

Attitudes and Consumer Perception towards the Risks and Benefits of Additives in Food

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Additives in food

What determines consumer acceptance

Key questions

Whom do food additives benefit?

- *The food industry?*
- *The food consumer?*
- *Food security and the planet?*
- Are these applications perceived to be beneficial or risky by consumers? Or simply irrelevant?
- What about functional properties of food additives?
 - *Improved consumer health?*
 - *Reduced food waste?*



Differences between expert and consumer/citizen perceptions of risk

- **Experts**

- Rely on technical risk assessments
- Use scientific argumentation which does not take account of socio-economic impacts
- In theory, balance risk against benefits (but it is not always clear how socio-economic benefits, or even technical benefits, are assessed).



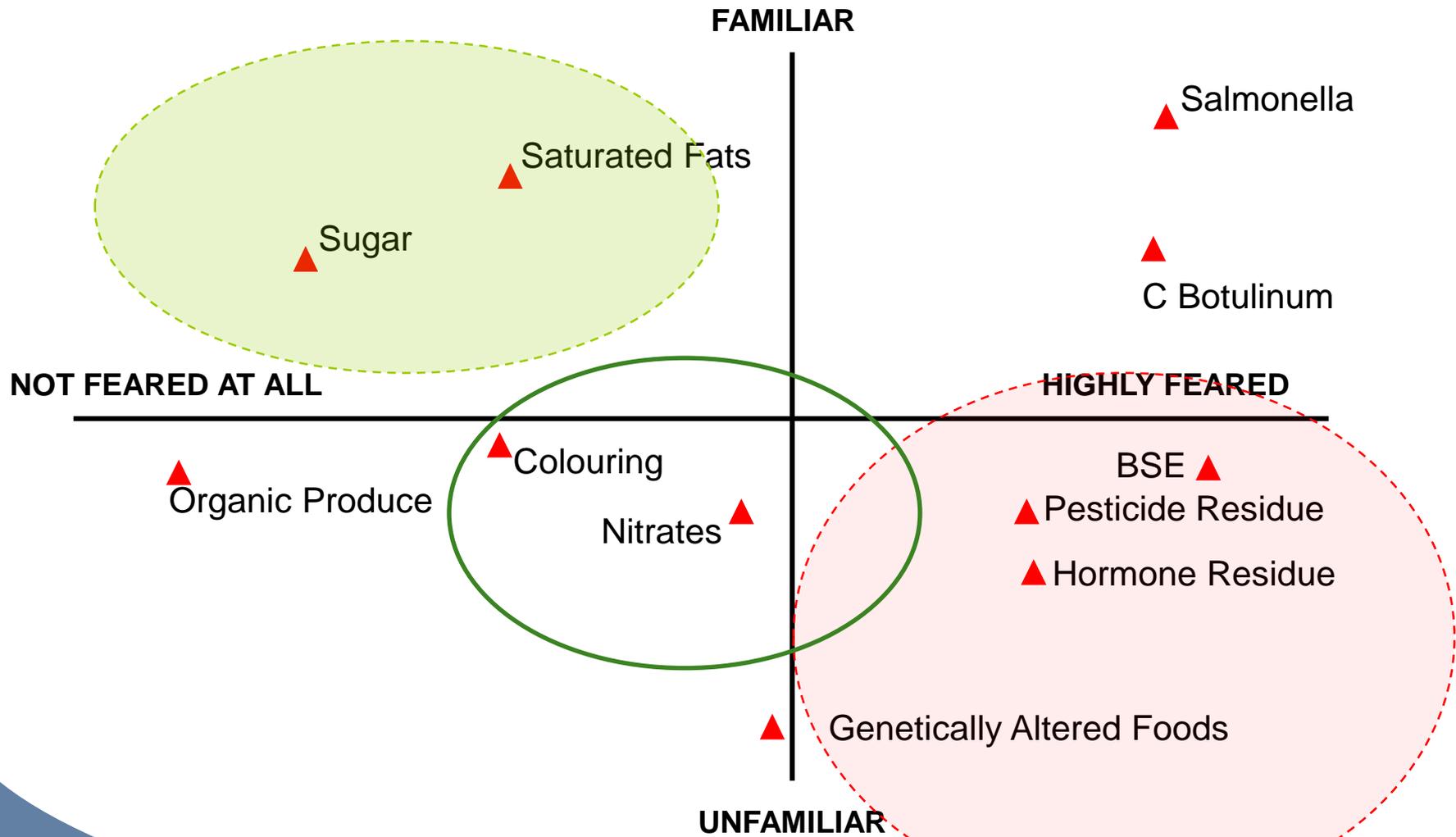
- **Public**

- Use their risk perceptions to make judgements about risk
- Require risk communication to take account of their concerns as well as technical risk estimates
- Emotional (or affective) responses are important.



Frewer et al, in press, *Critical Reviews in Food Science and Technology*

Assessing perceptions of food risks - Results of survey research



(Fife-Schaw and Rowe, 2000)

Risk Perception

- The psychology of risk perception drives public risk attitudes
*e.g. an **involuntary risk** over which people have no control is more threatening than one people choose to take*
 - Exposure to milk contaminated by melamine*
UNLABELLED food additives
- Potentially **catastrophic** risks concern people most
 - BSE in cattle and new variant CJD*
*Potentially **food additives**?*
- **Unnatural** (technological) risks are more threatening than natural ones
 - Food additives**
*Application of **food technology** to agrifood production*
Dioxin contamination of the food chain (e.g. In Belgium and in Ireland)
- **Ethical representations** and concerns are emerging as an important determinant of consumer decision making
 - Animal welfare,*
Environmental impact of agriculture
*Equity of distribution of **benefits and risks** of technological innovation*

Food additives and consumer perceptions

- Perceived personal benefits
 - Are there any?
- Perceived societal benefits (health, economic, social, environmental)
 - Are there any?
- Differential accrument of risks and benefits (fairness)
 - Benefits accrue to the manufacturer or retailer
- Ethical concerns
 - Fraud/ lack of consumer autonomy in case of (e.g.)Sudan 1
- Perceived personal risks
 - Health/carcinogenic properties,
 - Behaviour (in particular children)
