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Journal of Nutrition and Food Processing

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Open Access

Review Article

# Milletes For Global Food Security

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**Received date:** December 26, 2024; **Accepted date:** January 16, 2025; **Published date:** February 04, 2025

**Citation:** Naseem Zahra, Muhammad K. Saeed, Asma Saeed, Nimra Javed, Ayesha Rabiya, (2025), Milletes for Global Food Security, *J. Nutrition and Food Processing*, 8(2); **DOI:10.31579/2637-8914/288**



**Abstract:**

Millets are the group of small-seeded, annual cereal crops which are commonly grown in arid and semiarid regions of the world. Millets are known for their exceptional nutritional value, drought tolerance, and versatility in use. Despite their many benefits, millets have been largely neglected in the global food system, and their cultivation and consumption have declined in recent decades. However, in current years, there has been an increasing awareness about millets as a mean of enhancing global food security, particularly due to climate change and other environmental challenges. Millets are seen as a promising solution for increasing the resilience of agricultural systems and improving the livelihoods of small-scale farmers in developing countries. Millets have a number of advantages over other crops, including their ability to grow in poor soils with low inputs, their high nutritional value, and their resistance to pests and diseases. They are also relatively inexpensive to produce and can be stored for long periods of time without spoiling. To promote the cultivation and consumption of millets, a number of initiatives have been launched at both the national and international level. These include research and development programs to improve millet varieties, advocacy and awareness-raising campaigns to increase demand for millet-based products, and policy interventions to support millet production and trade. Overall, millets have the prospective to play an important role in ensuring global food security in the years to come. This review harness many benefits of this versatile and resilient crop to build more sustainable and equitable information regarding millets.

**Key words:** global food security; environmental challenges; research and development program; small scale farmers

## Introduction

Millet is a group of annual cereal grasses which are small-seeded and are broadly cultivated in developing countries, particularly in Asia and Africa. Millets are highly nutritious and have been used as a staple food for thousands of years, providing a source of carbohydrates, protein, and essential micronutrients to millions of people worldwide. Given its nutritional and agronomic properties, millet has been identified as a potential solution to global food security challenges (Belton et al., 2002). Millet can serve as a source of food for both humans and animals, and can be used in a variety of food products, including bread, porridge, and beer.

Millet can also be used to support small-scale farming and help to increase farmers' incomes. Millet is relatively easy to grow and harvest and can provide a reliable source of income for farmers who may not have access to other crops due to limited resources or unfavorable growing conditions. Millets have high resistance to drought and can be stored for longer duration (Adekunle et al., 2018). In addition to its potential as a food crop, millet can also play a role in promoting environmental sustainability.

Millets require less quantity of water and smaller number of pesticides than other crops, and can be used to promote soil health and prevent soil erosion. In recent years, millets have gained increased attention as a potential solution to global food security challenges. They are drought-tolerant and can grow in poor soils, making them a resilient crop that can withstand environmental stresses such as climate change. Millets are also relatively inexpensive to produce, making them an affordable food source for low-income populations.

Overall, millet has the potential to make an important contribution to global food security. By supporting the cultivation and consumption of this nutritious and versatile crop, sustainable food sources for communities around the world can be provided.

### Common millet types:

There are numerous different types of millets, each with its own distinctive characteristics and uses. The most common types of millets are given below and in Table

| | |
|---|---|
| **Pearl Millet (Pennisetum glaucum):** It is the most commonly grown type of millet and is known for its high tolerance to drought and poor soil conditions. It is a good source of protein, fiber, and minerals (Fontaneli et al., 2001). |  |
| **Foxtail Millet (Setaria italica):** Foxtail millet is a small, yellowish-brown grain that is rich in protein, iron, and calcium. It is often used to make porridge, bread, and other baked goods. |  |
| **Finger Millet (Eleusine coracana):** It is also known as ragi, is a reddish-brown grain that is rich in calcium, iron, and fiber. It is commonly used to make porridge and baked goods, and is a popular ingredient in South Indian cuisine (Sulistyaningrum & Aqil, 2017). |  |
| **Sorghum (Sorghum bicolor):** Sorghum is a versatile grain that can be used for food, feed, and fuel. It is high in protein, fiber, and antioxidants, and is commonly used to make porridge, flatbreads, and other baked goods (Rooney, 2007). |  |
| **Kodo Millet (Paspalum scrobiculatum):** Kodo millet is a small, light brown grain that is rich in fiber and protein. It is commonly used to make porridge and is a popular ingredient in Indian cuisine (Padulosi et al., 2009). |  |

