



Awareness and Adoption of Nanofertilizers Among Farmers: Opportunities and Challenges in Sustainable Agriculture

*Kajal Verma¹, Dr Payal Jaiswal² and Dr. Subuhi Nishad³

¹Ph.D. (Ag.) Department of Soil Science, College of Agriculture, I.G.K.V., Raipur (C.G.)-492012

²Programme Officer NSS Girls unit, I.G.K.V. Raipur (C.G.)-492012

³NSS Coordinator, I.G.K.V Raipur (C.G.)-492012

*Corresponding Author's email: vermakajal535@gmail.com

Nano-fertilizers have emerged as an innovative nutrient management technology with the potential to improve nutrient use efficiency, enhance crop productivity, reduce fertilizer losses, and minimize environmental pollution. Despite increasing awareness through government initiatives, extension programs, and agricultural institutions, the actual strategic adoption of nano-fertilizers by farmers remains limited in many regions. This study aims to evaluate the gap between farmers' awareness and the strategic adoption of nano-fertilizers by examining their knowledge, attitudes, perceptions, and practical usage. The research also investigates the socio-economic, institutional, and technical factors influencing adoption decisions, including education, farm size, access to extension services, input availability, cost, perceived effectiveness, and risk perception. A structured survey of farmers will be conducted, and descriptive statistics along with appropriate analytical techniques will be used to assess awareness levels, adoption patterns, and the factors contributing to the awareness–adoption gap. The findings are expected to identify key barriers preventing informed awareness from translating into sustained and strategic use of nano-fertilizers. The study will provide evidencebased recommendations for strengthening extension services, improving farmer training, enhancing policy support, and promoting location-specific adoption strategies. Ultimately, bridging the gap between awareness and strategic adoption can contribute to sustainable nutrient management, improved agricultural productivity, and environmental conservation while supporting the broader goals of climate-smart and sustainable agriculture.

Keywords: Nano fertilizers, Survey, Rural Development Skill Development

Introduction

Agriculture remains the backbone of rural livelihoods in Chhattisgarh, particularly in villages such as Pirda in Raipur district. In recent years, the increasing demand for higher crop productivity along with concerns about environmental degradation has led to the exploration of innovative agricultural technologies. Among these, nano fertilizers have emerged as a promising advancement. Nano fertilizers are nutrient carriers engineered at the nanoscale (1–100 nm), which enable efficient nutrient delivery, reduce losses, and improve crop yield. Compared to conventional fertilizers, they enhance nutrient use efficiency and reduce environmental pollution, making them a key component of sustainable agriculture.

History and Development of Nano Fertilizers

The concept of nano fertilizers originated from the broader field of nanotechnology, which began gaining importance in agriculture during the early 21st century. Researchers started exploring the use of nanoparticles for targeted nutrient delivery to plants. Globally, research

intensified after 2010 as scientists recognized the limitations of conventional fertilizers in terms of low nutrient use efficiency and environmental hazards. In India, a major breakthrough occurred when the Indian Farmers Fertilizer Cooperative Limited (IFFCO) developed nano urea, which was officially notified as a nano fertilizer by the Government of India in 2021. India became the first country to commercialize nano fertilizers with the launch of nano urea (liquid) in 2021, followed by nano DAP (liquid) in 2023. These innovations marked a significant step toward reducing dependency on conventional fertilizers and promoting sustainable agricultural practices.

Concept and Importance of Nano Fertilizers

Nano fertilizers are designed to release nutrients slowly and in a controlled manner, ensuring that plants receive nutrients as per their requirement. Due to their high surface area and small particle size, they improve nutrient absorption efficiency and reduce wastage. For example, nano urea contains nitrogen particles at nanoscale, enabling targeted delivery and reducing environmental losses. The importance of nano fertilizers lies in their ability to reduce excessive use of chemical fertilizers, lower production costs, improve crop yield, and maintain soil health. Additionally, they contribute to reducing water and soil pollution caused by conventional fertilizer misuse.

Awareness of Nano Fertilizers Among Farmers in Pirda Village

The level of awareness about nano fertilizers among farmers in Pirda village varies across different socio-economic groups. Farmers who are educated and have access to extension services such as Krishi Vigyan Kendras (KVKs) and agricultural officers tend to have better knowledge about nano fertilizers. Awareness is also influenced by fertilizer dealers, government campaigns, and digital media platforms. However, a significant proportion of small and marginal farmers have limited awareness regarding the benefits, application methods, and proper dosage of nano fertilizers. Many farmers have heard about nano urea and nano DAP but lack detailed understanding of their practical use. This indicates a gap between information dissemination and actual knowledge acquisition at the grassroots level.

