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From ancient grains to modern solutions: A history of millets and their significance in agriculture and food security

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Abstract

The research article provides an overview of the history of millets, highlighting their significance as a staple food crop in various regions of the world. Millets have been cultivated for thousands of years, with evidence of their use dating back to ancient civilizations such as those of China and India. Over time, millets have spread to other regions, including Africa, Europe, and the Americas, where they have been adapted to suit local growing conditions and culinary traditions. The article also discusses the various nutritional benefits of millets, including their high levels of protein, fiber, and antioxidants, which make them an important component of a healthy diet. Finally, the article explores the challenges facing millet cultivation and consumption in the modern era, including competition from other crops, changing dietary habits, and climate change, and offers suggestions for promoting the continued cultivation and consumption of this important crop.

Keywords: Millets, history, cultivation, health benefits, food security, sustainable development

Introduction

The term "Millet" originated from the Latin word "Milum" means grain^[1]. Millets are a group of small-seeded grasses belonging to the botanical family Poaceae, widely grown around the world as cereal crops or grains for human food and fodder for millions of resource-poor farmers and play a vital role in the ecological and economic security of India. These millets are also known as "coarse cereals" or "cereals of the poor" (apeda.gov.in)^[2]. They have been cultivated in various parts of the world for thousands of years. They are known for their hardiness and ability to grow in a variety of conditions, including arid and semi-arid regions. Millets are a staple food in many parts of Africa and Asia and are often used to make bread, porridge, and other traditional dishes. This article will explore the history of millets, including their origins, spread around the world, cultural significance, etc.

Origins of Millets

Millets have been cultivated for thousands of years and their exact origins are not known. It is believed that millets originated in different parts of the world independently and that they were among the earliest domesticated crops.

Current archaeobotanical evidence has proved that foxtail millet (*Setaria italica*) and broomcorn millet (*Panicum miliaceum*) were both cultivated in northern China no later than 8000 cal. BP (Deng *et al.*, 2017)^[3]. Millets were also cultivated in Africa, the Middle East, and Europe around the same time. These early farmers discovered that millets were easy to grow, had a short growing cycle, and could be stored for a long time. They also found that millets were highly nutritious and could sustain human life for extended periods.

In India, millets have been mentioned in some of the oldest Yajurveda texts, identifying foxtail millet (*priyangava*), Barnyard millet (*aanava*), and black finger millet (*shyaamaka*), thus indicating that millet consumption was very common, pre-dating to the Indian Bronze Age 4,500 BC.

Millets have been a staple food for centuries, especially in rural areas in India. Millets were traditionally grown as rain-fed crops and were well-suited to the dry climate of the Deccan Plateau in southern India.

Multiple varieties of millets are produced in India such as Pearl Millets, Sorghum, Finger Millet, Foxtail, Kodo, Barnyard, Proso, Little Millet, and Pseudo Millets like Buckwheat and Amaranths. Pearl millet (Bajra), Sorghum (Jowar), and Finger Millet (Ragi) constitute the largest share of India's total production of millets [5]. Millets were used to make a variety of dishes, including porridge, bread, dosa, pancakes, etc.

In China, millets were also an important crop, particularly in the northern regions where wheat and rice did not grow well. The culture-historical importance of foxtail and broomcorn millet in China is symbolized by the legendary Houji of the Xia Dynasty (2070–1600 BC). “Houji” translates as “Lord of Millets” (Crawford 2014). Millets were used to make a variety of dishes, including porridge, dumplings, and noodles. In addition to their use as a food source, millets were also used in traditional Chinese medicine.

Millet began to be cultivated in Europe not 7,000 years ago in the Neolithic period as previously thought, but in the Bronze Age, about 3.5 thousand years ago, and was particularly popular in eastern and central Europe [7]. Millets were used to make porridge, bread, and beer. In the Balkans, a type of porridge made from millet called polenta became a staple food.

