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Millets in Food Policy and Promotion

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Abstract
Millets in food policy and promotion, focusing on their health benefits, policy implications, promotional strategies, diverse food applications, nutritional composition, global production, and the economic impact with associated policy recommendations. Millets, renowned for their exceptional nutritional profile, encompass high fiber, essential minerals, and a low glycemic index, contributing significantly to human health. In the context of food policy, incentivizing millet cultivation and incorporating them into national dietary guidelines is imperative. Promotion efforts should involve awareness campaigns to educate consumers about the health advantages and versatile uses of millets in diverse food products.The economic impact of millets is substantial, fostering sustainable agriculture, creating employment opportunities, and bolstering local economies. Governments should consider policy measures such as subsidies, research funding, and market support to further enhance millet production. Diversifying food diets with millets not only addresses malnutrition concerns but also aids in achieving food security and resilience in the face of climate change.Promoting millets in food policy is a holistic strategy that not only improves public health but also has far-reaching economic and environmental implications. Governments and international organizations should prioritize policies that support millet production, create market access, and provide financial incentives. Such measures can lead to a more resilient and sustainable food system, positively impacting both the health of populations and the economies of regions that embrace millet cultivation.

Introduction

Millets are one of the cereals asides the major wheat, rice, and maize.Along with the staples of wheat, rice, and maize, millets are a type of cereal. Millions of people around the world, particularly those who live in hot, dry climates, depend heavily on millets as a food source. e (Yang *et al.,* 2012). They are primarily grown in marginal locations under agricultural circumstances where major grains fail to produce significant yields. Because millets can grow in hard climates with low levels of rainfall, they are an essential food in many underdeveloped countries. For millions of people in Africa, on the other hand, millet serves as their primary source of protein and energy. (Adekunle *et al.*, 2012).There are many varieties of millets: Pearl millet (*Pennisetum glaucum*), which accounts for 40% of global production, Foxtail millet (*Setariaitalica*), White millet (*Panicum miliaceum*), and

Finger millet (*Eleusine coracana*) are the four main types. Pearl millet produces the largest seeds and it is the most commonly used for human consumption (Devi *et al.,* 2011). Pearl millet [*Pennisetum glaucum (L.*): After rice, maize, and sorghum, pearl millet (*Pennisetum glaucum*) is the fourth largest tropical grain and the sixth most important cereal worldwide. It is grown on over 26 million each year, with 11 million in South Asia, 2 million in West Africa, and 1 million in Brazil (Rachie*et al.,*1980).

The term "millet" derived from the French word "Mile," which means a thousand, underscoring that a handful of millets contains thousands of grains. Millets are commonly cultivated in semi-arid regions with minimal rainfall and on marginal or depleted lands with limited nutrient content. These crops are a lifeline for communities in areas prone to recurring famine, offering a more reliable harvest compared to other crops in regions with low rainfall (Tadele 2016). Millets are C4 plants, known for their exceptional photosynthetic efficiency, short growth duration, high dry matter production capacity, and remarkable tolerance to heat and drought. They also readily adapt to degraded, saline, acidic, and aluminium-contaminated soils (Yadav and Rai 2013).

Millets are valuable contributors to agrobiodiversity and offer potential ecological advantages. Traditional cultivation of a variety of millet types, each suited to specific local conditions, enhances the diversity of agroecosystems (Dekker 2003). This diversity plays a crucial role in maintaining soil health, managing pests and diseases, and bolstering the resilience of ecosystems in the face of challenges like climate change. Millets typically demand fewer resources compared to other cereals, such as reduced fertilizer and pesticide usage, resulting in a decreased environmental footprint. Furthermore, their deep root systems promote soil health by enhancing its structure, facilitating water infiltration, and preventing erosion.Millet stands out as a superior seed grain in terms of nutrition; however, it remains underutilized in both developed and developing nations due to a lack of awareness. In regions like Africa and Asia, millet serves as a traditional staple food, whereas in most Western countries, it is primarily relegated to use as animal feed (Hariprasanna*et al.,*2016). The significance of millets lies in their crucial role in ensuring food and nutrition security, offering a sustainable crop alternative to address global hunger and the increasing demand for grains. To enhance their integration into mainstream food production, millets could undergo processing to create value-added, nutritionally rich functional products, given their high nutritional content (Kumar *et al.,*2018).The landscape of technology licensing for startups has evolved into a structured ecosystem complete with a startup pipeline. To facilitate the progress of these startups, supportive systems have become essential. In response to this need, IIMR initiated experimentation with incubation programs, beginning with the Agri-Business Incubation (ABI) funded by ICAR. Subsequently, the Institute extended its incubation efforts in collaboration with the Department of Science and Technology (DST) under the Government of India (Singh *et al.,* 2023).

Policy Recommendations

GOVERNMENT

Government policies have a substantial impact on encouraging the growth and utilization of millets. Many nations provide policy initiatives aimed at assisting millet farmers. These initiatives providing financial assistance for millet seeds and agricultural machinery, establishing price stability measures, and enhancing farmers' access to credit.

The Indian Institute of Millets Research (IIMR) is a leading agricultural research institution that conducts fundamental and strategic research on sorghum and various other millet varieties within the framework of ICAR (Indian Council of Agricultural Research). IIMR plays a central role in overseeing and promoting national-level research on millets through programs like AICRP on Millets, which encompasses Pearl Millet, sorghum, and Small Millets. Additionally, IIMR establishes connections with various national and international organizations to facilitate collaborative efforts in millet research. And later expanded to include collaboration with the Department of Science and Technology (DST) under the Government of India (Gupta *et al.,*2015).

Karnataka has taken the lead in celebrating the International Year for Millets in 2023. The state has arranged an international trade fair dedicated to millets and has incorporated millets into the Public Distribution System (PDS) as part of the Anna Bhagya Yojana scheme. Additionally, Karnataka has initiated the Sahaja Samrudha scheme to promote millets (Lokesh *et al.,*2022).

India's Prime Minister has expressed the ambition to transform IYM 2023 into a 'People's Movement' and to establish India as the 'Global Hub for Millets.' Acknowledging the significant potential of millets, which also aligns with multiple UN Sustainable Development Goals (SDGs), the Government of India has placed a high priority on millets (Poshadri*et al.,*2023). The National Millets Mission (NMM) was initiated in 2007 with the aim of encouraging both the cultivation and consumption of millets (Srivasthava).

