



The Role and Challenges of Okra [*Abelmoschus esculentus* (L.) Moench] Cultivation in Nigerian Agriculture

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Abstract: Okra (*Abelmoschus esculentus* (L.) Moench) plays a crucial role in Nigerian agriculture and significantly contributes to small-scale farmers' food security and income generation. It is a staple vegetable in many Nigerian households and is also valued for its nutritional benefits, including vitamins A and C, fibers, and antioxidants. This review paper highlights the various challenges confronting the cultivation of okra. Pests and disease outbreaks, such as okra leaf curl virus and aphids, pose serious threats that result in reduced yield and quality of products. Furthermore, many farmers lack access to high-quality seeds, which are essential for establishing resilient crops under the militating changes in climatic conditions. The lack of high-quality fertilizers further exacerbates this problem and limits the potential for optimal growth and productivity. The lack of high-quality fertilizers further exacerbates this problem and limits the potential for optimal growth and productivity. Furthermore, postharvest losses are often a significant obstacle, resulting from inadequate storage facilities and poor processing practices that lead to damage and reduce farmers' return on investment. These challenges require urgent and targeted interventions. To address these constraints through improved agricultural practices, access to resources, and better training for farmers, it is essential to increase okra's productivity to meet the increasing population demand. This will, in turn, help ensure a sustainable contribution of the okra to the agricultural sector and the overall economy, ultimately improving the livelihoods of small-scale farmers in Nigeria.

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1. Introduction

Okra [*Abelmoschus esculentus* (L.) Moench], a warm-season vegetable cultivated extensively for its edible fruits, rich in vitamins, minerals, and dietary fiber (Hussain and Kumar, 2019). Okra is a highly nutritious crop, providing a valuable source of carbohydrates, proteins, fats, minerals, and vitamins, particularly vitamins A and C (Elkhalifa *et al.*, 2021). Additionally, the crop has garnered attention for its medicinal properties and industrial applications, such as the use of its mucilage as a thickener in the food industry (Elkhalifa *et al.*, 2021). Originating from Africa, okra is now grown in various parts of the world, particularly in tropical and subtropical regions, where it is a staple crop due to its adaptability to diverse environmental conditions (Akinmoladun and Olabiyi, 2018). According to the Food and Agriculture Organization, Nigeria produced approximately 1.8 million metric tons of okra in 2023 (FAO, 2024).

Despite its widespread cultivation and consumption, okra remains an "under-researched" crop, particularly in certain regions of Africa, where it plays a crucial role in food security (Asante *et al.*, 2024). The growth and productivity of okra are

influenced by a range of factors, of which low soil nutrient status is a major constraint (Akinmoladun and Olabiyi, 2018). Among the essential plant nutrients, micronutrients play a significant role in influencing both the vegetative growth and reproductive phases of this plant (Ali *et al.*, 2017). Nonetheless, recent studies have shed light on various aspects of okra production, including the impact of irrigation and fertilizer application on its yield and water productivity (Elkhalifa *et al.*, 2021). Researchers have also explored the genetic and molecular diversity of okra accessions, identifying genotypes with potential adaptations to water deficit conditions (Mkhabela *et al.*, 2022). This knowledge is particularly valuable in regions where water availability is a limiting factor for agricultural production (Mkhabela *et al.*, 2022).

2.1 Importance of the Okra Plant:

The okra plant's importance extends beyond its culinary uses to include its roles in sustainable agriculture, economic development, and health improvement. Okra is cultivated worldwide due to its adaptability to different climates, high nutritional value, and wide variety of uses.

2.1.1 Nutritional importance of okra:

Okra is a highly nutritious vegetable rich in essential vitamins, minerals, fiber, and antioxidants. It is an excellent source of vitamin C, vitamin A, folate, and several B vitamins, which are important for immune function, skin health, and metabolic processes (Liu *et al.*, 2019). Okra also contains significant amounts of calcium, potassium, magnesium, and iron, minerals that support bone health, cardiovascular function, and oxygen transport in the body (Alam *et al.*, 2017). The fiber content of okra, particularly soluble fiber, is beneficial for digestion and helps to maintain healthy blood sugar levels (Alam *et al.*, 2017).

Antioxidants such as flavonoids, phenolic acids, and beta-carotene in okra further enhance its health benefits. These antioxidants are known to neutralize free radicals, which can help reduce oxidative stress and lower the risk of chronic diseases such as cancer and cardiovascular disease (Zhou *et al.*, 2018). Okra's high fiber content also promotes gut health by improving digestion, preventing constipation, and supporting the growth of beneficial gut bacteria (Sivapalan and Rajagopal, 2017).