- Perceived societal risks (health, economic, social, environmental) ??
- Perceived efficacy of regulatory framework
 - Recalls must be perceived to be efficient
- Trust (in regulators, Industry and science)
 - No fraudulent use by industry
 - Trust governments to prioritise consumer protection

The “Sudan I” global recall

“More than 350 food products have been taken off shop shelves after they were contaminated with an illegal food dye”

– BBC, 2005

- The Sudan I dye, linked to an increased risk of cancer, was in chilli powder used by Premier Foods to make a Worcester sauce used in other products.
- The Food Standards Agency has issued a warning advising people not to eat the products but said there was "no need to panic" because of the "very low risk".
- Used for colouring solvents, oils, waxes, petrol, and shoe and floor polishes.
- Not permitted in food in the UK, EU and Australia and New Zealand due to concerns that the dyes may be carcinogenic in animals
- Legal in other parts of the world
- Impacts on human health uncertain

Message

“All food additives are potentially dangerous”



“Chemicals in food”

- One incident, or category of incidents, signals that all chemicals and additives are bad...



Food colourings and children

- Tantrum-linked additives in 132 new products - 13 May 2007
- Health experts described the findings as "worrying" and called for the removal of unnecessary additives in all new food and drink products.

Prof Fergus Lowe - "It is common sense that if food and drink additives pose any risk at all to a child's health, they should not be used."

Any potential risk involving children's food is therefore perceived to be unacceptable

- The "Southampton six"



Food Additives Drug Children

By eliminating the chemical preservatives and coloring commonly found in processed foods, Dr. Ben Feingold, a San Francisco specialist, has learned that he can cure some kinds of hyperactivity — a nervous condition which makes a difficult to concentrate.

Hyperkinesia — or hyperactivity — is no small problem. Feingold cites a California study which estimates that in the past 10 to 12 years the incidence of hyperactivity and learning difficulties rose from 2% to an average of 20-25% and in some cases, 40% of the entire school population.

If initial studies prove correct, a synthetic-free diet may, for many children, become an alternative to present methods of drug treatment. Feingold estimates that as many as 80% of the several million children now given drugs like Ritalin (a behavior modifier), amphetamines (commonly known as "speed"), or tranquilizers to control their behavior may be able to stop simply by restricting their diets to natural foods.