Cultivation

To increase the millet cultivation, State Agriculture Universities and Agriculture Departments can play a vital role by offering technical and physical support. This support should primarily focus on areas such as soil health management, integrated nutrient management, quality seed production, and the introduction of farm mechanization. These initiatives will not only increase millet crop productivity and profitability but also serve as incentives for millet producers. Agricultural research institutions can also contribute by identifying, developing, and promoting climate-resilient millet varieties tailored to specific agro-climatic conditions, ensuring suitable options for various terrains. To further encourage millet farming, the government can extend agricultural subsidies that cover the challenging aspects of millet cultivation to assist the farming community (Mishra *et al.,* 2014). The introduction of organic millet cultivation, coupled with the

necessary certification and marketing infrastructure, can offer premium prices to growers practicing organic methods. This initiative aims to boost sustainability by encouraging organic farming and the utilization of organic fertilizers like vermicompost, with the provision of financial and technical assistance. Such efforts are expected to popularize the sustainable cultivation of organic millets. Promoting the intercropping of millets with leguminous crops can significantly enhance soil fertility through the process of nitrogen fixation. This approach may be expanded on a larger scale with support in the form of agricultural inputs and technical guidance to further improve sustainable millet farming.Despite their higher emission rates, major cereal crops are extensively cultivated and serve as the primary sources of nutrition for the global population. In contrast, lesser-known cereal crops such as millets and sorghum exhibit significantly lower carbon footprints. This fact underscores the potential of millets to contribute to reducing the overall global carbon footprint (Prasad *et al.,*2009). According to the FAO (2014), the most commonly cultivated millet varieties on a global scale include Pearl, Proso, Foxtail, Japanese Barnyard, Finger, and Kodo.

Conservation

Farmers can collaborate to form community-based organizations (CBOs) aimed at preserving the genetic diversity of millets within their local regions. It is essential to safeguard the distinct genetic reservoir of millets in order to protect regional biodiversity. Incentives, such as rewards and recognition, can be established to motivate CBOs to actively engage in conserving landraces and promoting efficient management of natural resources.Encouraging intercommunity learning and the exchange of knowledge and experiences can be achieved by forming alliances among community-based organizations. This approach will streamline the sharing of information and bolster marketing networks. The study's discoveries and policy recommendations were communicated to various stakeholders through diverse platforms. This collaborative effort included the publication of research papers, oral presentations, posters, and videos, all aimed at reaching policymakers in government sectors and local governing bodies through national and international seminars, conferences, and policy gatherings. Print and electronic media were utilized to raise awareness among scholars, scientific communities, and farmers and to disseminate the study's results.

Promotes

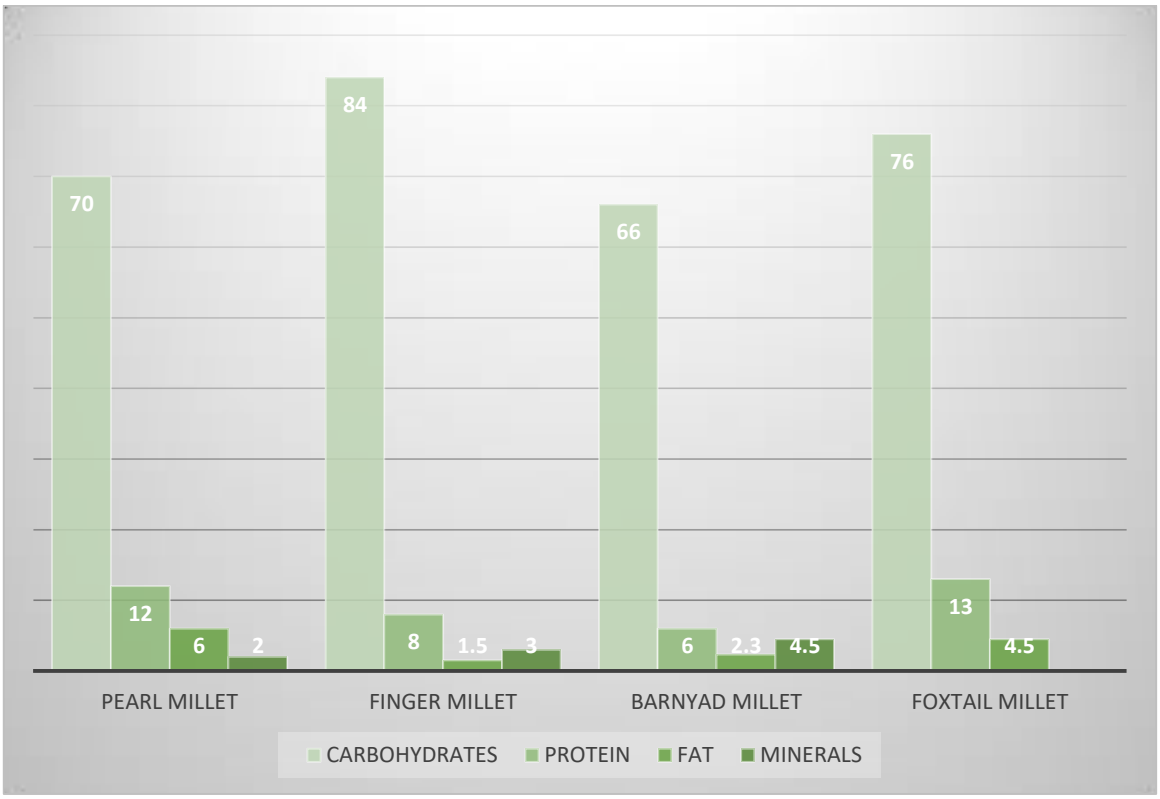
- NUTRITIONAL

	PEARL MILLET	FINGER MILLET	FOXTAIL MILLET	BARNYAD MILLET
Protein (g)	10-11.5	7-7.7	11.8-12.4	6.2
Lysine (g/100g)	1.7-2.8	2.5-2.9	1.5-1.9	1.2-1.4