In Africa, millets remain an important food source, mainly in the Sahel region where they are a staple crop. Millets are also grown in other parts of Africa. Tef and fonio are among those millets that were domesticated in the African continent and are still grown there almost exclusively, where teff, a type of millet, is used to make injera, a sourdough flatbread that is a national dish, and Fonio is considered to be the oldest West African cereal and its cultivation is thought to date back to 5000 B.C. (The Story of Millets, 2018) [8].

During the colonial period, millets were largely replaced by other crops such as wheat and rice, which were seen as more modern and prestigious. However, in recent years there has been renewed interest in millets as a healthy and sustainable food source. Millets are gluten-free and have a low glycaemic index, making them a good choice for people with celiac disease or diabetes.

Despite having a lot of evidence and theories the origin of millets is still a topic of debate among researchers.

Spread of Millets

Millets were the first crops to be domesticated by mankind in Asia and Africa which later on spread across the globe as critical food sources to the evolving civilizations. All these millets are nutritionally rich, and complete their life cycle in 2 to 4 months, adapting to the shorter cropping windows that facilitated wider adaption, shifting cultivation, and with standing nature's unforeseen vagaries [9]. The spread of millets can be traced through human migration and trade routes. As early humans migrated from Africa to other parts of the world, they likely carried millet seeds with them and cultivated them in new regions. Millets were also traded between different civilizations along the Silk Road, a network of trade routes that connected the East and the West. Finger millet *Eleusine coracana* is originally an African millet and was transported to India in the pre-Aryan times (Mehra 1963). In a recent study, the area of probable domestication of *Eleusine coracana* was in the highlands from Ethiopia to Uganda; for *Sorghum bicolor* in a wide zone in the broad-leaved savannah belt that stretches from Lake Chad to eastern central Sudan (evidence from Kadero). Pearl millet (*Pennisetum americanum*) was domesticated in the dry

savannah from Sudan to Senegal (Harlan 1971) [11]. It will be interesting to enquire whether this millet reached the Indian Peninsula by land or by some other route. Their integration into the Indian subsistence seems to have taken place towards the closing centuries of the third millennium B.C. Today the millets form an essential item in the dietary system of the poorer sections of society and are a valuable source of fodder for cattle. (Singh, 1996) [12]. Millets such as foxtail millet, pearl millet, and finger millet were grown for their ability to thrive in arid regions with low rainfall. These crops were also resistant to pests and diseases, making them an ideal choice for farmers in areas with limited resources.

Millets spread to other parts of the world over time, including Africa, Asia, Europe, and the Americas, particularly in regions with challenging growing conditions, carried by traders, explorers, and settlers. In Asia, millets were introduced to India and Southeast Asia, where they became important crops in many regions. Millets were also brought to Europe by early traders and were grown in regions such as Greece and Italy. In the Americas, millets were introduced by European settlers and were grown in regions such as the southern United States and South America.

One of the reasons for the popularity of millets in many parts of the world is their hardy nature and the ability to grow in harsh conditions. Millets can grow in soils with low fertility and areas with limited rainfall, making them ideal for cultivation in regions with dry climates.

Millets also have a short growing season and can be harvested in as little as 60 days, making them a valuable crop in areas where other crops may not grow.

In addition to their use as a food source, millets have other important cultural and economic roles. In many parts of the world, millets are used in religious and cultural ceremonies and are also an important source of income for small-scale farmers.

In recent years, there has been a renewed interest in millets as a food crop, particularly in developing countries where they are still a staple food. Millets are seen as a way to improve food security and reduce poverty in regions with limited resources. Millets are also being promoted as a way to address the issue of climate change, as they are a low-input crop that can be grown using sustainable farming practices.

Today, there are ongoing efforts to promote the use of millets as a sustainable and nutritious food source. In India, for example, the government has launched a program to promote the cultivation and consumption of millets, intending to improve the health and livelihoods of small-scale farmers.

There are several types of millets, each with its own unique characteristics and nutritional benefits. Here are some of the most commonly grown types of millets.