Feingold points out that drug treatment is not a cure for hyperactivity, but only serves to mask the problem. And yet, he conservatively estimates that nationally at least two million of the approximately five million children labelled hyperactive are given drugs, but receive no other kind of therapy or treatment. One school official in Yolo County California says that nearly 16% of the children in his school are being given behavior modifying drugs.

In an adult, using Ritalin or amphetamines has the effect of making one more active. But in the case of hyperactive children, Ritalin seems to have the "paradoxical" reverse effect of slowing them down. The scientific explanation of this phenomenon is still conjectural, and some experts are now beginning to question whether the effect is in fact paradoxical.

These specialists point out that hyperactive children normally quiet down when put in stressful situations like visiting a doctor's office. Amphetamines and Ritalin, they hypothesize, could be putting the children under constant stress. Their ability to concentrate, however, might not have improved at all. And long term usage of stress-inducing drugs would have disastrous effects on the children's nervous system and general health.

Most hyperactive children, Feingold says, can probably be taken off drugs fairly quickly once they are on a careful diet. The problem is that it is nearly impossible to keep children away from the ubiquitous food additives. In one case, Feingold says, a child had been treated with Ritalin from the age of three and a half, and several years later he still couldn't calm down by himself. Two weeks after being

kept away from synthetic dyes and flavorings, his behavior became normal.

A few weeks after that, however, the boy was back in a hyperactive state. It turned out that he had eaten a donut with synthetic coloring. He again returned to normal, but then contracted a chest cold and needed medicine. Since there are almost no medicines for children without some form of artificial flavoring or dye, in treating the cold the child once more became uncontrollably hyperactive.

The nation's top food, drug and chemical corporations have developed synthetic additives into over a \$500 million a year business, churning out close to a billion pounds of them in 1970. Additives cut costs for the manufacturers: cakes that once needed eggs and butter need only tiny amounts of synthetic flavoring and coloring and emulsifier. Fruit juices no longer need fruit. And often the price of these "convenience foods" is more even though the cost of producing them is less.

Feingold describes an average child's breakfast as follows: a cereal "loaded with non-essential flavors and colors added to entice the child. A beverage, either chocolate or other drinks, most of which are rich with many artificial flavors and colors. Pancakes made from a mix, frozen waffles dyed with tartrazine, or frozen french toast."

Then the conscientious and concerned parent gives the child vitamins, usually chewable, which are also loaded with additives.

Editor's Note: This article, reprinted from the Syracuse SUN, is taken from an article written by William Dowell and distributed by Pacific News Service. Additional information was added by Liberation News Service.



THE DANGER LIST

Additive	Where used	Potential problems
E102 - tartrazine	Sweets, biscuits, mushy peas	Hyperactivity, asthma, rashes
E124 - ponceau 4R	Sweets, biscuits, drinks	Allergy, intolerance
E110 - sunset yellow	Sweets, ice cream, drinks	Gastric upset, allergy
E122 - carmoisine	Biscuits, jelly, sweets, ready meals	Allergy, intolerance
E104 - quinoline yellow	Sweets, smoked haddock, pickles	Hyperactivity, asthma, rashes.
E129 - allura red	Soft drinks, cocktail sausages	Some evidence of hypersensitivity
E211 - sodium benzoate	Soft drinks, baked goods, lollies	Hyperactivity; asthma