Fat (g)	5-6	1.2-1.5	4-4.5	2.3
Palmitic %	10-14	20-25	7-10	5-11
Stearic %	2-3	1-2	1-3	0.5-1
Oleic %	20-25	46-51	11-16	24-27
Linoleic %	37-54	8-21	65-69	48-58
Linolenic %	1-2	2-4	2-3	0.6-1.0
Carbohydrates (g)	60-68	71-84	61-75.3	66
Dietary fibre	10.7-11.2(g/100g)	11.5-18.6	2-2.3 (g/100g)	-
Crude fibre (g)	1.2-2.3	3.5-4.1	4.5-8	9.7-14
Minerals (g)	1.5-2.1	2.7-3	2-3.4	4.5
Calcium (mg/100g)	43	345	30	20
Magnesium (mg/100g)	133-136	130-135	78-81	76-82
Iron (mg/100g)	8	4	2.17-2.9	5
Phosphorus (mg/100g)	295	282	290	280
Manganese (mg)	1.15	-	0.5-0.6	0.96
Zinc (mg/100g)	3	2.3	2.4-2.79	3
Potassium (mg/100g)	302-306	408	249	-
Sodium (mg)	11	-	4.6	-
Copper (mg)	1.06	-	2-2.3	0.6
Vitamins (mg/100g)				
Thiamine (mg/100g)	0.3	0.4	0.6	0.33
Riboflavin (mg/100g)	1.4	0.6	1.5	4.2
Niacin (mg/100g)	1.11	0.8	0.56	0.10
Vitamin E (/100g)	0.2-1.1	1.2-2.2	2-3.1	-
Phytate (mg)	540-585	450-590	590-660	-
Oxalate (mg)	-	29-30	25-28	-

Gopalan *et al.,* 2016, Paschapur*et al.,* 2021, Li *et al.,* 2008; Maha Ali *et al*., 2003

Majour Macronurients Present In Millets (g)



Health Benefits-Medicinal Use

Millet consumption results in a decreased blood glucose response and glycosylated hemoglobin levels, thereby reducing the glycemic index, which aids in lowering the risk of diabetes, demonstrating its anti-diabetic properties. Millet grains contain phenolic compounds that effectively eliminate free radicals, reducing oxidative stress. Furthermore, millet extracts exhibit anti-cancer properties by inhibiting the proliferation of cancer cells in cell lines (Mishra *et al.,* 2014).The human body employs various mechanisms to combat oxidative stress, generating antioxidants both naturally and through dietary intake. These antioxidants serve as scavengers for free radicals, playing a crucial role in preventing and repairing the harm inflicted by reactive oxygen species (ROS). Consequently, they contribute to bolstering the immune defense system and reducing the likelihood of degenerative illnesses (Pham Huy *et al.,* 2008).There is promise for using phenolic acid and other bioactive component extracts as natural alternatives for food preservation and medicinal applications (Xu *et al.,* 2011). The risk of heart attacks and strokes is increased by obesity, smoking, eating a poor diet, not getting enough exercising."Niacin-rich foods are advisable for reducing the risk of cardiovascular diseases (CVDs), and within the cereal category, millets stand out as a significant source of niacin. Consequently, millets have the potential to mitigate CVD risk by lowering LDL cholesterol." Heart

disease is prevalent becoming worse in the majority of the world's nations (Kumari *et al.,* 1997). The process of nonenzymatic glycosylation, which occurs when the amino group of proteins and the aldehyde group of reducing sugars combine chemically, is a primary cause of the difficulties associated with ageing and diabetes (Monnier 1990).Millets are abundant in phenolics and antioxidants, such as tannins, phenols, and phytates, which can support antioxidant activity, which is crucial for ageing, health, and metabolic syndrome (Sarita *et al.,* 2016). Consuming millets can help suppress oxidative stress, thereby lowering the risk of the degenerative diseases mentioned earlier (Mishra *et al.,* 2022).

For Low Income Peoples-Small Holders

Small-scale farmers in Africa encounter various challenges when it comes to initiating new crops. These difficulties encompass restricted access to high-quality seeds, and when available, the seeds are often of subpar quality. Moreover, the availability of seeds is even scarcer or entirely lacking for indigenous or local crops, which can be crucial for ensuring food security. Additionally, the national systems responsible for producing and distributing seeds inadequately meet the demand for seeds, leaving farmers heavily dependent on their own saved seeds (Guei *et al.,*2012).Promoting the inclusion of millets in the diets of low-income individuals holds significant potential to address several pressing issues. Millets, such as sorghum, pearl millet, and finger millet, are nutritionally dense, packed with essential vitamins, minerals, and dietary fiber, which can help combat malnutrition and improve overall health in vulnerable populations. These grains are cost-effective and require minimal resources to cultivate, making them a sustainable and affordable option for small-scale farmers. Moreover, millets are highly adaptable and resilient to adverse environmental conditions, contributing to food security by reducing the vulnerability of communities to crop failures. Their versatility in cooking applications also makes them a valuable addition to low-cost, nutritious meals.

Government support is instrumental in promoting millets among low-income populations. Through various agricultural policies and programs, governments can incentivize millet cultivation and create accessible markets for these grains. Subsidies on millet seeds, advanced farming techniques, and post-harvest processing can encourage smallholder farmers to adopt millet farming. Furthermore, public awareness campaigns and educational initiatives can help inform communities about the nutritional benefits of millets and provide guidance on incorporating them into daily diets. By investing in research, infrastructure, and market development, governments can play a pivotal role in promoting millets as a vital component of food security and improved nutrition for low-income individuals.

Millet Products

PRODUCT	DESCRIPTION	REFERENCE
Fermented products	In India and Africa, fermented products made from sorghum and pearl millet. The typical fermentation process includes both malting and souring, achieved through the action of mixed cultures comprising yeast and *lactobacilli*.Millets serve as a valuable protein source; however, their protein quality, particularly regarding lysine and tryptophan content, is relatively low.The pearl millet underwent fermentation through the inoculation of microflora, specifically *S. diastaticus, S. cerevisiae, L. brevis, and L.* fermentation.This fermentation process occurred at 30°C for 72 hours in single culture, mixed culture, and sequential culture. Following fermentation, the samples were subjected to oven drying and fine grinding. It was observed that controlled pure culture fermentation did not alter the protein and ash content of both sprouted and flour forms of pearl millet. However, it significantly increased the starch digestibility of the flour. High levels of dietary calcium and phytic acid can diminish the bio-availability of zinc, forming complexes such as Zn-Ca-phytate or Zn-phytate. Fermentation emerged as a cost-effective and efficient method for substantially reducing polyphenols and phytic acid while enhancing the HCL-extractability of zinc. Fermentation helps to increase acidity and protein digestibility.	Gazzaz*et al.,*1989, Rai *et al.,*2008, Sripriya *et al.,* 1996b; Murali and Kapoor, 2003 Jaybhaye*et al.,* 2014 Akinola *et al.,* 2017, Ali *et al.,* 2023
Flakes	Pearled grains undergo a process of soaking in water, steaming, or pressure cooking to achieve full starch gelatinization. The resultant mixture is	Malleshi, N. G. (1989)

