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MILLETS: The Nutri-Cereals Crop Trends in India

[1]Deeksha Dhaniya, [2] Vandana verma and [3]Ella Rani

[1]MSc Scholar, Department of Extension Education and Communication Management CCS Haryana Agricultural University, Hisar Haryana India 125001

[2, 3]Assistant Professor, Department of Extension Education and Communication Management CCS Haryana Agricultural University, Hisar Haryana India 125001

Corresponding Author: Deeksha Dhaniya

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ABSTRACT: Millets play a crucial role for farmers in arid regions due to their nutritional richness and adaptability to extreme climates. Despite these advantages, millets have declined in popularity compared to commercial crops in recent decades. Factors contributing to this decline include reduced demand, changing dietary preferences, and the widespread availability of cheaper cereals like rice and wheat through the Public Distribution System. Several challenges, including longer cooking times, complex preparation processes, inadequate domestic storage, limited marketing infrastructure, and suboptimal processing methods, have led to decreased millet consumption. The United Nations has recognized the significance of millets by declaring 2023 as the "International Year of Millets" to raise awareness about their health benefits. Millets stand out as an exceptional source of macro- and micronutrients, boasting a superior mineral profile and essential amino acid composition compared to major cereals like wheat and rice. Rich in protein, carbohydrates, fats, minerals, vitamins, and bioactive substances, millets contribute significantly to combating various health issues, including diabetes, cardiovascular problems, high blood pressure, thyroid disorders, and celiac disease by regulating blood pressure and sugar levels. This review paper explores the trends in millet production and consumption in India over the years. The production of millets has seen a Compound Annual Growth Rate (CAGR) of 0.94%, rising from 16.03 million metric tons (MT) in 2012 to 17.60 million MT in 2022Nevertheless, the cultivation area dedicated to millets in India witnessed a decline from 15.40 million hectares (Ha) in 2012 to 14.00 million Ha in 2022, as reported by APEDA in 2022. Remarkably, there has been a notable decrease in per capita millet consumption in India from 1960 to 2021-23. This emphasizes the significance of collaborative initiatives to reverse the downward trend in millet consumption and promote awareness of their nutritional benefits.

KEYWORDS: Millets, Consumption, Production, Heath benefits.

I. INTRODUCTION

Millet grains constitute approximately one-sixth of the overall food grain production, playing a crucial role in the food grain economy of India [32]. Millets are resilient grains that thrive in low-quality soil, exhibit minimal nutritional requirements, withstand temperature fluctuations, and boast a distinctive short growth season [25]. They have the adaptability to thrive in waterlogged or moist areas, as well as in drought-prone regions, making them suitable for cultivation in both arid and semi-arid environments [27]. In India, a variety of millets are grown suiting to different agro-climatic conditions including pearl millet (*Pennisetum glaucum*), foxtail millet (*Setaria italica*), finger millet (Eleusine coracana), proso millet (*Penicum miliaceum*), barnyard millet (*Echinochloa utilis*), kodo millet (*Paspalum setaceum*) and little millet (*Panicum sumatrense*) [36]. Millet, commonly referred to as "Nutri-cereals," has the potential to contribute to sustainable nutritional security, as these climate-resilient crops outperform wheat and rice in marginal growing conditions and offer a superior

nutritional profile [22]. Millets are highly nutrient-dense crops, exhibiting elevated levels of carbohydrates, proteins, dietary fiber, essential fatty acids, potassium, iron, zinc, phosphorous, calcium, and vitamins compared to rice and wheat [30]. Millets are characterized by a substantial carbohydrate content of 60–70 per cent, a significant dietary fiber component ranging from 10–12 per cent, a moderate protein content of 6–9 per cent, low fat levels at 1.5–5 per cent, and a considerable mineral content ranging from 2–4 per cent [2]. Millets play a crucial role in combating various diseases, including diabetes, cardiovascular disease, high blood pressure, thyroid issues, and celiac disease. Additionally, the nutrients present in millets contribute to preventing gallstone formation, insulin resistance, obesity, ischemic stroke, breast cancer, and premature death [5]. Millets contribute to maintaining healthy blood pressure and sugar levels, thereby promoting overall well-being [1].

