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Challenges and Opportunities in Millet Production: A Sustainable Perspective

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Abstract

Millet are nutrient-rich, climate-resilient crops with great potential for food security and sustainable agriculture. However, its cultivation faces several challenges that impact its productivity and market potential. Low grain yield compared to major cereals, susceptibility to erratic weather patterns, pest attacks, and limited availability of improved seed varieties hinder widespread adoption. Additionally, inadequate processing facilities and weak supply chains make commercialization difficult, reducing profitability for farmers. Consumer preference for other staple grains, along with a lack of awareness about the nutritional and environmental benefits of millet, further limits demand. Limited research and financial support have also slowed advancements in cultivation techniques and value addition. Addressing these issues requires better farming practices, investment in crop improvement programs, modern processing technologies, and initiatives to educate consumers.

1. Introduction

Millets are a diverse group of small-seeded cereal crops cultivated for centuries, particularly in arid and semi-arid regions, and are among the first crops to be domesticated. They are also referred to as "Cereal of the Poor", "Nutri-Cereal", and "Shree Anna". Millets can be divided into major millet (sorghum, pearl millet, finger millet), minor millet (foxtail millet, proso millet, barnyard millet, kodo millet, little millet), and pseudo-millet(buckwheat, amaranth) based upon their size and use (Abah et al., 2020; Saxena et al., 2018) (Table 1). Major millet includes the widely grown millet crop, minor includes the less commonly grown varieties and pseudo-cereal includes non-grass cereal species. They are valued for their resilience to biotic and abiotic stresses, having short crop cycles, and being grown on marginal land with minimum management practices, making them an essential component of sustainable agriculture. Millets are said to be highly water efficient as compared to rice and can tolerate temperatures up to 42°C . They are nutritionally rich, providing high levels of dietary fiber, essential amino acids,

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Table 1: Types of millets

Name	Scientific name	Local names	Origin	
Major millet				
Sorghum	*Sorghum bicolar*	Jower, Jola, Juar	Eastern Sudan	
Pearl millet	*Pennisetum glaucum*	Bajra, Kamboo	West Africa	
Finger millet	*Elusine coracana*	Ragi, Madua	East Africa	
Minor millet				
Foxtail millet	*Setaria italica*	Navane, Kakun, Kangni	China	
Proso millet	*Panicum miliaceum*	Cheena, Chiná	Northeast China	
Barnyard millet	*Echinochloa frumentacea*	Sawan, Shamula	Japan	
Kodo millet	*Paspalum scrobiculatum*	Harakn, Varagu	India	
Little millet	*Panicum sumatrense*	Samae, Kutki	India	
Pseudo-millet				
Buckwheat	*Fagopyrum esculentum*	Kuttu	China	
Amaranth	*Amaranthus* spp.	Chaulai	America	

and minerals such as iron, calcium, and zinc, and are low in fat, and naturally gluten-free, making them suitable for individuals with gluten intolerance and individuals suffering from celiac disease. According to FAO, India is the largest producer of millet in the world, contributing 41% of the global production. The government of India (GOI) declared 2018 as the "National year of millet" for the promotion of millet. In the same year, millets were also recognized as Nutri-cereals and included under the 'Poshan Abhiyan' and 'National Nutrition Mission'. Incorporating millet in our diet helps achieve the UN 2030 Agenda for Sustainable Development constituting particularly SDG 2 (Zero Hunger), SDG 3 (Good health and well-being), SDG 8 (Decent work and economic growth), SDG 12 (Responsible consumption and production), SDG 13 (Climate action) and SDG 15 (Life on land). There is a need to address constraints to millet production through scientific research, policy interventions, and value chain improvements is crucial for enhancing millet production and ensuring food security.

2. Constraints in Millet Production

2.1. Agronomic constraints

Millet production is constrained by several agronomic factors that affect its productivity and sustainability. One major challenge is low yield potential, as millets generally produce lower grain yields compared to staple cereals like rice and wheat increasing the yield gap (Yadav et al., 2019). Additionally, climatic sensitivity poses a significant threat, as millets, despite their drought tolerance, are still vulnerable to erratic rainfall, extreme temperatures, and poor soil fertility. The presence of pests and diseases further reduces productivity, as millets lack well-developed resistant varieties. Processed millets are more prone to rancidity reducing their shelf life. Moreover, the lack of improved varieties due to limited breeding programs restricts access to high-yielding, disease-resistant cultivars, hindering efforts to enhance millet production.

