Promoting Nutritional and Sustainablevalue of Shree Anna (Millets)in India

Abstract

"Shree Anna (Millets)" stands out as a viable contender in the search for wholesome and sustainable food solutions because it presents a nuanced strategy for tackling today's global food issues as well as the agrarian and nutritional aspects of millets, highlighting their capacity to change perceptions about food production. When it comes to harsh growing conditions, millets—a "nutri-cereals" crop that is compliant with climate change regulations—perform better than other grains like wheat and rice. These grains are meant to provide enough food that is both sufficient and nutritious, while also maximizing climate resilience, minimizing resource demands, and adapting to a variety of ecological conditions. Millets are renowned for their excellent nutritional value, which includes increased concentrations of calcium, magnesium, potassium, iron, manganese, zinc, and B complex vitamins, as well as balanced amino acids, complex carbs with a low GI, dietary fiber, and high-quality unsaturated fat. Additionally, they have a lot of bioactive phytochemicals. Because of these qualities, millets have become a long-term substitute for sustainable food production methods, protecting farmers' livelihoods and food security. The United Nations General Assembly has proclaimed 2023 as the "International Year of Millets" in an effort to increase awareness of millets as a crop and to highlight the importance of nutrient-rich crops for climate resilient agriculture.

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Keywords: Shree Anna (Millets), nutrition, food security, sustainability and climate resilient

Introduction

High-energy meals such as millets or nutri-cereals were domesticated and grown as early as 10,000 years ago [1]. Millets are considered a major grain in the world, however they are the least used. Because millet grain is high in nutrients and phenolic compounds that are good for health [2]. Typically, marginal and degraded areas with little rainfall and low soil nutrient content are used for millets growth. A handful of millets is said to contain thousands of grains, as the name "millet" comes from the French word "mile," which means thousand[3]. Millets have a competitive advantage over other cereals. The purpose of millets, also known as mini millets, is to produce tiny kernels, which are the offspring of small Poaceae family grassland plants. Although they go by a different name, minor millets are significant crops because of their nutritional worth, therapeutic uses, ability to feed animals, and ability to survive a food crisis. [4]. Millets are a nutritious, locally grown grain that is high in bioactive compounds, low in GI, high in fiber, and a wonderful source of gluten-free protein. They also offer protection against diabetes and cardiovascular disease[2].

The principal nutri-cereals farmed in India consist of pearl millet, also known as bajra (*Pennisetumtyphoides*), finger millet, also known as mandua/ragi (*Eleusine coracana*), foxtail millet, also known as kangni (*Setariaitalica*), little millet, also known as kutki (*Panicum miliare*), kodo millet, known as kodo millet, sawan or barnyard millet (*Echinochloa frumentacea*), proso millet, also known as cheena (*Panicum miliaceum*), and brown top millet, also known as korale (*Brachiariaramosum*) [5].In some Indian states, there have been multifaceted institutional initiatives focused on millets with the goal of boosting both rural and urban output. The Ministry of Agriculture and Farmers Welfare, GOI, refers to the very diversified group of grasses known as millets as Nutri-cereals. Sorghum, big millets, and tiny millets are all members of the Poaceae (true grass) family. Due to their tiny size, millet seeds thrive in arid environments[6]. It's a crop that can withstand drought and be kept pest-free for an extended period of time. It is best suited for dry culture; however, the labor-intensive cultivation process lowers its cultivation value. The world's largest producer of millet is India. Pearl millet, the most widely grown type of millet, is a significant crop in regions of Africa and India [6]. While the overall amount of sorghum produced in India has grown recently, the amount produced on a small scale has decreased dramatically over the years, from 5.29 million hectares to 0.97 million hectares. In India, Karnataka is the state that produces the most foxtail millet. Although more than 58% of the world's output is millet, not many people are aware of its nutritional and health benefits[7].