| Millets Type | Botanical Name | Common Name | Regions of cultivation | Growing Conditions | References |
|---|---|---|---|---|---|
| **Finger millet** | *Eleusine coracona* | Bird's food millet or African millet | Different parts of Africa and India | Oppose high temperatures and salinity, temperature of 11 to 27ºC, soil pH of 5-8.2 and a average precipitation atmosphere | • Devi, (2014).<br>• Upadhyaya et al., (2008). |

| | | | | | |
|---|---|---|---|---|---|
| **Pearl Millet** | *Pennisetum typhoides* | Bulrush millet | Africa, Central Eastern and Southern, Pakistan, India, the southern coast of the Arabian Peninsula | Arid climates, marginal soils, Rainfall 200–500 mm | • Guigaz, (2002).<br>• International Crops Research Institute for the Semi-Arid Tropics, (1996). |
| **Foxtail millet** | *Setaria italica* | Hay millet, Italian millet or German millet | China, India, Indonesia, Europe, Korea, the former U.S.S.R. | Less water, short duration | • Vetriventhan et al., (2014).<br>• Zhang et al., (2007). |
| **Kodo millet** | *Paspalum scorbiculatum* | German millet, Italian millet or hay millet | Tropical and sub-tropical regions | Elevated drought resistance, good yield, 80–135 days duration | • Roshevits, (1980).<br>• Zarnkow et al., (2009).<br>• Zarnkow et al., (2010). |
| **Sorgham millet** | *Sorghum bicolor* | Durra, great millet, milo, orshallu | Central Eastern and Southern Africa | Grows best in climates with long summers. Growing season of 115–140 days | • Rakshit, et al., (2017).<br>• Saxena, et al., (2018). |

**Table 1:** Different types of millets

### Benefits of millets:

Millets are highly nutritious and have a number of benefits that make them an important part of global food security efforts. Some of the benefits of millets as a global food source are:

**Nutritious:** Millets are a rich source of various nutrients including fiber, protein, vitamins, and minerals. According to a study published, millets contain high amounts of dietary fiber which can help prevent chronic diseases such as heart disease, diabetes and certain types of cancers. Millets are also rich in micronutrients such as calcium, iron and zinc which are essential for maintaining fine health (Saleh et al., 2013).

**Climate-resilient:** Millets are hardy crops that can grow in a variety of environmental conditions including drought, high temperatures, and poor soil quality. According to a study published, millets require less water than other cereals such as wheat and rice, making them a good option for regions facing water scarcity (Ceccarelli and Grando, 2007). Millets are also tolerant of a wide range of pests and diseases, making them a low-risk crop for farmers (Dida et al., 2008).

**Sustainable:** Millets are typically grown using traditional farming methods that are sustainable and do not require high levels of chemical inputs. According to a study published, millets can be grown using organic farming practices, which can help reduce the environmental impact of agriculture (Branca et al., 2011). Millets also have a low carbon footprint compared to other crops, due to their low water and fertilizer requirements.

**Affordable:** Millets are generally less expensive than other grains such as wheat and rice, making them an affordable option for people in low-income communities. According to a study, millets can be grown on marginal lands that are not suitable for other crops, which can help increase the availability of food in resource-poor areas (Sanjana et al., 2021). Millets can also be stored for longer periods of time than other cereals, making them a good option for food security in times of crisis.

**Versatile:** Millets can be used in different dishes like porridges, snacks, bread and beer. They are also used as animal feed and forage, making them a versatile crop that can provide multiple benefits. Millets are also highly adaptable to different cooking methods and can be used in a variety of cuisines (Mahanthesha et al., 2017).