In regions where access to high-quality protein and vitamins is limited, okra serves as an affordable and readily available source of essential nutrients. For example, in sub-Saharan Africa and parts of Asia, okra is commonly consumed as a part of everyday meals, contributing to food security and nutrition in these regions (Hussain and Kumar, 2019).

2.1.2 Economic significance of okra:

Okra plays a crucial role in the economies of both developing and developed countries, particularly in regions where it is a key crop for smallholder farmers. The global production of okra is valued at millions of dollars annually, and it is imperative in tropical and subtropical regions where it serves as a significant cash crop. Okra's economic importance can be seen in countries such as India, Nigeria, and Egypt, where it is grown not only for local consumption but also for export to international markets (Gupta *et al.*, 2013).

In developing countries, okra is often cultivated in small-scale farming systems, contributing to food security, poverty alleviation, and rural development. Okra's relatively low input requirements—such as the need for minimal irrigation and pest control—make it a viable crop for smallholder farmers with limited resources. This makes it a key component of sustainable agricultural systems in areas where other crops may not thrive (Kshasha and Oda, 2022). Furthermore, okra's ability to grow in diverse soils and climates has made it an important crop rotation and intercropping system,

contributing to soil health and resilience in agroecosystems (Jadhav *et al.*, 2014).

The global demand for okra has also led to the development of commercial farming operations, particularly in the United States and parts of South America, where okra is grown for domestic consumption and export. This commercial expansion has created job opportunities in the agricultural and food processing sectors, further boosting the economic benefits of okra cultivation (Tariq *et al.*, 2014).

2.1.3 Ecological role and agricultural importance:

Okra's role in sustainable agriculture extends beyond its economic and nutritional value. Okra is often grown in crop rotation and intercropping systems, where it helps to improve soil health by preventing soil erosion, enhancing soil structure, and fixing nitrogen in the soil through its deep root system (Fageria *et al.*, 2002). Its adaptability to drought conditions and heat tolerance make it an ideal crop for regions facing water scarcity and temperature fluctuations, two major challenges posed by climate change (Asante *et al.*, 2024).

In addition to its benefits for soil fertility, okra's resilience to pests and diseases, particularly compared to other vegetable crops, makes it an attractive option for integrated pest management systems. Okra can be grown with reduced pesticide use, minimizing the environmental impact and the need for costly inputs (Gupta *et al.*, 2013). Furthermore, okra's ability to thrive in different soil types—ranging from loamy to sandy soils—makes it a highly adaptable crop for various agricultural environments (Hussain and Kumar, 2019).

2.1.4 Culinary uses and cultural importance:

Okra is a staple vegetable in many cuisines worldwide, particularly in Africa, Asia, and the southern United States. In West Africa, it is used in a variety of traditional dishes such as soups, stews, and sauces. In the southern United States, okra is a key ingredient in gumbo, a traditional dish that symbolizes the cultural fusion of African, Native American, and European culinary practices (Akinmoladun and Olabiyi, 2018). In India, okra, known as "bhindi," is widely used in curries and stir-fries, making it an integral part of everyday meals across the country (Bose, 2002).

The versatility of okra in cooking is one of its most prized qualities. It can be prepared in numerous ways, including steaming, frying, pickling, and roasting, and is often paired with rice, meat, or legumes in savory dishes. The unique mucilaginous texture of okra is particularly appreciated in thickening soups and sauces, which adds to its culinary value (Tariq *et al.*, 2014). Furthermore, okra's cultural significance is not limited to its use as food; it also

holds symbolic importance in several African and Asian communities, where it is often associated with health, prosperity, and resilience.

2.1.5 Medicinal and therapeutic properties

Beyond its nutritional benefits, okra is also valued for its medicinal and therapeutic properties. In traditional medicine, okra has been used to treat a variety of ailments, including digestive disorders, skin conditions, and respiratory problems (Sivapalan and Rajagopal, 2017). The mucilage in okra is thought to soothe the digestive tract, making it beneficial for individuals suffering from ulcers, gastritis, and acid reflux (Zhau *et al.*, 2018). In addition, the anti-inflammatory properties of okra make it useful for reducing symptoms of inflammatory conditions such as arthritis (Alam *et al.*, 2017).

