malnutrition, obesity, anaemia, and diabetes. In addition to their nutritional value, they have unparalleled agronomical benefits, such as drought tolerance, adaptation to degraded soil, and climatic resilience. The government initiatives, such as the Year of Millets 2023 and POSHAN Abhiyan, have catalysed their revival and integration in food security programmes. The medicinal plants of India, such as ashwagandha, tulsi, and giloy, have unprecedented health benefits and economic potential. Traditional tribal knowledge and Ayurvedic knowledge emphasize food as medicine. These traditional ideas and modern approaches can help redefine nutritional sovereignty. The production of millets and medicinal plants contributes directly to the United Nations' sustainable development goals (SDGs), such as SDG 2 (zero hunger), SDG 3 (good health and wellbeing), SDG 12 (responsible consumption), and SDG 13 (climate action). Policy interventions such as minimum support prices, decentralized procurement, public distribution systems, and incentivizing farmers are critical for the revival of these crops.

This chapter addresses several challenges, such as the awareness gap, supply chain insufficiency, and the need for mechanization for millet and medicinal plant processing. This chapter argues that nutritional sovereignty can be achieved only by integrating traditional knowledge with modern scientific methods. The road map to Viksit Bharat includes farmers' empowerment, consumer education, and global leadership in millet-based solutions.

Keywords: Millets; Medicinal plants; Traditional knowledge; ITKs; Public health; SDG; Sustainability

1. Introduction

Food sovereignty in India has been a concerning topic since independence. India is among the leading countries in terms of agricultural products. However, there is a need for the rational use of these resources to ensure nutritional security. Nutritional sovereignty extends beyond food security; it emphasizes local control over food systems,

agroeconomic practices, and culturally appropriate food for all. India is facing a dilemma where the food supply is in surplus and 16.3% of the population is undernourished (PIB, 2025). The major reason for this malnutrition is the growing reliance on monocultures of rice and wheat. This dependence on monocultures has led to calorie-dense and nutrient-poor diets and a nutritional sovereignty focus on quality over quantity. The solution to these issues can be derived by reviving millets and medicinal plants that decentralize their nutritional sources.

The true purpose of nutritional sovereignty is to nourish people with dignity, sustainability, and cultural relevance. This will ensure food justice and nutritional empowerment for every Indian individual. The Indian Ministry of Health and Family Welfare (IMHFW) is working towards solving the problem of undernutrition under anganwadi services and POSHAN Abhiyaan (PIB, 2025). These initiatives work towards ensuring healthy nutrition, delivery, and development of a convergent ecosystem for health, wellness, and immunity. The Indian food security programme consists of a number of initiatives that work simultaneously towards combating hunger and malnutrition among different demographics. Some of these initiatives are the National Food Security Act (NSFA), Mission Antyodaya & Gram Panchayat Development Plans, Deendayal Antyodaya Yojana - National Rural Livelihoods Mission (NRLM), Pradhan Mantri Formalization of Micro Food Processing Enterprises (PMFME), 2020, and Millet Promotion under International Year of Millets (IYM) 2023 (**Table 1**).

Table 1: Pillars of nutrition sovereignty and Indian government initiatives

Pillars	**Key initiatives and policies**
Community-Based Food Systems	NFSA, NRLM, POSHAN Abhiyaan, SHG-led models
Local Processing Infrastructure	PMFME, PMKSY, AIF, FPO Policy
Biodiversity Protection	PKVY, NMSA, Biodiversity Act, Millets Revival

Note: SHG- self-help groups, PMKSY- Pradhan Mantri Krishi Sinchayee Yojana, AIF- Agriculture Infrastructure Fund, FPO- Farmer Producer Organization, PKVM- Pramparagat Krishi Vikas Yojana, NMSA-National Mission of Sustainable Agriculture

The vision of Viksit Bharat by 2047 significantly focuses on economic growth, environmental sustainability, social progress, and good governance. Agriculture plays a significant role in the Indian economy. Therefore, the focus of agriculture needs to shift from

only increasing production to creating a resilient, inclusive, and sustainable agricultural system to improve farmers' income and ensure food and nutritional security. Indigenous food systems play a crucial role in achieving the goals of Viksit Bharat by contributing to sustainability, resilience, nutritional security, biodiversity preservation, technical advancement, and traditional knowledge preservation.

The Viksit Bharat 2047 initiative strongly emphasizes the local for the globe. These initiatives included promoting region-specific food production, giving value to traditional crops, and using community knowledge to build sustainable and decentralized systems. Indian indigenous communities and conventional farmers have developed agroeconomic systems for centuries. The indigenous communities have an excellent understanding of intercropping and mixed farming. They use ingenious seeds, collect wild foods rich in micronutrients, and prepare foods in traditional ways that increase the bioavailability of nutrients (Kapoor, Sabharwal, & Ghosh-Jerath, 2022).

The International Year of Millets 2023 was a global initiative that highlighted millets in more than 75 countries, and India is one of these countries. Millet is a healthy alternative to conventional wheat and rice. Millets and traditional medicinal plants constitute the cornerstone of sustainable development. The production of millets and medicinal plants contributes directly to the United Nations' sustainable development goals (SDGs), such as SDG 2 (zero hunger), SDG 3 (good health and well-being), SDG 12 (responsible consumption), and SDG 13 (climate action) (A. Kumar et al., 2025). Food sovereignty in India will be a challenging journey, but with innovations, community engagement, gender inclusion, policy development, and traditional knowledge preservation, we can achieve this goal. This chapter explores the multidimensional framework for food sovereignty in India. Continued learning, the incorporation of traditional knowledge and innovation, and the development of climate-resilient nutritional food will help us achieve the goal of food sovereignty for every Indian individual.

