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Shree Anna: The Nutritional Powerhouse Paving the Path for Health Security in India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Millets often referred to as Shree Anna; represent a group of small-seeded cereal grains renowned for their remarkable health benefits and drought tolerance. These grains have a long history of cultivation and are consumed across diverse regions worldwide, with a pronounced emphasis on Asia and Africa. However, recent years have seen a decline in Shree Anna cultivation and consumption due to a shift towards more profitable and higher-yielding crops. This shift has resulted in reduced food and nutritional security for communities that rely on millets for their livelihoods and sustenance. It is a rich source of protein, fiber, micronutrients, and vitamins, making it a valuable resource in addressing iron, zinc, and protein deficiencies, particularly among women and pre-school children. In India, Shree Anna holds a critical position as a predominant cereal crop, especially among low-income families, owing to its well-known nutritional value. However, despite

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its nutritional potential, Shree Anna remains underexplored in India, and there is significant untapped potential for its utilization. Unlocking the full potential of Shree Anna could have a profound impact on nutritional security, sustainable agriculture, and the economic well-being of communities.

Keywords: Shree anna; nutritional; elixir; health potential; nutritional security.

1. INTRODUCTION

The term “millet” has its origins in the French word “Mile” which means “thousand,” signifying that a handful of millets contain thousands of grains [1]. Millets are affectionately referred to as Shree Anna in India due to their deep cultural and historical significance. The term “Shree Anna” translates to “the honoured grain” or “the mother of all grains” in English. Shree Anna constitutes a category of cereal crops characterized by small seeds and a remarkable ability to thrive in drought-prone conditions [1], with their seeds being harvested for both human consumption and as animal feed [2].

Shree Anna is categorized as a C_4 plant [1] that is distinguished by its high photosynthetic efficiency, short growth periods, increased capacity for dry matter synthesis, and resistance to heat and drought. Furthermore, they show strong adaptability to saline, acidic, or aluminum-toxic soils [3].

From a nutritional perspective, Shree Anna offer remarkable benefits as their energy value, protein content, and macronutrient profile are not only comparable to but in some cases even exceed those of conventional cereals. Furthermore, it serves as abundant sources of dietary fiber and essential micronutrients, enhancing their nutritional value and their potential to contribute to balanced and healthy diets [4]. Shree Anna is categorized into two main types: major millets (Sorghum, Pearl Millet, and Finger Millet), make significant contributions, while minor millets (Little Millet, Proso Millet, Kodo Millet, Foxtail Millet, and Barnyard Millet) offer diverse nutritional benefits. Together, these millets play a vital role in promoting balanced and sustainable diets globally [5]. The contemporary sedentary lifestyle, which is linked to various health concerns, has prompted individuals to seek healthier and more nutritious dietary options. Small millets meet the nutritional requirements of today's civilization. Shree Anna is high in key nutrients and provides a helpful solution to the quest for healthier eating [1]. For instance, finger millet grains are notable for their high calcium level (>350 mg/100 g). Protein content is high in foxtail millet, barnyard millet, and proso millet (>10%). Little millet and foxtail millet, on the other hand, have a greater fat content (>4.0%). Furthermore, foxtail millet, barnyard millet, and small millet are high in crude fiber (6.7–13.6%) [1]. among these, barnyard millet and small millet contain significant levels of iron (9.3–18.6 mg/100 g), exceeding rice, wheat, barley, maize, and sorghum [6]. Additionally, Shree Anna stands out as gluten-free grains, and they are notably high in essential minerals such as zinc, magnesium, iron, calcium, and vitamin-B [7,8]. In arid regions, Shree Anna assumes a critical role as the primary source of both protein and energy for the local population [9]. Along with this, Shree Anna offers a wide array of health benefits, encompassing reduced heart disease and diabetes risk, improved digestive health, lower cancer susceptibility, effective detoxification, enhanced respiratory immunity, increased energy levels, and better muscular and neural systems [10]. Additionally, it acts as a safeguard against degenerative diseases like metabolic syndrome and Parkinson’s disease [8,11].