It is crucial to investigate strategies for raising public knowledge of the nutritional advantages of millet. Exploring these underutilized/neglected species can contribute to sustainability, ecological diversification, rural people's economic empowerment, and nutritional and health security—all of which the modern world desperately needs [8]. In recent years, there has been a growing global interest in rediscovering traditional and nutritious food sources. Among these, millets have emerged as a promising nutritional and agrarian solution to address the challenges of food production, especially 0in the face of climate change. Shree Anna, a collective term for

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various millet varieties, has gained attention for its resilience, adaptability, and exceptional nutritional profile. This review explores the nutritional benefits and the potential role of Shree Anna in ensuring food security for sustainable agriculture.

Nutritional Composition of Millets (Shree Anna Millets)

Rich in Nutrients

Numerous vital components, including vitamins, minerals, and dietary fiber, may be found in abundance in millets, especially those grouped together under the name Shree Anna. These grains greatly contribute to a healthy diet by offering a nutritional profile that is well-balanced. Millets are nutritionally comparable to ordinary cereals, if not more so in terms of calories, protein, and macronutrient concentrations (Table 1). Unlike rice and wheat, millets are a strong source of micronutrients such vitamins A, B, D, E, niacin, pyridoxine, antioxidants, iron, and zinc in addition to being high in calories and key nutrients like protein. Compared to rice and wheat, millets contain higher protein contents (10–12.3 g/100 g), fat contents (1%–5%), iron contents (0.5–19.0 mg), and calcium contents (10–410 mg) [9]. They are a valuable complement to the diets of both humans and animals because of their high calorie content, calcium, iron, zinc, lipids, and quality proteins. They are also great sources of nutritional fiber and vitamins.

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Table 1: Comparing the nutritional makeup of millets with typical grains

Composition	Rice	Wheat	Maize	Millets
Protein (%)	7.5	14.4	12.1	7.3–14.5
Carbohydrates (%)	77.2	64	62.3	56.1–72
Fat (%)	2.4	2.3	4.6	1.3–5.1
Dietary fibers (%)	3.7	12.1	12.8	7.0–37.8
Total phenols (mg/100 g)	2.51	20.5	2.91	51.4–368
Calcium (%)	0.02	0.04	0.03	0.01–0.33
Iron (%)	19	40.1	30	18–21.9
Zinc (%)	10	30.9	20	15–29.5
Sodium (%)	0.00	0.04	0.14	0.11
Thiamine (mg/100 g)	0.07	0.57	0.38	0.32–0.63

Composition	Rice	Wheat	Maize	Millets
Riboflavin (mg/100 g)	0.03	0.12	0.14	0.05–0.22
Nicotinic acid (mg/100 g)	1.6	7.4	2.8	0.3–3.7

(Source: [9]**)**

Although the nutritional makeup of millet varies significantly depending on the variety, millets are generally very nutritious grains with a number of health advantages. This is a broad summary of millets' nutritional makeup

Carbohydrates: Starch, soluble sugar and fiber constitute the carbohydrate portion of millets. Carbohydrates in millets are divided into non-structural (starch and fructosans and sugars) and structural (cellulose, hemicelluloses and pectin substances) carbohydrates. Starch is the chief constituent of non-structural sugar. Amount of the pigments in the pericarp and in the leaves of the sorghum plant defines the color of starches in sorghum. Most abundant component is starch while soluble sugars are low.

Starch: Weight is starch varies from one half to three fourth. Energy is utilized from stored starch for germination. It is composed of linear chains of glucose joined by α-1, 4-glycosidic bonds called amylopectin. The pigments of millet grain pericarp sometimes discolor the starch, giving a light pink color, green and yellow colors.

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Fatty Acid (Lipids): In millets lipids are relatively minor constituents. Lipid content is significantly reduced when the germ is removed during decortication or degermination. The typical fatty acid composition of sorghum lipid is similar to that of maize oil. The lipids can be subdivided into polar, nonpolar and non saponifiable lipids.