Fig 1: Different variants of millets

Sorghum (*Sorghum bicolor*): Sorghum is a warm-season crop, intolerant of low temperatures but fairly resistant to serious pests and diseases. It is known by a variety of names (such as great millet and guinea corn in West Africa, Asia, and parts of the Middle East). Most of the sorghum produced in North and Central America, South America, and Oceania is used for animal feed (FAO, 1995). Sorghum is one of the ancient cereal grains and it is a staple crop in India also in Africa. It is considered a safe food grain alternative for people with celiac disease and gluten insensitivity. Being a gluten-free grain, it is also much preferred by those who can't tolerate wheat-based products. It is also packed with iron, protein, and fiber [14].



Fig 2: Sorghum

Pearl millet (*Pennisetum glaucum*): Bajra or Pearl millet is estimated to be originated as early as 5000 years in Africa (Andrews and Kumar 1992) and was introduced to the Indian subcontinent around 3000 years ago [16]. Pearl millet is a hardy crop that can grow in poor soil and withstand drought. It is a good source of protein, fiber, and several important micronutrients such as iron and zinc. Pearl millet consists of magnesium which helps in reducing respiratory problems in asthma patients and helps to reduce the effect of migraine. The fiber content of pearl millet helps the reduction of gallstone occurrence. The insoluble fiber present in pearl millet helps in the reduction of excessive bile in our system, as excessive bile in our system leads to gallstones (Shweta, 2015) [18]. Pearl millet is generally used in the preparation of various value-added food products such as cutlets, weaning food, vermicelli, instant beverage powder, bread, cakes, muffins, chapati, instant idli, kheer, extruded product, cookies, snack bar, and beverages [34, 35].



Fig 3: Pearl millet

Finger Millet (*Eleusine coracana*): Finger millet or Ragi is a staple food in many African and South Asian countries and is believed to have been domesticated around 4,000 years ago. It is also considered a helpful famine crop as it is easily stored for lean years (FAO, 2012) [19]. The grain is readily digestible, highly nutritious, and versatile, and can be cooked like rice, ground to make porridge or flour, or used to make cakes. Finger millet is also used to make liquor (arake or areki in Ethiopia) and beer. Finger millet is a good source of protein, fiber, and several important micronutrients such as calcium, iron, and potassium. It is also gluten-free and has a low glycemic index, making it a good choice for people with celiac disease or diabetes.



Fig 4: Finger millet

Foxtail millet (*Setaria italica*): The probable center of origin of Foxtail millet or Italian millet is China; however, the crop is known to be domesticated during Neolithic culture. It is among one the ancient cereals cultivated in Europe and Asia, with China contributing more than 45% of world production (Jiaju and Yuzhi 1994). The crop is well adapted to cooler climates and matures in less than 70-120 days [16]. Foxtail millet is a good source of protein, fiber, and several important micronutrients such as iron, magnesium, and phosphorus



Fig 5: Foxtail millet

Little Millet (*Panicum sumatrense* Roth.): Eastern Ghats of India are known to be the place of domestication of little millet as early as 2000 years ago and the crop is majorly cultivated in peninsular Indian states like Andhra Pradesh, Karnataka, Tamil Nadu, and Kerala. The crop is adapted to both dry and humid conditions and can be cultivated in drought-prone areas as well as water-logged conditions, as the crop matures early and withstands adverse Conditions [16]. Little millet is a good source of protein, fiber, and several important micronutrients such as iron, calcium and phosphorus.



Fig 6: Little millet

Kodo Millet (*Paspalum scrobiculatum*): Kodo millet is believed to have originated in India and has been cultivated for over 3,000 years. It is widely grown in India, especially in the southern and western regions. Kodo millet is a good source of protein, fiber, and several important micronutrients such as iron, calcium, and potassium. Kodo millet is a traditional food that closely resembles rice and helps to use in weight loss. It is easily digestible and is rich in phytochemicals and antioxidants which help in preventing different lifestyle-related diseases. Kodo millet also helps in reducing joint and knee pain and helps in regularizing menstruation in a woman (Deshpande, *et al.*, 2015) Kodo millet is popular in tribal regions of India and they are cooked similarly to rice and develop several types of products like idli, dosa, papad, kheer, etc. [36].