In India, the major millets including Sorghum, Pearl Millet, Finger Millet, and other small millets have been extensively studied in terms of their state-wise area, production, and productivity. India holds the distinction of being the world’s largest producer of Shree Anna, contributing 80% of Asia’s and 20% of global production. Shree Anna is cultivated extensively across the country, although the concentration varies significantly from state to state. **According to MoA & FW Report 2023-24,** the total area under Shree Anna cultivation in India is 9.5 million hectare with production of 12.20 million metric tonnes and productivity of 1.3 million tonnes per hectare [12]. Shree Anna productivity in India is approximately 127.35 kg/ha [5]. In India, Rajasthan was the leading millet producer in the year 2020-21, contributing a substantial 5.15 million MT, which accounted for 28.61% of the country’s total millet production. Karnataka held the second position as a major contributor, yielding 2.56 million MT and accounting for

14.26% of the national Shree Anna production. In the realm of significant Shree Anna (millets) production, Maharashtra (2.51 million MT, 13.95%), Uttar Pradesh (2.29 million MT, 12.75%), Haryana (1.36 million MT, 7.58%), and Gujarat (1.09 million MT, 6.06%) assumed key roles. These top six states accounted for over 80% of India's Shree Anna production in the 2020-21. The per capita consumption of millets in India has witnessed a significant and concerning decline over the years. In 1960, the annual per capita consumption stood at a substantial 30.94 kg. However, by 2022, this figure had plummeted to a mere 3.87 kg [5]. This dramatic decrease in Shree Anna consumption reflects a notable shift in dietary preferences and choices, with a growing reliance on other staple grains and processed foods. This data underscores the need for greater awareness and initiatives to revitalize the consumption of Shree Anna, given their nutritional value and potential benefits for both health and sustainability. Recognizing the pivotal nutritional role that millets can play in public health, the Government of India took a significant step by declaring millets as "Nutri-Cereals." In a concerted effort to shed light on the nutritional importance and potential of millets, India celebrated the "National Year of Millets" in 2018, raising awareness about these wholesome grains.

India's commitment to promoting millets on the global stage was further demonstrated when it proposed the concept of an "International Year of Millets" to the United Nations General Assembly (UNGA). This proposal garnered support from approximately 70 countries, underlining the widespread recognition of millets' significance in addressing global nutrition and food security challenges. As a testament to this broad support, the United Nations General Assembly passed a resolution to officially observe 2023 as the "International Year of Millets."

Shree Anna, despite their exceptional nutritional value, often remains overlooked as a primary food source, primarily due to a lack of awareness among the general populace. However, in the realm of biomedical research, Shree Anna have been gaining increasing significance, driven by mounting evidence suggesting their positive effects on human health [13]. The common names and nutritional values of Shree Anna are provided in Table1.

Fig. 1. Different types of Shree Anna
Source:-Tiwari et al, [14]

2. HISTORY AND DISTRIBUTION

Shree anna was the first crops cultivated by humans in Asia and Africa [4], later becoming a staple food source that spread worldwide. These grains hold a profound historical significance deeply rooted in our traditions and have played a vital role in shaping our diets and cultures over centuries. The history of Shree Anna is intertwined with the evolution of human civilization [15]. These grains have been an integral part of our ancestors' diets since ancient times. The discovery of Shree Anna traces in the remains of the Indus Valley Civilization, which dates back 3000 years and stands as one of the world's oldest civilizations, serves as a testament to their historical significance [16]. Shree Anna has endured the test of time, offering valuable sustenance and nourishment to people across generations. In the past, coarse grains were not only a staple food but also deeply rooted in our traditions. They formed an essential part of crop rotation and our diets until the advent of the Green Revolution. Approximately five to six decades ago, certain crops were named based on their combinations, such as **Dhankodai for the cultivation of paddy and kodo,** and **Gozai for wheat and barley [17]**. These crops held such prominence in our traditions that some individuals in villages were even identified by the names of these crops. Furthermore, the renowned poet Ghagh eloquently depicted the virtues of millets through his couplets, highlighting their exceptional qualities. One verse extolled the rejuvenating effects of millets, proclaiming, **"Uth ke bajra u hassibolai, khayebudhajuvahojaaye"** (Even an old person becomes young after consuming millets). Another couplet emphasizes the harmonious combination of millets with fish and yogurt, stating, **"Maduameen, peen sang dahi, kodo ka bhaatdoodh sang dahi"**. Similarly, an Ayurvedic couplet proclaims, **"Roti makke ki bhali, theek kare liver aapka TB bhiho door"** (Maize bread is beneficial, it improves your liver and even helps alleviate tuberculosis) [17].