Traditionally, millets were extensively produced and consumed in India, with nearly equal land coverage compared to rice and wheat [36]. However, the consumption of millets in India experienced a decline following the Green Revolution in 1965, during which rice and wheat gained broader acceptance among the population compared to other locally grown crops [21]. The primary reasons for this decline include low remuneration compared to other food crops, the absence of input subsidies, subsidized distribution of refined cereals through the Public Distribution System (PDS), shifts in consumer preference, the limited shelf life and the relatively lower social status associated with millets [19]. This review paper deals with the trends of millet production and consumption over the years and government initiatives to promote millet in India.

II. HEALTH BENEFITS OF MILLETS:

Millet's nutritional composition is comparable to major staple cereals such as rice, wheat, and maize, as they serve as rich sources of carbohydrates, protein, dietary fiber, micronutrients, vitamins, and phytochemicals. The diverse nutritional profile of millets contributes to several health benefits.

Here are some health benefits:

Millets	Scientific name	Health benefits
Pearl millet	*Pennisetum glaucum*	Pearl millet is rich in folate, serving as a biofortificant to address anemia. The presence of magnesium in pearl millet can aid in the treatment of migraines and may contribute to reducing respiratory problems in individuals with asthma [1]. Pearl millet also contains phytonutrients such as apigenin, flavonoids, lignin, and myricetin, which play a role in preventing breast cancer, cardiovascular disease, and exhibit anti-fungal and anti-ulcerative properties [37].
Sorghum	*Sorghum vulgare*	Sorghum is believed to have anti-carcinogenic properties and has been associated with the potential to lower the risk of oesophageal cancer [10]. Sorghum is highly nutritious and possesses nutraceutical properties that contribute to addressing both pre and post-transition health issues, including arthritis, cardiovascular diseases, low body weight, low body mass index (BMI), malnutrition, obesity, and more [9].

Foxtail millet	*Setaria italica*	Foxtail millet is rich in bioactive compounds such as catechin, quercetin, apigenin, and kempherol that contribute to combating diabetes, cardiovascular disease, and maintaining healthy lipid levels (dyslipidemia). Due to its magnesium content, foxtail millet is recognized as a heart-healthy food. It possesses antimicrobial and anti-tumorigenic properties and aids in body detoxification [37].
Barnyard millet	*Echinochloa* spp.	Barnyard millet effectively lowers blood sugar levels and offers protection against celiac disease because it's gluten-free [33]. Its primary compounds—luteolin, N-(p-coumaroyl), serotonin, and tricin—possess anti-cancer, anti-rheumatic, and anti-diabetic properties [37].
Little millet	*Panicum miliar*	Little millet contains apigenin, a compound known for its beneficial effects in combating diabetes, celiac disease, cardiovascular disease, high cholesterol levels, and exhibiting anti-cancer properties [37].
Finger millet	*Eleusine coracana*	Finger millet is rich in calcium (10 times more than rice and wheat) and phosphorus, aids in controlling high blood cholesterol, addressing constipation, and reducing the risk of intestinal cancer [27]. It is highly regarded as an excellent food choice for diabetic individuals as it effectively regulates hyperglycemia and helps maintain healthy blood sugar levels [33]. Finger millet possess antimicrobial properties and exhibit characteristics that counteract tumor formation (anti-tumorigenic) [37].
Kodo millet	*Paspalum scrobiculatum*	Kodo millets contributes to strengthen the nervous system. Including kodo millet in the diet is beneficial for post-menopausal women dealing with issues such as high cholesterol or dyslipidemia, elevated blood pressure, and heart-related conditions [33].
Proso millet	*Panicum miliaceum*	Proso millet aids in improving the lipid profile and reducing cholesterol levels. It's beneficial for bone health and can help combat cardiovascular diseases as well as potentially contribute to preventing breast cancer [33].

Health benefits of Millet

III. INTERNATIONAL YEAR OF MILLET:

Acknowledging the significant potential of millets, the Government of India (GOI) emphasized their importance, designating 2018 as the National Year of Millet which aimed to revive the ancient tradition of including millets in daily diets [35]. The Government of India's proposal for an International Year of Millets in 2023 received approval during the 75th Session of the UN General Assembly and from members of the FAO Governing Bodies [23]. However, the official launch of the International Year of Millets - 2023 took place on December 6, 2022, in Rome, Italy, under the auspices of the Food and Agriculture Organization (FAO) of the United Nations [26,28]. Meanwhile, scientists predict that the global millets market is expected to experience a compound annual growth rate (CAGR) of 4.5% between 2021 and 2026 [26]. To attain these goals, the International Year of Millets - 2023 will concentrate on three primary pillars:

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The main pillars of the International Year of Millets 2023

The International Year of Millet 2023 provides an opportunity to promote the significance of millets in various aspects, including human health, the environment, and economic growth [6].