CHEMICALS UNDER THE MICROSCOPE

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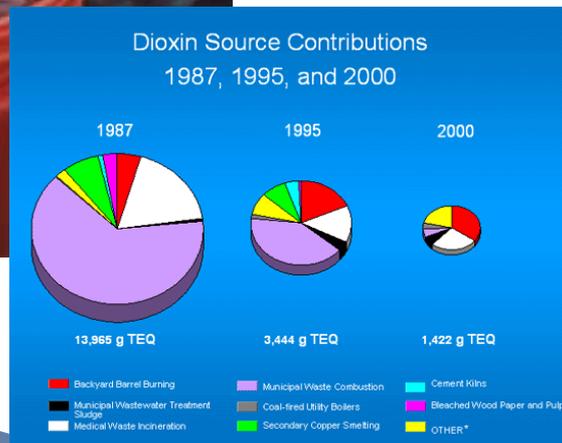
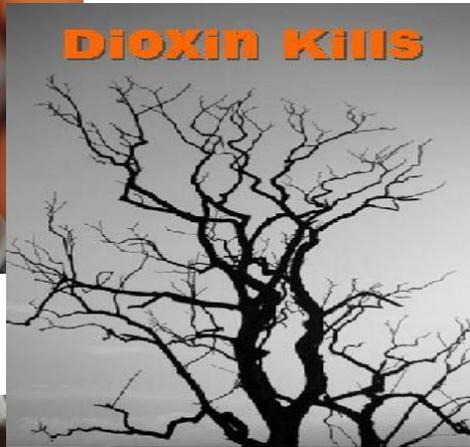
Incidents of *chemical contamination* also linked *perceptually* to food additives



Dioxins in the environment

Table 1. Documented Dioxin Contamination Incidents

- 1930s-onward Dow Chemical, Michigan
- 1962-1971 Operation Ranch Hand, Vietnam
- 1976 Factory emission, Seveso, Italy
- 1996 SE contamination of broiler flocks with ball clay added to soybean meal as an anti-caking agent, U.S.
- 1998 Milk contamination from citrus pulp imported from Brazil, EU
- 1999 Animal feed contamination with recycled industrial oil, Belgium and adjoining countries
- 2007 Guar gum from India in prepared foods, EU
- 2008 Contamination of hog feed with an ingredient containing industrial oil waste, Ireland



Wattagnett.com, 2012

Recent dioxin-related food safety issues

- Belgium (poultry feed supply chain 1999)



- Ireland (pig feed supply chain 2008)



- Germany (animal feed supply chain 2011)



Harles und Jentzsch plant in northern Germany

Attitudes to additives and sweeteners in SE Asia

The views of experts

- Obesity is becoming problematic in the SE Asia Region
- What do Malaysian experts (nutrition and industry) think about use of artificial sweeteners?

Amin, Hashim, Chan, Ngee, Richards, and Frewer (2015, and in preparation).



RESPONDENTS

CATEGORY	OPINION LEADER*	n
EXPERT	FOOD SCIENTISTS / TECH.	65
	NUTRITIONISTS / DIETITIANS	57
	HEALTH COMMUNICATORS	34
	TOTAL	156
ORGANIZATION	ACADEMIC / RESEARCH	56
	FOOD INDUSTRIES	25
	FOOD SAFETY & REGULATORY	28
	PUBLIC HEALTH AGENCY	47
	TOTAL	156