Table1. Types of Shree Anna their Common and Scientific Name

S. No.	Millets/ Shree Anna	Common Name	Scientific Name
1.	Finger Millets	Ragi	*Eleusine coracana*
2.	Foxtail Millets	Kangni	*Setariaitalica*
3.	Sorghum Millets	Jowar	*Sorghum bicolor*
4.	Pearl Millets	Bajra	*Pennisetum glaucum*
5.	Proso Millets	Chena	*Panicum miliaceum*
6.	Kodo Millets	Kodon	*Paspalum scrobiculatum*
7.	Barnyard Millets	Sanwa	*Echinochloacrusgalli*
8.	Little Millets	Kutki	*Panicum sumatrense*

Table2. Shree Anna and its Nutritional Composition (mg/100 g)

S. No.	Millets	Protein	Fat	Fibre	Minerals	Carbohydrates	References
1.	Finger Millets	7.30	1.30	11.50	2.70	72.20	[18]
2.	Foxtail Millets	11.20	4.00	6.70	3.30	63.20	[14]
3.	Sorghum Millets	10.40	3.10	2.00	1.68	70.70	[19]
4.	Pearl Millets	11.80	4.80	2.30	2.20	67.00	[20]
5.	Proso Millets	11.00	3.50	8.50	1.90	56.15	[21]
6.	Kodo Millets	8.35	1.50	5.20	3.30	65.56	[22]
7.	Barnyard Millets	10.50	3.60	12.60	2.00	68.70	[23]
8.	Little Millets	8.92	2.50	6.39	1.72	65.48	[13]

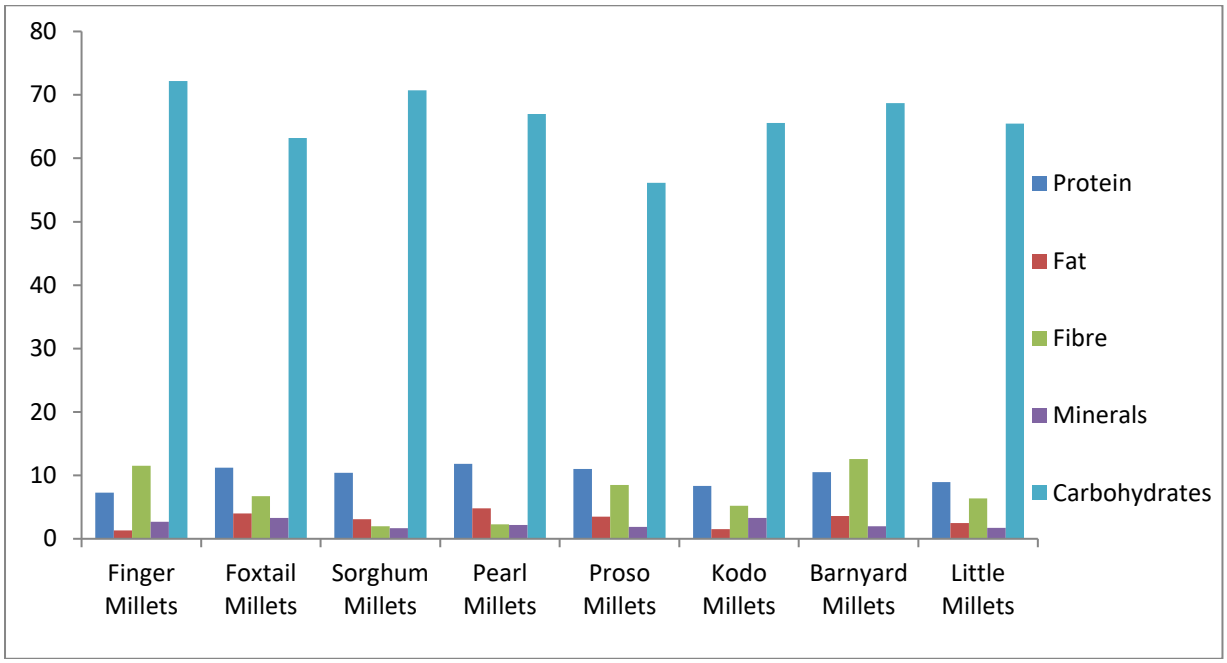

Fig. 2. Shree Anna and their Nutritional Composition (mg/100 gm)

Types of Shree Anna: Shree Anna, encompassing seven distinct varieties within the Poaceae family, stands as a group of small-seeded, spherical cereals. These grains, considered among the earliest domesticated cereal grains used by humans, manifest diverse characteristics in colour, shape, size, and cultivation regions. Here, descriptions of Shree Anna provided below.