IV. INITIATION TAKEN BY INDIA GOVERNMENT TO PROMOTE MILLET PRODUCTION AND CONSUMPTION:

The Government of India is adopting a multi-stakeholder approach for the observance of the International Year of Millets (IYM) - 2023. The action plan for IYM-2023 emphasizes strategies to improve production and productivity, consumption, exports, strengthen the value chain, enhance branding, and raise awareness of health benefits, among other objectives.

- To endorse Shree Anna, a comprehensive yearlong action plan, comprising monthly activities, has been formulated collaboratively by Central Ministries, State Governments, and Indian Embassies [11].
- In 2018, the Indian government initiated the "National Program on Nutri-Cereals" aimed at fostering the cultivation of millets and other nutritious cereals like sorghum and barley [8].
- The Government of India has given special attention to 212 millet districts spanning across 14 states through the revised National Food Security Mission Operational Guidelines (NFSM). This initiative intends to provide farmers with incentives for quality seed production and distribution, conduct field-level demonstrations, offer training, establish primary processing clusters, and extend research support. At the 'Centres of Excellence,' the implementation of 67 value-added technologies has been accompanied by the release of 77 high-yielding and 10 bio-fortified varieties [17].
- The Government is actively promoting nutri-cereals by providing extensive research and development support. There's also assistance provided to start-ups and entrepreneurs aiming to develop recipes and value-added products that encourage millet consumption. From 2018 to February 2022, a total of eight bio-fortified varieties/hybrids of Bajra have

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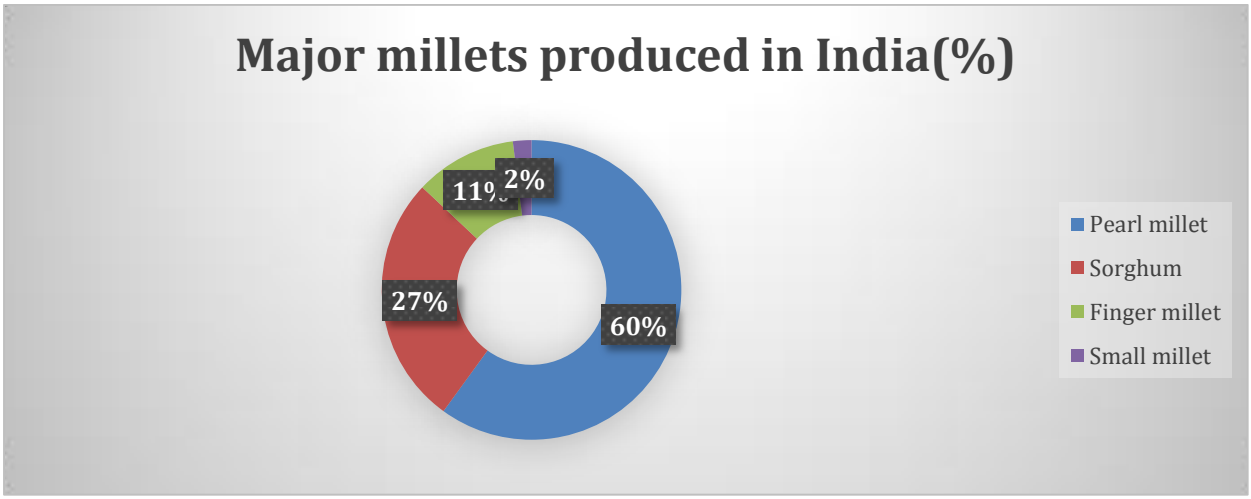
been officially released for cultivation [13].