Protein: Protein content in millets varies due to agronomic conditions (water availability, soil fertility, temperatures and environmental conditions during grain development) and genotype. Millet proteins are located in the endosperm (80%), germ (16%) and pericarp (3%). These fractions are located primarily within the protein bodies and protein matrix of the endosperm, respectively. Protein quality of millet in terms of amino acid profile is poor when compared to other cereals.

Dietary Fiber: Both soluble and insoluble dietary fiber may be found in millets, which are a great source of it. In addition to encouraging regular bowel movements and lowering the risk of gastrointestinal problems, fiber is crucial for digestive health.

Vitamins: Millets are rich in a variety of vitamins, including the B-complex vitamins, which include riboflavin (B2), thiamine (B1), niacin (B3), and vitamin B6. These vitamins are vital for neuron function, energy metabolism, and general cellular health.

Minerals: Iron, magnesium, phosphorus, and zinc are among the many minerals found in millets. Magnesium is essential for bone health, muscular function, and nerve transmission; iron is needed for the synthesis of red blood cells and the transportation of oxygen. Zinc promotes wound healing and immune system function, whereas phosphorus is required for the development of bone and teeth.

Low in Fat: Millets are a good choice for anyone managing their fat consumption because they are comparatively low in fat when compared to other grains.

Phytochemicals: Millets are a rich source of various phytochemicals including tannins, phenolic acids, anthocyanins, phytosterols and pinacosanols. These phytochemicals have potential positive impact on human health. Millets are rich in flavonoids and phenolic substances, which help shield cells from the oxidative harm that free radicals bring to cells. A lower risk of chronic illnesses like diabetes, cancer, and heart disease has been associated with antioxidants. All millet grain and especially sorghum fractions possess high antioxidant activity in vitro relative to other cereals and fruits. Millets are a good source of phenolic compounds with a variety of genetically dependent types and levels of phenolic acids, flavonoids and condensed tannins. Most sorghum does not contain condensed tannins, but all contain phenolic acids.

Millets for food and nutritional importance

Millions of people around the world depend on sorghum and millets as key staple foods. These are nutri-cereals, which are noted for their high nutrient content with varied nutraceutical importance and have potential health benefits (Table 2). According to epidemiological research, consuming millets lowers the risk of developing heart disease, prevents diabetes, improves the digestive system, lowers the risk of cancer, detoxifies the body, boosts immunity and respiratory health, gives you more energy, strengthens your muscles and nervous system, and protects you from a number of degenerative diseases like metabolic syndrome and Parkinson's disease [10-12].

Table 2: Nutraceutical potential of millets

Sl. No.	Disease	Benefit	Positive factors
1.	Diabetes	• Treating diabetes	With low glycemic index
2.	Cancer	• Anti-cancer property	Inhibit the tumor formation
3.	Anemia	• Help in increase in hemoglobin	High iron and zinc concentration
4.	Heart health	• Phytonutrients and lignin act as a strong antioxidant thus prevent heart disease • High content of magnesium useful in controlling blood pressure and heart stress	As strong antioxidant
5.	Respiratory problems for asthma patients	• High amount of magnesium reduces respiratory problems (asthma patients) • Reduce migraine attacks	High amount of magnesium
6.	Weight loss (obesity)	• Useful in weight loss contains high fibre content • Reduces the overall consumption of food	High fibre content
7.	Anti-allergic properties	• Highly digestible • Low allergic response	Due to hypo allergic property

(Source: [13]**)**

Gluten-Free Alternative

Millets is inherently gluten-free, making it an excellent alternative for individuals with gluten sensitivity or celiac disease. For those living in hot, humid areas, millets are a mainstay gluten-free diet. It has a lot of lipids, carbohydrates, and protein among other nutritional components. They are better than other cereals because of their less reliance on the environment and resilience in difficult environments. In order to avoid consuming gluten, consuming millets might serve as a substitute supply of all the vital biological macromolecules needed for the body's regular maintenance [14]. Given their advantageous nutritional and cost-effective characteristics as well as other connections to food security, they are perfect for addressing the deficiencies associated with malnutrition and helping to meet the main sustainable development aim of promoting health and well-being. The rising prevalence of gluten-related disorders has increased the demand for gluten-free grains, positioning millets as a viable option.