Fig 7: Kodo millet

Barnyard Millet (*Echinochloa esculenta* A. and *Echinochloa colona*): This is a multi-purpose crop that is cultivated for food and fodder. Barnyard millet is native to India and has been cultivated for over 4,000 years. It is widely grown in India, especially in the eastern and central regions. It is a good source of protein, which is highly digestible, and is an excellent source of dietary fiber with a good amount of soluble and insoluble fractions. The carbohydrate content of barnyard millet is low and slowly digestible, which makes barnyard millet a nature gift for modern mankind who is engaged in sedentary activities (Dayakar Rao B. 2017). Barnyard millet is most effective in reducing blood glucose and lipid level. Barnyard millet is also a good source of several important micronutrients such as iron, calcium, and phosphorus. Barnyard millet is generally used in the preparation of different value-added products such as vermicelli, roti/chapati, noodles, biscuits, cookies, malt-based weaning food, extruded products, snack food, laddoo, halwa, biryani, dosa [34, 35].

Proso millet (*Panicum miliaceum*): Broomcorn millet or Proso millet has probably originated in the Manchurian region of China and is presently cultivated in northwest China, southern and central parts of India, Australia, the USA, and Europe. It is the third most important millet crop cultivated after pearl millet and foxtail millet and it is well adapted to temperate climatic conditions up to altitudes of 3500 m and various soil types (A. & Paschapur 2021). Proso millet is beneficial in preventing Pellagra's condition, which is caused due to niacin Vitamin B3 deficiency. It has a high content of Niacin. Traditionally it is used as recuperative food, especially post-pregnancy or illness [14]. Proso millet is a good source of protein, fiber, and several important micronutrients

such as iron and magnesium also. Proso millet is generally used for preparing chakli, noodles, cookies, chapati, khichari, chila, idli, dosa, namkeen, biscuits, halwa, Payasam, roti, bread, ready-to-eat breakfast cereal [35].



Fig 8: Barnyard millet



Fig 9: Proso millet

Cultural Significance of Millets

Millets have played a significant role in the culture and traditions of many communities around the world for thousands of years. Here are some of the cultural significance of millets:

- **Religious and Ritual Significance:** In many cultures, millets are used in religious ceremonies and rituals. In Hinduism, for example, millets are used in offerings to gods and goddesses during festivals and other religious ceremonies. In some cultures, millets are also used in traditional medicine and healing practices.
- **Traditional Food:** Millets have been a staple food for many communities for generations. They are often used in traditional dishes and are an important part of the local cuisine. For example, in India, different types of millets are used to make traditional dishes such as bhakri, dosa, idli, etc.
- **Farming and Harvesting Rituals:** Millets have been an important crop in many farming communities. In some cultures, rituals, and festivals are celebrated during the sowing, harvesting, and processing of millets. These rituals are meant to invoke blessings from the gods and ensure a good harvest.
- **Sustainable Agriculture:** Millets are known for their resilience and ability to grow in poor soil and harsh conditions. They require less water and fertilizer than

other crops, making them an important part of sustainable agriculture. Many communities around the world rely on millets as a source of food and income.

- **Social and Community Significance:** Millets have played an important role in the social and community life of many cultures. In some communities, the harvesting and processing of millets is a communal activity that brings people together and strengthens social bonds.
- **Folklore and Stories:** Millets have been a part of many folklore and stories in different cultures. For example, in India, there are many stories about the origins of different types of millets and their significance in local culture.

Millets have played an important role in the cultures and cuisines of many regions of the world. In addition to their culinary uses, millets have also been used for medicinal purposes in many cultures. In traditional Chinese medicine, for example, millets are used to treat a variety of ailments, including digestive problems, urinary tract infections, and insomnia. Millets are also used in Ayurvedic medicine in India, where they are believed to have cooling and soothing properties.

In Africa, millets were grown in the Sahel region, which stretches from Senegal to Sudan. Millets were an essential part of the diet of people in this region. They were used to make a variety of dishes, including porridge, bread, and beer. Millets were also used in traditional medicine to treat various ailments.