2. Millets: Climate-Resilient Nutritional Superfoods

2.1.Historical significance and cultural roots

Millets constitute a significant part of ancient diets. Ragi, bajra, and jowar were staples in the Indus Valley civilizations. Archaeological evidence has shown that millets were consumed during the Harappa and Rakhigarhi civilizations (Ramesh, 2023). Evidence also

suggests that foxtail and barnyard millets grow alongside wheat and barley. Vedic and post-Vedic texts have also mentioned that kudhanya (small-seeded grains) were used as food (Basu & Hemamalini, 2023). Tamil texts mention that finger millet (kezhvaragu) is a worrier food (Manohar, S, 2021). Millets dominated the agricultural economy before the green revolutions. Millets contributed 40% of the total agricultural yield. Millet production in India decreased after the Green Revolution (Samtani, Mishra, & Neogi, 2024). Nevertheless, the majority of the indigenous community depends on nutritionally dense crops such as millets, pulses, and wild greens, as they are economically sustainable and culturally embedded (Choudhary, Bharadwaj, & INDIA, 2025). One such example is the Kondh tribal community of Odisha, which uses more than 300 wild plant species for food and medicines. The people's biodiversity register documented these practices at the grassroots level. The AYUSH (Ayurveda, Yoga, Unani, Siddha, and Homoeopathy) system works to integrate the traditional diet and therapeutic uses of conventional food with the modern health approach (Samal, 2015). Another initiative in this direction is the Odisha Millet Mission launched in 2017. This is a state government initiative that works toward reviving millet cultivation and consumption in Odisha. It aims to improve the livelihood of farmers, enhance nutrition, and promote sustainable agriculture (Islam & Nathan, 2025).

2.2 Nutritional profile and health benefits

Millets are also referred to as "nutri cereals" or "shree anna" owing to their nutritional benefits. Millets have high macro- and micronutrient contents compared with staple cereals such as rice and wheat. They have a low glycaemic index and high fibre content and are rich in minerals (Table 2). The millet provides an abundant amount of micronutrients, such as vitamins and beta carotenoids, that are sold as pharmaceutical supplements. They are a good source of vitamin B, antioxidants, manganese, phosphorus, iron, and amino acids such as lysine, threonine, methionine, and cysteine. They also contain essential fatty acids such as linoleic acid, oleic acid, palmitic acid, monogalactosyl diacylglycerols, digalactosyl diacylglycerols, phosphatidyl ethanolamine, phosphatidyl serine, and phosphatidyl choline and trace amounts of arachidic acid, behenic acid, and erucic acid (V & Ambati, 2019).

Table 2 Nutritional profile of millet (adapted from V & Ambati, 2019))

Nutrients	Sorghum	Finger millet	Foxtail millet	Kodo millet	Little millet	Pearl millet	Proso millet	Barnyard millet

Proteins	11	7.3	12.3	8.3	7.7	1.6	12.5	11.2
Fibres	6.5	3.6	8	9	7.6	1.3	2.2	10.1
Minerals	2.7	2.7	3.3	2.6	1.5	2.3	1.9	4.4
Iron	3.4	3.9	2.8	0.5	9.3	16.9	.8	15.2
Calcium	13	344	31	27	17	38	14	11

Note: Proteins, Fibres, and minerals in g/100 g, Iron, and Calcium in mg

28 The largest emerging health problem in India is obesity and associated chronic diseases such as diabetes and cardiovascular diseases (Fig. 1). Studies suggest that the high fibre content of millet (22%), compared with that of wheat (12.6%) and rice (4.6%), slows digestion and absorption, reducing the risk of chronic diseases (V & Ambati, 2019). A relatively high fibre content can reduce the risk of constipation, flatulence, stomach cramps, and bloating. Good digestion and absorption can reduce the risk of gastrointestinal illnesses, such as ulcers and colon cancer (Reddy, 2017).