Finger millet: Finger millet, scientifically referred to as Ragi, holds significant importance as a staple food among socio-economically disadvantaged populations and individuals managing metabolic conditions such as diabetes and obesity. Noteworthy for its nutritional richness, finger millet serves as a healthy alternative to rice or wheat, being a valuable source of minerals, dietary fiber, proteins, and carbohydrates [24]. Its capacity for prolonged storage and substantial nutritional content underscores its significance [15]. Rich in dietary fiber, finger millet serves as an effective natural laxative, aiding in the prevention of constipation. Moreover, its abundant calcium content renders it particularly beneficial for young children, the elderly and expectant mothers. Additionally, finger millet proves highly advantageous for lactating mothers, promoting optimal breast milk production [25].

Foxtail millet: Foxtail millet (*Setaria italica* L.) stands as a globally cultivated and consumed cereal, wielding substantial economic significance, particularly in regions such as India, China, and various parts of Asia, North Africa, and the Americas. Classified within the Panicoideae subfamily of the Poaceae family [26], this cereal's gluten-free nature, high protein content, and low carbohydrate composition contribute to the synthesis of the neurotransmitter acetylcholine, facilitating signal transmission between muscles and nerves. The nutritional prowess of foxtail millet aids in sustaining endurance, bolstering strength, and enhancing immunity against various diseases. Its nutrient-rich profile establishes it as a vital dietary component promoting overall health and vitality.

Sorghum: Sorghum, known as Jowar, holds immense agricultural significance globally, occupying substantial cultivated land and production capacity. This gluten-free grain boasts a nutrient-rich profile, comprising various chemical compounds with physiological effects. As the world's fifth-largest cereal crop, sorghum finds diverse applications as a grain, sweetener, forage, low-lignin, and biomass crop, thriving across a range of climates. Its resilience to heat and drought renders it a viable crop for cultivation in arid environments [27]. The nutritional composition of sorghum encompasses iron, calcium, fiber, protein, and wax policosanols, each contributing distinct health benefits, including cholesterol reduction [16]. Furthermore, sorghum's rich content of tannins

and polyphenols bestows it with anticancer and anti-mutagenic properties, emphasizing its potential for promoting health and combating certain medical conditions [28].

Pearl millet: Pearl millet, known as Bajra, stands resilient among cereal crops, particularly thriving in regions with limited rainfall, distinguishing itself from wheat and rice. As the sixth most crucial grain globally, semiarid areas of Asia and Africa heavily rely on it as a dietary staple [29]. Representing a significant member of the millet family, pearl millet commands a substantial presence in global agriculture, contributing to approximately 40% of worldwide production [30].

Developing nations account for over 95% of pearl millet production, with India leading at 9.8 million hectares cultivated globally [31]. The grain's noteworthy oil content (ranging between 4–9%) facilitates easy storage at lower temperatures and minimal moisture. Moreover, pearl millet boasts significant quantities of unsaturated fatty acids, folate, copper, zinc, iron, magnesium, calcium, vitamin B complex, and various other minerals, enhancing its nutritional value and dietary significance [19].

Proso millet: Proso millet, also known as Broomcorn millet, emerges as a climate-resilient, gluten-free, small-grain cereal that bears significant benefits for both human consumption and environmental sustainability. Rich in proteins and vitamins, proso millet holds historical usage as a restorative food, particularly post-childbirth or during recovery from illnesses. Notably, proso millet contains a high concentration of niacin, a form of vitamin B3, aiding in the treatment of Pellagra, a condition characterized by dry, scaly, and rough skin [32]. Its nutritional composition renders it highly advantageous for human consumption, offering specific attributes such as drought tolerance and a short growth season. These properties position it as an ideal rotational crop within dry land farming systems, especially in conjunction with winter wheat. Employed in a two-year wheat/summer fallow cropping system, proso millet presents an economically advantageous production strategy [21].