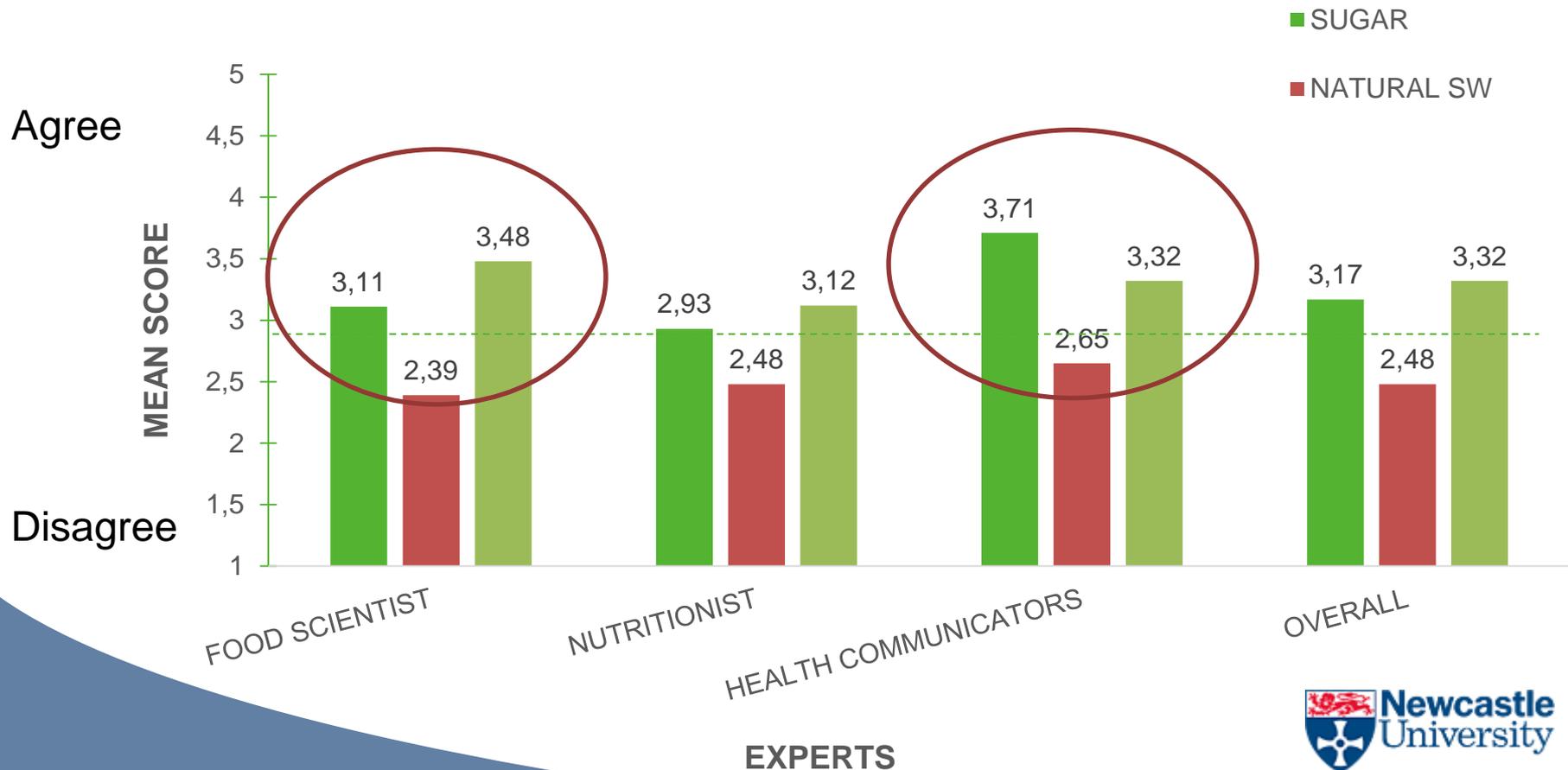
The use of the following sweeteners in food and beverage products is **beneficial** for human health



The use of the following sweeteners in food and beverage products is beneficial for human health



The use of the following sweeteners in food and beverage products is harmful to human health