Low Glycemic Index

The low glycemic index of millets makes them suitable for individuals with diabetes. Shree Anna can help regulate blood sugar levels, providing a steady release of energy and promoting better overall health. Millets contain 13–38 % of total dietary fiber, which could be considered in the management of disorders like diabetes mellitus, obesity, hyperlipidemia, etc. The glycemic load-lowering effects are highest in barnyard millet. On the GI chart, millets have a score between 40 and 70, which is lower than the GI values of maize, rice, wheat, and refined flour [15]. When compared to millets made from wheat and corn, ingestion of proso millets had a lower GI.

Millets for food security

When enough safe, nutrient-rich food is available to everyone at all times to meet their dietary needs and food choices for an active and healthy life, then there is food security. This may be achieved by physical, social, and economic means. FAO statistics show that as of 2019, over 820 million people worldwide were hungry, underscoring the enormous difficulty of achieving the Zero Hunger goal by 2030. Feeding everyone on the earth is one of the biggest issues facing the modern world. This issue is exacerbated by a number of variables, including a shortage of micro- and macronutrients, the inability to produce enough food to fulfil demand, wars that destabilise certain parts of the world, and others. Forecasts indicate that by 2050, a combined effect of diminishing rates of food production and the extra burden of feeding a population that exceeds 9 billion people might result in 2-3 billion cases of hunger and food and nutritional insecurity [16,17].

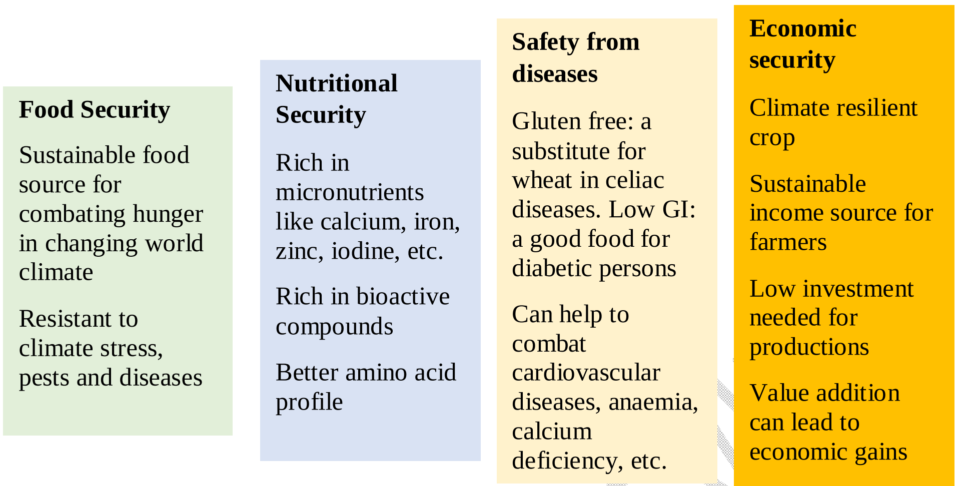

Fig. 1: Importance of Millets

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Millets are useful for many things. Compared to wheat, they grow in half the time, consume 70% less water, and require 40% less energy to process. They provide a thorough solution for long-term food security in the face of water scarcity, drought, and climate change. When examining the distribution of nutrients among food groups, and in order to achieve food and nutrition security, emphasis should be placed on providing food groups that contain both macro and micronutrients in suitable levels. Millets and cereals are abundant in nutrients; they contribute about 50% of nutrients like iron [18]. Sustainable crop substitutes are necessary to reduce global hunger and boost farmer incomes. When creating long-term plans to achieve food and nutritional security, millets are essential. Due to its significant role in nutritional security and possible rising health repercussions, millet is presently addressing an important area of research for food scientists. To ensure food and nutritional security, innovative, high-value food and healthcare products are increasingly required. Therefore, using both conventional and cutting-edge methods to convert millets into convenient food items or value addition might be a great strategy to implement for increased consumption.

