NANOFOODS

Risks/Benefits

Nanotechnology is now in our food.
What are the health impacts?
How are nanofoods regulated?

"Current Food Policy and Risks/Benefits of Nanotechnology"

Darryl Benjamin
4 Isabel Circle, Montpelier VT 05602
Phone: 802.585.5855
Email: darryl@realfoodseminars.com

Terms:
Nanoparticles
Nanofood
Nanopackaging
Nanocapsules
Nanoemulsions
Nanosystems

Definition & Behavior

The theory behind nanotechnology is that by manipulating and assembling molecules and atoms—the building blocks of matter—scientists can create almost anything.

NANOSCIENCE

Nanoscience is the **study of phenomena and manipulation of materials** at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale.

NANOTECHNOLOGY

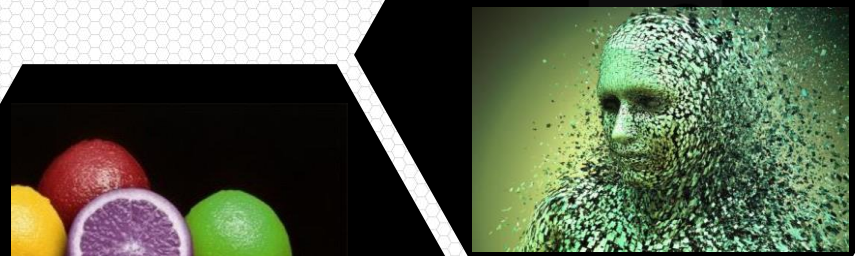
Nanotechnologies are the design, characterization, production and **application of structures, devices and systems** by controlling shape and size at nanometer scale.

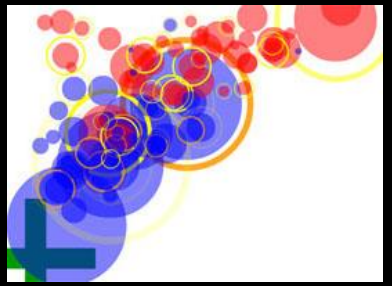
GMOs

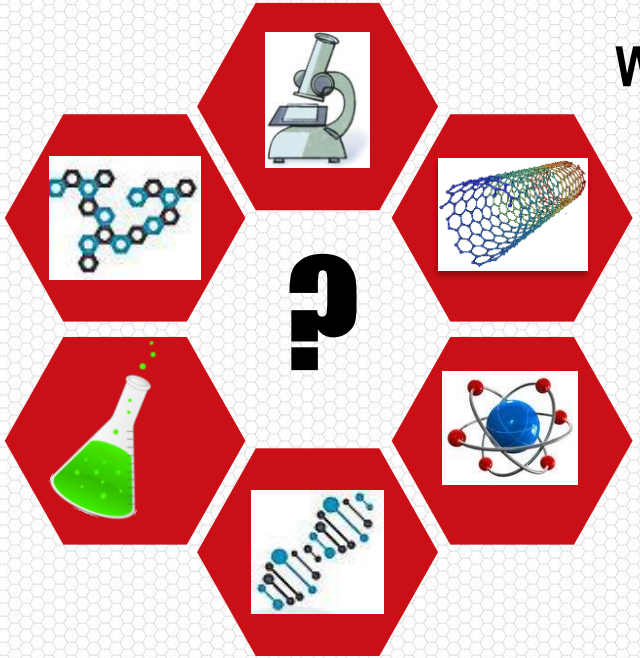
The technique of removing, modifying or **adding genes across species to a living organism** via genetic engineering. Also referred to as gene splicing, recombinant DNA (rDNA) technology or genetic engineering.

OVERVIEW

At the nano-scale, the laws of chemistry and physics work differently, and materials develop unique properties not seen at normal size. Opaque materials, such as copper and zinc, become transparent; stable materials, such as aluminum, become explosive; and solids, such as gold, turn into liquids.