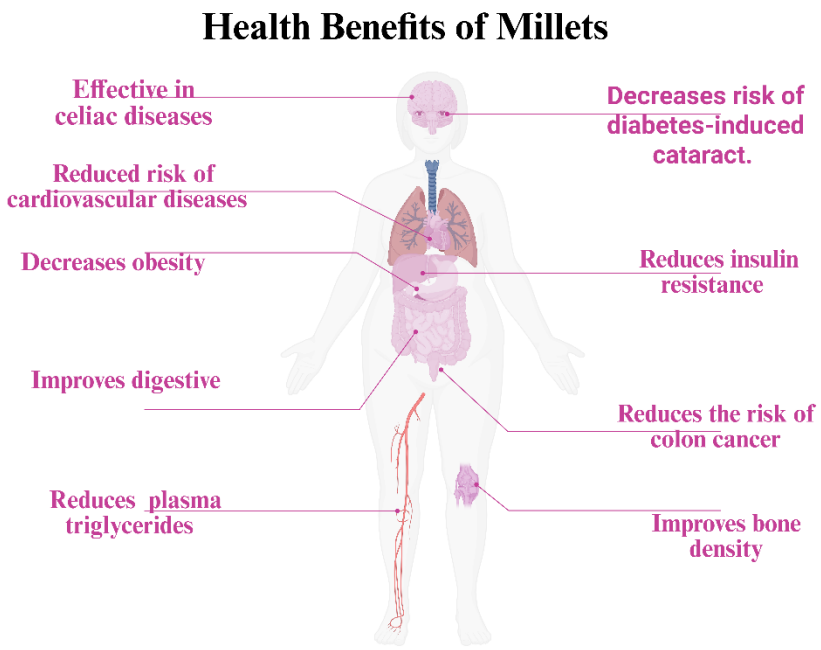

Figure 1: Millets act as functional foods for chronic disease prevention and management; they are helpful in combating obesity, diabetes, and cardiovascular diseases while promoting

gut health. These compounds improve digestion, insulin sensitivity, and bone density while reducing triglyceride levels and the risk of colon cancer.

The glycemic index of millet is low, hence reducing blood glucose levels. Millets contain significantly greater amounts of magnesium, which increases the efficiency of insulin, decreasing the risk of type 2 diabetes (Reddy, 2017). They also contain enzymes such as aldose reductase that prevent the accumulation of sorbitol, leading to a decrease in the risk of diabetes-induced cataracts. The millet can be an effective solution for reducing cardiovascular diseases, as it is rich in phytochemicals that lower cholesterol levels by reducing plasma triglycerides (Lee, Chung, Cha, & Park, 2010). The millet is gluten-free and can effectively minimize irritation in patients with celiac disease (Saleh, Zhang, Chen, & Shen, 2013).

2.3 Agroecological advantages and climate resilience

Millets offer a robust solution to climate change, water scarcity, and soil degradation, as they require minimal input. Millets show a remarkable evolutionary pattern that helps them adapt and thrive in marginal environmental conditions, where conventional crops fail to grow. Millets have a deep root system that allows them to absorb subsoil moisture, while the C4 photosynthetic pathway helps them in efficient carbon fixation under water-scarce conditions. Millets use a leaf rolling mechanism to reduce transpiration and save water (Zhang et al., 2021). They can survive dry spells during critical growth stages and can grow in conditions with less than 200 mm of rainfall.

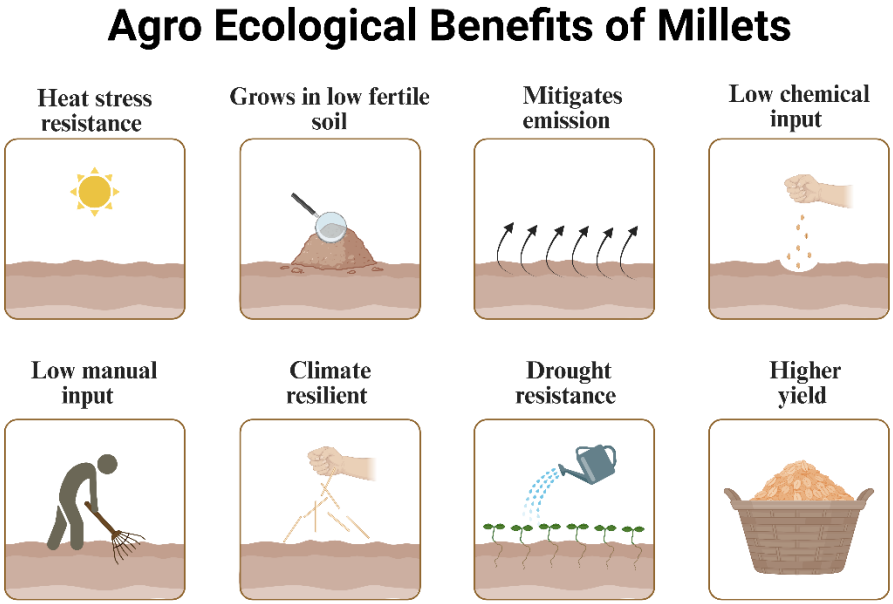

Figure 2: Millets offer significant agroeconomic benefits, making them a sustainable choice in modern agriculture. Millets exhibit significantly high heat resistance and drought resistance, thrive in low-fertility soil, and require minimal chemical and manual inputs while providing high yields. They are climate resilient and mitigate the problem of agricultural emissions.

Millets are also resilient to heat stress. Studies have shown that they can produce up to 70% of the optimal yield where wheat completely fails to grow. They provide an effective solution to pesticide usage, and they promote farmland biodiversity by supporting birds and beneficial insects that provide natural pest control. Millets act as a natural carbon sink, as they store 30 to 40% more carbon than do wheat fields. They also reduce methane and nitrous oxide emissions due to low flood irrigation and reduced fertilizer use. The comparative assessment revealed that millets have a triple win solution (Fig. 2), as they are climate resilient, mitigate emissions, and ensure food security compared with monoculture crops (Ashoka et al., 2023).