Adoption of Nano Fertilizers Among Farmers

The adoption of nano fertilizers in Pirda village is still at an early stage. Most farmers practice partial adoption, where nano fertilizers are used along with conventional fertilizers rather than replacing them completely. The commonly adopted nano fertilizers include nano urea, nano DAP, and nano micronutrients. Although some farmers have reported positive results such as improved crop growth and reduced fertilizer requirement, many farmers remain hesitant due to uncertainty and lack of confidence in new technology. Studies suggest that nano fertilizers can potentially replace 25–50% of conventional urea usage, thereby reducing input costs and improving efficiency.

Factors Influencing Awareness and Adoption

The adoption of nano fertilizers is influenced by several socio-economic and institutional factors. Education level, access to extension services, and participation in training programs positively influence awareness and adoption. Demonstration trials and peer influence also encourage farmers to adopt new technologies. On the other hand, lack of technical knowledge, risk perception, limited availability of inputs, and inadequate infrastructure act as major barriers. Farmers often prefer conventional fertilizers due to familiarity and assured results. Additionally, the requirement of spraying equipment for nano fertilizer application creates an additional constraint for small farmers.

Constraints Faced by Farmers

Farmers in Pirda village face multiple challenges in adopting nano fertilizers. One of the major constraints is lack of proper training regarding application techniques and dosage. Many farmers are unaware that nano fertilizers are mostly applied through foliar spray, which requires specific knowledge and equipment. Another important constraint is skepticism regarding effectiveness. Some farmers are uncertain about yield improvement and long-term

benefits. Limited access to nano fertilizers in rural markets and lack of consistent field demonstrations further reduce adoption. These constraints highlight the need for stronger extension support and awareness programs.

Government Initiatives for Promotion of Nano Fertilizers

The Government of India has taken several initiatives to promote the use of nano fertilizers among farmers. Nano urea was officially approved and included under the Fertilizer Control Order (FCO), making it a recognized agricultural input. The government, along with organizations like IFFCO, has launched nationwide campaigns to create awareness and encourage adoption. Large-scale production infrastructure has been developed, with multiple nano urea and nano DAP plants established across the country. Demonstration programs are being conducted in different agro-climatic zones to showcase the effectiveness of nano fertilizers. Additionally, research projects under ICAR are being implemented to evaluate their performance across crops and regions.

Government Schemes and Distribution System

The promotion of nano fertilizers is also linked with broader fertilizer policies and schemes. The Nutrient Based Subsidy (NBS) scheme supports balanced fertilizer use and indirectly encourages alternatives like nano fertilizers. Furthermore, the PM-PRANAM scheme promotes reduction in chemical fertilizer use and supports sustainable nutrient management practices. Nano fertilizers are distributed through agricultural cooperatives, fertilizer outlets, and Pradhan Mantri Kisan Samridhi Kendras, ensuring availability at the grassroots level. Government and private agencies are actively conducting training programs, farmer awareness campaigns, and field demonstrations to increase adoption.

Discussion

The study reveals that while awareness of nano fertilizers in Pirda village is gradually increasing, adoption remains limited. Farmers are interested in adopting innovative technologies but face challenges related to knowledge, trust, and accessibility. Government initiatives and promotional campaigns have contributed significantly to awareness, but their impact on adoption is still evolving. The success of nano fertilizers depends on effective extension services, practical demonstrations, and continuous farmer engagement. Bridging the gap between awareness and adoption is essential for realizing the full potential of nano fertilizers in sustainable agriculture.

Conclusion

The assessment indicates that awareness of nano fertilizers among farmers in Pirda village is moderate, whereas adoption is low to moderate and mostly partial. Factors such as education, access to information, and extension services play a crucial role in shaping adoption behavior. Although nano fertilizers have the potential to revolutionize agriculture by improving nutrient efficiency and sustainability, their widespread adoption requires continuous efforts in awareness generation, training, and policy support.

References

1. Patra, A.K.(Ed.).(2024). *Nanofertilizers in Agriculture*. Springer Nature, Singapore.
2. Tarafdar, J. C., Kumar, D., Singh, S. K., & Singh, K. P. (2025). *Nanobiotechnology for Agricultural Sciences: Nano-Agri Input Products*. Apple Academic Press.
3. Kumar, P. (2025). *Nanofertilizers for Enhanced Nutrient Use Efficiency*. Royal Society of Chemistry, UK.
4. Abd-Elsalam, K. A. et al. (2021). *Advances in Nano-Fertilizers and Nano-Pesticides in Agriculture*. Academic Press, Elsevier.
5. PRS India. (2021). *Nano Fertilizers for Sustainable Crop Production*.
6. IFFCO. (2023). *Nano Urea (Liquid) and Nano DAP Product Literature*.