- To boost the export of nutri-cereals, the Ministry of Commerce and Industry, via the Agricultural and Processed Food Products Export Development Authority (APEDA), has formulated a comprehensive strategy to promote the global export of Indian millets, set to commence in December 2022 [15].
- The government has undertaken the promotion of Indian millets and their value-added products by creating 30 e-Catalogues, each focusing on specific targeted countries. These catalogues contain comprehensive information about various Indian millets, their diverse range of value-added products available for export, listings of active exporters, start-ups, Farmers Producer Organizations (FPOs), importer/retail chains, hypermarkets, etc. The plan involves circulating these catalogues to Indian Embassies abroad, importers, exporters, start-ups, and relevant stakeholders [12].
- NITI Aayog entered into a Statement of Intent (SoI) with the United Nations World Food Program (WFP) on December 20, 2021. This collaborative partnership is centered on mainstreaming millets and assisting India in assuming a global leadership role in knowledge exchange, leveraging the occasion of 2023 as the International Year of Millets [14].
- In the Union Budget 2022-23, a significant emphasis was placed on supporting post-harvest value addition, boosting domestic consumption, and initiating branding efforts for millet products on both national and international platforms [16].
- To improve nutrition among children, the Central Government has urged State Governments and Union Territory Administrations to consider the inclusion of millets within the PM POSHAN scheme, particularly in districts where consuming millets is a culturally accepted dietary practice [18].

V. INDIAN MILLET SENARIO:

India stands as the world's foremost producer of millets, holding the highest position globally in millet production. India stands as the largest global producer of millets, contributing approximately 42 per cent of the total production, followed by Niger (11%), China (8%) and Nigeria (6%) [40]. According to USDA's 2022-23 report, India's millet production amounted to approximately 13.51 million metric tonnes. Among the major millets produced, pearl millet comprised 60 per cent, followed by sorghum at 27 per cent, finger millet at per cent, and small millets at 2 per cent in India (as per the 4th Advance estimate 2021- 22).



As per the 4th Advance estimate 2021-22

India experienced a notable growth of 29.56 per cent during the 2022-23 period compared to the previous year [3]. The primary millet-producing states in India include Rajasthan, Karnataka, Maharashtra, Uttar Pradesh, Haryana, Gujarat, Madhya Pradesh, Tamil Nadu, Andhra Pradesh, and Uttarakhand. When it comes to total millet production, the three major states of Rajasthan, Uttar Pradesh, and Haryana collectively contributed to more than 81 per cent of the total output [4]. Rajasthan leads in pearl millet production with 46.99 lakh tonnes, followed by Uttar Pradesh at 20.64 lakh tonnes, while Haryana contributes 10.49 lakh tonnes. In sorghum production, Rajasthan contributes 5.90 lakh tonnes, followed by Uttar Pradesh with 3.29 lakh tonnes and Madhya Pradesh contributes 2.65 lakh tonnes. Karnataka leads in finger millet production, yielding 7.35 lakh tonnes, followed by Tamil Nadu with 1.53 lakh tonnes and Uttarakhand with 1.18 lakh tonnes [39].