	dried to approximately 18 percent moisture and compressed to the desired thickness between robust rollers. The compressed mixture is then dried to create flakes. These flakes exhibit rapid hydration when introduced to warm water or milk and are utilized in the preparation of both sweet and savory dishes. Additionally, when subjected to deep frying, the flakes expand, yielding crispy products. The smaller size and swift hydration characteristics of millets make them particularly well-suited for flake production.	
Baked products	Biscuits made from pearl millet exhibited an improved amino acid composition. Consequently, biscuits prepared by combining pearl millet with chickpea demonstrated enhanced true digestibility and net protein utilization compared to those made from finger millet and chickpea.Biscuits and cakes of diverse varieties were created by utilizing blanched pearl millet flour, all of which received positive sensory acceptance.	Sehgal *etal.,*2002, Sehgal *et al.,*2003
Noodlesand Pasta	The popularity of millet noodles, specifically those made from finger millet, is increasing due to growing awareness of their nutritional benefits. Various noodle combinations are produced, including those exclusively made from finger millet, a 1:1 ratio of finger millet and wheat, and a blend of finger millet, wheat, and soy flour in a 5:4:1 ratio. Noodles, similar to pasta, are considered convenience foods and are created through a cold extrusion system. They become hard and brittle after drying, making them easy to cook within a few minutes. Extrusion technology offers an innovative	Gull *et al.,*2014 Lekalake 1993, Kunetz 1997 Sehegal*et al.*, 2003

	approach to convert ingredients into products with added value.The optimal pasta products are obtained from sorghum characterized by a soft texture, yellow endosperm, white pericarp, and the absence of pigmented testa. Although noodles made from 100% sorghum flour may not match the quality of rice noodles, they are edible and maintain their texture when cooked.	
Popping or Puffing	Puffing and roasting are closely related processes, with puffing exhibiting a greater degree of volume expansion.Roasting millet flours at 97°C resulted in the inactivation of lipase. This inactivation, in turn, minimized the hydrolysis of fat.The bioavailability of iron was enhanced in weaning foods through the roasting of barnyard and finger millet. The puffing or popping of finger millet stands out as a widely embraced traditional technique, yielding ready-to-eat (RTE) products comprising popped millet and its flour, boasting an enjoyable texture and alluring flavor. This popping process contributes to an improved nutritional profile by deactivating specific antinutritional factors, thereby elevating the digestibility of proteins and carbohydrates.To achieve puffing, the entire finger millet grain undergoes a preparation process involving the addition of extra water to attain a moisture content within the 18-20% range. Subsequently, the conditioned grains are allowed to temper for approximately 4-6 hours under shelter. Puffing is then accomplished by agitating the prepared grains on a hot sand surface, which is maintained at	Srivastava *et al.,* 1994, Bookwalter *etal.,*1987, Greenvani et al.,1996, Gahalwat*et al.,*1994, Pragya *et al.,* 2012, Nirmala *et al.,* 2000, Verma *et al.,* 2013

	temperatures around 230 - 250 ˚C for a brief duration, employing a high-temperature and short-time (HTST) method.	
Extruded products	The popularity of millet noodles, specifically those made from finger millet, is increasing due to growing awareness of their nutritional benefits. Various noodle combinations are produced, including those exclusively made from finger millet, a 1:1 ratio of finger millet and wheat, and a blend of finger millet, wheat, and soy flour in a 5:4:1 ratio. Noodles, similar to pasta, are considered convenience foods and are created through a cold extrusion system. They become hard and brittle after drying, making them easy to cook within a few minutes.Extrusion technology offers an innovative approach to convert ingredients into products with added value. Extruded products made from various grains have gained popularity among people of all ages, with increasing demand, particularly beloved by children. Lifestyle changes have significantly influenced dietary habits, and extruded foods, being ready-to-eat (RTE) snacks, have become a preferred choice. Cereals rich in starch can undergo extrusion after being turned into flour and conditioned appropriately. Finger millet flour or grits, specifically, demonstrate favorable extrusion characteristics. Extrusion cooking has the capacity to fully gelatinize and cook the product, making it suitable as a ready-to-eat (RTE) food.The application of extrusion cooking offers clear benefits such as flexibility, elevated productivity, superior product quality,	Verma *et al.,* 2013 Dahlin *et al.,*1992 Jaybhaye*et al.,*2014

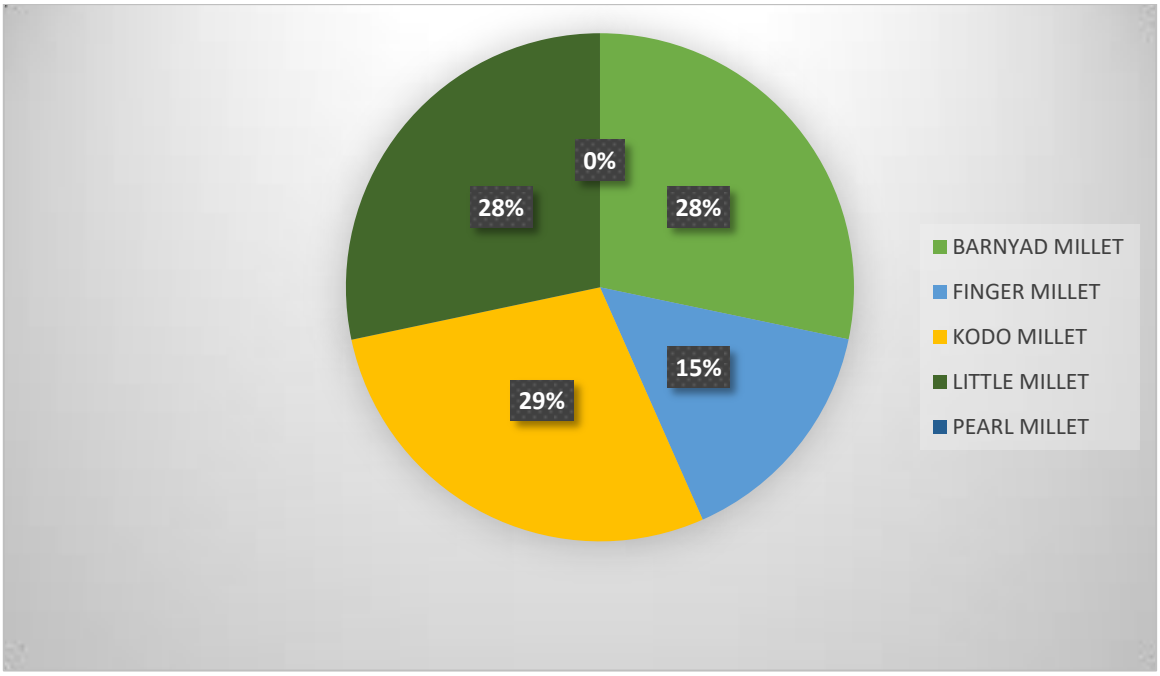
	enhanced in-vitro protein digestibility and the generation of new foods without the generation of effluents. Extrusion cooking involves the application of heat, either directly through steam injection or indirectly through a jacket, or through the dissipation of mechanical energy through shearing within the blend.	
Roti	Several significant food items made from millets include roti, mudde, and porridge. Millet grains are a gluten-free source of protein, making them unsuitable for complete food product formulations. Instead, they are employed as components in bakery product preparation. For instance, when making roti, hot water is combined with millet flour to facilitate partial starch gelatinization. This process is essential for binding, and the resulting mixture is rolled into thin sheets. In the case of millet flour mixed with cold water and a small amount of buttermilk, left overnight, a mild fermentation process occurs. The resulting slurry can then be utilized in the preparation of porridge.	Devi *et al.,*2014, Deshpande *et al.,*2023

