

# NANOTECHNOLOGY

## THE NEW THREAT TO FOOD

*Hundreds of foods on the supermarket shelves may now contain untested and unlabelled nanotechnology ingredients, yet consumers are none the wiser.*

### The new assault on holistic agriculture

Following on from genetic engineering, nanotechnology represents the latest high-technology attempt to infiltrate our food supply. Senior scientists have warned that nanotechnology—the manipulation of matter at the scale of atoms and molecules—introduces serious new risks to human and environmental health. Yet in the absence of public debate or oversight from regulators, unlabelled foods manufactured using nanotechnology have begun to appear on our supermarket shelves.

Around the world there is an increased interest in our food, health and environment. We want to know where, how, why and by whom products are produced, how far they have travelled and how long they have been stored. The organic and local food movements have emerged as an intuitive and practical response to the increasing use of chemicals in food production and to the growing alienation of industrial agribusiness from holistic agricultural systems. People have chosen to eat organic foods because they care about the health of their families and the health of the environment. Organic agriculture also enables people to support integrated, environmentally friendly agriculture and appropriate technology rather than chemical-intensive factory farming.

Support for organics has also grown as a direct response to biotechnology giants' efforts to genetically engineer our food crops. Farmers and food buyers around the world were, and continue to be, enraged by the introduction of genetically engineered food crops. For many, the inevitable conclusion was that whereas the biotechnology companies stood to benefit from the entry of genetically engineered foods into the food chain, consumers, farmers and the environment shouldered all the risks.

Now, nanotechnology introduces a new wave of assaults on our foods. Nanotechnology is the high-technology, atomically processed antithesis of organic agriculture, which values the natural, health-giving properties of fresh, unprocessed wholefoods. It further transforms the farm into an automated extension of the high-technology factory production line, using patented products that will inevitably concentrate corporate control. It also introduces serious new risks for human health and the environment.

### Introduction to nanotechnology: what is it, and why is it different?

Nanotechnology is a powerful new technology for taking apart and reconstructing nature at the atomic and molecular levels. Nanotechnology embodies the dream that scientists can remake the world from the atom up, using atomic-level manipulation to transform and construct a wide range of new materials, devices, living organisms and technological systems.

Nanotechnology and nanoscience involve the study of phenomena and materials and the manipulation of structures, devices and systems that exist at the nanoscale, i.e., less than 100 nanometres (nm) in size. To put 100 nm in

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From the web page:  
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context, a strand of DNA is 2.5 nm wide, a protein molecule 5 nm, a red blood cell 7,000 nm and a human hair 80,000 nm.

The properties of nano-particles are not governed by the same physical laws as larger particles but by quantum mechanics. The physical and chemical properties of nano-particles—for example, colour, solubility, strength, chemical reactivity and toxicity—can therefore be quite different from those of larger particles of the same substance.

The altered properties of nano-particles have created the possibility for many new and profitable products and applications. Engineered nano-particles are used in literally hundreds of products that are already available on supermarket shelves, including transparent sunscreens, light-diffracting cosmetics, penetration-enhanced moisturisers, stain- and odour-repellent fabrics, dirt-repellent coatings, long-lasting paints and furniture varnishes, and even some food products.

The APEC (Asia-Pacific Economic Cooperation) Center for Technology Foresight has predicted that nanotechnology will revolutionise all aspects of our economy and society, with associated large-scale social upheaval.

### **How will nanotechnology be used for food production and processing?**

Industry analysts and proponents predict that nanotechnology will be used to transform food from the atomic level up.

"Thanks to nanotechnology, tomorrow's food will be designed by shaping molecules and atoms. Food will be wrapped in 'smart' safety packaging that can detect spoilage or harmful contaminants. Future products will enhance and adjust their color, flavor or nutrient content to accommodate each consumer's taste or health needs. And in agriculture, nanotechnology promises to reduce pesticide use, improve plant and animal breeding, and create new nano-bioindustrial products"—or so states The Project on Emerging Nanotechnologies' 2006 report on the use of nanotechnology in food and agriculture (available at <http://www.nanotechproject.org>).

The food and agriculture industries have been investing billions of dollars into nanotechnology research, with an unknown number of unlabelled nano-food products already on the market. In the absence of mandatory product labelling anywhere in the world, it is impossible to tell how many commercial food products now contain nano-ingredients.

The Helmut Kaiser Consultancy Group, a pro-nanotechnology analyst, suggests that there are now over 300 nano-food products available on the market

worldwide (see <http://www.hkc22.com>). It estimates that the global nano-food market was worth US\$5.3 billion in 2005 and will rise to US\$20.4 billion by 2010. It predicts that nanotechnology will be used in 40 per cent of the food industries by 2015.