2.4. Revival Through the International Year of Millets, 2023

The United Nations General Assembly declared 2023 the International Year of Millets (IYM) after India's proposal for climate-smart superfoods with a deep cultural heritage. This campaign was inaugurated in January 2023 in India. The action plan of IYM-

2023 focused on production, consumption, export, and branding and created awareness about the health benefits of millets. The Department of Agriculture and Farmers Welfare started a mission, Nutri-Cereals, under the National Food Security Mission. The government started initiatives such as the Centre of Excellence, seed hubs for Shree Anna, and farmer-producer organizations. To promote millets, the governments of Assam, Bihar, Chhattisgarh, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Uttarakhand, and Uttar Pradesh started individual state initiatives. The Ministry of Food Processing Industries started an initiative, the Production Linked Incentive Scheme for the Food Processing Industry for Millet-based Products (PLISMBP), with a budget of Rs 800. The Micro Food Processing Enterprises (PMFME) Scheme under the Atma-Nirbhar Bharat Abhiyan is working towards starting millet processing enterprises (PIB, 2023).

2.5.Millets in Government Policy (e.g., POSHAN Abhiyan, MSP Inclusion)

Millets play a significant role in government policies. Under the national nutrition mission (POSHAN Abhiyan), integrated millets are provided as 50% take-home rations in public distribution systems. Another initiative is to incorporate millets in the food prepared for students under the midday meal scheme and anganwadi supplementary nutrition. The initiatives work towards reducing maternal anaemia, preventing child stunting, and providing adolescent nutrition. To economically strengthen the communities, incentives are provided for growing millets, with a 5% increase in organic produce, and a minimum support price has been set for the purchase of Ragi, Jowar, and Bajra. Agricultural extension policies increase the plantation and production of millet and provide subsidized seed and crop insurance under Pradhan Mantri Fasal Bima Yojana (Sen, Meena, & Shekhar, 2023). These policies highlight India's commitment to transforming millets from marginal crops to mainstream solutions for nutritional sovereignty.

3. Medicinal Plants and Traditional Knowledge Systems

3.1. Ayurveda and ethnobotanical heritage

India has an age-old and intensely entrenched ritual of using medicinal plants for healthcare, combined into arrangements such as Ayurveda, Siddha, Unani, and folk medicine. Among these, Ayurveda, over 5000 years old, is one of the oldest all-inclusive health systems, concentrating on harmonizing the body, mind, and spirit through diet, herbal treatments, and yogic breathing. Core Ayurvedic texts (Charaka Samhita and Sushruta

Samhita) classify approximately 600 plant species used for remedies, many of which are used significantly in today's herbal medicine (Nesari, 2023).

Ethnobotany, the study of how people interact with plants, plays a vigorous role in sustaining the traditional knowledge systems (TKSs) of indigenous and tribal groups. In India, nearly 400 tribal groups have recognized more than 8,000 plant species, many of which are used for inhibition and treatment. These traditional systems are backing bioprospecting, the search for new medicines, and assisting as the cultural foundation of Indian rural healthcare (Lydia Pramitha, Ganesan, Francis, Rajasekharan, & Thinakaran, 2023). Initiatives such as the traditional knowledge digital library (TKDL) have been created to document and safeguard these resources against biopiracy and promote research-based integration into modern healthcare (Bandyopadhyay, World, & 2023, 2023).

3.2.Commonly Used Medicinal Plants in Indian Households

Table 3: Medicinal Plants commonly used by Indian Households (Patel, Sharma, Singh, Tiwari, & Singh, 2022; Ralte, Sailo, & Singh, 2024)**.**

Sr. No.	Medicinal Plant	Botanical Name	Key Properties	Common Uses
1.	Tulsi	*Ocimum sanctum*	Adaptogenic, antimicrobial, anti-inflammatory	Respiratory conditions, stress management, immune support
2.	Neem	*Azadirachta indica*	Antibacterial, antifungal, anti-diabetic	Skin disorders, dental hygiene, blood purification
3.	Turmeric	*Curcuma longa*	Antioxidant, anti-inflammatory, anticancer (rich in curcumin)	Anti-inflammatory remedies, general wellness, culinary spice
4.	Amla	*Phyllanthus emblica*	Rich in Vitamin C, polyphenols, and antioxidants	Rejuvenation therapies (Rasayana), immunity boosting, digestive health
5.	Ashwagandha	*Withania somnifera*	Adaptogenic, anxiolytic, anti-diabetic	Nervine tonic, stress relief, blood sugar

				regulation
6.	Giloy	*Tinospora cordifolia*	Immunomodulatory, antipyretic, hepatoprotective	Fever management, liver health, and immune system enhancement

Herbal medicinal plants such as Tulsi (*Ocimum sanctum*) and Neem (*Azadirachta indica)* are generally used to release cerebral tension and improve the immune system. Amla (*Phyllanthus emblica*) and turmeric (*Curcuma longa) have* antioxidant and anti-inflammatory properties that support an overall healthy digestive system. Ashwagandha (*Withania somnifera) is* widely known for its adaptogenic effect, which regulates stress relief and maintains blood sugar levels. Every part of Giloy (*Tinospora cordifolia*) is widely used for fever, boosting the immune system (Table 3).

3.3.Integration into healthcare and nutrition

Research institutes such as the Indian Council of Medical Research (ICMR), the Council of Scientific and Industrial Research (CSIR), and the Central Council for Research in Ayurvedic Sciences (CCRAS) have conducted widespread pharmacological and clinical studies of Ayurvedic medicines (Acharya, Narayanan, Mahajon, Khanduri, & Srikanth, 2022). Nutritionally, medicinal plants are being studied not only for their healing properties but also for their ability to deliver vitamins, antioxidants, and bioactive complexes that support metabolic health. Perceptions such as "food as medicine" and nutraceuticals are gaining popularity, specifically for treating lifestyle-associated diseases such as obesity, diabetes, and cardiovascular conditions (D. B. Singh, 2022).

