# Nano Iron Fertilization as a Sustainable Farming Practice for Improving Productivity and Nutritional Quality of Pearl Millet

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## Abstract

Sustainable agricultural intensification is essential for meeting the growing demand for nutritious food while conserving natural resources and maintaining soil health. Pearl millet (*Pennisetum glaucum* L.), a climate-resilient cereal crop, plays a vital role in ensuring food and nutritional security, particularly in arid and semi-arid regions. However, micronutrient deficiencies, especially iron deficiency in soils, often limit crop productivity and reduce the nutritional value of grains. Recent advances in nanotechnology have introduced nano-fertilizers as an innovative and eco-friendly alternative to conventional fertilizers, offering enhanced nutrient use efficiency and reduced environmental losses. Nano iron fertilization has emerged as a promising strategy for improving iron availability to crops through targeted nutrient delivery and efficient uptake. The application of nano iron not only supports better plant growth and productivity but also contributes to grain nutrient enrichment, thereby addressing hidden hunger caused by micronutrient malnutrition. In pearl millet, iron biofortification through nano-fertilizer interventions can serve as an effective approach to enhance both agricultural sustainability and human nutrition. This paper highlights the potential of nano iron fertilization as a sustainable farming practice for improving crop performance and grain quality in pearl millet. The technology promotes efficient nutrient utilization, supports physiological and metabolic processes, and enhances the accumulation of essential micronutrients in grains. Furthermore, the reduced application rates and improved nutrient delivery associated with nano-fertilizers can minimize nutrient losses and environmental impacts, aligning with the principles of sustainable agriculture and resource conservation. The integration of nano iron fertilization with biofortified pearl millet cultivars offers a viable pathway for increasing productivity, improving nutritional quality, and strengthening resilience in farming systems. Adoption of such innovative nutrient management practices can contribute significantly to food and nutritional security while supporting sustainable agricultural development. The study underscores the importance of nano-enabled nutrient technologies in addressing future agricultural challenges and promoting environmentally responsible farming practices.

## Keywords

Pearl millet, Nano iron fertilization, Sustainable farming, Biofortification, Nutritional quality, Micronutrient management, Nano-fertilizers, Crop productivity, Soil health, Nutritional security.