Kodo millet: Kodo millet, believed to have originated in India, is traced back to its domestication around 3000 years ago [33]. Renowned as a traditional food resembling rice and known for its weight loss promoting properties, kodo millet boasts high digestibility and a rich abundance of phytochemicals and antioxidants, aiding in the prevention of diseases linked to a sedentary lifestyle [25]. Particularly beneficial for postmenopausal women experiencing symptoms of cardiovascular disease like high blood pressure and elevated cholesterol levels, kodo millet stands out for its elevated antioxidant content, offering protection against oxidative stress and contributing to stable blood sugar levels, thereby assisting in diabetes management. Its usage has shown potential in managing conditions including asthma, migraines, high blood pressure, heart attacks, atherosclerosis, and diabetic heart disease [21].

Barnyard millet: Barnyard millet, an ancient crop belonging to the *Echinochloa species*, finds cultivation across warm, temperate regions worldwide. Particularly popular in Asia, notably in India, China, Japan, and Korea, this millet variety holds significance as the fourth most widely cultivated minor millet, contributing significantly to the food security of numerous economically disadvantaged populations globally [34, 35].

Primarily intended for human consumption, although also utilized as animal feed, barnyard millet encompasses various cultivated and wild species, notably *Echinochloa frumentacea* (Indian barnyard millet) and *Echinochloa esculenta* (Japanese barnyard millet) [36]. This resilient crop exhibits a short growth cycle and demonstrates remarkable tolerance to a diverse range of biotic and abiotic stresses, thriving in unfavourable environmental conditions with minimal input requirements.

Little millet: Little millet, also known as Kutki, represents a unique minor cereal extensively cultivated in tropical regions, serving as a staple in the diets of various low-income groups worldwide. Despite its diminutive size, little millet stands as a comparable source of protein, fat, carbohydrates, and crude fiber akin to mainstream cereals like rice and wheat. Notably, it provides an array of minerals, vitamins, and phytochemicals such as flavonoids, phytate, phenolic acids, and tannins [37]. While it may appear less nutrient-dense owing to its size, little millet harbours significant quantities of Vitamin B and various minerals including calcium, iron, zinc, and potassium. Its composition also incorporates essential fats conducive to weight loss. Additionally, its high fiber content renders it an excellent alternative to rice in traditional dishes like Pongal or even Kheer, contributing to a balanced and wholesome dietary choice [16].

Health benefits of Shree Anna: Given their high nutritional value, Shree Anna are even more relevant globally in the consequences of the COVID-19 pandemic [38].

There is several health benefits of Shree Anna described below-

1. **Blood Pressure and Heart Health-**Shree Anna consumption is associated with lower blood pressure levels and reduced risk of heart disease, cardiovascular ailments, and tumors. They contribute to a heart-healthy diet [39].
2. **Cancer Prevention-**The presence of certain compounds in Shree Anna grains has shown potential in preventing cancer, contributing to cancer risk reduction [39].
3. **Digestive Health-**Shree Anna grains aid in slowing stomach emptying and provide essential roughage to the intestines, promoting digestive health [39].
4. **Alkaline Properties-**Millets, being alkaline-forming foods, help in maintaining the body's optimal pH balance, crucial for immune health and defence against infections [40].
5. **Phytic Compounds and Essential Minerals-**Millets are dietary staples in numerous African and Asian countries due to their high content of phytic compounds and essential minerals, providing significant nutrition [41].
6. **Cost-Effective Production-**Millets stand out as grains with highly cost-effective agricultural production, making them accessible and economically viable [41].
7. **Micronutrient Bioavailability-**Processed Shree Anna grains improve the bioavailability of micronutrients, offering a highly nutritious option for consumption [42].
8. **Kodo Millet for Cardiovascular Health-**Incorporating kodo millet in the regular diet is particularly beneficial for maintaining cardiovascular health, especially for postmenopausal women managing symptoms of increased blood pressure and cholesterol levels [43].
9. **Child Growth and Development-**The high protein content in millets supports healthy growth and development in children [32].
10. **Bone Health and Anaemia Treatment-**Millets' calcium content stimulates bone development and reduces the risk of fractures, while their high-quality iron aids in the treatment of anaemia [32].
11. **Gluten-Free and Celiac Disease-**Millets' gluten-free nature makes them suitable for individuals with celiac disease and those sensitive to gluten, offering a safe and nutritious alternative [32].