Furthermore, parts of the Sustainable Development Goals (SDG), including SDG 1 (no poverty), SDG 2 (zero hunger), SDG 3 (excellent health and wellbeing), and SDG 15 (life on land), can be accelerated by growing millets [19]. To tackle these problems, a paradigm change is required, moving away from the existing incremental adaptation strategies and towards ground-breaking substitutes that prioritise human health, nutrition, and environmental sustainability. Products made from millet are popular and have a longer shelf life. A study conducted by Durairaj et al. [20] found that schoolchildren who regularly ate nutritious millet-based diets saw significant improvements in their height, weight, and haemoglobin levels. This highlights the significance of millets for food and nutritional security as they can be cultivated in adverse conditions and provide nutrients that are otherwise hard to come by. Many experts believe that growing millets is a step towards food security and sustainability. India is making national and international attempts in this field. The United Nations declared 2023 to be the International Year of Millets at India's request. Seventy countries backed the action.

Agrarian Advantages of Shree Anna Millets

Climate resilience and adaptability to diverse conditions:

Millets are known for their adaptability to diverse climatic conditions. Shree Anna varieties are particularly resilient to drought, making them a valuable crop in regions facing water scarcity. This resilience contributes to the sustainability of agricultural practices (Fig. 2). Climate change is now causing typical environmental changes that agriculture must deal with. These include sudden temperature increases, increased levels of CO_2 and other greenhouse gases, unpredictable monsoon rains, and an increase in the frequency of natural disasters such heat waves, floods, and droughts. In these circumstances, climate-resilient agriculture need to be implemented, wherein the production of climate-smart crops will be essential in guaranteeing the future demand for food. Without a doubt, millets will be the future's climate-smart crops, able to both mitigate the adverse impacts of climate change and adjust to the more diverse agro-climatic conditions [21]. Global warming potential for wheat and rice is around 4 tons CO_2 equivalent/ha and 3.4 tons CO_2 equivalent/ha, respectively. This finally results in high carbon equivalent emissions for wheat and rice, which are 1000 and 956 kg C/ha, respectively. Because millets have a lower carbon footprint than main cereals, growing millets can help lower carbon emissions [22]. Since millets need only 12–14 weeks to complete their life cycle—while rice and wheat take up to 24 weeks—their short life span helps them avoid stress.