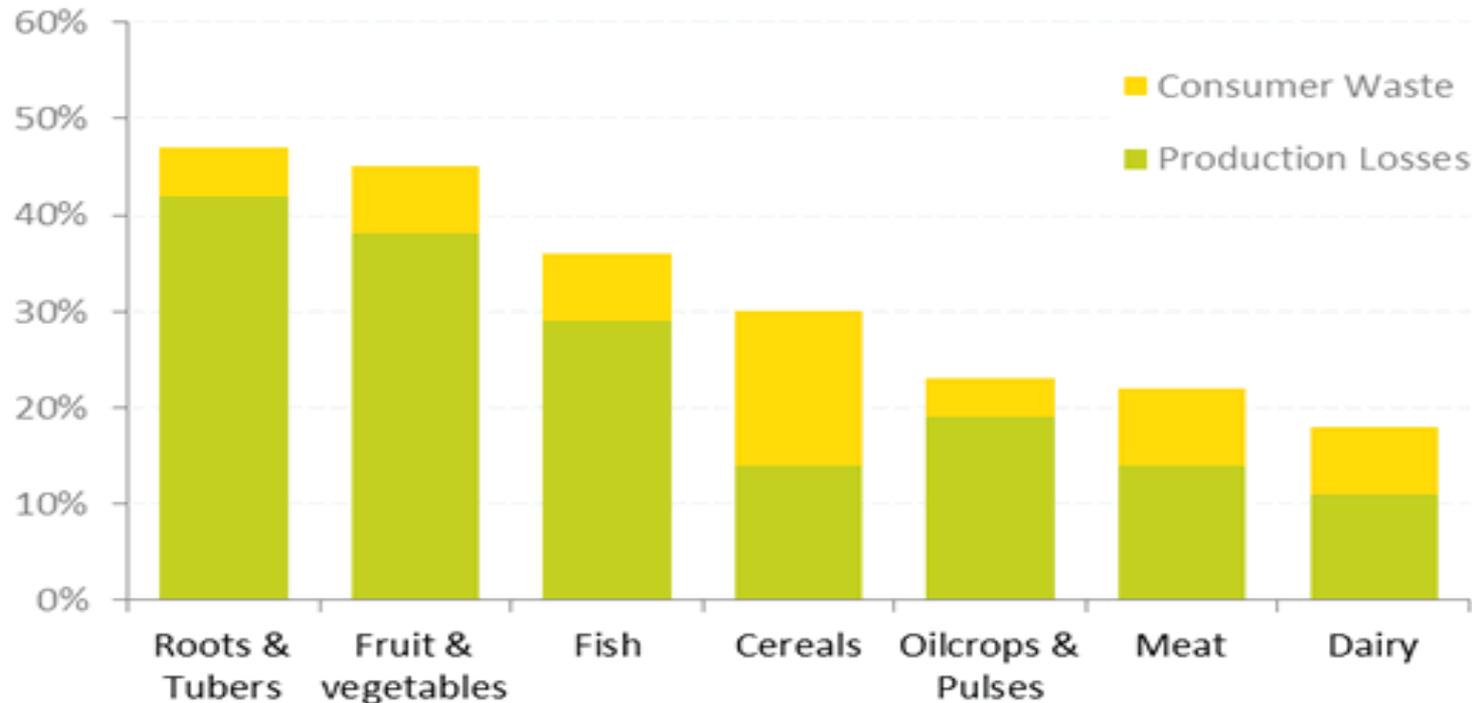
- Overall, all groups of respondents perceived natural intense sweeteners as the **least harmful** compared to sugar and **artificial intense sweeteners**
- All organizations and experts believed that **artificial intense sweeteners** were the most harmful, except Health Communicators and Public Health Agency who claim Sugar as the most harmful
- Are the risks perceived by Malaysian opinion leaders associated artificial sweeteners ***outweighing the potential benefits to health?***



- Are the perceived risks of artificial sweeteners outweighing the benefits?

Global food waste estimates

Food losses and food waste (share of total supply)



Note: Consumer waste is the share of total edible food supply discarded at household level. Production losses are a combination of losses from harvest, storage, handling, transportation, processing, distribution and spoilage at retail level. Production losses account for 25% of global food supply, while consumer waste is around 10%.

Source: Gustavsson et al (2011), FAO

What about additives as a food preservative?

- The problem of food waste...



Consumer waste in the UK

- UK – estimates around 30%
- Waste exists throughout the supply system
 - Retailer behaviours
 - Rejection of non-uniform food and vegetables
 - Two for one offers (mix offerings!)
 - Do consumers really want uniform vegetables or discounted bulk buys?



