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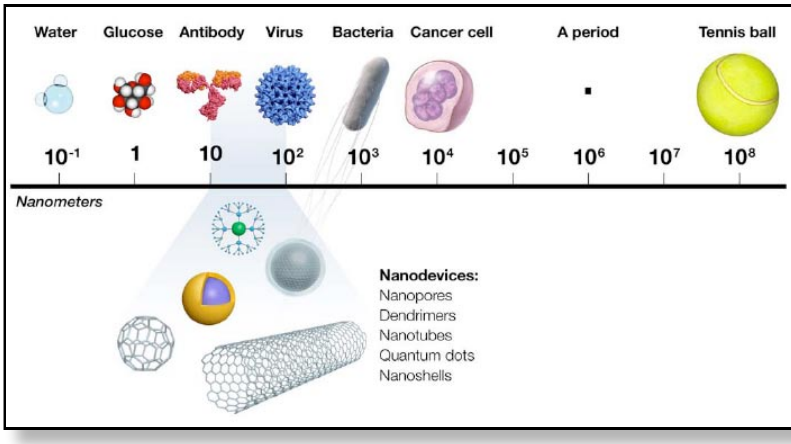

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Nanotechnology: Transforming Food and the Environment

By Dr Kristen Lyons*

Nanotechnology is the latest technological innovation being used to transform food, farming and the environment. Nanotechnology breaks down and manipulates foods, seeds, chemical pesticides and food packaging at the micro-scale, and in so doing, is driving a nano-food and farming revolution (ETC Group, 2004; Friends of the Earth, 2008). While proponents of nanotechnology promise it will help address climate change and global hunger, opposition is mounting from civil society, unions and some of the world's leading scientists, who point to ecological, health and socio-economic risks associated with nanotechnology (RS-RAE, 2004; Scrinis and Lyons, 2010). Given this controversy, it is striking that many nano products are already on the market, and most governments, including the U.S, have no nano specific regulations, testing or labeling requirements.

What is nanotechnology?

Nanotechnology is defined as any engineered materials, structures and systems that operate at a scale of 100 nanometers (nm) or less (one nanometer is one billionth of a meter) (Moraru et al., 2003). To put this scale into perspective, a strand of DNA is 2.5 nm wide, a red blood cell is 7000 nm, while a human hair is about 80,000 nm wide (Friends of the Earth, 2008).

Nanotechnology is not a separate techno-scientific field, but rather a new platform for a range of existing disciplines—including chemistry, physics, biology, biotechnology, neurology, information technology and engineering— allowing a shift down to the nano scale (ETC Group, 2003). Nanotechnologies are being applied across a range of industries beyond food, including military and energy, pharmaceuticals, medicine, and cosmetics. Nano techniques include the manufacture of nanoparticles, nanofabrication, and nano-biotechnology techniques. Nanoparticles are produced by breaking down larger-scale chemical compounds and materials into nano-scale bits, as well as the manufacture of distinctly new materials, such as carbon nanotubes, buckyballs and quantum dots (Maynard, 2006). Nano-scale particles exhibit novel character traits (including different chemical reactivity, bioactivity and absorption capacity), compared to the same material in its bulk form (Hunt and Mehta, 2006). Silver, for example, demonstrates anti-bacterial and odor-eating qualities in its nano form (Senjen and Illuminato, 2009). Manufacturers have sought to harness these nano-scale characteristics; adding nano silver to refrigerators, chopping boards, and chopsticks; marketing these products as 'safe, clean and hygienic.' Despite the marketing hype around nano silver, its manufacture, use and disposal poses significant ecological, public health and social justice risks and concerns.

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Nano Food in the Grocery Store

A wide variety of nano-based products and processes are already on our plates, largely driven by the corporate sector, including Kraft Foods, H.J. Heinz, Nestle, Unilever, Cargill, Pepsi-Cola, Syngenta and Monsanto (Friends of the Earth, 2008). The Woodrow Wilson International Centre for Scholars estimates at least 84 food-related items containing nano products are in the market, while investigations by Friends of the Earth report 104 food items and an additional 400-500 nano packaging products (Friends of the Earth, 2008). So what are the agri-food corporations up to at the nano scale?

Nano Food Packaging

Nano food packaging is the most commercialized of the agri-food nanotechnologies. Nano packaging materials include barrier technologies, which enhance the shelf life, durability and freshness of food—or at least slow the rotting process. DuPont produces a nano titanium dioxide plastic additive that reduces UV exposure that they claim will minimize damage to food contained in transparent packaging (ElAmin, 2008).