Production of Millets in World

India leads the global millet production, contributing 41% and generating 24.95 million USD, securing the top position according to FAO 2020 and UN Comtrade 2020 data. Millets surpass major cereals in terms of water use efficiency (Sathish 2018), nutrient use efficiency (Nagaraj *et al.,* 2013), climate resilience (Kumar *et al.,* 2018), and exhibit tolerance to biotic/abiotic stresses (Kumar *et al.,* 2018, Singh *et al.,* 2022). Millets are noted for their nutritional density (Jenkins *et al.,* 2008, Shobana *et al.,* 2009).According to the FAO, the global production of millets in 2020 amounted to 89.17 million metric tonnes, cultivated across 74.00 million hectares. The predominant millet varieties, sorghum and pearl millet, contribute to nearly 90% of the global production, with other types including finger millet, foxtail millet, proso millet, barnyard millet, little millet, and kodo millet making up the rest. Millets, encompassing pearl millet and lesser millets, are cultivated in over 93 countries worldwide. Notably, sorghum, classified among millets, is grown across 42.1 million hectares in 105 nations, while data on pearl millet and other minor millets are available from 93 countries. Millets are predominantly grown

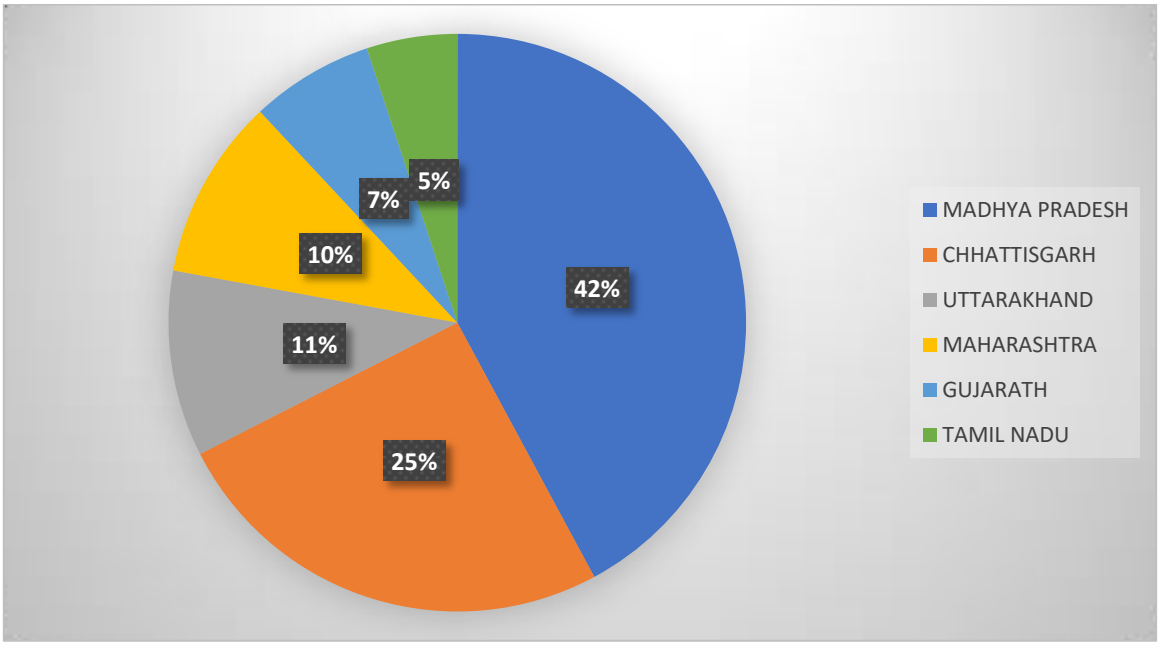
and consumed in developing nations, particularly in Africa and Asia, accounting for approximately 97% of the global consumption. India stands out as the largest millet producer globally, contributing 26.6% of the world's millet farming area and 83% of Asia's. Within India, states such as Odisha, Madhya Pradesh, Jharkhand, Rajasthan, Karnataka, and Uttarakhand have a longstanding tradition of incorporating millets into tribal cuisine (Sood *et al.,* 2019).