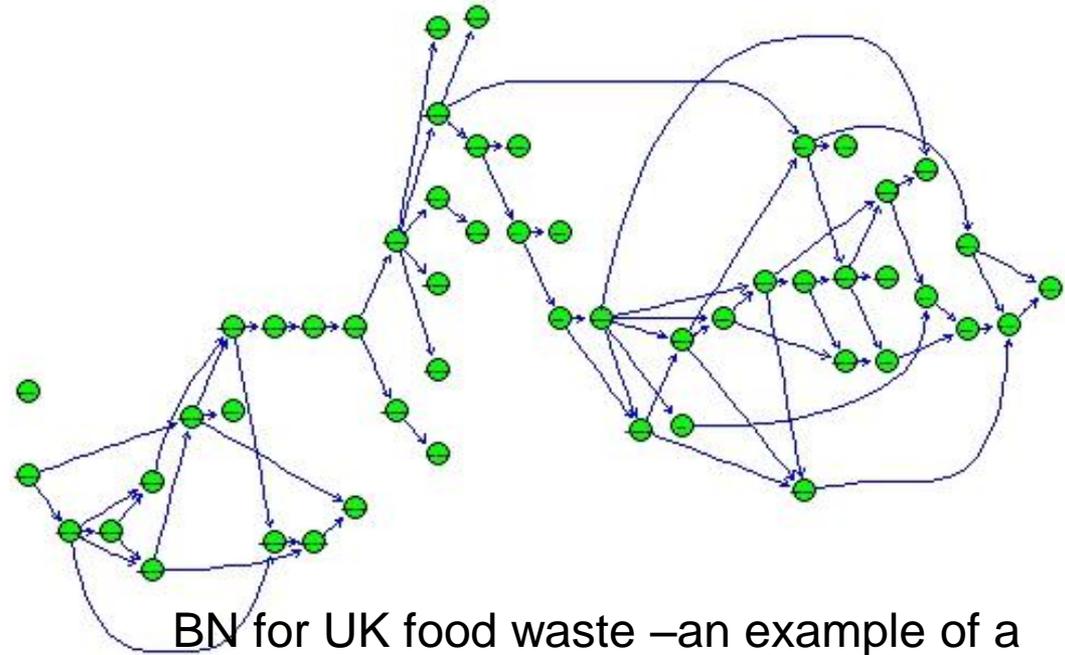
Understanding the drivers of food waste

- Machine learnt systems models (Bayesian Networks) applied to identify variables with the largest effect on food waste.
- Two different datasets
 - wide geographic focus (EU Barometer 388) with self-reported food waste
 - narrow geographic focus (WRAPs compositional analysis, England and Wales) *including* objective measure of food waste (weight of avoidable food waste).
 - Networks were “learnt” using the Hill-climbing algorithm in the R package “Bnlearn”.
 - This process finds the most parsimonious structure based on relationships between variables.

Grainger et al. (in prep) The use of decision analytical systems models to identify drivers of food waste

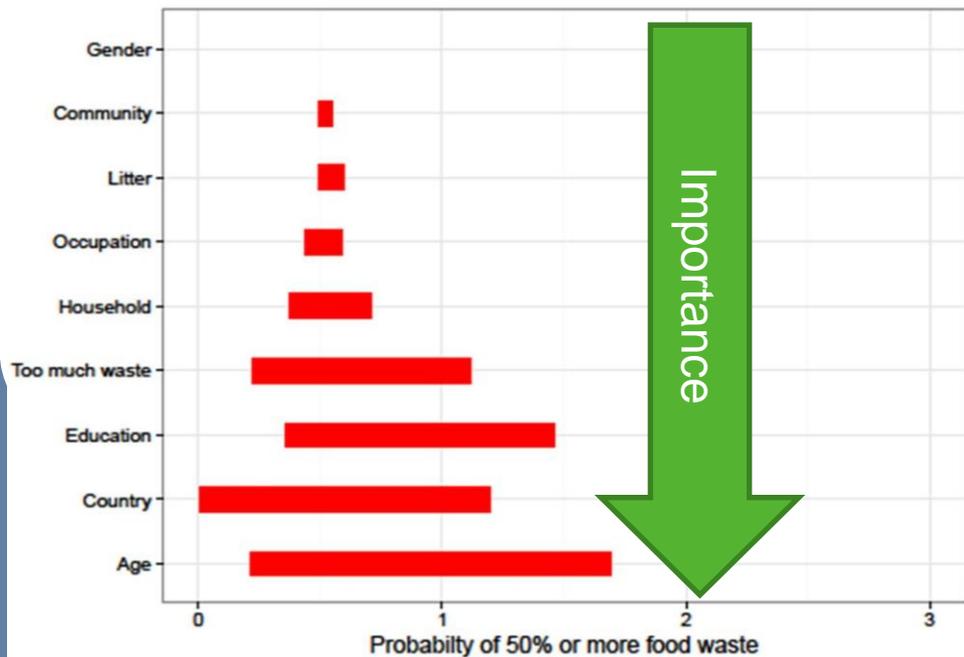
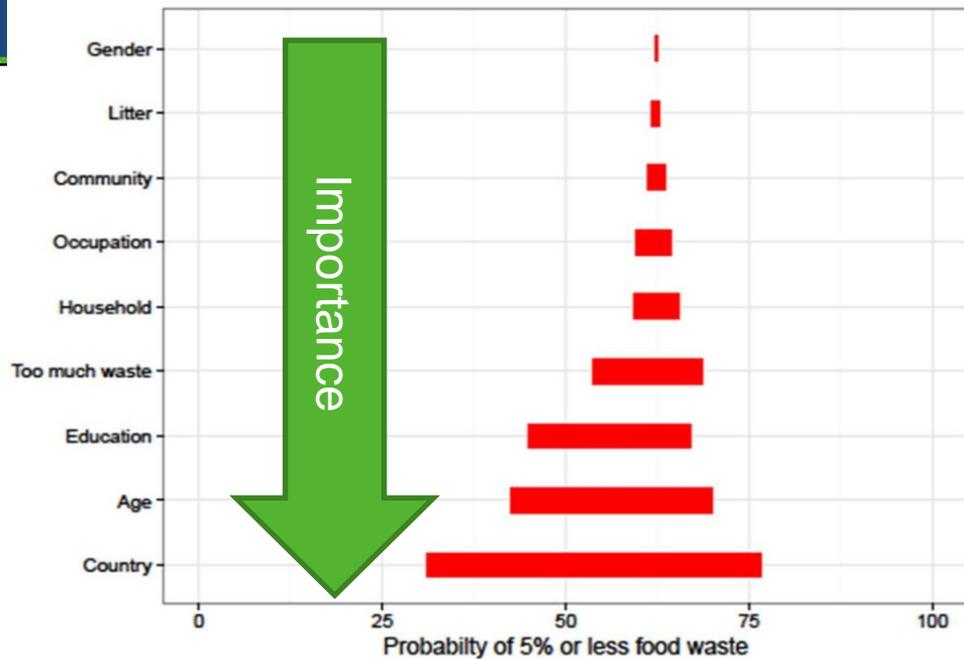
Using systems models to identify drivers of food waste