2.2. Economic and market constraints

Their low commercial value and profitability compared to staple cereals like rice and wheat discourage farmers from prioritizing millet cultivation. Additionally, poor market linkages and limited processing infrastructure make it difficult to establish efficient supply chains, restricting farmers' access to competitive markets (Mishra et al., 2018). The high production costs, coupled with inadequate processing facilities, further reduce the economic viability of millet farming, as subsidies and incentives are often directed toward major cereals. Moreover, integrating millets into mainstream food supply chains remains a challenge due to low consumer demand, limited awareness, and the lack of diversified millet-based products.

2.3. Social constraints

Millet consumption is limited by social stigma and low consumer awareness, affecting its acceptance in mainstream diets. There has been a decrease in the area under millet cultivation. Often perceived as a "poor man's food," millets are less popular in urban and affluent communities, reducing their market demand. Additionally, limited awareness of their health benefits and declining familiarity with traditional millet-based recipes have contributed to their reduced consumption. The lack of promotion and innovation in millet-based foods further restricts their appeal, as modern diets continue to favor rice and wheat.

2.4. Policy and institutional challenges

Millet production faces policy and institutional challenges that limit its growth and adoption. Unequal policy focus favors staple cereals like rice and wheat, leading to fewer incentives and subsidies for millet cultivation. Additionally, limited research investments hinder advancements in high-yielding varieties, mechanization, and large-scale production. The lack of adequate farmer training programs further restricts productivity, as extension services fail to provide essential knowledge on improved millet cultivation practices.

3. Strategies for Intervention

- **Improved agronomic practices**

Following proper agronomic practices such as timely sowing, and transplanting of crops along with proper nutrient, and weed management helps realize its yield potential. Additionally, the System of Millet Intensification (SMI) developed for finger millet has been reported to double the yield as compared to conventional practices.

- **Boosting research, breeding programs and policy support**

Investing in millet breeding programs is essential to develop high-yielding, climate-resilient varieties that can withstand drought, pests, and diseases. The setting of seed hub for the distribution of quality seed to the

farmers. Advanced genetic research and biotechnology can enhance millet productivity, making it a more viable crop for large-scale cultivation. Strengthening policy support, increasing research funding, and enhancing farmer education can help promote millet production.

- **Improving processing and value addition**

Investing in modern processing technologies such as dehulling, milling, and extrusion can enhance millet quality and expand its use in ready-to-eat products. Developing value-added millet-based foods like flour, breakfast cereals, and snacks can increase consumer appeal and market opportunities.

- **Consumer awareness campaigns**

Educating the public about millet's nutritional benefits, environmental sustainability, and culinary versatility can help shift consumer preferences towards millet-based diets. Collaboration with food industries, chefs, and media platforms can promote innovative millet recipes and increase their acceptance in modern diets.

- **Strengthening market infrastructure**

Enhancing supply chains through better storage, transportation, and distribution networks can improve millet availability and reduce post-harvest losses. Strengthening farmer cooperatives and millet-based agribusinesses can help small-scale farmers access better markets, ensuring fair prices and economic sustainability.

- **Promoting millet cultivation**

GOI is encouraging farmers, traders, and exporters to participate in buyer-seller meets and international trade expos has been organized. Agricultural and Processed Food Products Export Development Authority (APEDA) took the task of promoting millet in various countries. Also, GOI is promoting startups to export 'Ready to Eat' cereals, noodles, biscuits, snacks, etc.

4. Conclusion

Millets are highly nutritious, climate-resilient crops with immense potential to enhance global food security and sustainable agriculture. However, their production is constrained by agronomic, economic, technological, social, and policy-related challenges that limit their widespread adoption. Addressing these issues requires a comprehensive approach, including advancements in breeding programs, improved processing technologies, stronger government support, and enhanced consumer awareness. By integrating millets into mainstream food systems through policy reforms, research investments, and market-driven strategies, their cultivation and consumption can be significantly increased. Promoting millets as a viable alternative to staple cereals will not only support agricultural sustainability but also contribute to improved nutrition and resilience against climate change.

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