### Nutritional aspects of millets:

**High fiber content:**

Millets are a rich resource of dietary fiber which can help to promote digestive health and reduce the risk of chronic diseases such as heart disease, diabetes, and certain types of cancer (Saleh et al., 2013).

### Rich in minerals:

Millets are a good source of several essential minerals, including iron, magnesium, and zinc. These minerals play important roles in maintaining strong bones, supporting immune function, and promoting overall health and well-being (Lestienne et al., 2005).

### High protein content:

Millets are a good source of plant-based protein, which can help to maintain muscle growth and repair, keep healthy skin and hair, and support overall health and vitality (Chandrasekara & Shahidi, 2010).

### Low glycemic index:

Millets have a low glycemic index, which means that they can help to control blood sugar levels and lessen the risk of diabetes and other metabolic disorders (Kaur et al., 2018).

Nutritional aspects of different millets were compared and summarized in Table 2.

| Nutrient | Finger Millet (Ragi) | Foxtail Millet (Kangni) | Pearl Millet (Bajra) | Kodo Millet | Sorghum (Jowar) |
|---|---|---|---|---|---|
| **Energy (kcal/100g)** | 328 | 351 | 378 | 342 | 329 |
| **Carbohydrates (g/100g)** | 72.6 | 73.8 | 67 | 66.6 | 72.9 |
| **Protein (g/100g)** | 7.3 | 11.2 | 11 | 9.8 | 11.3 |
| **Fat (g/100g)** | 1.3 | 3.6 | 5.2 | 4.22 | 3.3 |
| **Fiber (g/100g)** | 3.6 | 8.3 | 1.2 | 5.2 | 6.3 |
| **Iron (mg/100g)** | 3.9 | 4.9 | 2.8 | 2.9 | 4.4 |
| **Magnesium (mg/100g)** | 137 | 126 | 114 | 120 | 141 |

Saleh et al., (2013)

**Table 2:** Nutritional aspects of different millets

## Cultivation of millets in different countries:

Millets are widely grown as cereal crops in many parts of the world. Millets are known for their resilience and adaptability to harsh growing conditions such as drought and poor soil fertility. They are also rich in nutrients such as protein, fiber, and minerals, making them a valuable food source for many people, particularly in developing countries.

**China** is one of the largest producers of millets in the world. According to the Food and Agriculture Organization (FAO) of the United Nations, China produced over 30 million metric tons of millets in 2019, accounting for more than half of the global production. Millets are mainly grown in the northern and western regions of China, particularly in the provinces of Inner Mongolia, Shanxi, and Gansu.

**India** is another major producer of millets. According to the FAO, India produced over 11 million metric tons of millets in 2019, making it the 2nd largest producer in the world. Millets are widely grown in many parts of India, particularly in the states of Rajasthan, Maharashtra, and Karnataka. Millets are an important food source for many people in India, particularly in rural areas.

**Nigeria** is the biggest producer of millets in Africa. According to the FAO, Nigeria produced over 5 million metric tons of millets in 2019, making it the 3rd largest producer in the world. Millets are widely grown in many parts of Nigeria, particularly in the northern regions of the country. Millets are an important staple food for many people in Nigeria, particularly in rural areas.

**Niger** is another major producer of millets in Africa. According to the FAO, Niger produced over 4 million metric tons of millets in 2019, making it the 4th largest producer in the world. Millets are widely grown in many parts of Niger, particularly in the Sahelian regions of the country. Millets are an important food source for many people in Niger, particularly in rural areas.

**Mali** is also a significant producer of millets in Africa. According to the FAO, Mali produced over 3 million metric tons of millets in 2019, making it the 6th largest producer in the world. Millets are widely grown in many parts of Mali, particularly in the southern and central regions of the country. Millets are an important food source for many people in Mali, particularly in rural areas (Mundia et al., 2019, Malathi et al., (2016), Michaelraj & Shanmugam, (2013).