Although millets should be a regular part of our diet due to their many nutritious advantages, the majority of informed people have never ever heard of millets or their advantages. Foods devoid of fibre are causing serious health problems for people all over the world [44, 45]. By incorporating Shree into a person's normal diet and avoiding refined foods like rice, wheat, processed meats, refined flours, refined oils, and ready-to-eat foods, all lifestyle diseases can be eradicated, according to prior research findings [32]. Millets are high in phenolic acids, phytates, and tannins, which are anti-nutrients that lower the incidence of colon and breast cancer. Millets can lower blood sugar levels by enzymatically hydrolyzing complex carbohydrates in hyperglycemia. The aldose reductase enzyme benefits in reducing sorbitol formation and lowers the chance of developing diabetes.

Magnesium, which lowers the risk of heart attack, is abundant in millets. A good source of phyto-chemicals that lower cholesterol and help prevent heart disease is millets [39]. Fibre is present in millet, which promotes healthy digestion and helps to control bowel habits. Additionally, it possesses prebiotic qualities that aid in the development of prebiotic bacteria in the micro biome by enhancing immune function all around and digestion; this has positive health effects [46,47-52].

Significance of Shree Anna in Indian Diet:

1. **Nutritional Abundance-**Shree Anna stands out as a nutritional powerhouse, boasting an impressive profile of protein, dietary fiber, essential vitamins, and minerals. Millet offers potential health benefits, including the protection of cardiovascular health, diabetes prevention, assistance in achieving and maintaining a healthy weight, and the management of gut inflammation. It is fiber-rich, a source of magnesium, Niacin (Vitamin B_3), gluten-free, and high in protein.
2. **Water-Efficient Crop-**Shree Anna plays a vital role in semi-arid regions, ensuring food and nutritional security for communities facing challenges such as inadequate rainfall and poor soil fertility. They are highly nutritious and serve as a crucial food source in rural areas.

Fig. 3. Major Health benefits of Shree Anna

3. **Soil Adaptability-**Shree Anna thrives in low to moderately fertile soils and can flourish in regions with limited rainfall. Jowar, Bajra, and Ragi are among the prominent millets cultivated in India.
4. **Profitable Farming Choice-**Shree Anna is an excellent choice for farmers seeking profitability, versatility, and sustainability in their agricultural practices.
5. **Drought Resilience and Sustainability-** Often hailed as the "wonder grains" of the future, Shree Anna exhibit remarkable drought resistance, requiring minimal external inputs. Due to their high resilience to harsh environmental conditions, millets are not only sustainable for farmers but also environmentally friendly. They offer cost-effective, nutrient-rich options for consumers.
6. **Extended Shelf Life-**In a country where approximately 40% of the food produced is wasted annually, millets play a crucial role in reducing food wastage. Millets have a long shelf life and remain suitable for consumption even after 10-12 years of cultivation, contributing significantly to food security and minimizing food wastage.

4. CONCLUSION

An extensive analysis delves into India's key Shree Anna—Jowar, Bajra, Ragi, and various small Shree Anna—examining their state-wise metrics in terms of area, production, and productivity. Madhya Pradesh emerges with the largest small Shree Anna cultivation area, while Uttarakhand leads in production, and Pondicherry showcases the highest productivity. Focusing on individual Shree Anna, Maharashtra dominates both Jowar cultivation area and production, whereas Andhra Pradesh stands out for productivity. Rajasthan shines with extensive Bajra cultivation, with six states contributing 95% of its total production. Meanwhile, Karnataka dominates Ragi cultivation, contributing a noteworthy 67% to the national production. Yet, amidst these statistics lies a concerning trend: a decline in small Shree Anna cultivation area at a rate of -3.60% per annum, while productivity sees a modest 0.74% increase annually.

Shree Anna's cultivation in India fortifies a governmental intervention through incentives and subsidies can incentivize greater Shree Anna farming. Farmer-friendly procurement policies ensuring fair prices for Shree Anna produce serve as an additional encouragement. Moreover, substantial investments in research and development are essential to cultivate improved Shree Anna varieties resistant to drought, pests, and diseases, promising higher yields.

In the arena of today's society, consumer trends favour fast food and bakery items, linked to various health issues. Therefore, this study underscores the nutritional value of wholesome foods and advocates for integrating Shree Anna

into regular diets. Despite its relative obscurity, Shree Anna—a cherished ancient grain—offers a trove of health benefits. Raising awareness about its advantages becomes supreme for promoting a healthier, more fulfilling life. It stands as a reminder of our ancestors' wisdom, encapsulating remarkable benefits that Shree Anna brings as a valuable addition to modern diets.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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