Nano packaging is also being designed to enable materials to interact with the food it contacts; emitting antimicrobials, antioxidants, nutraceuticals and other inputs. This 'smart' or 'active' packaging, as manufacturers brand it, is being developed to respond to specific trigger events. For example, packaging may contain nanosensors that are engineered to change color if a food is beginning to spoil, or if it has been contaminated by pathogens. This technology is already being used in the U.S. with carbon nanotubes incorporated into packaging materials to detect microorganisms, toxic proteins and food spoilage (ElAmin, 2008).

Nano Farming

The agri-chemical and information technology industries have shifted down to the nano-scale to produce new agricultural chemicals, seeds, and livestock with novel functions and capabilities, as well as new systems of farm monitoring and management (Kuzma and VerHage, 2006; Friends of the Earth, 2008). Syngenta, BASF, Bayer Crop Science, Cargill and Monsanto are all undertaking research and commercialization in these areas. Syngenta, for example, has harnessed the properties of nano-scale materials to produce nano pesticides including "gutbuster" microcapsules that contain pesticides engineered to break open in the alkaline conditions of an insect's stomach. They argue this will enable the more targeted delivery of pesticides (Syngenta, 2007).

The convergence of nanotechnologies with biotechnology, also provides industry with new tools to modify genes and even produce new organisms. For example, nanobiotechnologies enable nanoparticles, nanofibres and nanocapsules to carry foreign DNA and chemicals that modify genes (ETC Group, 2004; Torney et al., 2007). In addition to the re-engineering of existing plants, novel plant varieties may be developed using synthetic biology; a new branch of technoscience that draws on the techniques of genetic engineering, nanotechnology and informatics. In a recent breakthrough in this area, researchers completely replaced the genetic material of one bacteria with that from another—transforming it from one species to another (ETC Group, 2007). These technologies clearly up the ante, increasing both the opportunities and risks offered by each of these technologies in isolation.

Nano Food

Nanotechnologies are being used to manufacture entirely new foods. These include 'smart' foods—nutritional profiles that respond to an individual's allergies, dietary needs or food preferences. While such designer food sounds like the stuff of fantasy, nanotechnologies make them scientifically possible.

Nanotechnology is also being used to alter the properties and traits of food; including its nutrition, flavor, texture, heat tolerance and shelf life. For example, Unilever has reported breakthroughs in the manufacture of low-fat and low-calorie food that retains its rich and creamy taste and texture, applying this to a range of very low-fat ice-creams, mayonnaise and spreads (Daniells, 2008). Meanwhile, food companies are using microcapsules to deliver food components such as omega 3-rich fish oil. The release of fish oil into the human stomach is intended to deliver claimed health benefits of the fish oil, while masking its fishy taste (Friends of the Earth, 2008).

Ecological and Health Implications of Nano-Food

There are mounting ecological concerns associated with nanotechnologies. Nanomaterials are introducing new and unexpected forms of pollution. The size, dissolvability and other novel characteristics of nanomaterials enable them to readily contaminate soils, waterways and food chains, posing new and little understood ecological risks. For example, antimicrobial properties of nanoparticles are able to shift into microbial populations—disrupting signals between nitrogen-fixing bacteria and plant hosts—with negative impacts for entire ecosystems (RCEP, 2008). Nanoparticles can also transport other contaminants. Studies with fish demonstrate titanium dioxide can significantly increase cadmium accumulation. Nanoparticles can also bioaccumulate with recent findings demonstrating that carbon nanotubes are taken up by microbial communities and root systems, thereby concentrating up the food chain (RCEP, 2008).

Nanotechnology also introduces a new order of health risks. Studies show that nanoparticles gain ready access to the blood stream after being inhaled, while some can directly penetrate the skin (Friends of the Earth, 2008). Scientific evidence demonstrates nanoparticles are able to cross-cellular barriers (including the stomach wall), increasing absorption rates and bioavailability. There is also evidence demonstrating nanoparticles are cytotoxic (i.e. toxic to cells). (Chaudhry et al., 2008; Pustzai and Bardocz, 2006). Meanwhile, carbon nanotubes (used in food packaging materials) have been likened to asbestos, with evidence demonstrating exposure may lead to mesothelioma, or lung cancer, in test mice (Poland et al., 2008).

It is also possible that nanoparticles in food packaging materials may migrate into food it comes into contact with (Friends of the Earth, 2008). This is cause for alarm; given research into a range of nanoparticles that are widely used in food packaging (including nano silver, nano zinc oxide and nano chlorine oxide) demonstrate specific adverse health impacts—with tests on nano zinc oxide producing damaging health impacts in mice and rats, as well as being toxic to human cells, even at very low concentrations (Poland et al., 2008). Despite these results, the U.S. Food and Drug Administration has already approved certain nanoparticles (including titanium oxide and silicon dioxide) for use in food.

