Vol. 4 Issue- 6, February 2024 (e-ISSN: 2582-8223)

Millets: A Smart Crop Solution for Enhancing Food Security Amidst Climate Change

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ARTICLE ID: 30

Introduction

Climate change and the subsequent rise in global average temperatures are increasingly recognized for its profound impact on crop productivity and the sustainability of food systems. It is imperative to acknowledge that the agricultural sector is a significant contributor to greenhouse gas emissions, particularly methane. These emissions are predominantly attributed to intensive agricultural practices that are currently prevalent. Notably, amongst the majorly cultivated cereals, rice exhibits the highest total carbon emissions, with an average of 11.2 t CO_2 eq $ha^{-1}yr^{-1}$, followed by wheat and maize with emissions of 5.9 and 4.9 t CO_2 eq $ha^{-1}yr^{-1}$, respectively. While, minor cultivated crops like sorghum, and other millets, have the total carbon emissions of 3.4 and 2.5 t CO_2 eq $ha^{-1}yr^{-1}$, respectively. Millets, a group of ancient grains belonging to the *Poaceae* family, are now being recognized as a potential solution to address these intricate challenges These crops are generally grouped into two broad categories: Major millets, which are widely cultivated and consumed, and minor millets, which are grown and consumed locally on a smaller scale. Major millets include pearl, finger, and foxtail millet, while the minor millets include proso, kodo, little, and barnyard millet. Additionally, the rich nutritional properties can help address dietary deficiencies and significantly contribute towards tackling malnutrition. They are a good source of energy, proteins, and dietary fibers. Millets are particularly high in micronutrients such as iron, zinc, and B vitamins, which are essential for human health but often deficient in many diets. Given these attributes, it is imperative that we embark on an intensive exploration of millets, scrutinizing their agronomic, nutritional, and stress-tolerance qualities. By acknowledging their unique attributes and conducting rigorous research, we can bridge the gap between maximizing agricultural productivity and ensuring the long-term well-being of our environment, nutrition, and climate resilience.

Millets' role in enhancing resilience to climate change

Agricultural policies have predominantly centred on a single-minded pursuit of maximizing productivity. This exclusive focus on productivity has, regrettably, overshadowed the critical imperatives of sustainability within our food systems. Here are several pivotal ways through which millets contribute to climate resilience:

Carbon Sequestration:

Millets, classified within the C4 group of cereals, play a crucial role in mitigating global warming by efficiently converting carbon dioxide into oxygen. The C4 photosynthetic trait is particularly advantageous for millets, as it facilitates this process. In the C4 system, carbon dioxide (CO_2) is concentrated near the enzyme ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO), thereby preventing the undesirable oxygenation and photorespiration of ribulose 1,5-bisphosphate (RuBP). The primary photosynthetic CO_2 reduction reaction catalayzed by RuBisCO is the conversion of atmospheric CO_2 into two molecules of 3-phosphoglycerate (3PGA). This reaction serves as the cornerstone for the photosynthetic fixation of carbon, vital for sustaining life's organic components. The C4 mechanism enhances the CO_2 concentration in the bundle sheath cells, significantly reducing photorespiration (by approximately 80%) and enhancing the catalytic activity of RuBisCO within the plant. Notably, millets exhibit remarkable water nitrogen use efficiency surpassing C3 photosynthesis by 1.5-4 times.

Drought Tolerance:

Millets are well-known for their exceptional drought tolerance, thriving in arid and semi-arid regions with limited water resources. Given the increasingly unpredictable rainfall patterns and crop losses attributed to climate change, many farmers have returned to cultivating sorghum, little millet, and foxtail millet. These grains have proven their resilience to environmental stressors, consistently yielding crops even in the face of both insufficient and excess rainfall, all while maintaining an economical input cost structure. Kodo Millet, in particular, exhibits remarkable drought resistance, thriving in infertile lands with pebbles and adapting to various soil types. Small millets have gained popularity among farmers due to their reliability, yielding 8 -10 quintals per acre with minimal input costs, that prominently stands in contrast to resource-intensive staple crops like wheat and rice.

Low Water Requirements & Adaptability:

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Millet crops demonstrate a remarkable frugality when it comes to water consumption, in stark contrast to major cereal crops like rice and wheat. This intrinsic ability to thrive on limited irrigation renders millets an eco-friendly choice in water-scarce regions where erratic rainfall patterns prevail. Reduced irrigation needs underscore the sustainability of millets. By way of a poignant comparison, the stark difference in water consumption between millets and rice cultivation becomes evident. Millets can flourish across diverse climates and soil types, embodying resilience in the face of evolving environmental dynamics driven by climate change.

Shorter Growth Cycle & Reduced Reliance on Synthetic Inputs:

The relatively brief growth cycles of millets confer an advantageous agility upon farmers. Their shorter maturation periods empower cultivators to harvest crops before extreme weather events, such as late-season droughts or heavy rains, can inflict substantial damage. Barnyard millet distinguishes itself among millet varieties as the fastest growing, maturing in a mere six weeks and boasting tenfold the fiber content of wheat. By and large, millets demand limited utilization of chemical fertilizers and pesticides in comparison to certain other crops. This dual benefit of reducing the environmental impact of chemical inputs while curbing production costs bolsters their sustainability.

Crop Rotation and Diversification:

During the Kharif season, farmers in the northern and southern regions of Karnataka judiciously intermingle millets with other staple crops like groundnut, ushering in a season of enhanced food security and crop diversification. Notably, millets lend themselves readily to intercropping or rotation with other food crops, a practice that safeguards food security, enhances soil health, and curtails disease and insect infestations. The millet's brief annual growth cycle (2.5–4 months) optimally utilizes agricultural space, while its root system rapidly sequesters carbon, thus ameliorating greenhouse gas emissions.

Conclusion

Comprehensively, millets stand as linchpins in the tapestry of climate-resilient agriculture and sustainable food systems. Their unique attributes, adaptability, and multifaceted contributions not only fortify resilience in the face of climate change but also address pressing concerns related to malnutrition. The promotion of millet cultivation and consumption serves as a pivotal strategy, securing food security, championing environmental sustainability, and uplifting the well-being of communities on a global scale. Various laws and policies must be enacted to promote cultivation and consumption of millets. To integrate millets into daily life, there is a dire need to focus on sustainable supply chain that entails the management of material, information, and capital movements with the purpose of achieving simultaneous balancing of economic, environmental, and social goals through collaboration among the factors involved and meeting population demands.