In Europe, millets were cultivated in the Mediterranean region. The Greeks and Romans were known to consume millets, and they were also used to make bread. Millets were also grown in Eastern Europe and Russia, where they were used to make porridge and soups.

Decline in Millet Production

Some of the agricultural foods are not used as human main food because of unawareness of people. Millets are one of them. Millets are being used as animal and bird feed. Millet has many nutritious and medical functions reported. These are underutilized and neglected crops because of little knowledge of people and some critical problems like lower cooking quality, taste, and low bioavailability of millets [23].

Despite the widespread cultivation of millets, their production declined in many parts of the world during the 20th century. Due to the Western development model, India has neglected its traditional wisdom. Millets are cited as too primitive and coarse grains. It was looked at only as the food of rural people or ancestors. Besides that, the Green Revolution harmed the production of millet which promoted high-yielding crops such as rice and wheat. The emphasis on these crops led to a decrease in the cultivation of traditional crops such as millets [24].

The decline in millet production had a significant impact on the societies that depended on them. In many regions, millets were replaced by less nutritious crops, which led to malnutrition and other health problems. Additionally, the loss of traditional crops led to a loss of cultural identity and knowledge. These problems can be solved and make them valuable as food for poor families to combat malnutrition and an important source of income [23].

Recent Revival of Millet Production

The revival of millets can be achieved through concerted efforts of research, marketing testing, and entrepreneurial training and demonstration to stimulate the processing of

high- quality competitive products.

In recent years, there has been a renewed interest in millet production. This is due to the growing awareness of the benefits of millets for human health and the environment. Millets are highly nutritious, gluten-free, and have a low glycemic index, which makes them an ideal food for people with diabetes and other health conditions and also highly adaptable to different climatic conditions, which makes them an ideal crop for small farmers in developing countries. Millets require less water and fertilizers than other crops, which makes them a sustainable option for agriculture medicine in India, where they are believed to have cooling and soothing properties.

Millets possess immense potential in our battles against climate change and poverty and provide food, nutrition, fodder, and livelihood security. Being hardy crops, they can withstand extreme temperatures, floods, and droughts. They also help mitigate the effects of climate change through their low carbon footprint of the 3,218-kilogram equivalent of carbon dioxide per hectare, as compared to wheat and rice, with 3,968kg and 3,401kg, respectively, on the same measure. In the past, millets were a poor farmers insurance against the vagaries of the Indian monsoon. In the future, millets can be our insurance in times of climate change (Tiwari, *et al.*, 2022) [28].

The Role of Millets in the Human Diet

They are 'nutri-cereals'. Integrating millets into our diets can offer an array of nutritional benefits that range from addressing under-nutrition and micronutrient deficiency to controlling over-nutrition. Millets have played an important role in the human diet for thousands of years. Millets surpass other cereals in several ways, as they have elevated levels of iron, magnesium, and zinc, a low glycaemic index (beneficial for diabetics), good levels of protein and fiber, and are gluten-free making them an ideal food for people with celiac disease or gluten intolerance [28].

Millets are commonly used to make porridge, flatbreads, and baked goods. In India, millets such as ragi (finger millet), jowar (sorghum), and bajra (pearl millet) are used to make traditional dishes such as chapatti, dosa, idli, etc. In Africa, millets are used to make porridge, bread, and beer.

The Importance of Millets in Food Security

Food security exists when all people, at all times, have physical, social, and economic access to safe, sufficient, and nutritious food to meet their dietary needs and food choices for an active and healthy life. The four pillars of food security are the availability of food, access to food, utilization of food, and food stability. The term "food security" does not explicitly define the nutrition aspect of food of adequate sanitation, health care, and services, allowing for a healthy and active lifestyle." (Tiwari, *et al.* 2023) [30].

Millets are an important crop for food security, particularly in areas where climate change and other factors have made traditional crops such as rice and wheat difficult to grow. Millets require less water than rice and wheat, making them ideal for areas with low rainfall. Millets are also more resilient to pests and diseases, reducing the need for pesticides and herbicides. In addition, millets are often grown by small-scale farmers, providing a source of income and food security for rural communities.

