# Use of Nano-Trace Minerals in Livestock Feeding

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Feeding adequate amounts of balanced diets containing required quantity of trace minerals to the animals is one of the important factors for maintenance of good health and optimum production. Nutritional inadequacies occur in almost all parts of the world especially in livestock reared under traditional farming system. Grazing ruminants are the most likely species to suffer from under nutrition due to insufficient supply of nutrients through the forage they graze upon. The Indian farmers small & marginal exclusively depend on straw based feeding system to meet the nutrient requirements. These crop residues are not only low in energy and protein but also deficient in minerals. In the tropics under-nutrition is cited to be one of the major constraints towards efficient animal production and inadequate trace mineral nutrition is perhaps a more limiting factor in this regard compared to the deficiency of energy and protein. Grasses & cereal straws fed livestock usually does not receive mineral supplementation, except for common salt and must depend largely on forages to supply their mineral requirements. However, only rarely, can forages completely satisfy all mineral requirements for livestock. Therefore, mineral supplementation can be a low cost input for the improvement of livestock production. However, mineral supplementation in excess than the need of the animals may yield only diminishing returns and excretion through feces to environment is a major source of pollution (Eguia *et al*., 2009). Hence, to elicit the maximum benefit out of the supplementation a specific strategy must be chalked out prior to the start of the mineral supplementation.

Many factors influence the availability of minerals to animals. The availability of mineral to the animal does not solely depends upon the amount the feed contains, rather depends upon the chemical form in which the mineral is present and presence of other dietary components with which it interacts at the site of absorption or metabolically. Traditionally, inorganic salts such as oxides, sulfates and carbonates have been added to the diet to provide the desired amount to meet the requirements of the animals. These are broken down to varying extents during digestion to 'free' ions' and are then absorbed. However, they may also complex with other dietary molecules and become difficult to absorb or, if completely bound, totally unavailable to the animal. Thus, the availability of the element may decrease substantially. Because of these uncertainties, excess amount of minerals over 20-30 fold higher than the normal requirement are provided in the diet than the minimum amount required for the optimum performance, resulting in over-supply and unnecessary wastage, extra cost and obvious environmental pollution. Alternatively organic sources of minerals are promising, as they have much higher bioavailability than inorganic sources of minerals (Sridhar *et al*., 2015). However, organic sources of minerals are much costlier than traditional inorganic sources (Zhao *et al*., 2014).

Recently, it has been demonstrated that material at nano meter dimension exhibit novel properties different from its normal sized particles. Such as, greater specific surface area, higher surface activity, high catalytic efficiency and stronger adsorbing ability which are due to the advantage of size effect and high surface reactivity (Zhang *et al*., 2001). Bioavailability of the trace minerals can be enhanced by increasing the surface area and nano minerals are used to enhancing the bioavailability in livestock (Rajendran *et al.*, 2013). Liao *et al.*, (2010) reported that nanoparticle showed new characteristics of transport and uptake and exhibit higher absorption efficiencies and reaches deeper into the tissues. The nano-sized particles are having higher potential than their conventional sources and reduces the quantity required (Sri Sindhura *et al*., 2014). Thus, nanotechnology applications have the great potential to advance the science of mineral nutrition and as trace mineral supplement in animals, require very lower doses than the conventional organic and inorganic sources.

**Importance of trace mineral supplementation in livestock**

The importance of mineral elements to the health and well-being of animals has been recognized for centuries even though, individual elements involved were discovered later. They are required for maintenance, growth and reproduction of animals. Livestock most commonly suffer from nutritional deficiencies due to stress of high level of production and deficient feeding leading to poor reproductive performance. Micro minerals are very essential part of animal's ration which is required only in smaller amounts and excess feeding of some of these may show toxicity symptoms. Trace elements are needed in less than 100 ppm in the diet (NRC, 2001) of ruminants. For optimum reproductive performance in farm animals, twenty-two such elements have been identified. The important trace minerals include copper, cobalt, manganese, selenium iodine, iron, chromium and molybdenum where as others are of less practical value.

Trace minerals play wide variety of role in the animal body. They are involved in several biological processes, such as component of metallo-enzymes and enzyme co factors. These works both as activator of enzymes involved in intracellular detoxification mechanism of free radicals and in stabilization of secondary molecules. Some of these trace minerals are component of hormones and thus directly involved in regulation of endocrine activities. Due to its involvement in carbohydrate, protein and nucleic acid metabolism, any change in its level may alter the production of reproductive and other hormones. Its deficiency may affect embryonic development, post-partum recovery activities and over all fertility of animal will be impaired. In male animals it may change spermatogenesis and affect libido. Most of the non-conventional feeds are deficient in trace minerals and are likely to increase chances of reproductive problems.

**Brief history of nanotechnology**

Richard Feynman, also known as father of Nanotechnology brought the concept of nanotechnology in year 1959. For his work in this field, he also received Noble prize in 1965. In 1974, Prof. Norio Taniguchi introduced the term 'nanotechnology'. First book on nanomedicine called "Nanomedicine" came in year 1999 by R. Freitas. In 2000 – "National Nanotechnology Initiative" (NNI) was launched in the USA.

**Nanotechnology**

Definitions of nanotechnology are as diverse as its applications. Basically, it is the ability to design and control the structure of an object at all length scales from the atom up to the macro scale. The term nano technology has been derived from the Latin word *nanus,* meaning *dwarf.* Nanotechnology is defined as the technology of materials and structures, whose size is in nanometers.

**The differences in the properties of nanoparticles are due to:**

The physical, chemical, electrical, optical, mechanical and magnetic properties at an atomic scale are quite different from those present at a larger scale, even when compared with those present at a scale of microns (10-6) (Buzea *et al*., 2007).

**The mechanisms of action of the nanoparticles are as follows (chen *et al*., 2006).**

- Increase the surface area available to interact with biological support
- Prolong compound residence time in GIT
- Decrease influence of intestinal clearance mechanisms
- Penetrate deeply into tissues through fine capillaries
- Cross epithelial lining fenestration (e.g. liver)
- Enable efficient uptake by cells
- Efficient delivery of active compounds to target sites in the body

**Effects of feeding nano-trace minerals in livestock production**

So far, very little information is available on the suitability and efficacy of nanoparticles on the performance of animals and most of the studies regarding use of nanotechnology in animal nutrition is focused mainly to assess the effect of supplementation of nano particles of minerals in the diet of non-ruminants, as we know the bioavailability of inorganic sources of trace minerals is quite low and alternatively organic sources of minerals are having much higher bioavailability than inorganic sources of minerals (Sridhar *et al*., 2015) but the disadvantage with organic sources of minerals is that they are much costlier than traditional inorganic sources of minerals (Zhao *et al*., 2014). Some of the nano mineral proven to at laboratory include nano zinc, nano copper, nano cromium, nano iron and nano selinum.These can be used at lower doses and can provide better result than the conventional sources and indirectly prevents environmental contamination also.

**Conclusion**

Studies so far have indicated that the application of nano minerals in animal production, immunity and reproduction is promising. Because, applications of nano-minerals are immensely useful, the safety in application of nanominerals needs to be assessed before it is being applied in the livestock industry. However, work on use of nano particles of minerals is still very limited and needs to be taken up.

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