Social Transformations From Nano-foods

The broad range of nano-technological innovations is being used to support the continuation of the dominant industrial food system; despite the obvious social, economic and ecological limits of this system. In many instances, nano innovations offer short-term techno-fixes to the problems facing modern industrial agriculture and food systems, or introduce new efficiencies within large-scale systems. There are many parallels between nano-food innovations and the introduction of genetically engineered foods. While promising to ameliorate some of the health and ecological problems associated with industrial food production, processing and distribution, they also threaten to introduce new dangers to the environment and human health. At the same time, these applications threaten to further concentrate corporate ownership and control of large sections of food production systems and markets, and to increase inequalities and power imbalances across the food system.

Nanotechnologies are likely to extend some of the adverse impacts associated with the introduction of earlier technologies as well, including genetic engineering. For example, it can be expected that nanotechnology will support large-scale, capital and chemical-intensive production, given that nano-pesticides and nanosensors (and other nano innovations) are likely to deliver the greatest benefits to large-scale farming operations. They are also likely to support the further expansion of chemical-intensive, mechanized and automated farming operations. Given patterns of corporate ownership and high levels of concentration across the nano industries, the adoption of these technologies is also likely to further erode farmers' autonomy and control over their farm operations (ETC Group, 2004).

Conclusions

The nano-revolution is driving a high-tech approach to farming and food. This is set to further entrench a chemical, industrial and corporate agri-food system, furthering inequitable social and economic power relations in both the developed and developing world, as well as introducing a new level of ecological and health concerns. Despite the myriad claims from government and industry associated with nanotechnologies—including promises it will address climate change and global food insecurity—the global, corporate nano-revolution is set to steer us further away from a localized, democratic and sustainable agri-food system.

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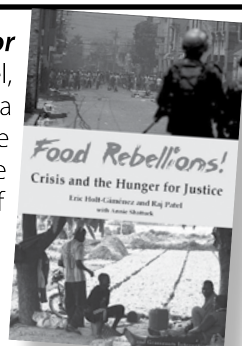
BOOKS FROM FOOD FIRST



Food Rebellions! Crisis and the Hunger for Justice by Eric Holt-Giménez and Raj Patel, with Annie Shattuck. Today there are over a billion hungry people on the planet, more than ever before in history. Why, in a time of record harvests, are a record number of people going hungry? And why are a handful of corporations making record profits? *Food Rebellions!* tells the real story behind the global food crisis and documents the growing trend of grassroots solutions to hunger spreading around the world. Official plans to solve the world food crisis call for more free trade and technical fixes--solutions that have already failed. *Food Rebellions!* is a trail marker on the journey to end hunger and build food sovereignty. $19.95

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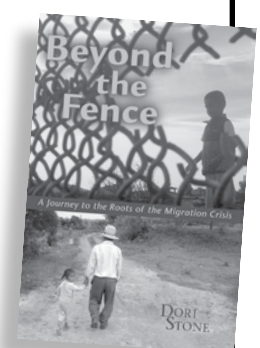
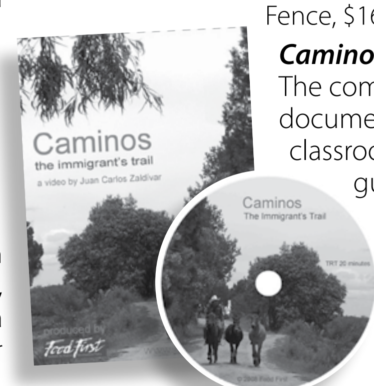
Authors include Miguel Altieri and Elizabeth Bravo, Eric Holt-Giménez and Isabella Kenfield, Gretchen Gordon and Jessica Aguirre, Richard Jonasse, Maria Luisa Mendonça, Laura Hurtado, Annie Shattuck, and Rachel Smolker and Brian Tokar. $18.95



Beyond the Fence: A Journey to the Roots of the Migration Crisis, by Dori Stone, informs the immigration debate in the U.S., which is highly controversial, emotional, and often confusing. She explores migration issues that are largely unnoticed by the public in the U.S. and the mainstream media - the stories and surprising possibilities that get lost in the debate over fences and undocumented migrants exploited at below minimum wage. They are the tales of people's desperation and irretrievable loss, but also their growing visions of hope. They are the stories of farmers, politicians and activists on both sides of the border. *"The book is ideally suited for students, but I can think of few people who would not benefit from reading it."* - Angus Wright, author of *The Death of Ramon Gonzales: The Modern Agricultural Dilemna*. Beyond the Fence, $16.95



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