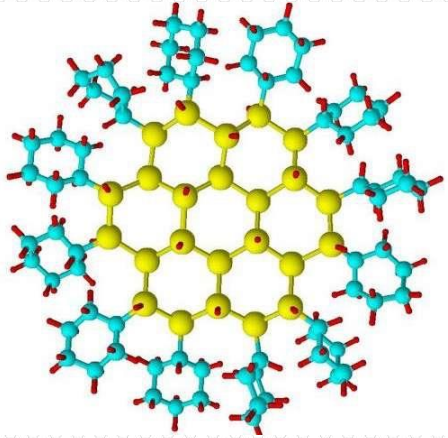


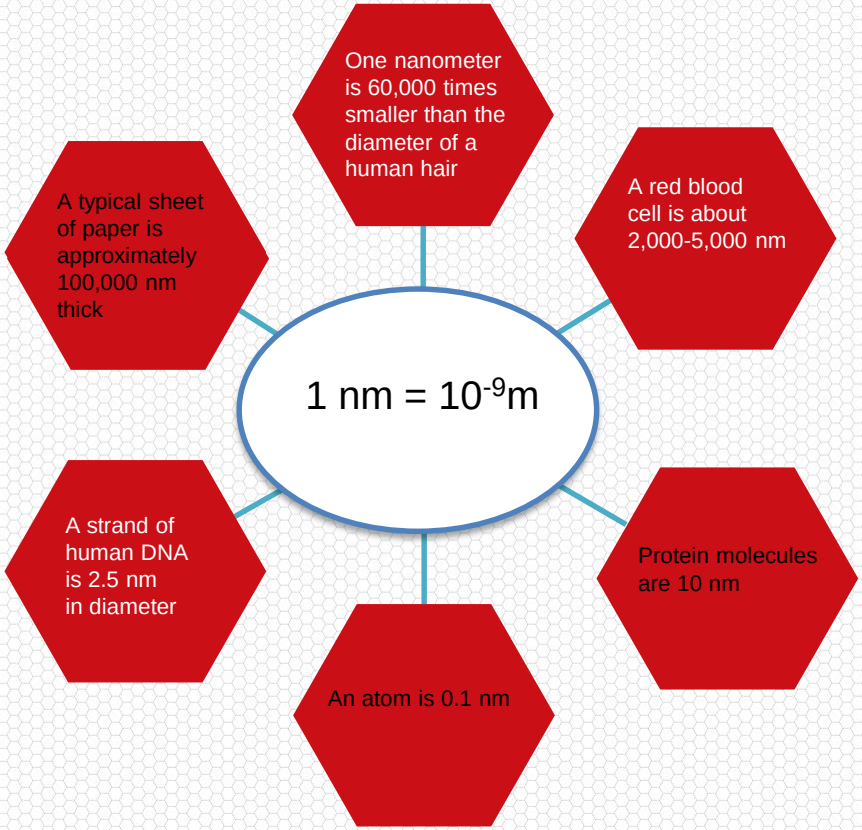
Why are food and agriculture companies interested in nanotechnology?

- Enabling soft drinks, ice cream, chocolate or chips to be marketed as “health” foods by **reducing fat, carbohydrate or calorie content or by increasing protein, fiber or vitamin content**;
- Producing **stronger flavorings, colorings, nutritional a**dditives and processing aids to increase the pace of manufacturing and to lower costs of ingredients and processing;
- Developing foods capable of **changing their color, flavor or nutritional properties** according to a person’s dietary needs, allergies or taste preferences;
- Packaging to **increase food shelf life by detecting spoilage, bacteria, or the loss of food nutrient**, and to release antimicrobials, flavors, colors or nutritional supplements in response;
- Reformulating on-farm inputs to produce **more potent fertilizers, plant growth treatments and pesticides** that respond to specific conditions or targets.