Top Most Produced Millets in India



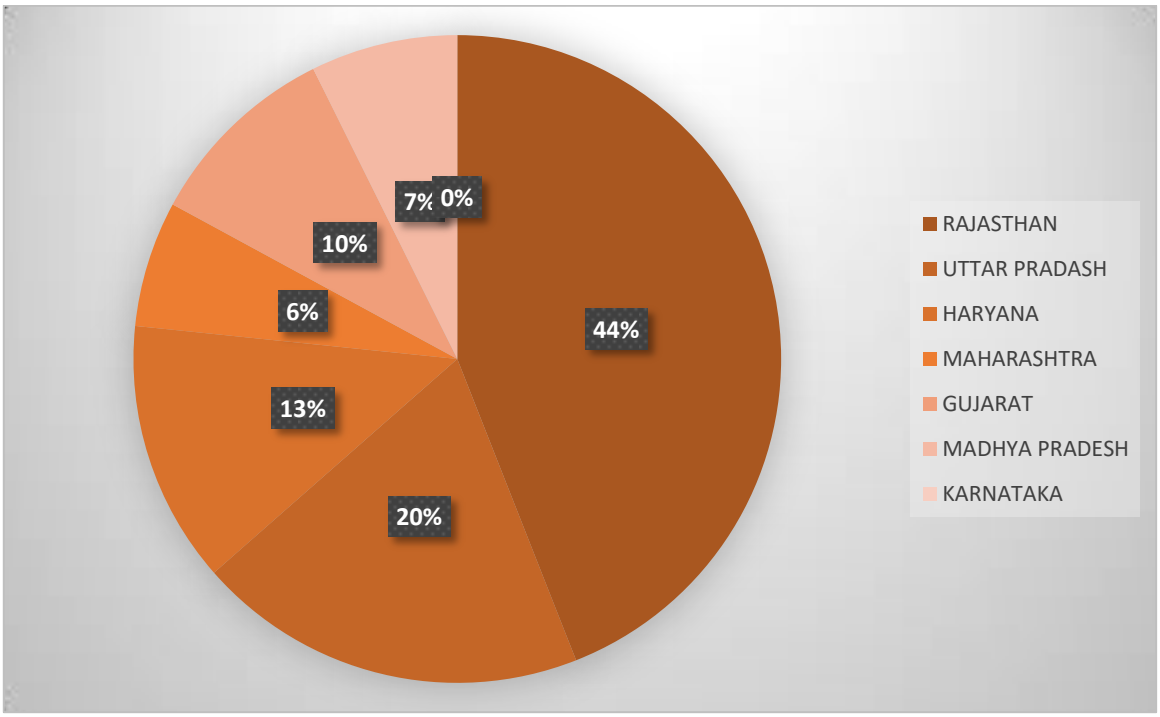
Nehru *et al.,* 2023

Production of Millets in India



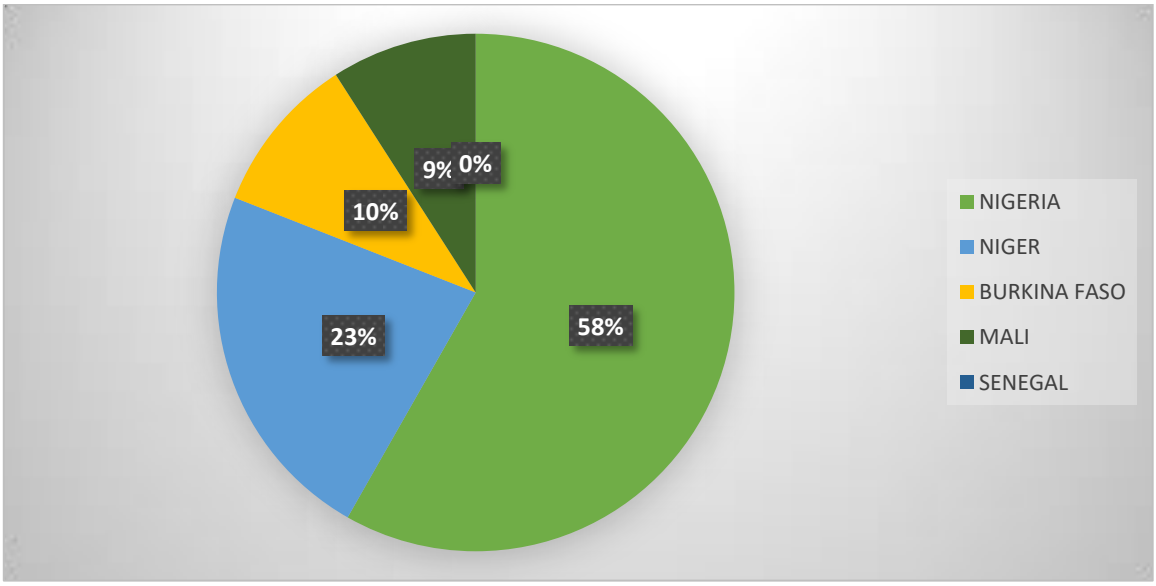
Anbukkani*et al.,*2017; Singh *et al.,* 2023

Production of Bajra in India (2020-2021)



Rani *et al.,*2023

Production of Finger Millet in West Africa



Opolo *et al.,*2019

Conclusion

Millets into food policy and promotion represents a multifaceted approach with far-reaching benefits. Millets, with their exceptional nutritional composition, offer a wealth of health benefits, including high fiber content, essential minerals, and

low glycemic index. Embracing millets in food policies and promoting their cultivation and consumption not only supports sustainable agriculture but also contributes to dietary diversification, addressing global concerns about malnutrition and diet-related health issues. Policy measures aimed at incentivizing millet production, encouraging the use of millets in various food products, and promoting awareness among consumers are crucial components of this strategy. The emphasis on millets can play a pivotal role in supporting low-income populations by providing affordable and nutritious food options. As the world recognizes the importance of resilient and diverse food systems, millets emerge as a promising solution for enhancing both human health and sustainable agriculture on a global scale. So, this review helps in understand and utilization of millets and its important, their superior nutritional, health benefits and functional attributes.

References

1. Adekunle, A. A. (2012). Agricultural innovation in sub-saharanafrica: experiences from multiple stakeholder approaches. Forum for *Agricultural Research in Africa*, Ghana. ISBN 978-9988-8373-2-4.
2. Akinola, S. A., Badejo, A. A., Osundahunsi, O. F., & Edema, M. O. (2017). Effect of preprocessing techniques on pearl millet flour and changes in technological properties. International Journal of Food Science and Technology, 52(4), 992–999.
3. Ali, M. A., El Tinay, A. H., & Abdalla, A. H. (2003). Effect of fermentation on the in vitro protein digestibility of pearl millet. Food Chemistry, 80(1), 51–54.
4. Anbukkani P, Balaji SJ, Nithyashre ML. Production and consumption of minor millets in India - a structural break analysis. Ann Agric Res. 2017;38(4):1– 8.
5. Bookwalter GN, Lyle SA, Warner K (1987). Millet processing for improved stability and nutritional quality without functionality changes. J. Food Sci., 52 (2): 399-402.
6. C. Gopalan and S. B. B. Rama. (2018). Nutritive value of Indian foods. Hyderabad: *National Institute of Nutrition*.
7. Dahlin K and Lorenz K (1992). Protein digestibility of extruded cereal grains. Food Chemistry, 48: 13-18.
8. Deshpande, S., Tripathi, M. K., Mohapatra, D., & Jadam, R. S. (2021). Product development from millets. Millets and Millet Technology, 143-160.
9. Devi, P. B., R. Vijayabharathi, S. Sathyabama, N. G. Malleshi and V. B. Priyadarisini. (2011). Health benefits of finger millet (*Eleusine coracana* L.) polyphenols and dietary fiber: a review. *J. Food Science Technolnology.*
10. Dias-Martins, A. M., Pessanha, K. L. F., Pacheco, S., Rodrigues, J. A. S., & Carvalho, C. W. P. (2018). Potential use of pearl millet (Pennisetum glaucum (L.) R. Br.) in Brazil: Food security, processing, health benefits and nutritional products. Food research international, 109, 175-186.

