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# NENO FERTILIZERS: FUTURE'S DEMAND

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**Introduction:** Agricultural scientists are facing a wide spectrum of challenges such as stagnation in crop yields, low nutrient use efficiency, declining soil organic matter, multi-nutrient deficiencies, climate change, shrinking arable land and water availability and shortage of labour besides exodus of people from farming. . In addition, satellite images reveal that the earth is quickly running out of fertile land and that food production will soon be incapable to keep up with the growing world population (Baruah and Dutta, 2009). In spite of immense constraints faced, we need to attain a sustainable growth in agriculture at the rate of 4% to meet the food security challenges. To address these problems, there is a need to explore one of the frontier technologies such as 'Nanotechnology' to precisely detect and deliver the correct quantity of nutrients and pesticides that promote productivity while ensuring environmental safety and higher use efficiency. The nanotechnology can be exploited in the value chain of entire agriculture production system (Subramanian and Tarafdar, 2011).

Nantechnology deals with the matter at nanoscale (1-100 nm) dimensions. These materials when reduced to the nanoscale show some properties which are different from what they exhibit on a macro scale, enabling unique applications. Nanoscience has brought revolution in different fields by helping develop processes and products that are hardly possible to evolve through conventional methods. The nanotechnology aided applications have the potential to change agricultural production by allowing better management and conservation of inputs of plant and animal production. A survey by Salamanca–Buentella et al. (2005) predicted several nanotechnology applications for agricultural production for developing countries within next 10 years. These included - (i) Nanoforms zeolites for slow release and efficient dosage of water and fertilizers for plants; drugs for livestock; nanocapsules and herbicide delivery (ii) Nanosensors for soil quality and for plant health monitoring; nanosensors for pests detection (iii) Nanomagnets for removal of soil contaminants and (iv) Nanoparticles for new pesticides, insecticides, and insect repellents.

Fertilizers have an axial role in enhancing the food production in developing countries especially after the introduction of high yielding and fertilizer responsive crop varieties. In spite of this, it is known that yields of many crops have begun to depression as a result of imbalanced fertilization and decrease in soil organic matter. Moreover, excessive applications of nitrogen and phosphorus fertilizers affect the groundwater and also lead to eutrophication in aquatic ecosystems. Such cases along with the fact that the fertilizer use efficiency is about 20-50 percent for nitrogen and 10-25 percent for phosphorus fertilizers implies that food production will have to be much more efficient than ever before (Shaviv, 2000; Chinnamuthu and Boopathi, 2009). According to this and limited availability of land and water resources, development of agriculture can be achieved exclusively through increasing productivity by

effective use of modern technologies. Among these, nanotechnology has the potential to revolutionize the agricultural systems, biomedicine, environmental engineering, safety and security, water resources, energy conversion, and numerous other areas (Baruah and Dutta, 2009).

**What is Nenofertilizers?** Nano fertilizers are nutrient carriers of nano dimensions ranging from 30- 40 nm ($10^{-9}$ m or one-billionth of meter) and capable of holding bountiful of nutrient ions due their high surface area and release it slowly and steadily that commensurate with crop demond.