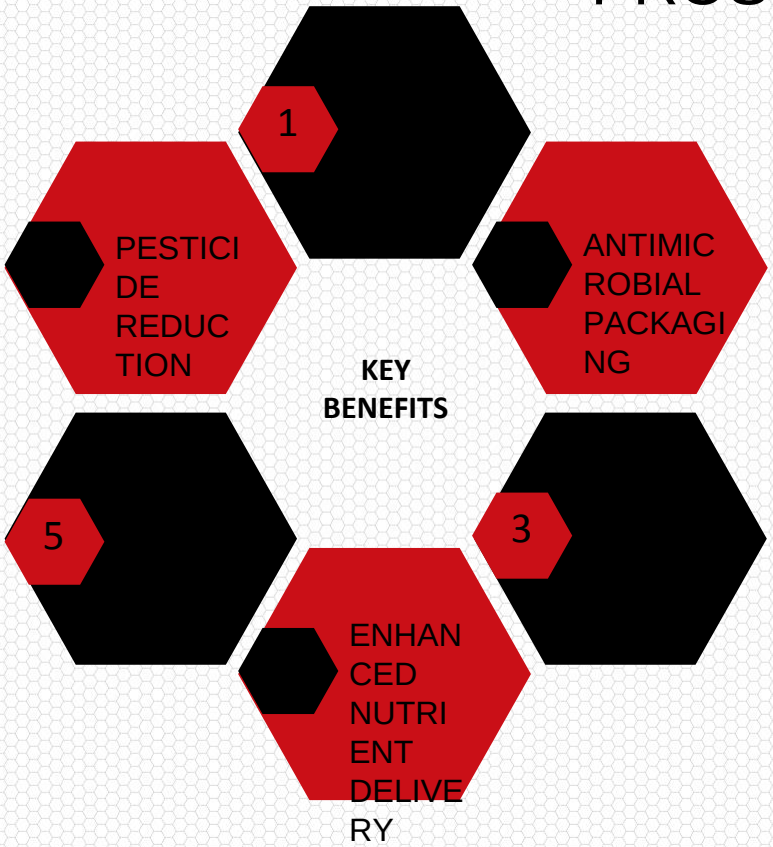
NANOPARTICLE SIZE

Nanoparticles are particles between 1 and 100 nanometers.