There are four key focus areas for nanotechnology food research:

- nano-modification of seed and fertilisers/pesticides;
- food "fortification" and modification;
- interactive "smart" food;
- "smart" packaging and food tracking.

### **Nanomodification of seeds and fertilisers/pesticides**

Proponents say that nanotechnology will be used to further automate the modern agribusiness unit. All farm inputs—seeds, fertilisers, pesticides and labour—will become increasingly technologically modified.

Nanotechnology will take the genetic engineering of agriculture to the next level down: atomic engineering.

Atomic engineering could enable the DNA of seeds to be rearranged in order to obtain different plant properties including colour, growth season, yield, etc. Highly potent atomically engineered fertilisers and pesticides will be used to maintain plant growth. Nano-sensors will enable plant growth, pH levels and the presence of

nutrients, moisture, pests or disease to be monitored from far away, significantly reducing the need for on-farm labour input.

The concerned organisation, The Action Group on Erosion, Technology and Concentration (ETC), warns in its seminal report "Down on the Farm" (available at <http://www.etcgroup.org>) that in a nanotechnology-shaped future "the farm will be a wide-area biofactory that can be monitored and managed from a laptop and food will be crafted from designer substances delivering nutrients efficiently to the body".

### **Food "fortification" and modification**

Nanotech companies are working to fortify processed food with nano-encapsulated nutrients, its appearance and taste boosted by nano-developed colours, its fat and sugar content removed or disabled by nano-modification, and its "mouth feel" improved.

Food "fortification" will be used to increase the nutritional claims that can be made about a given processed food; for example, the inclusion of "medically beneficial" nano-capsules will soon enable chocolate chip cookies or hot chips to be marketed as health promoting or artery cleansing. Nanotechnology will also enable

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junk foods like ice cream and chocolate to be modified to reduce the amount of fats and sugars that the body can absorb. This could happen either by replacing some of the fats and sugars with other substances or by using nano-particles to prevent the body from digesting or absorbing these components of the food. In this way, the nano-industry could market vitamin- and fibre-fortified, fat- and sugar-blocked junk food as health promoting and weight reducing.

### **Interactive "smart" food**

Companies such as Kraft and Nestlé are designing "smart" foods that will interact with consumers to "personalise" food, changing colour, flavour or nutrients on demand. Kraft is developing a clear, tasteless drink that contains hundreds of flavours in latent nano-capsules. A domestic microwave oven could be used to trigger release of the colour, flavour, concentration and texture of the individual's choice.

"Smart" foods could also sense when an individual is allergic to a food's ingredients and then block the offending ingredient. Alternatively, "smart" packaging could release a dose of additional nutrients to those whom it identifies as having special dietary needs; for example, calcium molecules to people suffering from osteoporosis.

### **"Smart" packaging and food tracking**

Nanotechnology will dramatically extend food shelf life. Mars Inc. already has a patent on an invisible, edible, nano-wrapper which will envelop foods, preventing gas and moisture exchange.

"Smart" packaging, containing nano-sensors and antimicrobial activators, is being developed that will be capable of detecting food spoilage and releasing nano-antimicrobes to extend food shelf life, enabling supermarkets to keep food for even greater periods before its sale.

Nano-sensors, embedded into food products as tiny chips invisible to the human eye, would also act as electronic barcodes. They would emit a signal that would allow food, including fresh food, to be tracked from paddock to factory to supermarket and beyond.

### **What are the key concerns about nanotechnology in food and agriculture?**

Concerns about the use of nanotechnology in agriculture and food production relate to the further

automation and alienation of food production, serious new toxicity risks for humans and the environment, and the further loss of privacy as nano-surveillance tracks each step in the food chain. The failure of governments to introduce laws to protect the public and the environment from nanotechnology's risks is a most serious concern.

Nanotechnology in agriculture is based on the premise that we can improve efficiency and productivity by rearranging atoms in seeds, by developing even more potent chemical inputs, by using high-technology surveillance to allow electronic rather than person-based surveillance of on-farm conditions and by further automating inputs to plant growth.

It is assumed that applications of nanotechnology in food processing can "improve" the taste, texture, appearance, nutritional content and longevity of food by manipulating it at the atomic level. It has even been argued that this will result in food that is "safer". These assumptions are based on the flawed belief that humans can remake the natural world from the atom up—and get a better result. It is assumed that we can predict the consequences of our actions, even when we are dealing with highly unpredictable processes and forces such as quantum mechanics.