Recent scientific studies have further supported these traditional uses, showing that okra contains bioactive compounds that exhibit anti-inflammatory, antioxidant, and antimicrobial activities (Zhao *et al.*, 2018). Furthermore, extracts from okra seeds and pods have been shown to possess hypoglycemic effects, making them beneficial in managing blood sugar levels in diabetic patients (Sivapalan and Rajagopal, 2017). These therapeutic properties highlight the growing potential of okra not only as a food crop but also as a source of natural medicines.

2.1.6 Industrial

The stem of the plant is used industrially in the strengthening of polymer complexes and the gum produced from the crop can be used in the clarification of water through its flocculating properties (Santulli *et al.*, 2014). With their composition resembling that of a thick polysaccharide film, okra mucilage is currently under development for use as a biodegradable food packaging (Dantas *et al.*, 2021). Okra oil was recommended for use as biofuel substrate in a 2020 study (Adejumo *et al.*, 2020), while okra mucilage is recommended for industrial and medicinal uses according to a 2021 study by Dantas *et al.* (2021). Okra mucilage is however industrially used in the manufacture of glaze paper and also in confectionery.

2.2 Challenges of the Okra Plant:

Okra faces many challenges that can limit its growth, yield, and overall productivity despite its resilience and adaptability to several climates. These challenges arise from environmental stressors, pest and disease pressures, soil fertility issues, and other agronomic factors that directly influence the plant's health and yield potential. Addressing these challenges through proper management and understanding the role of essential nutrients such as boron can significantly improve okra production. This section

will explore the key challenges faced by okra, with a focus on how factors like micronutrient deficiencies, particularly boron, affect its growth and productivity.

2.2.1. Environmental stress factors:

Okra, although tolerant of a wide range of environmental conditions, is still vulnerable to extreme climatic events such as drought, excessive rainfall, high temperatures, and low humidity. These stress factors can severely affect its growth, yield, and quality.

Drought stress: Okra is relatively drought-tolerant, but prolonged periods of water deficit can hinder its development, leading to reduced pod formation, poor flowering, and smaller, malformed pods. The plant's sensitivity to water stress during flowering and fruiting stages is particularly critical, as water deficit at this stage can result in reduced yield and poor-quality fruits (Jadhav *et al.*, 2014). In regions facing erratic rainfall and water shortages, drought stress becomes a major limiting factor for okra cultivation.

Heat stress: While okra thrives in hot climates, it is still susceptible to temperatures above 35°C, especially with water stress. Prolonged exposure to high temperatures can cause flower abortion, poor pod set, and delayed maturity (Jadhav *et al.*, 2014). The impact of heat stress is exacerbated in areas with insufficient irrigation or poor soil moisture retention, which can lead to a reduction in okra yield.

Flooding and excessive rainfall: On the other hand, excessive rainfall or waterlogging can also affect okra growth, as it is sensitive to poorly drained soils. High moisture levels can lead to root rot and other fungal infections, which can drastically reduce plant health and yield (Fageria *et al.*, 2002). Okra's shallow root system makes it vulnerable to waterlogged conditions, further complicating cultivation in areas with poor drainage.

2.2.2 Pest and disease pressures:

Pests and diseases are a significant threat to okra production. Although okra is generally less susceptible to pests than some other vegetable crops, it still faces challenges from a range of insects, fungi, and bacteria. These biotic stresses can affect plant health, reduce yields, and lower the market value of the harvested pods.

Insects: Okra is commonly attacked by a variety of insect pests, including aphids (*Aphis gossypii*), whiteflies (*Bemisia tabaci*), and the flea beetle (*Epitrix hirtipennis*). Aphids, in particular, are known to transmit viruses such as the Okra Enation Leaf Curl Virus (OELCV), which can cause significant damage to the leaves and flowers, reducing photosynthesis and overall plant growth (Bose, 2002). Whiteflies are also major vectors for viral diseases, including the Tomato Yellow Leaf Curl Virus (TYLCV), which further

compromises the plant's health and yield (Jadhav *et al.*, 2014).

Fungal diseases: Fungal infections such as *Fusarium* wilt and *Verticillium* wilt can cause severe damage to okra crops. These soil-borne diseases affect the plant's vascular system, leading to wilting, yellowing of leaves, and ultimately plant death. The fungi thrive in moist and warm conditions, which can be exacerbated by poor irrigation practices or humid climates (Fageria *et al.*, 2002). Managing fungal diseases in okra requires proper crop rotation, resistant varieties, and sometimes fungicide applications.