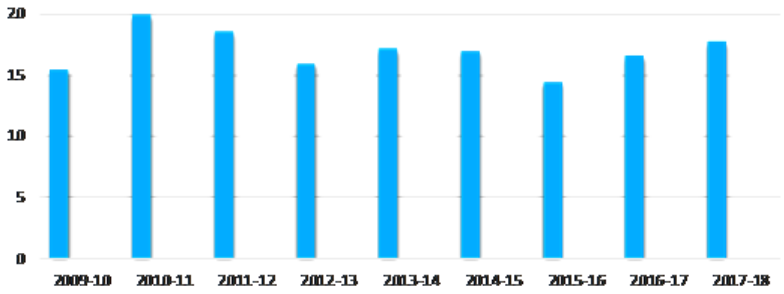


**Figure 1:** Millets production in Million Tons in Asia (2010-2018)

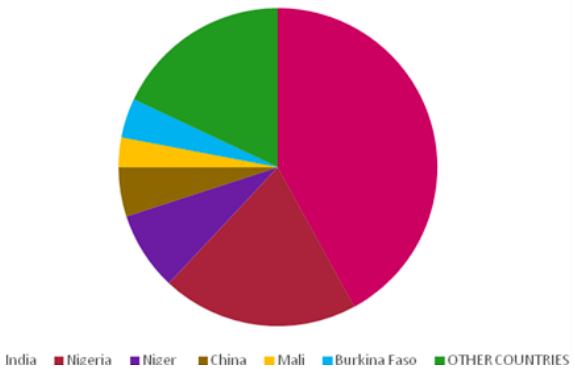


**Figure 2:** Global cultivation of millets

### Products of millets:

Millet is a group of small-seeded grasses that have been cultivated for thousands of years as a staple food crop in many parts of the world. Millet is a gluten-free grain that is high in fiber, protein, and essential nutrients like magnesium, potassium, and B vitamins. Millet can be cooked and used in a variety of dishes, including porridge, salads, soups, and stews. Here are some common products made from millets:

**Flour:** Millet flour is used to make various baked goods, including bread, pancakes, and muffins (Singh et al., 2005).

**Porridge:** Millet porridge is a popular breakfast dish in many parts of the world. It can be made sweet or savory, depending on the ingredients used (Sumathi et al., 2007)

**Couscous:** Millet can be ground into a fine texture and used as a substitute for traditional wheat-based couscous.

**Popped Millet:** Popped millet is a crunchy snack that can be eaten on its own or added to other dishes like granola or trail mix (Ushakumari et al., 2007)

**Millet Beer:** Millet is used to make beer in some African countries. The beer is fermented using millet, sorghum, or corn and has a sour taste (Arora et al., 2011)

**Millet Noodles:** Millet noodles are a gluten-free alternative to wheat-based noodles. They can be used in soups, stir-fries, or salads (Devaraju et al., 2006)

**Millet Bread:** Millet flour can be used to make bread. It is often mixed with other flours like rice or cornmeal to improve the texture (Begum et al., 2003)

**Millet Cereal:** Millet cereal is a nutritious breakfast option that can be made by cooking millet with milk or water and adding fruits, nuts, or honey (Fujita et al., 1996)

**Millet Crackers:** Millet can be used to make crackers that are gluten-free and high in fiber (Dahlin and Lorenz, 1992)

**Millet Pilaf:** Millet pilaf is a savory dish made by cooking millet with vegetables and spices. It can be served as a side dish or a main course.

### Work on millets in pakistan:

Millets have been cultivated for thousands of years and are known for their nutritional value and climate resilience. In Pakistan, millets have been traditionally grown and consumed, but their cultivation has declined over the years due to the increasing popularity of other crops such as wheat and rice which are widely consumed in the country. However, there have been recent efforts to promote the development and utilization of millets in Pakistan, which could have important implications for food security and nutrition.

### Here are some studies that have been conducted on millets in Pakistan:

Nutritional and functional properties of millets in Pakistan (Siddiqui et al., 2018)- It was summarized that the nutritional and functional properties of different millet varieties grown in Pakistan, including pearl millet, finger millet, and foxtail millet, are rich in protein, fiber, minerals, and vitamins, and have functional properties such as antioxidant and antimicrobial activity. It was suggested that promoting the cultivation and consumption of millets could have important implications for addressing malnutrition and improving food security in Pakistan.