VI. TRENDS IN MILLET PRODUCTION:

Millets cultivation in India has fluctuated due to factors such as urbanization, shifting consumer preferences, government policies, rice and wheat availability through Public Distribution System, preparation inconvenience, short shelf life, and insufficient incentives for millet production [20]. Despite challenges, there's a rising interest in millets. The government and various stakeholders are actively working to boost millet production, focusing on nutrition and health benefits. Sreekala [36] observed a consistent decline in millet cultivation from 1970–71 to 2018–19. Pearl millet's area decreased by 34 per cent, but production rose by 63 per cent due to a 2.5-fold increase in productivity. Sorghum's area dropped by 64 per cent, leading to a 44 per cent reduction in production, despite a 51 per cent increase in productivity. Finger millet's area nearly halved, resulting in a 23 per cent production decrease, despite a 68 per cent growth in productivity. Small millets experienced the most significant area reduction (85%), causing a 77 per cent drop in production, although yield improved by 58 per cent. In summary, increased productivity has not offset the overall decline in millet cultivation, except for pearl millet. Lokesh [24] noted a consistent decrease in the cultivation area of bajra over the last decade. The production of bajra exhibited a declining trend in 2011-2012, 2015-2016, and 2018-2019, with sudden spikes in 2017-2018 and 2019-2020 due to increased productivity and expanded cultivation area compared to other years. Despite fluctuations, the overall productivity of bajra has gradually increased in the past decade, attributed to high-yield varieties and hybrids. Additionally, ragi crop in India experienced instability in area, production, and productivity from 2016 to 2020. The production of minor millets initially decreased from 2010-2011 to 2015-2016, followed by an observed increase from 2015-2016 to 2017-2018. Patra [29] found that the cultivation area for small millets, jowar, bajra, and ragi has consistently decreased from 1950 to 2021, with Compound Annual Growth Rates (CAGRs) of -3.60 per cent, -1.86 per cent, -1.27 per cent, and -0.60 per cent, respectively. The production of small millets and jowar also declined, with growth rates of -2.89 per cent and -0.63 per cent, respectively. Bajra production exhibited a modest growth rate of 0.12 per cent per annum from 1950-51 to 2020-21, while ragi production increased at a rate of 1.68 per cent. From 2012 to 2022, millet production in India increased at a decadal Compound Annual Growth Rate (CAGR) of 0.94 per cent, reaching 17.60 million metric tonnes in 2022 from 16.03 million metric tonnes in 2012. However, the cultivation area for millets declined from 15.40 million hectares in 2012 to 14.00 million hectares in 2022, showing a negative CAGR of 0.95 per cent during the same period. Despite the reduction in cultivation area, millet productivity improved from around 1.04 metric tonnes per hectare in 2012 to 1.26 metric tonnes per hectare in 2022, representing a decadal CAGR of 2 per cent [5].

VII. TRENDS IN CONSUMPTION OF MILLET:

Millets possess significant potential to enhance dietary diversity. However, cultivation and consumption in our country are sharply declining due to constraints on both demand and supply. The per capita consumption of millets plummeted from 32.9 kg in 1962 to 4.2 kg in 2010 [31]. There has

been a downward trend in per capita sorghum consumption in both rural and urban India. In rural areas, consumption has decreased from 19.1 to 5.2 kg per year, reflecting a 68% decline. Similarly, in urban India, per capita sorghum consumption has dropped from 8.5 to 2.7 kg per year, indicating a 70% decline [32]. According to another study, the per capita consumption trend of pearl millet witnessed a decline between 1972/1973 and 2004/2005 in both rural and urban areas of India. In rural regions, per capita consumption decreased from 11.4 to 4.7 kg per year, while in urban areas, it dropped from 4.1 to 1.4 kg per year during the same period [5]. In a similar study, it was reported that millet consumption witnessed a decline, and the gap in total millet consumption between rural and urban areas was 10 kgs in 2004-05, narrowing to 4 kgs in 2011-12. A comparison of millet consumption during these years revealed a downward trend, with nearly a 50 per cent reduction in rural areas and a 35 per cent decrease in urban areas from 2004-05 to 2011-12 [43]. The per capita consumption of millets in India has experienced a decline, decreasing from 30.94 kg per annum in 1960 to 3.87 kg per annum in 2021-23. This decline can be attributed to the relatively stagnant production of millets, coupled with a continuous increase in the domestic population. The consumption pattern within the millet basket indicated a decline in sorghum consumption over the decade, while the consumption of other millets experienced growth. This shift reflects an increasing awareness of the health benefits associated with the latter group of millets [4].

VIII. CONCLUSION

Despite a decrease in both cultivation and consumption of millets in recent decades, these grains remain crucial for the food security and nutrition of many people in India. A thorough analysis of production trends from 1968-69 to 2022-23 indicates a significant reduction in millet cultivation across the country. Significantly, there was a decrease in the production of jowar, ragi, and small millets, with the exception of bajra, which witnessed a growth in output owing to enhanced yield levels. The consumption of millets, particularly pearl millet, sorghum, and ragi, decreased from 1962 to 2011-12. However, there has been growth in the consumption of pearl millet, ragi, and other millets, with the exception of sorghum, which did not experience an increase by 2022-23. Despite these trends, there is a need to raise awareness among both farmers and consumers regarding the nutritional significance of millets in a balanced diet. Promoting awareness can be achieved through various means, including implementing training programs, making millets more readily available locally can enhance their accessibility, and diversifying millet products by developing value-added items such as millet-based snacks, breakfast cereals, and bakery products has the potential to boost demand and consumption among consumers. This approach could contribute to revitalizing the cultivation and consumption of millets in India.

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