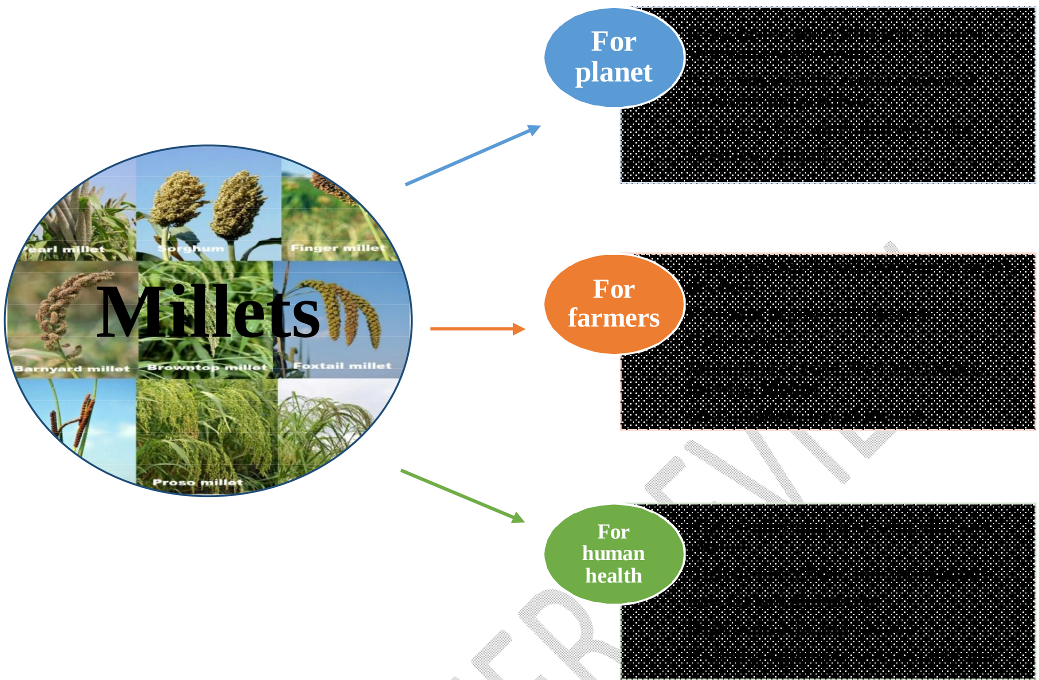

Fig. 2: Millets for sustainability

Millets have superior resilience to environmental stressors in comparison to other main cereals due to a number of morpho-physiological, biochemical, and molecular traits. Because millets are C4 plants, they can absorb more CO_2 from the environment and create more assimilates through photosynthesis, even in situations when the atmospheric CO_2 content is higher [23]. Additionally, millets have a higher water use efficiency (WUE) than major cereals. For instance, foxtail millet requires only 257 g of water to produce 1 g of dry biomass, and it requires half as much water as wheat (510 g) and maize (470 g) to produce the same amount of dry biomass [21]. As a result, millets are automatically chosen to address the water shortage. Additionally, millets require less nutrients, thus encouraging their growth will help preserve the environment in an indirect way. The C4 mechanism inhibits photorespiration (by about 80% depending on temperature) and RuBisCO's in plant catalytic activity as a result of increasing the concentration of CO_2 in the bundle sheath [24].

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Millets benefit from C4 photosynthesis in addition to WUE and NUE. These benefits include reduced hydraulic conductivity per unit leaf area, increased ecological enactment in hotter climes, and more flexible biomass allocation patterns [25]. Abiotic stress tolerance in millets is conferred by a few genes that have been found. Because of these qualities, millets are considered next-generation crops with a lot of promise for study into climate-resilient features and the application of that knowledge to the future enhancement of main cereals.

Enhancing Soil Health and Biodiversity:

Millets are well-suited for sustainable farming practices. They require fewer inputs like water and synthetic fertilizers compared to conventional cereal crops. The cultivation of Shree Anna helps improve soil health, reducing the environmental impact of agriculture. Improving soil health and biodiversity are essential components of sustainable agriculture[26]. A wide variety of plant species and beneficial creatures may be encouraged within agricultural landscapes by farmers via the use of techniques like crop rotation, cover crops, and agroforestry, which enhances the resilience and stability of ecosystems. Conservation tillage methods reduce soil disturbance, maintain soil structure, and encourage organic matter buildup, which supports nutrient cycling and the health of soil microbial populations.

Furthermore, reducing dependency on synthetic inputs, minimizing environmental consequences, and supporting the natural balance of ecosystems are all made possible by composting organic waste, integrating various crop species, and putting integrated pest control measures into practice[27]. Farmers may establish healthy ecosystems that promote biodiversity, strengthen soil health, and maintain agricultural production for future generations by carefully managing water resources, restoring natural habitats, and protecting agricultural regions [28,29]. Integrating Shree Anna into agricultural systems promotes crop diversity, which is crucial for overall ecosystem health. Additionally, millet cultivation supports biodiversity by providing a habitat for various beneficial insects and microorganisms.