Despite their many benefits, millets have been neglected in recent years in favor of more profitable crops such as rice and wheat. This has led to a decline in millet cultivation,

particularly in India, where millets were once a staple food. To address this issue, organizations such as the Millet Network of India and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) are working to promote millet cultivation and consumption.

The government can play an important role in promoting the cultivation, processing, and consumption of millets in several ways

Agricultural research: Governments can fund research into the development of new and improved millet varieties that are more resistant to pests and diseases, and that have higher yields and better nutritional content.

Agricultural extension services: Governments can provide agricultural extension services to help farmers adopt best practices in millet cultivation, including soil and water conservation, pest management, and crop rotation.

Subsidies and incentives: Governments can provide subsidies and incentives to encourage farmers to grow millets, such as reduced prices for millet seeds and fertilizers, and tax breaks for millet processing and marketing businesses.

Market development: Governments can promote the development of millet markets, including the creation of local and regional markets, and the promotion of millet-based food products.

Nutrition education: Governments can promote the nutritional benefits of millets and provide education on the preparation and cooking of millet-based foods.

The government of India had proposed to United Nations for declaring 2023 as the International Year of Millets (IYOM). The proposal of India was supported by 72 countries and United Nation's General Assembly (UNGA) declared 2023 as the International Year of Millets on 5th March 2021^[30]. The goal of the International Year is to promote the production, consumption, and trade of millets, as well as to encourage research and innovation in millet agriculture.

The Department of Agriculture and Farmers Welfare has taken a proactive multi-stakeholder engagement approach engaging all the central government ministries, states/UTs, farmers, start-ups, exporters, retail businesses, hotels, Indian Embassies, etc. to achieve the aim of IMY2023 and taking Indian millets globally, Ministries, states and Indian embassies have been allocated focused months in 2023 to carry out various activities for the promotion of IYM and increases awareness about benefits of millets for the consumers, cultivator, and climate^[31].

Millets are also an integral part of the G-20 meetings and delegates will be given a true millets experience through tasting, meeting farmers, and interactive sessions with start-ups and FPOs (PIB 2023). The spirit of the whole government approach is indeed seen in the celebration of the International Year of Millets 2023^[31].

The International Year of Millets is expected to provide a platform for governments, farmers, researchers, and other stakeholders to collaborate and promote the use of millets as a means of achieving sustainable development goals. Millets making a comeback is not just the popularization of a neglected and underutilized crop but also an effort to achieve the sustainable development goals (SDGs) – mainly SDG 2 (zero hunger), SDG3 (good health and well-being), SDG 12 (sustainable consumption and production), and SDG 13

(climate action) [UN News, 2021].

International Year of Millets will be an opportunity to raise awareness of, and direct policy attention to the nutritional and health benefits of millets and their suitability for cultivation under adverse and changing climatic conditions. The year will also promote the sustainable production of millets while highlighting their potential to provide new sustainable market opportunities for producers and consumers.

Conclusion

In conclusion, millets are an important crop with a long history of cultivation by humans. They are a rich source of nutrients and are well-suited to areas with low rainfall and harsh weather conditions. Millets have played an important role in the human diet for thousands of years, and continue to be an important crop for food security. However, the decline in millet cultivation in recent years is a cause for concern, and efforts must be made to promote millet cultivation and consumption.

Millets have a rich history that spans thousands of years. They have been an essential part of the diets and cultures of many societies throughout history. Although millet production declined in many parts of the world during the 20th century, there has been a renewed interest in millet production in recent years. Millets are highly nutritious and sustainable, which makes them an ideal crop for small farmers in developing countries. The revival of millet production has the potential to improve the lives and health of millions of people around the world. Millets are a group of small-seeded grasses that have been grown for thousands of years in different parts of the world. They are known for their hardy nature and the ability to grow in harsh conditions, making them a staple crop in many regions with arid climates.

Millets are thus environmentally, ecologically, and economically friendly sources of food and nutrition^[37].

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