Production potential of millets in Pakistan (Mahmood et al., 2021) - This study assesses the production potential of different millet varieties in different agroecological zones of Pakistan. The authors report that millets have the potential to yield higher than wheat and rice in some areas, and that they are well-suited to the climate and soil conditions of many parts of Pakistan. They suggest that promoting the cultivation of millets could have important implications for improving the resilience of agricultural systems to climate change and reducing the dependence on wheat and rice.

Millets and food security in Pakistan (Akram et al., 2019) - This study analyzes the role of millets in addressing food security challenges in Pakistan. The authors report that millets have been traditionally grown and consumed in many parts of Pakistan, but their cultivation has declined over the years due to the increasing popularity of other crops. They suggest that promoting the cultivation and consumption of millets could have important implications for improving food security, especially for vulnerable populations such as women and children.

Millet-based foods in Pakistan: Current status and future prospects (Ghafoor et al., 2019) - This study assesses the current status and future prospects of millet-based foods in Pakistan. The authors report that millets are currently not widely consumed in Pakistan, but that there is a growing interest in their nutritional and health benefits. They suggest that promoting the development of millet-based foods could have important implications for improving nutrition and food security in Pakistan.

Millets have been cultivated for thousands of years in the world because of rich nutrients, fibers, vitamins, protein and essential minerals, and are considered to be more sustainable and resilient than many other cereal crops. In modern era, there has been a growing need of millets as a solution to different global challenges, including malnutrition, food security and climate change.

### Here are some future perspectives of millets:

### Increasing demand for millets as a healthy food:

Millets are best known for their high nutritional value and health benefits. Millets are gluten-free, having low glycemic index, and contain a range of nutrients, including iron, magnesium, phosphorus, and zinc. They are also a good source of fiber and protein. As people have become more health cognizant and are now well aware of the benefits of whole foods, the requirement for millets as a healthy food is likely to increase. A study by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) found that the demand for millets in India is expected to increase by 3-4% annually due to rising health awareness (Awika & Rooney, 2004).

### Potential for millets to address malnutrition:

Starvation is an important worldwide challenge, disturbing millions of people worldwide. Millets have the potential to address malnutrition as they are rich in essential nutrients, including iron, calcium, and vitamin B-complex. A study by the National Institute of Nutrition in India found that incorporating millets into the diets of malnourished children can improve their nutritional status and reduce the incidence of malnutrition. Millets have also been found to be effective in managing diabetes, a condition that affects millions of people worldwide (Govindaraj et al., 2020).

### Millets as a sustainable and climate-resilient crop:

Millets are a sustainable and climate-resilient crop, requiring less water and fertilizers compared to other cereal crops. They can grow in a variety of soil types and are drought-tolerant, making them an ideal crop for

regions facing water scarcity and climate change. A study by the Food and Agriculture Organization (FAO) found that millets have a low carbon footprint and are more environmentally friendly compared to other cereals (Singh et al., 2022).

### Millets as a potential cash crop for smallholder farmers:

Smallholder farmers in developing countries often face challenges in accessing markets and earning a decent income from their crops. Millets have the potential to be a cash crop for smallholder farmers, as they have a longer shelf life and can be stored for longer periods compared to other grains. Millets also have a higher value in local and niche markets, providing smallholder farmers with a better return on investment. A study by the International Food Policy Research Institute (IFPRI) found that promoting millets as a cash crop can improve the livelihoods of smallholder farmers in India (Lalou et al., 2019).

In conclusion, millets have significant potential as a sustainable, healthy, and resilient crop. As the world faces various challenges related to food security, nutrition, and climate change, millets can offer a solution that benefits both farmers and consumers. With continued research and investment, millets can play a crucial role in ensuring a healthy and sustainable future for all.

## Conclusion:

In conclusion, millets have the potential to play a momentous role in reducing global food security challenges. Their nutritional value, sustainability, and resilience make them a promising crop option for smallholder farmers and rural communities. Greater investment in millet production and consumption can help improve the livelihoods of farmers and contribute to a more sustainable and resilient food system.

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**DOI:10.31579/2637-8914/288**