Reducing Carbon Footprint:

In order to mitigate climate change and promote environmental sustainability, reducing carbon footprint is essential. There are several steps that cities, corporations, and individuals may do to reduce their carbon emissions and help the environment. Key tactics for cutting carbon emissions include switching to renewable energy sources like solar and wind power, enhancing building and transportation energy efficiency, and implementing sustainable farming methods[30]. Furthermore, minimising resource use and lowering greenhouse gas emissions may be achieved by supporting carpooling, bicycling, and public transportation in addition to cutting waste and adopting the circular economy concepts. To achieve meaningful reductions in carbon footprint, it is imperative to invest in carbon offset projects, support reforestation initiatives, and advocate for legislation that prioritise environmental preservation and sustainability [31,32].

Incorporation of millets in Indian food supply chain

To feed the population, we first need to produce and process millets and enjoy their nutritional benefits. But the scope for enhancement of productivity under irrigated conditions is limited because of over exploitation of available resources, but there are many opportunities for boosting yield in drylands by uptaking suitable crops and cropping systems[33]. The combination of cereal and legume intercropping can be a major help to farmers in subsistence farming, targeting livelihood security[34]. They also have numerous advantages, such as increased crop productivity, increased resource efficiency[35], reduced water run-off, soil conservation in erosion-prone areas, and prevention of soil nutrient loss, improved soil health, and insurance against crop failure. Due to unusual weather, and a higher monetary return and benefit-cost ratio.

Snacking has become a common practice among children and adults; therefore, an attempt should be made to develop some healthy snacks like muffin cakes and biscuits from processed malted finger millet flour to get the maximum advantage of their nutrient content in terms of bioavailability[36]. Fermenting and cooking the ready-made mix to create idli and dosa, germinated powders of minor millets were blended and incorporated with other fundamental traditional components like rice powder and de-husked black gram powder in defined proportions[37]. In comparison to rice-based idli, high proportions of protein (15–18%), fat (8.5–9.8), and carbohydrates (69–72%) were determined[37].

A key factor in achieving the estimated benefits of real diversification is the extent to which agronomic characteristics will permit switches between crops[1]. On the one hand, historical policy regimes have promoted the widespread cultivation of crops in places that may not have otherwise been agro-ecologically suitable or sustainable (e.g., rice in northern India) and on the other hand, certain areas where rice is grown may not be able to support the cultivation of coarse cereals[38]. Assessments quantifying the range of biophysical conditions that can support the cultivation of each cereal will therefore be essential for understanding the potential magnitude of co-benefits from increased cereal production[39]. An increase in the production of coarse cereal has largely occurred in the places where the cultivation of these cereals is currently centred. This is encouraging from a farmer's perspective, as the local knowledge of effective crop management practises[39] may be more readily available.

Conclusion

Preserving and promoting Shree Anna Millets represents a positive beginning towards building an equitable and sustainable global food system. Millets have the potential to be a viable substitute for the world's current major crops because of their better environmental adaptations and capacity to flourish in challenging environments. A number of significant challenges, including resistance to climate change, nutritional security, smallholder livelihoods, biodiversity protection, and resource efficiency, may be addressed by adopting millets as staple crops and encouraging their cultivation, consumption, and value addition. In addition to providing food for millions of people, millets also contribute to the preservation of traditional knowledge, cultural history, and the variety of agro-ecosystems, particularly in areas that are vulnerable to environmental stress.It is anticipated that the changing climate will have significant effects on the types of crops cultivated in the next century. According to this study, millet grains provide similar and beneficial levels of different nutrients to primary cereal grains. Therefore, in order to raise millet diet standards and increase the micronutrients' bioavailability, new processing and preparation techniques are required. The bioavailability, metabolism, and health benefits of millet, grains, and their many constituents in humans require more investigation.

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