3.4.Role of AYUSH and Medicinal Plant Boards

To mainstream traditional medicine, the Ministry of AYUSH was established in 2014. The objectives are to grow, encourage, and mix conventional health systems with current medical care. The ministry promotes clinical research, drug standardization, and health education through institutes such as the All India Institute of Ayurveda (AIIA) and the National Institutes of Ayurveda. The National Medicinal Plants Board (NMPB) under AYUSH plays a dynamic role in preserving, sustainably refining, and evolving the value chain of medicinal plants. Their line-ups back farmers and local healers in farming and

dealing out, confirming both livelihood enhancement and biodiversity protection (Muthappan et al., 2022).

4. Convergence of Millets and Medicinals in Local Diets

4.1. Traditional Recipes and Functional Foods

India's earliest nutritional traditions have long combined nutrient-rich, climate-resilient cereals such as finger millet (ragi), pearl millet (bajra), foxtail millet (kangni), and small millet (kutki) with medicinal herbs and spices to make functional dishes (Table 4). These combinations are extremely fixed in Ayurvedic and local culinary traditions and are known for enhancing both flavours and health benefits (Chauhan, Kumari, & Verma, 2024).

Table: 4 Traditional Millet–Medicinal Food Combinations (Gokhale, Lele, et and, & 2021, 2021).

Sr. No	Traditional Recipe	Key Ingredients	Health Benefits
1.	Ragi Malt with Ashwagandha/Shatavari	Ragi, Ashwagandha, or Shatavari	Improves stamina, manages blood sugar levels
2.	Kambu Koozh with Tulsi/Betel Leaves	Fermented Pearl Millet, Tulsi, or Betel Leaves	Aids digestion, provides cooling effects
3.	Millet Khichdi with Moringa & Turmeric	Millet, Moringa Leaves, Turmeric	Rich in protein, fibre, antioxidants, and anti-inflammatory compounds
4.	Amruth Balli Leaf Chutney with Kodo Millet	Tinospora Leaves, Kodo Millet	Boosts immunity, part of traditional tribal diets in Karnataka and Chhattisgarh

Ashwagandha and Shatavari combined with ragi is the traditional formula, which improves stamina and maintains the blood sugar level. Similarly, betel leaves combined with kambu koozh with Tulsi promote healthy digestion. Moringa and turmeric with millet khichdi offer fibres, proteins, and anti-inflammatory properties. Kodo millet mixed with balli leaf chutney is used in tribal staple diets to improve the immune system.

4.2. Role in Managing Lifestyle Diseases (Diabetes, Hypertension, Obesity)

Together, millet and medicinal herbs have important potential for monitoring noncommunicable diseases (NCDs). Millets are rich in dietary fibre, magnesium, iron, resistant starch, and polyphenols, which jointly support glycaemic regulation, lipid metabolism, and weight management. Even ingestion has been linked to a lower risk of type 2 diabetes, hypertension, and atherosclerosis (Yang, Liu, & Zhang, 2022).

A systematic evaluation revealed that millet-based diets lowered fasting blood glucose levels by 12–15% in diabetes patients. The low glycaemic index and high satiety index of these individuals make them beneficial for treating metabolic diseases. When stimulated or combined with herbs such as fenugreek (*Trigonella foenum-graecum*), curry leaves (*Murraya koenigii*), cinnamon (*Cinnamomum verum*), or insulin plants (*Costus igneus*), the properties are improved, leading to improved insulin sensitivity and blood pressure regulation (Chaurasia, Bharati, & Singh, 2022).

4.3.Community Nutrition Practices in Tribal and Rural Areas

Tribal and rural societies in India have extensively supported environmentally sustainable and nutrient-compact food systems, which are acutely connected to regional biodiversity and traditional knowledge. These diets are not only periodic and sustainable but also naturally heal, reflecting an all-inclusive view of health and nature. Central to these culinary traditions are forest-based foods, diverse millets, and medicinal herbs, which help with both nutritional and disease prevention. Communal dietary practices include the use of wild greens such as *amaranthus*, *chenopodium*, and *colocasia*, which are frequently cooked with kodo millet to increase mineral and fibre consumption. Additional practices involve the production of millet gruels, which support digestion and promote gut health (Shweta et al., 2023).

Moreover, bitter plants such as neem blossoms and karela are consumed throughout seasonal changes to detoxify the body and support liver function. In winter, millet-based recipes are enriched with desi ghee, ginger, garlic, and ajwain—substances recognized for their warming properties and ability to improve circulation and immunity (Gokhale et al., 2021). These community-based dietary traditions reveal a long-standing combination of food and medicine and have contributed valuable lessons for modern nutritional research and public health efforts. NGOs, self-help groups (SHGs), and public health programs are

increasingly recognizing the importance of this knowledge in developing community-level nutrition initiatives. (Panda & Kumari, 2024).

Government initiatives such as the National Nutrition Mission (POSHAN Abhiyan) and the Millet Mission under various state governments support integrated child development services (ICDS) and midday meals, especially in tribal districts. These efforts aim not only to combat hunger but also to reduce the increasing prevalence of chronic diseases among rural populations (Shinde, Kumbhar, Nikam, …, & 2023, 2023).