PROS: BENEFITS OF NANOFOODS

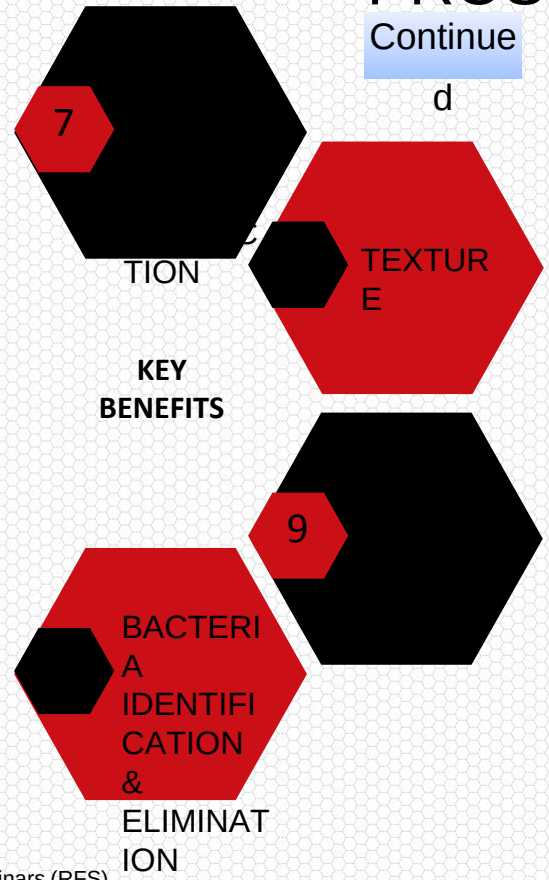


1. Immediately detect E. coli bacteria in a food sample; if Salmonella bacteria are present, the nano-sized dye particles become visible. No need to send out to the lab and wait days for culturing results with instantaneous sensors.
2. Edible food films that are able to kill certain E. coli; packaging made with nanoparticles of zinc, calcium, magnesium oxide and titanium dioxide — materials that are more cheaply sourced and safer than nano silver.
3. Nanoclays embedded in plastic bottles and nylon food films stiffen packaging and reduce gas permeability; the nano-enhanced barrier keeps oxygen-sensitive foods fresher and can reduce packaging costs for manufacturers.
4. Improves solubility of vitamins, antioxidants, healthy omega oil fractions and other nutrients; nano-nutrient particles are fully soluble and invisible in water and oil, widening the door for potential nutraceutical beverages.
5. Biodegradable bioplastics from the starch of organic, non-genetically modified corn; using chitin, the main component of lobstershells, Chitosan is dissolved using electrospinning in solvent and the solution is drawn through a tiny hole with applied electricity, a long, nano-slim fiber spins out from the hole. These strong and naturally antimicrobial nano fibers from a sustainable source can be developed into green food packaging.
6. A Cornell University team headed by textile scientist Margaret Frey developed a cloth farmers can use to reduce the amount of crop agrichemicals. Planted along with seeds, the cloth's saturated nano fibers slowly release pesticides and herbicides so that additional spraying of crops becomes unnecessary. The targeted release also eliminates chemical leaching into the water supply to benefit both consumers and the environment.

PROS Continued

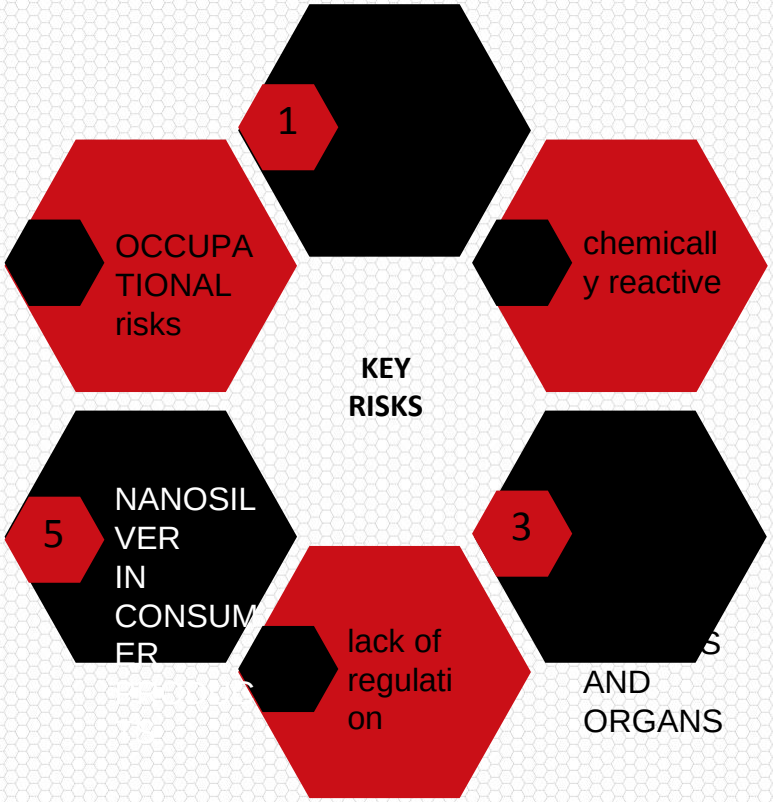
PROS: BENEFITS OF NANOFOODS

Continued



7. Nanobarcodes from nanoparticles that contain silver and gold stripes varying in width, length and amount, create billions of combinations to tag individual products; barcodes have been primarily used to assure brand and authenticity in pharmaceuticals; applications are forthcoming that trace food batches. Combined with pathogen sensors, the barcodes read by modified microscopes could trace sources of an outbreak.
8. Scaling down the size of food molecules to nano-sized crystals creates more particles for an overall greater surface area; food technologists say food spreadability and stability improve as a result of incorporating multiple emulsions — for example, a low-fat mayonnaise formulation provides a satisfying fatty mouth feel — extra stabilizers and thickeners aren't needed to achieve the desirable texture. The nano-emulsion could have its application in formulating other low-fat products.
9. Novel flavors such as cold and creamy based on a rethinking of how taste buds perceive flavor; researchers identified which individual cells on a given taste bud perceive a flavor. Each cell would recognize just one of the five main flavors — bitter, salty, sweet, sour and umami. a company has developed a **library of flavors**, including compounds called bitter blockers. These specialized molecules trick the tongue into not tasting the bitterness in foods such as cocoa or soy. (These bitter blockers as well as Senomyx's sweet and salty enhancers have already gotten the nod from Nestle and Coca Cola who are responding to consumer desires for packaged foods and beverages formulated with less salt and sugar.)
10. Chicken feed to remove campylobacter — feed enriched by nano carbohydrate particles binds with the bacterium's surface to remove it through the bird's feces; use in chickens might reduce the one million annual outbreaks of campylobacteriosis in Americans.

