

Organic Agriculture and Nanotechnology

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Abstract

Organic agriculture is a holistic production management system which promotes and enhances agroecosystem health, including biodiversity, biological cycles and soil biological activity. Nanotechnology is a rapidly developing domain of research and practice, the terminology is in a state of flux and usage is evolving. In agriculture, nano-pesticides and nano-sensors are changing the nature of agricultural production. In regard to use of nanotechnologies in organic production currently, there are no national or international regulation, definitions, licensing or declaration requirements. We are still a long way off from conclusively assessing nanotechnologies or individual substances with nanoparticles, since we do not yet have the toxicological and ecological bases to do this. In our view, all of nanotechnology applications should be evaluated case by case. Positive or negative lists seem to be a good tool to regulate the use of nanotechnology in organic agriculture.

Introduction

As per the definition of FAO, organic agriculture defined as an unique production management system which promotes and enhances agroecosystem health, including biodiversity, biological cycle and soil biological activity, and this is accomplished by using on-farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs. Thus organic farming as a system which avoids the use of synthetic inputs such as fertilizers, pesticides, hormones, feed additives etc.

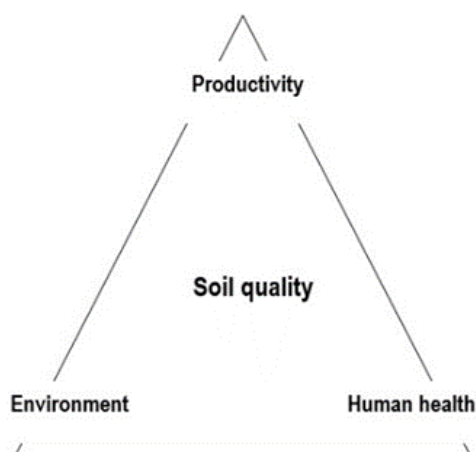


Figure 1. Soil quality and the three related concerns in organic farming (Schjonning et al. 2004)

On the other hand, Nanotechnology is the fast growing science of the ultra-small; it is creating engineered particles in the size range 1 to 100 nanometers (Paul and Lyons, 2008). Nanomaterials include nanoparticles and nanoemulsions and nanostructures including nanocapsules, nanotubes, fullerenes quantum dots and nanowires (Blike, 2008). This technology is being used increasingly in numerous area of agricultural production.

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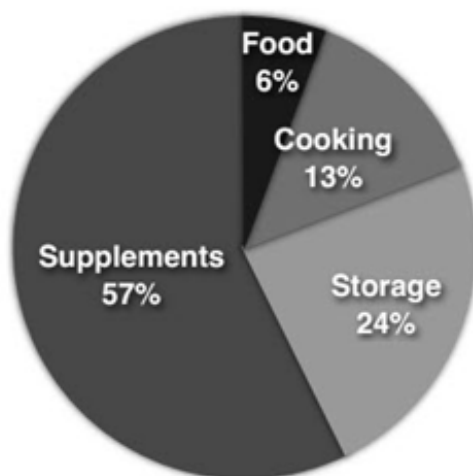


Fig. 2. Distribution by sub-category of nanotechnology products classified as 'Food and Beverage' (PEN, 2010).