5. Socioeconomic Dimensions and Livelihood Security

Millets offer significant economic opportunities by creating income and employment avenues for smallholder farmers, especially in rural areas where agriculture remains a dominant livelihood. As high-value crops, millets can be transformed into various processed products, such as flour, porridge, snacks, and beer, which yield higher market returns than raw grains do (Gupta, Gangoliya, & Singh, 2015; Vyas, 2023). Their ability to flourish across diverse agroecological zones and withstand droughts or crop failures makes them key contributors to food security, reducing their dependence on imported grains.

In addition to their economic and nutritional value, millets play crucial roles in strengthening livelihood security, advancing gender equity, revitalizing rural economies, preserving cultural traditions, and enabling climate-resilient income generation. To fully realize their potential, targeted interventions should focus on mainstreaming millets into government procurement systems, fostering producer cooperatives and community seed banks, supporting millet-based enterprises, and enhancing research and extension services dedicated to millet agronomy and value addition (Vyas, 2023).

5.1. Role of Women, Farmer Producer Organizations (FPOs), and SHGs

Millets offer economic, ecological, and nutritional benefits, making them vital for small-scale farmers, who lack access to costly inputs such as fertilizers and pesticides. In India, millets are cultivated on 30 million hectares, primarily in semiarid tropics, and are integrated into government programs promoting sustainable agriculture and food security. Their low-input requirements and drought resistance increase their environmental

sustainability, making them crucial for water-scarce regions (Mehta, Vyas, Dudhagara, Patel, & Parmar, 2024).

In rural India, 84% of women depend on agriculture, and they are central to millet cultivation, comprising 80% of millet farmers. Supporting them with inputs and training in sustainable practices can significantly increase millet movement and empower women economically. Given their role in household nutrition, training in millet processing and marketing benefits both individual farmers and self-help groups. Women's contributions span seed savings to value addition, and their traditional knowledge is vital for biodiversity and cultural heritage. Millet-based livelihoods enhance women's income control, economic participation, and food security (Anand et al., 2025; Roy, Arulmanikandan, & Kalra, 2023).

Farmer producer organizations (FPOs) play crucial roles in sustainable agricultural development and millet marketing, addressing the needs of farmers at the grassroots level. Governments support farmers by providing seeds, with FPOs facilitating distribution, market access, and value addition (Anand *et al.*, 2025).

FPOs empower farmers by enhancing price discovery, improving direct marketing opportunities, and strengthening input negotiations, leading to better economic returns. They serve as an efficient extension mechanism, reaching many farmers with minimal time and effort while fostering sustainable linkages between farmers, suppliers, and technology providers (S. Singh, 2019).

Additionally, self-help groups (SHGs) contribute to millet value chains by supporting the production, processing, and promotion of millet-based foods such as porridge, pitha, khir, samosa, laddu, biscuits, and noodles. In Odisha, WSHGs under the Shakti mission played a significant role in increasing millet production. These products are marketed at local fairs, exhibitions, and government-backed platforms such as the Millet Shakti Tiffin Wheels initiative, increasing their visibility and accessibility and benefiting both producers and consumers (S. Kumar *et al.*, 2024).

5.2. Market Potential and Value Chain Development

The millet market, valued at USD 11.92 billion in 2024, is projected to grow at a CAGR of 4.82%, reaching USD 17.38 billion by 2032. The rising urban demand for healthy foods and concerns over unsustainable rice and wheat production are driving growth. Farmers, particularly in Asia–Pacific nations such as China and India, are shifting from wheat

and rice cultivation to millet cultivation due to increasing market demand and sustainability benefits (Millet Market report, 2025).

The millet value chain spans several interconnected stages, beginning with input supplies such as seeds, fertilizers, and insecticides and progressing through cultivation, where sustainable practices help ensure yield quality. Timely harvesting minimizes postharvest losses, followed by processing steps such as cleaning, dehusking, and milling to improve product appeal and market readiness. Packaging extends shelf life, while effective distribution systems ensure availability across regions (A. Pandey & Bolia, 2023). Marketing and sales efforts, including branding and promotional strategies, play a key role in increasing consumer demand. The cycle culminates in consumption, where millet-based products contribute significantly to nutritional security. Overcoming challenges such as limited market access, inadequate infrastructure, and export barriers is essential to scaling up millet production and promoting global adoption (Shanmuka & Shireesha, 2023).

5.3. Opportunities for Startups and Agribusiness Models

Millets, known for their nutritional richness and climate resilience, offer immense potential for innovation and enterprises in India's food industry. As consumer demand for healthy, sustainable diets grows and government policies support millet cultivation, startups have a timely opportunity to lead this evolving market.

The increasing preference for nutritious and eco-friendly foods makes millet an ideal choice, given its gluten-free properties and essential nutrients. Entrepreneurs can develop value-added products such as ready-to-eat meals, snacks, cereals, bakery items, and beverages, which cater to health-conscious consumers, athletes, children, and individuals with dietary restrictions (V. Kumar *et al.*, 2024).

Government-backed schemes, subsidies, and nutrition programs further strengthen millet-based business viability, integrating them into school meals, anganwadi nutrition, and public distribution systems, creating a strong institutional demand for these grains. Entrepreneurs are innovating ways to incorporate millets into consumer-friendly offerings, promoting their adoption. Moreover, market linkages are strengthening, as startups and enterprises directly collaborate with farmers, creating a demand-driven ecosystem that ensures fair pricing and better economic opportunities for millet producers (Shanmuka & Shireesha, 2023).