11. Gazzaz SS, Rasco BA, Dong FM, Borhan M. 1989. Effects of processing on the thiamine, riboflavin, and vitamin B12 content of fermented whole grain cereal products. J Food Process Preserv 13:321–34.
12. Geervani P, Vimala V, Uma Pradeep K, Rama Devi M (1996). Effect of processing on protein digestibility biological value, and net protein utilization of millet and legume based infant mixes and biscuits. Plant Foods Hum. Nutr., 49: 221-227.
13. Gopalan C, Ramashastri BV, Balasubramanium SC (2016) *Nutritive value of Indian foods*. National Institute of Nutrition, ICMR, Hyderabad
14. Guei, R. G., Barra, A., & Silue, D. (2012). Promoting smallholder seed enterprises: quality seed production of rice, maize, sorghum and millet in northern Cameroon. In Sustainable Intensification (pp. 91-99). Routledge.
15. Gull, A., Jan, R., Nayik, G. A., Prasad, K., & Kumar, P. (2014). Significance of finger millet in nutrition, health and value - added products: a review. Magnesium (mg), 130(32), 120.
16. Gupta RK, Gangoliya SS, Singh NK (2015). Reduction of phytic acid and enhancement of bioavailable micronutrients in food grains. *Journal of Food Science and Technology.*52:676-684.
17. Hariprasanna, K., & Rakshit, S. (2016). Economic Importance of Sorghum (pp. 1–25). Springer, Cham.
18. Hegde PS, Chandrakasan G &Chandraa TS. (2022). Inhibition of Collagen Glycation and Crosslinking in Vitro by Methanolic Extracts of Finger Millet (*Eleusine coracana*) and Kodo Millet (Paspalum scrobiculatum). *Journal Nutrition Biochemistry*. 13: 517–21
19. Jaybhaye, R. V., Pardeshi, I. L., Vengaiah, P. C., & Srivastav, P. P. (2014). Processing and technology for millet- based food products: a review. Journal of ready to eat food, 1(2), 32-48.
20. Jenkins A L, Jenkins D J, Wolever T M, Rogovik A L, Jovanovski E, Bozikov V, Rahelić D and Vuksan V. 2008. Comparable postprandial glucose reductions with viscous fiber blend enriched biscuits in healthy subjects and patients with diabetes mellitus: acute randomized controlled clinical trial. Croatian Medical Journal 49(6): 772–82.
21. Kumar A, Tomer V, Kaur A, Kumar V and Gupta K. 2018. Millets: A solution to agrarian and nutritional challenges. Agriculture and Food Security 7(1): 1–15.
22. Kumar, A., Tomer, V., Kaur, A., Kumar, V., & Gupta, K. (2018). Millets: A solution to agrarian and nutritional challenges. In Agriculture and Food Security (Vol. 7, Issue 1, p. 31). BioMed Central Ltd..
23. Kumari SK, Thayumanavan B. (1997). Comparative study of resistant starch from minor millets on intestinal responses, blood glucose, serum cholesterol and triglycerides in rats. *Journal Science Food Agriculture*75:296–302.

24. L. A. Pham-Huy, H. He, and C. Pham-Huy. (2008)"Stem cell," Ataturk University Journal of Veterinary Sciences, 14:221–228.
25. Lokesh, K., Dudhagara, C. R., Mahera, A. B., & Kumar, S. (2022). Millets: The future smart food. *The Pharma Innovation Journal*, 11(4): 75-84.
26. Malleshi, N. G. (1989). Processing of small millets for food and industrial uses. Small millets in global agriculture, 325-339.
27. Masset E, Gelli A. (2014). Improving community development by linking agriculture, nutrition and education: Design of a randomised trial of ''home-grown'' school feeding in Mali. Trials. 14:1-23.
28. Mishra, C. S., Taraputia, T., & Suchen, B. (2014). Policy advocacy for climate smart agriculture in Millets: An initiative for ensuring food security in tribal communities of Koraput tract, Odisha, India. *Global Advanced Research Journal of Agricultural Science*, 3(7): 179-185.
29. Mohod, N. B., Borah, A., Goswami, P., Koshariya, A. K., & Sahoo, S. (2023). The International Year of Millet 2023: A Global Initiative for Sustainable Food Security and Nutrition. *International Journal of Plant & Soil Science*, 35(19): 1204-1211.
30. Monnier VM. (1990). Nonenzymatic glycosylation, the Maillard reaction and the aging process. J Gerontol 45:105–11
31. Nagaraj N, Basavaraj G and Rao P P. 2012. Future Outlook and Options for Target Crops: The Sorghum and Pearl Millet Economy of India. Policy brief no. 15, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Andhra Pradesh, India.
32. Nani, M., & Krishnaswamy, K. (2023). circular economy for food industry waste: Development and characterization of spray-dried acid whey encapsulated in millet matrix. ACS Food Science & Technology, 3(1), 123-133.
33. Naresh, R. K., Bhatt, R., Singh, P. K., Kumar, Y., Tiwari, H., Saini, A., ... & Thakur, H. (2023). Millet: The super food in context of climate change for combating food and water security: A review. The Pharma Inno, 12(3), 1040-1049.
34. Nehru, G., Reddy, A. T., Reddy, C. V., & Sreenivasulu, K. N. (2023). Study of Genetic Diversity in Indian Barnyard Millet Genetic Resources [Echinochloa frumentacea (L.)]. International Journal of Environment and Climate Change, 13(10), 3094-3110.
35. Obilana A.B., E.O. Manyasa, J.G. Kibuka, and S. Ajanga (2002) Finger Millet Blast Samples Collection in Kenya: Passport Data, Analyses of Disease Incidence and Report of Activities. NARO, Uganda-ICRISAT-HR, UK-KARI, Kakamega, ICRISATNairobi, 12pp.

    Obilana AB. Overview: importance of millets in Africa. In: Belton PS, Taylor JRN (eds) Proceeding of the workshop on the proteins of sorghum and millets: enhancing nutritional and functional properties for Africa, 2–4 April 2003, Pretoria, South Africa; 2003.