Unfortunately, history tells us that we are simply not very good at predicting the outcomes of complex systems. Witness the disasters that resulted from the introduction of biological controls such as the cane toad or of rabbits and foxes for sport. History is similarly littered with examples of huge health and environmental problems that resulted from the failure to respond to early warning signs about previously perceived "wonder" materials such as CFCs,

DDT and asbestos. This suggests that we should take the early-warning signs associated with the toxicity of nano-particles very seriously.

There is a small but growing body of toxicological literature that suggests that nano-particles are more reactive, more mobile and more likely than larger particles to be toxic to humans and the environment. Preliminary scientific research has shown that many types of nano-particles can result in increased oxidative stress, which can cause the formation of free radicals that can lead to cancer, DNA mutation and even cell death. Fullerenes—carbon nano-particles—have been found to cause brain damage in largemouth bass, a species accepted by regulatory agencies as a model for defining

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ecotoxicological effects.

In its 2004 report, the United Kingdom's Royal Society recognised the serious risks of nanotoxicity and recommended that "ingredients in the form of nanoparticles should undergo a full safety assessment by the relevant scientific advisory body before they are permitted for use in products" (see <http://www.nanotec.org.uk/finalReport.htm>). Despite this warning, there are still no laws governing the use of nanomaterials in consumer products to ensure that they do not cause harm to the public using them, the workers producing them or the environmental systems in which waste nano-products are released.

The use of nano-surveillance in food packaging will also introduce new privacy concerns. As the food industry's use of nano-tracking increases, it will gain the capacity to track the movement of food from the paddock to the factory to the supermarket and to your dinner plate. This will raise serious new privacy issues for which we are poorly prepared.

Alarming, despite the release of nanotech food and agriculture products into supermarkets and into the environment, governments worldwide have yet to introduce any regulation to manage nanotechnology's risks.

### **The struggle for a healthy food future: the alternatives to nanotechnology**

What will our food and technological future look like? We are in an epic battle for control of our food supply. Corporate or community ownership, global or local, small versus massive, processed versus wholesome—these are the paradigms that we need to choose between. A key way to promote healthy, holistic agriculture is to support it with our purchasing choices. Certified organic foods offer you better health, a better environment and a way for you to support a nano-free food future. With personal care products, buy organic or from a company that states it does not use nanotechnology.

There are many ways to help create a healthy food future. Shop at a farmers' market or buy from a box scheme direct from a farmer. Buy from an organic store or from the organic section in a supermarket. Consider joining a community garden or starting a garden of your own. Start an organic kitchen garden at your local preschool or school. Read product labels. Get involved and interested. Talk to your friends and family about the food issues that matter most to you. Let companies know through their 1-800 feedback lines that you are concerned about the use of nanotechnology in their products. Tell your local member of parliament that you want to see

products that contain engineered nano-ingredients labelled to allow you to make an informed purchasing choice.

It is exciting to see food politics debated by our mainstream media and our research and education institutions. However, while there are already unlabelled food products that contain engineered nano-ingredients available in our supermarkets, nanotechnology is only just starting to gain some attention. There are no regulations in place to protect public and environmental health, and almost no corporate or public monies being spent looking at the long-term consequences of manipulating our food at the atomic level. The similarity to the introduction of genetic engineering, with the added risk that there is no regulatory oversight, is chilling.

We must all get politically active on nanotechnology, just as we've done with genetic engineering. It is essential that we get moratoria enacted on the use of

nanotechnology until we have regulatory systems in place to protect human and environmental health and until we have genuine public involvement in decision-making regarding nanotechnology's introduction. We must also ensure that our governments put our hard-earned taxpayer dollars into support for the organic sector.

Together we can create a healthy food future that delivers to our community, not to corporate profits. ∞

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### **About the Authors:**

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### **Editor's Note:**

This paper was originally published in *Clean Food Organic*, vol. 4, May 2007, and is available at <http://nano.foe.org.au/node/198>. A 73-page report, "Out of the Laboratory and on to our Plates: Nanotechnology in Food and Agriculture", written in March 2008 by Georgia Miller and Dr Rye Senjen of the Friends of the Earth Australia Nanotechnology Project, is available as a PDF from web page <http://nano.foe.org.au/node/226>. A 12-page summary of this report is available at web page <http://nano.foe.org.au/node/233>. For more information on nanotechnology and the Friends of the Earth Australia Nanotechnology Project, visit the website <http://nano.foe.org.au/>.

See NEXUS 12/04–05 for our coverage of the ETC Group's report "Down on the Farm: The Impact of