Agribusiness innovation presents significant opportunities, allowing startups to establish integrated millet value chains through direct farmer engagement, decentralized processing, and efficient supply networks. Models such as contract farming, farmer producer organizations (FPOs), and cooperatives ensure a steady raw material supply while enhancing rural livelihoods.

Millets offer vast opportunities for innovation and entrepreneurship, empowering startups to advance public health, sustainability, and economic inclusion. Investing in quality, diversification, and strong supply chains can transform India's food ecosystem, ensuring lasting impacts (Gulhane & Niketan, 2023).

6. Policy and Institutional Support

6.1. National and State-Level Schemes Promoting Millets and Medicinal Plants

India has launched several national and state-level schemes to promote millet and medicinal plants, recognizing their value for nutrition, health, and sustainable agriculture. Nationally, initiatives such as the Sub-Mission on Nutri-Cereals under the National Food Security Mission (NFSM) and the National Millet Mission are central to increasing the production and market penetration of Shree Anna (millets). To further strengthen the value chain, the Production Linked Incentive Scheme for Millet-Based Products (PLISMBP), launched by the Ministry of Food Processing Industries (MoFPI), supports millet-based food processing enterprises, thereby increasing value addition and market reach.

State governments have also launched their own dedicated Millet Missions. States such as Assam, Bihar, Chhattisgarh, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Uttarakhand, and Uttar Pradesh are actively promoting local millet cultivation and consumption. These efforts are often integrated with national schemes such as the Rashtriya Krishi Vikas Yojana (RKVY), the Paramparagat Krishi Vikas Yojana (PKVY), and the Mission Organic Value Chain Development for the North Eastern Region (MOVCDNER), which collectively aim to promote nutricereals through organic and sustainable practices.

In the case of medicinal plants, the National AYUSH Mission (NAM) plays a pivotal role by supporting the market-led cultivation, postharvest management, and value chain development of prioritized species. The National Medicinal Plants Board (NMPB), which functions under the Ministry of AYUSH, administers the Central Sector Scheme for the

conservation, development, and sustainable management of medicinal plants. This scheme facilitates research, conservation, cultivation, and marketing initiatives to support farmers and industries engaged in the sector. Furthermore, the NMPB, in collaboration with the Centre for Development of Advanced Computing (C-DAC), has developed the "e-CHARAK" mobile application and web portal. This digital platform enhances information exchange and provides crucial market linkages for stakeholders involved in the medicinal plant value chain.

6.2. Inclusion in Mid-Day Meals, ICDS, and PDS

Millets are being increasingly integrated into major public nutrition programs to increase nutrition in children and mitigate the issue of malnutrition. Under the Mid-Day Meal Scheme (PM-POSHAN) and Integrated Child Development Services (ICDS), several states have initiated the inclusion of millets to provide nutrient-rich meals to children. In addition, schools are encouraged to serve millet-based meals once a week, hold cooking competitions for Cook-cum-Helpers, and screen awareness videos on millet benefits. It has been suggested that millet consumption may be discussed in school management committee (SMC) meetings and parent-teacher meetings (PTMs) to engage parents and the community. The public distribution system (PDS) has also been leveraged in states such as Odisha, Karnataka, and Telangana, where millets are distributed at subsidized rates to promote consumption among low-income households. These efforts have been made to mainstream millet into daily diets, improve nutritional outcomes, and support local millet farmers.

6.3.Role of the ICAR, Ministry of Agriculture, Ministry of AYUSH

The Indian Council of Agricultural Research (ICAR) plays a crucial role in developing high-yielding, climate-resilient millet and medicinal plant varieties, in addition to promoting best agronomic practices. The Ministry of Agriculture and Farmers' Welfare supports millet and medicinal plant cultivation through policy frameworks, funding schemes, and integration into value chains. The Ministry of AYUSH, through the National AYUSH Mission and the National Medicinal Plants Board (NMPB), focuses on the conservation, cultivation, and commercialization of medicinal plants while promoting their use in traditional medicine systems and wellness products.

7. Research, Innovation, and Educational Integration

7.1. Role of Agricultural Universities and Research Institutes

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Research and higher education institutions play a pivotal role in revitalizing indigenous knowledge systems through evidence-based scientific innovation. Their efforts focus on enhancing crop productivity, biofortifying nutritional profiles, advancing agroecological practices, and fostering a deeper understanding of the health, environmental, and cultural benefits of traditional crops such as millet and medicinal plants. Agricultural universities such as Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), the University of Agricultural Sciences, Dharwad, Tamil Nadu Agricultural University (TNAU), and Odisha University of Agriculture and Technology (OUAT) have developed high-yielding, drought-tolerant, and biofortified millet varieties that respond to both climate and nutritional challenges (Lydia Pramitha et al., 2023; Tanwar, Panghal, Kumari, & Chhikara, 2025). Simultaneously, these universities actively contribute to community outreach by raising awareness and providing capacity-building support, particularly by training farmers in sustainable and climate-resilient agricultural practices, through collaborative efforts with Krishi Vigyan Kendras (KVKs), the Indian Council of Agricultural Research (ICAR), and the Indian Institute of Millets Research (IIMR) (Tula & Karlsson, 2025).