**Nano-fertilizers for balanced crop nutrition:** In India, fertilizers, along with quality seed and irrigation, are mainly responsible for enhanced food grain production (55 mt) in 1960s to (254 mt) in 2011 coinciding with the spectacular increase in fertilizer consumptions from 0.5 mt to 23 mt, respectively. It has been conclusively demonstrated that fertilizer contributes to the tune of 35-40% of the productivity of any crop. Considering its importance, the Government of India is heavily subsidising the cost of fertilizers particularly urea. This has resulted in imbalanced fertilization and occurrence in some areas, nitrate pollution of ground waters due to excessive nitrogen application. In the past few decades, use efficiencies of N, P and K fertilizers have remained constant as 30-35%, 18-20% and 35-40%, respectively, leaving a major portion of added fertilizers to accumulate in the soil or enter into aquatic system causing eutrophication. In order to address issues of low fertilizer use efficiency, imbalanced fertilization, multi-nutrient deficiencies and decline of soil organic matter, it is important to evolve a nano-based fertilizer formulation with multiple functions. Nano-fertilizer technology is very innovative but scantily reported in the literature. However, some of the reports and patents strongly suggest that there is a vast scope for the formulation of nano-fertilizers. Significant increase in yields have been observed due to foliar application of nano particles as fertilizer (Tarafdar, 2012; Tarafdar *et al*. 2012a). It was shown that 640 mg $ha^{-1}$ foliar application (40 ppm concentration) of nanophosphorus gave 80 kg $ha^{-1}$ P equivalent yield of clusterbean and pearl millet under arid environment. Currently, research is underway to develop nano-composites to supply all the required essential nutrients in suitable proportion through smart delivery system. Preliminary results suggest that balanced fertilization may be achieved through nanotechnology (Tarafdar *et al*. 2012b). Indeed the metabolic assimilation within the plant biomass of the metals, e.g., micronutrients, applied as Nano-formulations through soil-borne and foliar application or otherwise needs to be ascertained. Further, the Nano-composites being contemplated to supply all the nutrients in right proportions through the "Smart" delivery systems also needs to be examined closely. Currently, the nitrogen use efficiency is low due to the loss of 50-70% of the nitrogen supplied in conventional fertilizers. New nutrient delivery systems that exploit the porous nanoscale parts of plants could reduce nitrogen loss by increasing plant uptake. Fertilizers encapsulated in nanoparticles will increase the uptake of nutrients (Tarafdar *et al.* 2012c). In the next generation of nanofertilizers, the release of the nutrients can be triggered by an environmental condition or simply released at desired specific time.

**Importance and role of nanofertilizers in improvement of nutrients use efficiency:** According to Royal Society, "Nanotechnologies are the design, characterization, production and application of structures, devices and systems by controlling shape and size at nanometer

scale"(Chinnamuthu and Boopathi, 2009). Nowadays, nanotechnology is progressively moved away from the experimental into the practical areas (Baruah and Dutta, 2009). For example, the development of slow/controlled release fertilizers, conditional release of pesticides and herbicides, on the basis of nanotechnology has become critically important for promoting the development of environment friendly and sustainable agriculture. Indeed, nanotechnology has provided the feasibility of exploiting nanoscale or nanostructured materials as fertilizer carriers or controlled-release vectors for building of so-called "smart fertilizer" as new facilities to enhance nutrient use efficiency and reduce costs of environmental protection (Cui *et al*., 2006; Chinnamuthu and Boopathi, 2009). Encapsulation of fertilizers within a nanoparticle is one of these new facilities which are done in three ways a) the nutrient can be encapsulated inside nanoporous materials, b) coated with thin polymer film, or c) delivered as particle or emulsions of nanoscales dimensions (Rai *et al.*, 2012). In addition, nanofertilizers will combine nanodevices in order to synchronize the release of fertilizer-N and -P with their uptake by crops, so preventing undesirable nutrient losses to soil, water and air via direct internalization by crops, and avoiding the interaction of nutrients with soil, microorganisms, water, and air (DeRosa *et al*., 2010).

**Advantages related to transformed formulation of conventional fertilizers using Nanotechnology :**

**Controlled release formulation**- So-called smart fertilizers might become reality through transformed formulation of conventional products using nanotechnology. The nanostructured formulation might permit fertilizer intelligently control the release speed of nutrients to match the uptake pattern of crop.

**Solubility and dispersion for mineral micronutrients** - Nanosized formulation of mineral micronutrients may improve solubility and dispersion of insoluble nutrients in soil, reduce soil absorption and fixation and increase the bioavailability.

**Nutrient uptake efficiency-** Nanostructured formulation might increase fertilizer efficiency and uptake ratio of the soil nutrients in crop production, and save fertilizer resource.