Bacterial diseases: Bacterial blight, caused by *Xanthomonas campestris*, is another common disease affecting okra. This disease leads to water-soaked lesions on the leaves, stems, and pods, which can result in defoliation and pod decay (Ounis *et al.*, 2024). Managing bacterial blight requires strict hygiene practices and, in some cases, the application of copper-based bactericides.

2.2.3. Nutrient deficiencies and soil fertility issues:

The okra plant is relatively a heavy feeder of available soil nutrients (Sharma and Chadak, 2022) and soil microbial communities (Akinrinola *et al.*, 2022). Okra requires a range of essential nutrients for healthy growth, and deficiencies in key nutrients can lead to poor growth, low yields, and reduced quality of the harvested pods. Consequently, regular cultivation of the crop rapidly depletes soil nutrient status. Among the essential nutrients, N, P, and K play crucial roles in the development of okra plants. The judicious and timely application of depleted nutrients is necessary for sustainable production (Olugbemi and Akinrinola, 2020).

Phosphorus and nitrogen deficiency: Phosphorus is essential for root development and energy transfer, while nitrogen supports vegetative growth and overall plant vigor. Deficiencies in these nutrients can lead to stunted growth, yellowing of leaves, and poor flowering (Triastinurmiatiningsih *et al.*, 2019). Fertilizer application strategies that include the application of balanced fertilizers are necessary to address these deficiencies and promote healthy growth and high yield.

Soil pH and drainage issues: The optimal soil pH for okra ranges between 6.0 and 7.0. Soil pH outside this range can hinder nutrient availability, leading to deficiencies or toxicities that affect growth (Bose, 2002). In addition to pH, soil drainage is crucial, as poorly drained soils can cause waterlogging, root rot, and nutrient leaching, which hinder nutrient uptake and reduce okra productivity (Yamini and Prasad, 2023).

2.2.4 Weed competition:

Weeds compete with okra for light, water, and nutrients, which can significantly reduce crop yield. Okra's relatively slow initial growth makes it vulnerable to weed competition during the early stages of growth (Akinrinola, 2023). Without proper weed management, okra plants may become stunted and unable to reach their full growth potential despite adequate soil nutrient status (Ibironke and Akinrinola, 2025). Weeds also harbor pests and diseases that can further compromise okra health. Weed management in okra farming requires timely interventions, such as manual weeding, mulching, or the application of herbicides (Hussain *et al.*, 2021). However, improper use of herbicides can result in damage to the okra plants, leading to yield loss. Integrated weed management strategies, including crop rotation and intercropping, are effective ways to control weed populations while maintaining soil health (Hussain *et al.*, 2021; Akinrinola and Fagbola, 2021).

2.2.5. Postharvest losses and market access:

Postharvest losses due to spoilage, mishandling, and inadequate storage conditions are a significant challenge for okra producers. Okra is highly perishable, with a shelf life of only a few days under normal conditions. Improper harvesting, transportation, and storage techniques can lead to a significant loss in quality and market value (Gupta *et al.*, 2013).

Handling and storage issues: The delicate nature of okra pods makes them prone to bruising and rapid deterioration during handling and transportation. Inadequate storage facilities and improper temperature control can accelerate spoilage, particularly in tropical climates where ambient temperatures are high (Ogedengbe *et al.*, 2022). As a result, postharvest losses reduce the profitability of okra farming, especially for smallholder farmers in developing countries.

Limited market access: In addition to postharvest issues, smallholder okra farmers often face challenges related to market access. Poor infrastructure, lack of cold storage facilities, and limited market information can prevent farmers from selling their crops at optimal prices. In some regions, access to international markets is limited by strict quality standards, further reducing the potential for profit from okra cultivation (Hussain and Kumar, 2019).

2.2.6. Genetic limitations:

While okra has a wide range of cultivars, the genetic diversity within okra varieties is relatively limited compared to other crops. This limits the potential for developing varieties resistant to specific pests, diseases, or environmental stresses. Although breeding programs have focused on improving disease resistance and yield, further research into the genetic

improvement of okra, particularly for tolerance to heat, drought, and nutrient deficiencies, is needed (Mkhabela *et al.*, 2022). The lack of high-yielding, disease-resistant varieties can make it more difficult for farmers to maintain consistent production in the face of changing environmental conditions.