Nanotechnology in food and agriculture

They are also just a preview of what appears to be a flood of food and farm applications of nanotechnology moving to market. In the food industry alone, experts estimate that nanotechnology will be incorporated into \$20 billion worth of consumer products by 2010. Five out of ten of the world's largest food companies are aggressively exploring the potential of the really small to make really big improvements in packaging, food safety, and nutrition. Similarly, in agriculture, some of the world's largest makers of pesticides, fertilizers, and other farm inputs and technologies are betting on nanotechnology to bring unprecedented precision to crop and livestock production. These applications are commonly known as "agrifood nanotechnology." However, while it is clear that agrifood nanotechnology is expected to become a driving economic force in the long-term, less certain is precisely what to expect in the near-term. This R&D is not just restricted to developed countries. Developing countries such as Iran have adopted their own nanotechnology programmes with a specific focus on agricultural applications. The Iranian Agricultural ministry is supporting a consortium of 35 laboratories working on a project to expand the use of nanotechnology in agro sector. The ministry is also planning to hold training programs to develop specialized human resources in the field. They have already produced their first commercial nanotechnology product Nanocid, a powerful antibacterial product which has potential applications in the food industry. The product has also widespread applications in the production of various kinds of detergents, paints, ceramics, air conditioning systems, vacuum cleaners, home appliances, shoes and garments. India has allocated 22.6 million USD in its 2006 budget to the Punjab Agricultural University in Ludhiana, in acknowledgement of its pioneering contribution to the Green Revolution. Its research on high-yielding crop varieties helped boost food production in the 1960s and new projects include the development of new tools and techniques for the agriculture industry.

Organic agriculture and nanotechnology

The organic community has adopted four guiding principles, the CHEF principles: care, health, ecology and fairness (IFOAM, 2005). By contrast, nanotechnology is quickly moving from the laboratory onto supermarket shelves and out kitchen tables. Therefore we investigated in a literature review and a comparison of the finding with the organic standards of organic farming to what degree nanotechnology can be applied in organic food production. In regard to use of nanotechnologies in organic production currently, there are no national or international regulation, definitions, licensing or declaration requirements. However, there is action on national and international levels regarding the regulation and standardization of nanotechnology. Nanotechnology is currently not addressed in any organic standard, other than that of the Soil Association (2008). The regulations do not restrict the use of nanotechnology in general. Because little is known about the impact on environment and human health, precaution should be taken when it comes to applying this technology in organic food production. The organic sector is concerned that the latest developments in

nanotechnologies will lead to an insufficiently considered use of nano-particles (the product of the nanotechnologies) within the agrifood sector. Nano-particles are increasingly available and there is a serious lack of relevant toxicological studies addressing their impact on the environment and human health. There exists a high level of uncertainty on how nanotechnology affects the products, the people and the environment. The organic sector is strategically positioned as a safe, healthy and environmentally friendly food alternative. An exclusion of nanotechnology from the organic food chain would be in line with the philosophy and principles of organics and would serve as a precautionary act to protect organic consumers, processors and farmers (Scrinis & Lyons, 2007; Paull & Lyons, 2008).

Table 1: Potential applications for nanotechnologies in the agricultural and food sectors, and their opportunities and risks (Nowack and Speiser, 2008)

Potential applications	New properties/ opportunities	Risks for organic systems
A. Addition of substances in the form of nano particles to food and animal feed		
Examples: Colouring, flavours and vitamins in nanocapsules	Dissolve better in beverages	Directly absorbed by the body, effect unknown!
B. Auxiliary substances		
Fertilizers	Less fertilizer needed due to selective application	Greater mobility?
C. Medicines		
(Vetrinary) Medicines	Medicines with nanoparticles can be targeted more precisely	Side effects on animal health systemic Displacement/accumulation in meat, milk, eggs?
D. Packaging		
Biopolymers with integrated nanoparticles	More stable than other biopolymers, compostable	What happens during composting?
E. Surface treatments		
Silver nano layer on the inside of refrigerators	Antimicrobial, combats bacteria and fungi	Pass into food?
F. New techniques for processing		
Nanofilters	Fewer resources consumed more efficient	

Conclusion

It is potentially bigger than GM, with much wider uses, and of course the one technology is already feeding into the other. Nanotechnology holds the promise of great potential, but it may also pose great risks. We are still a long way off from conclusively assessing nanotechnologies or individual substances with nanoparticles, since we do not yet have the toxicological and ecological bases to do this. The serious lack of recognized definitions, statutory regulations and defined methods also hampers the assessment. In our opinion, all of nanotechnology applications should be evaluated case by case. Positive or negative lists seem to be a good tool to regulate the use of nanotechnology in organic agriculture.

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