**Controlled release modes**- Both release rate and release pattern of nutrients for water-soluble fertilizers might be precisely controlled through encapsulation in envelope forms of semi-permeable membranes coated by resin-polymer, waxes and sulphur.

**Effective duration of nutrient release-** Nanostructured formulation can extend effective duration of nutrient supply of fertilizers into soil.

**Loss rate of fertilizer nutrients** -Nanostructured formulation can reduce loss rate of fertilizer nutrients into soil by leaching and/or leaking

**Conclusions**: Since fertilizers, particularly synthetic fertilizers, have a major potential to pollute soil, water and air; in recent years, many efforts were done to minimize these problems by agricultural practices and the design of the new improved fertilizers. The appearances of nanotechnology open up potential novel applications in different fields of agriculture and biotechnology. Nanostructured formulation through mechanisms such as targeted delivery or slow/controlled release mechanisms, conditional release, could release their active ingredients in responding to environmental triggers and biological demands more precisely. There is the possibility of using these mechanisms to design and construction of nanofertilizers. The use of these nanofertilizers causes an increase in their efficiency, reduces

soil toxicity, minimizes the potential negative effects associated with over dosage and reduces the frequency of the application. Nanofertilizers mainly delays the release of the nutrients and extends the fertilizer effect period. Obviously, there is an opportunity for nanotechnology to have a significant influence on energy, the economy and the environment, by improving fertilizers. Hence, nanotechnology has a high potential for achieving sustainable agriculture, especially in developing countries.

**References :**

**Baruah S, Dutta J. (2009).** Nanotechnology applications in sensing and pollution degradation in agriculture. *Env. Chem. Letters* J **7**:191-204.

**Chinnamuthu CR, Boopathi PM. (2009)**. Nanotechnology and Agroecosystem. *Madras. Agric. J* **96**:17-31.

**Cui HX, Sun CJ. Liu Q, Jiang J, Gu W. (2010).** Applications of nanotechnology in agrochemical formulation, perspectives, challenges and strategies. International conference on Nanoagri, Sao pedro, Brazil, 20-25 June 2010.

**DeRosa MR, Monreal C, Schnitzer M, Walsh R, Sultan Y. (2010).** Nanotechnology in fertilizers. *Nat. Nanotechnol. J* 5, 91..

**Naas 2013** Nanotechnology in Agriculture: Scope and Current Relevance. *National Academy of Agricultural Sciences*, New Delhi.

**Naderi, M.R. and –Shahraki, A.D. (2013).** Nanofertilizers and their roles in sustainable agriculture. *Intl J Agri Crop Sci*. **5** (19), 2229-2232

**Rai V, Acharya S, Dey N. 2012.** Implications of Nanobiosensors in Agriculture. *J. of Biomaterials and Nanobiotechnology* **3**: 315-324

**Subramanian, K. S. and Tarafdar, J. C. (2011).** Prospects of nanotechnology in Indian farming. *Indian Journal of Agricultural Sciences* **81**, 887-893.

**Tarafdar, J.C. 2012.** Perspectives of nanotechnological applications for crop production. *NAAS News* **12**, 8-11.

**Tarafdar, J.C., Raliya, R. and Rathore, I. (2012)a**. Microbial synthesis of phosphorus nanoparticles from Tri-calcium phosphate using Aspergillus tubingensis TFR-5. *Journal of Bionanoscience* **6**, 84-89.

**Tarafdar, J.C., Agrawal, A., Raliya, R., Kumar, P., Burman, U. and Kaul, R.K. (2012)b.** ZnO nanoparticles induced synthesis of polysaccharides and phosphatases by Aspergillus fungi. *Advanced Science, Engineering and Medicine* **4**, 1-5.

**Tarafdar, J.C., Xiang, Y., Wang, W.N., Dong, Q. and Biswas, P. (2012)c.** Standardization of size, shape and concentration of nanoparticle for plant application. *Applied Biological Research* **14**, 138-144.