2.3 Future Prospects and Research Directions for Okra Cultivation:

Okra cultivation faces several challenges however, there are exciting prospects for improving okra production through research and the application of modern agricultural technologies. The role of boron in enhancing the growth and yield of okra is one such area of focus, as research into nutrient management and soil health can significantly improve productivity.

2.3.1 Improvement of nutrient use efficiency:

One of the most significant research directions in okra cultivation is improving nutrient use efficiency, particularly the efficient utilization of micronutrients like boron. Research on the role of boron in okra has demonstrated that proper boron levels enhance the uptake of other nutrients, promote reproductive health, and improve overall plant vigor. Future studies should focus on the development of okra cultivars with higher K efficiency, enabling better growth in regions with K-deficient soils (Kumar *et al.*, 2020).

Additionally, the interaction between boron and other micronutrients such as calcium, magnesium, and sulfur is an area that warrants further investigation. A better understanding of these interactions could lead to more sustainable fertilizer application practices and improved yield (Singh *et al.*, 2016).

2.3.2 Development of drought and heat-tolerant varieties:

As climate change accelerates, one of the primary challenges for okra production will be adapting to rising temperatures and erratic rainfall patterns. Future breeding programs will need to focus on developing drought- and heat-tolerant okra varieties. Okra is already considered a relatively drought-tolerant crop, but improvements in its heat tolerance could significantly enhance its cultivation in arid and semi-arid regions. Combining the genetic traits for drought tolerance with improved boron utilization could lead to more resilient varieties (Singh *et al.*, 2016; Singh and Pandey, 2024).

Research into the physiological mechanisms behind heat and drought stress in okra, including how these stresses impact boron uptake and assimilation, is critical for developing varieties that can thrive under extreme environmental conditions.

2.3.3 Disease resistance and pest management:

Another significant challenge for okra cultivation is the prevalence of pests and diseases. Okra is susceptible to a wide range of pests, including

aphids, whiteflies, and caterpillars, as well as diseases such as Fusarium wilt, powdery mildew, and bacterial blight (Ounis *et al.*, 2024). Integrated pest management (IPM) strategies and the development of disease-resistant varieties through breeding are key areas of future research. The role of K in enhancing plant resistance to pests and diseases should also be explored further. Potassium is known to strengthen cell walls and improve the plant's ability to resist pathogen attacks (Kumar *et al.*, 2020).

2.3.4 Enhancement of nutritional quality:

In addition to yield improvement, there is increasing interest in enhancing the nutritional content of okra. Okra is rich in vitamins, minerals, and dietary fiber, but there is potential to further increase its health benefits. Genetic research into enhancing specific nutrients, such as increasing the levels of vitamins A and C, folate, and antioxidants in okra, could make the plant an even more valuable food crop. Boron may play a role in the synthesis of certain vitamins, and optimizing its levels could improve the overall nutritional profile of okra (Yamini and Prasad, 2023).

2.3.5 Mechanization and postharvest technologies:

Okra is a labor-intensive crop, particularly during the harvesting phase, as it requires frequent picking. Mechanization of the harvesting process remains a challenge due to the irregular shape and height of okra plants. However, advances in agricultural engineering and mechanization could provide solutions that make large-scale okra production more efficient. Research into postharvest technologies, such as improved packaging, storage, and processing methods, is also necessary to reduce postharvest losses and improve the shelf life of okra (Ogedengbe *et al.*, 2022).

2.3.6 Sustainable cultivation practices:

Sustainability in agriculture is increasingly important, and the development of sustainable practices for okra cultivation is a key area of research. These practices include organic farming methods, the use of bio-fertilizers, and the reduction of chemical inputs. Research into the role of boron in organic systems and how sustainable practices affect boron availability in the soil will be crucial in minimizing the environmental impact of okra production. Additionally, soil health management through crop rotation and cover crops can improve soil fertility and reduce dependence on synthetic fertilizers (Mariam *et al.*, 2016).

3. Conclusion

Okra (*Abelmoschus esculentus* (L.) Moench) plays an important role in Nigerian agriculture and contributes greatly to food security and income generation for smallholder farmers. However, its cultivation faces

many challenges, including pest and disease infestations, limited access to quality seeds and fertilizer sand loss after harvest due to insufficient storage and handling practices. Addressing these issues is essential to improve the productivity of okra and ensure its sustainable contribution to the agricultural sector.

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5/6/2025