7.2.Innovation in Millet-based Products and Nutraceuticals

The rising demand for functional foods and preventive healthcare has positioned millets at the forefront of nutraceutical innovation. Owing to their low glycaemic index, high dietary fibre content, and rich micronutrient profile, millets are being reimagined beyond traditional staples into a wide array of health-oriented products. Their nutritional superiority has encouraged a new wave of entrepreneurship, leading to the development of ready-to-eat meals, extruded flakes, snack bars, pasta, vermicelli, probiotic beverages, and gluten-free bakery items tailored to modern consumer preferences (Anal et al., 2024). Moreover, the supplementation of millet with medicinal plants such as moringa has given rise to a new class of millet-based nutraceuticals that address lifestyle diseases such as diabetes, cardiovascular ailments, and obesity (Gull, Nouman, & Olson, 2025). Emerging technologies such as 3D food printing are also being explored to create customized, nutrient-rich millet products with enhanced sensory appeal and health benefits. This approach has shown promise in the development of plant-based meat analogues and high-fibre snacks, offering new solutions for treating malnutrition and expanding the potential of millet in personalized nutrition (Anal et al., 2024).

7.3. Curriculum Integration for Awareness and Behavioral Change

Integrating millets into school and university curricula is key to fostering long-term dietary shifts, as a lack of awareness and familiarity hinders millet adoption (Prashanthi, Geetha Reddy, Neela Rani, Sucharitha Devi, & Meena, 2022). Educational programs should promote the health, environmental, and cultural benefits of millets through interactive learning, school meals, and kitchen gardens. Institutions can serve as platforms for behavioral nudges by offering millet-based meals and organizing food festivals. Early exposure and positive engagement can build lifelong healthy habits and help mainstream millets as everyday staples (N. L. Pandey, Rath, Datta, Choudhury, & Kandpal, 2023).

8. Challenges and Ways forward

8.1. Production, processing, and marketing bottlenecks

Despite being recognized as "Nutri-cereals," millets remain underutilized in Indian agriculture owing to biased policy support favouring rice and wheat. Small and marginal farmers often lack access to better millet seeds, technical knowledge, and irrigation infrastructure (Ministry of Agriculture & Farmers Welfare, 2021). With respect to medicinal plants, challenges include the depletion of wild resources, inconsistent cultivation practices, and low farmer awareness of the commercial viability of these plants.

The processing infrastructure for both sectors is inadequate. Limited mechanization for millet dehusking and grain cleaning increases drudery and postharvest losses, while medicinal plant value chains lack standardized drying, storage, and extraction facilities (NMPB, 2022). Marketing systems are also fragmented. For millet, its limited presence in mainstream retail and public procurement hinders scale, whereas for medicinal plants, weak market linkages and price volatility discourage farmer participation.

8.2. Need for Standardization and Quality Control

A major constraint on scaling both millet and medicinal plants is the lack of standardized quality control and certification systems. Millets are often sold without grading or branding, which impacts consumer perception and market competitiveness. Similarly, in the herbal sector, inconsistent quality and adulteration hinder access to export markets and erode trust in traditional medicine systems (FSSAI, 2020; Ministry of AYUSH, 2022).

To ensure nutrition and health sovereignty, robust systems for product standardization, traceability, and certification, such as organic, GI tags, and fair trade, are

essential. Strengthening FSSAI regulations for millets and harmonizing AYUSH and global standards for herbal products can significantly increase consumer confidence and value realization.

8.3. Suggestions for scaling and mainstreaming

Mainstreaming millet and medicinal plants requires a multidimensional approach:

Policy Support: Strengthen schemes such as the Millets Mission and National AYUSH Mission and ensure convergence with nutrition programs such as the ICDS and PM POSHAN. **Value Chain Development**: Invest in decentralized processing units, cold chains, and storage facilities, especially in millet- and herb-producing tribal and rain-fed regions.

Digital and Market Integration: Promotion of digital platforms for input services, market access, and real-time price discovery. Farmer producer organizations (FPOs) should be encouraged to aggregate and brand millet and herbal products.

Awareness and demand generation: Promotion of the health benefits of millets and traditional medicine through public campaigns, research dissemination, and institutional consumption (e.g., hospitals, schools, and armed forces).

Research and Capacity Building: Strengthening research on climate-resilient varieties, agronomic practices, and nutraceutical potential through institutions such as IIMR and NMPB.

9. Conclusion

Safe, healthy, dignified, and culturally appropriate food is a right of every Indian citizen; without this aspect, there is no food sovereignty. As we are moving toward Viksit Baharat, we need to ensure a sustainable and equitable division of food resources for healthy growth. The governmental policies under the banner of the Department of Agriculture and Farmers Welfare's initiative, the National Food Security Mission, are working towards ensuring that nutritious food is available to each individual. However, challenges remain due to the limited infrastructure for processing millet and medicinal plants—lack of quality seeds, inconsistent cultivation practices, and lack of commercial awareness of these crops. Proper awareness, education, and development of infrastructure for the processing and development of quality control for the sale and purchase of millet and medicinal plants can overcome these

challenges. To move towards nutrition sovereignty and Viksit Bharat, there is a need for community involvement, infrastructure development, and the integration of traditional knowledge with modern solutions. Viksit Bharat will be the nation where everyone has access to safe and healthy, economically available food that is culturally appropriate.

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