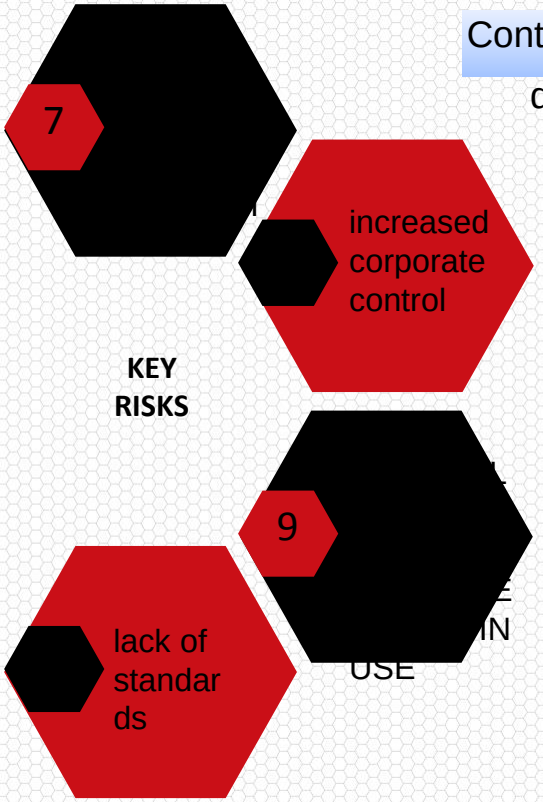
CONS: RISKS OF NANOFOODS



1. The tiny size of nanomaterials permit them to pass more easily through cell membranes and other biological barriers, allowing these particles to be easily taken up into organisms and cause cellular dysfunction.
2. Nanoparticles can be more chemically reactive and more bioactive than larger particles of the same chemicals. Greater bioactivity may introduce new toxicity risks.
3. Due to their very small size, nanoparticles also have much greater access to our bodies, so they are more likely than larger particles to enter cells, tissues and organs.
4. No nanotechnology-specific regulation or safety testing required before manufactured nanomaterials can be used in food, food packaging, or agricultural products.
5. Health experts have raised concerns that the widespread use of nano-silver in consumer products will further increase the problem of antibiotic-resistant superbugs.
6. In the food sector, workers may come into contact with nanomaterials during production, packaging, transport, distribution and waste disposal of food and agrochemicals. Studies have shown that nanomaterials can enter the bloodstream via the lungs (simply by inhaling), raising major occupational health and safety concerns.

CONS Continued

CONS: RISKS OF NANOFOODS



Continued

7. Nanotechnology appears likely to promote transport of fresh and processed foods over even greater distances.
8. Nanotechnology has the potential to further concentrate corporate control of global agriculture and food systems.
9. Nano-agrochemicals are now being used on farms and released into the environment, absent regulations that require product manufacturers to demonstrate the safety of new, more potent nanoscale formulations of existing chemicals.
10. The lack of standards and internationally recognized measurement methods, coupled with the shrouding of the nanotechnology industry and reinforced by the lack of regulation have created significant challenges to simply understanding where nanomaterials are being used and the reality of their interactions with the public and our environment.