36. Opole, R. (2019). Opportunities for enhancing production, utilization and marketing of finger millet in Africa. African Journal of Food, Agriculture, Nutrition and Development, 19(1), 13863-13882.
37. Paschapur, A. U., Joshi, D., Mishra, K. K., Kant, L., Kumar, V., & Kumar, A. (2021). Millets for life: a brief introduction. *Millets and Millet Technology*, 1-32.
38. Pragya, S., & Rita, S. R. (2012). Finger millet for food and nutritional security. African Journal of Food Science, 6(4), 77-84.
39. Prasad PV, Staggenborg SA. Growth and production of sorghum and millets. In Soils, Plant Growth and Crop Production; EOLSS Publishers Co., Ltd.: Oxford, UK, 2009, 2.
Rachie, K. O., and Majmudar, J. V. M. (1980). "Pearl Millet," Pennsylvania University Press,University Park.
40. Rai, K. N., Gowda, C. L. L., Reddy, B. V. S., & Sehgal, S. (2008). Adaptation and potential uses of sorghum and pearl millet in alternative and health foods. Comprehensive Reviews in Food Science and Food Safety, 7(4), 320-396.
41. Ramashia, S. E., Mashau, M. E., &Onipe, O. O. (2021). Millet's cereal grains: nutritional composition and utilisation in Sub-Saharan Africa (pp. 1-14). London: IntechOpen.
42. Rani, P., Charu, S., & Kumar, K. (2023). Growth trend of pearl millet and its impact on Indian economy: performance analysis. Int J Adv Multidiscip Res Stud, 3(3), 162-6.
43. Reynolds TW, Waddington SR, Anderson CL, Chew A, True Z, Cullen A (2015). Environmental impacts and constraints associated with the production of major food crops in Sub-Saharan Africa and South Asia. Food Security. 7: 795-822.
44. Saleh, A. S., Zhang, Q., Chen, J., & Shen, Q. (2013). Millet grains: nutritional quality, processing, and potential health benefits. Comprehensive reviews in food science and food safety, 12(3): 281-295.
45. Samtiya, M., Aluko, R. E., Dhaka, N., Dhewa, T., &Puniya, A. K. (2023). *Nutritional and health-promoting attributes of millet*: current and future perspectives. Nutrition Reviews, 81(6): 684-704.
46. Sarita, E. S., & Singh, E. (2016). Potential of millets: nutrients composition and health benefits. *Journal of Scientific and Innovative Research*, 5(2): 46-50.
47. Sathish G. 2018. The Story of Millets. Karnataka State Department of Agriculture, Bangalore, India in collaboration with ICARIndian Institute of Millets Research, Hyderabad, India.
48. Sehgal, S., Kawatra, A., & Singh, G. (2003). Recent technologies in pearl millet and sorghum processing and food product development. Alternative Uses of Sorghum and Pearl Millet in Asia, 60.
49. Shobana S, Sreerama Y N and Malleshi N G. 2009. Composition and enzyme inhibitory properties of finger millet (Eleusine coracana L.) seed coat

phenolics: Mode of inhibition of α-glucosidase and pancreatic amylase. Food Chemistry 115(4): 1268–73.

50. Singh P, Adhale P, Guleria A, Bhoi P B, Bhoi A K, Bacco M and Barsocchi P. 2022. Crop diversification in South Asia: A panel regression approach. Sustainability 14(15): 9363.
51. Singh, P. A. R. D. E. E. P., Arora, K. A. S. H. I. S. H., Kumar, S. U. N. N. Y., Gohain, N. A. M. A. M. I., & Sharma, R. K. (2023). Indian millets trade potential-cum-performance: Economic perspective. Indian Journal of Agricultural Sciences, 93(2), 200-204.
52. Singh, S., Yadav, R. N., Tripathi, A. K., Kumar, M., Kumar, M., Yadav, S., ... & Yadav, R. (2023). Current Status and Promotional Strategies of Millets: A Review. *International Journal of Environment and Climate Change*, 13(9): 3088-3095.
53. Singh, S., Yadav, R. N., Tripathi, A. K., Kumar, M., Kumar, M., Yadav, S., ... & Yadav, R. (2023). Current Status and Promotional Strategies of Millets: A Review. International Journal of Environment and Climate Change, 13(9), 3088-3095.
54. Singh, S., Yadav, R. N., Tripathi, A. K., Kumar, M., Kumar, M., Yadav, S., ... & Yadav, R. (2023). Current Status and Promotional Strategies of Millets: A Review. International Journal of Environment and Climate Change, 13(9), 3088-3095.
55. Sood S, Joshi DC, Chandra AK, Kumar A. Phenomics and genomics of finger millet: current status and future prospects. Planta. 2019;250:731–751.
56. Sripriya G, Usha Antony and Chandra TS (1996b). Changes in carbohydrate, free amino acids, organic acids, phytate and HCL extractability of minerals during germination and fermentation of finger millet (Eleusine coracana). Food Chemistry, 58(4): 345-350.
57. Srivastava, B., & Reddy, P. B. Promoting neglected and underutilized millets to strengthen food security. Recent explorations on millets: the nutri-cereals, 45.
58. Tadele Z (2016) Drought adaptation in millets. In: Shanker AK, Shanker C (eds) Abiotic and biotic stress in plants: recent advances and future perspectives. Intech, Rijeka, pp 639–662
59. Verma, V., & Patel, S. (2013). Value added products from nutri-cereals: Finger millet (Eleusine coracana). Emirates Journal of Food and Agriculture, 169-176.
60. Xu W, Wei L, Qu W, Liang Z, Wang J, Peng X, Zhang Y, Huang K. 2011. A novel antifungal peptide from foxtail millet Seeds. *Journal Science Food Agriculture*91:1630–7.
61. Yadav OP, Rai KN (2013) Genetic improvement of pearl millet in India. *Agriculture Research*2(4):275–292

62. Yang, X., Z. Wan, L. Perry, H. Lu, Q. Wang, C. Hao, J. Li, F. Xie, J. Yu, T. Cui, T. Wang, M. Li and Q. H. Ge (2012). Early millet uses in northern China. Proc. *National Academic Science* USA pp. 1–5.
63. Zhang J, Van Der Heijden MG, Zhang F, Bender SF (2020). Soil biodiversity and crop diversification are vital components of healthy soils and agricultural sustainability. *Frontiers of Agricultural Science and Engineering*. ;7(3):236.