NANOFOODS ON THE MARKET

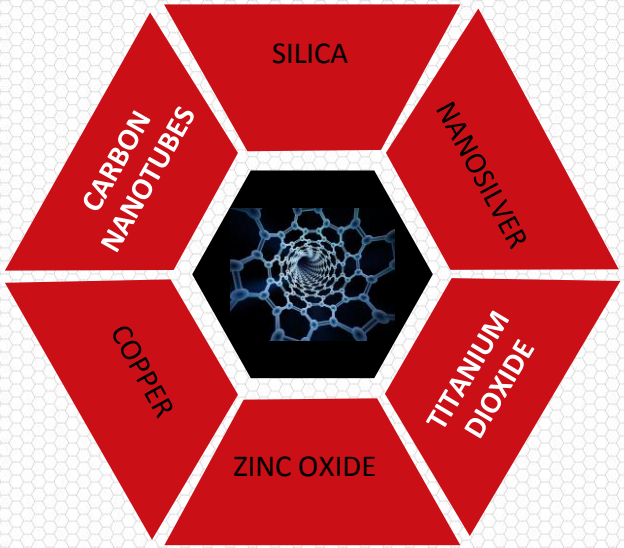
Table 1: A sample of food companies engaged in nanotechnology research and development

COMPANY	
• Altria (Mondelez)	• H.J. Heinz
• Associated British Foods	• Hershey Foods
• Ajinomoto	• La Doria
• BASF	• Maruha
• Cadbury Schweppes	• McCain Foods
• Campbell Soup	• Mars, Inc.
• Cargill	• Nestle
• DuPont Food Industry Solutions	• Northern Foods
• General Mills	• Nichirei
• Glaxo-SmithKline	• Nippon Suisan Kaisha
• Goodman Fielder	• PepsiCo
• Group Danone	• Sara Lee
• John Lust Group Plc	• Unilever
	• United Foods

Table 2: Food products that may contain manufactured nanomaterials

PRODUCTS	
• Almond beverages	• Milk
• Candy	• Mints
• Cereal	• Oils
• Chocolate	• Pasta
• Chocolate syrup	• Popcorn
• Coffee Creamer	• Pudding
• Cookies	• Rice beverages
• Crackers	• Salad Dressing
• Cream Cheese	• Soy
• Doughnuts	• Soy beverages
• Gum	• Sports Drinks and other beverages
• Mashed Potatoes	• Yogurt
• Mayonnaise	

NANOFOOD HEALTH CONCERNS



SILICA
- **"Trickle and flow"** aid in powdered food products, as a clearing agent in beer and wine, as a food additive and as a food coating;
- a significant percentage of the nanosilica remains undissolved and "the presence of **undissolved nanosilica particles in the gut** in vivo is considered likely."

NANOSILVER
- In the Woodrow Wilson inventory of nano products, silver is the most common nanomaterial mentioned in product descriptions. A recent court case in the United States found that the use of **nanosilver was "ubiquitous"** and that there was no way for consumers to avoid exposure.
- Food and food contact products containing nanosilver include **baby bottles, food containers, packaging, cutting boards, salad bowls, appliances, cutlery, ice trays, filtration devices and collapsible coolers.** In agriculture, it is used in poultry production and agricultural and aquacultural disinfectants.
- Health experts have also raised concerns that the widespread use of nanosilver in consumer products will **further increase the problem of antibiotic-resistant superbugs.**

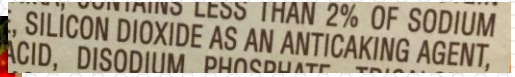
TITANIUM DIOXIDE
- A **whitener and brightener** in a range of food products.
- In contrast to bulk particles of titanium dioxide, nanoscale titanium dioxide is biologically very active. Studies show that titanium dioxide can damage DNA, disrupt the function of cells, interfere with the defense activities of immune cells and, **by adsorbing fragments of bacteria and "smuggling" them across the gastrointestinal tract,** can provoke inflammation.
- A single high oral dose of titanium dioxide nanoparticles was found to **cause significant lesions** in the kidneys and livers of female mice.
- A **possible carcinogen** if inhaled.

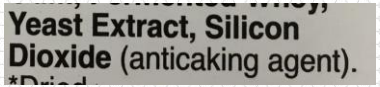
ZINC OXIDE (ZnO)
- **Surface coatings**.
- Nanoscale zinc oxide is **toxic when ingested** and has been found to **cause lesions in the liver, pancreas, heart and stomach**.

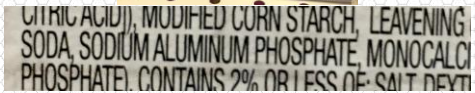
COPPER
- Dietary supplements.
- Nanoscale copper showed **adverse effects on the kidney, spleen and liver of mice**.

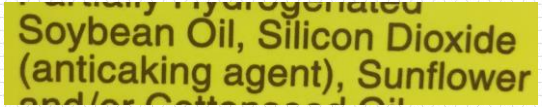
CARBON NANOTUBES
- While there are no confirmed commercial food and food contact products containing carbon nanotubes, food packaging and food sensors containing carbon nanotubes have been developed.
- Multi-walled carbon nanotubes "have been **shown to induce mesothelioma** in rodents."

In the Market Now. . .

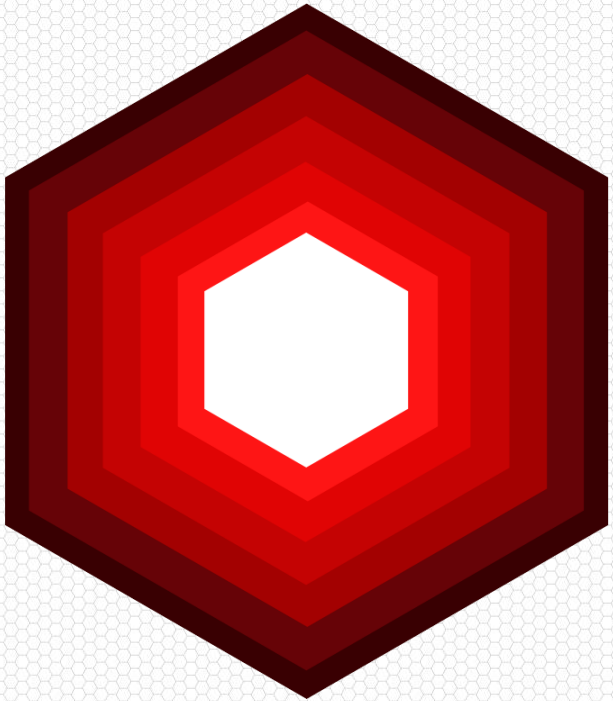








NANOFOOD REGULATORY GAPS



ACTION RECOMMENDATIONS

- MORATORIUM ON COMMERCIAL FOOD PRODUCTS
- **SIZE-BASED DEFINITION OF NANOMATERIALS EXTENDED**
- TRANSPARENCY IN SAFETY ASSESSMENTS
- PRODUCT LABELLING ESSENTIAL
- PUBLIC INVOLVEMENT IN DECISION-MAKING
- SUPPORT FOR SUSTAINABLE FOOD AND FARMING
- HOLD GOVERNMENT AND INDUSTRY TO ACCOUNT

“No Data, No Market”

REFERENCES

Tiny Ingredients, Big Risks: Nanomaterials Rapidly Entering Food and Farming by Friends of the Earth
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB0QFjAAahUKEwjm6bn0lfrHAhWLth4KHY0RCLc&url=http%3A%2F%2Fmedia-alliance.org%2Fdownloads%2FTinyIngredients_BigRisks.pdf&usg=AFQjCNFh5-g854R7eYSz7W8EF8cy6Lvh6g

Progress Review on the Coordinated Implementation of the National Nanotechnology Initiative 2011 Environmental, Health, and Safety Research Strategy
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=0CC0QFjACahUKEwiOrKL5lvrHAhVHGh4KHXxzDwE&url=https%3A%2F%2Fwww.nano.gov%2Fsites%2Fdefault%2Ffiles%2Fpub_resource%2Fnni_2011_ehs_research_strategy.pdf&usg=AFQjCNH7_uuFANGKyPYxxmVw_IB8wkQIGw

Guidance on the Risk Assessment of the Application of Nanoscience and Nanotechnologies in the Food and Feed Chain, On Request from the European Commission, Question No EFSA-Q-2009-00942, adopted on 6 April 2011.
http://www.efsa.europa.eu/en/supporting/pub/762e

NANOTECHNOLOGY: Improved Performance Information Needed for Environmental, Health, and Safety Research, United States Government Accountability Office
Report to the Chairman, Committee on Environment and Public Works,
U.S. Senate, May 2012
http://www.gao.gov/products/GAO-12-427