- EU food waste
 - EU Flash Barometer 388
 - Self-reported food waste (n = 26595 European citizens)
- UK food waste
 - WRAP compositional analysis
 - Weight of waste collected from the kerbside (n = 1746 households)



BN for UK food waste –an example of a complex system model

Drivers of EU food waste



- High (50% or more) and low (5% or less) waste driven by country, age and education of respondent
- Gender and community type (rural or urban) had little effect

Grainger et al. (in prep) The use of decision analytical systems models to identify drivers of food waste

Who wastes most food?

- Variability in EU food waste (self reported) is driven by country-level differences in food waste reporting and by age.
 - **Young people** waste more than people over 65.
 - **Families** waste more than single people
 - **Students** waste more than other employment status
 - People with more **frequent rubbish collection** waste more
 - Gender and community (rural, semi-urban or urban) made very little difference to the probability of wasting a high (greater than 50% of food purchased) or low (less than 5%) amount of food.



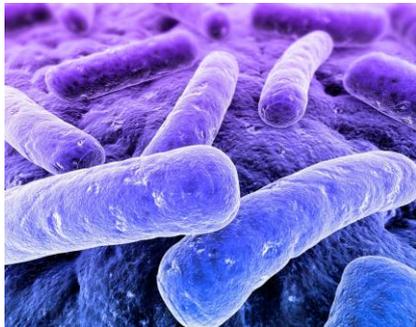
Drivers of UK food waste

- Household size drives UK food waste
 - Larger households (greater than 3 people) had a higher probability of wasting more. Two or fewer people in a household had higher probability of wasting less.
 - There was a higher probability of wasting more if the general waste stream was not utilised (home composting).
 - More frequent rubbish collection increased wastage
 - The presence of “fussy eaters” and discarding whole meals (both associated with families) leads to greater food waste



Potential policy conflicts (1)

- **Food safety *versus* sustainability and reduced waste**
 - Keeping food longer
 - Storage in domestic environment
 - Microbiological contamination
 - Aflatoxins
- Additional communication required about the benefits of appropriate food storage and preparation practices?
 - **Good BUT may encourage waste**

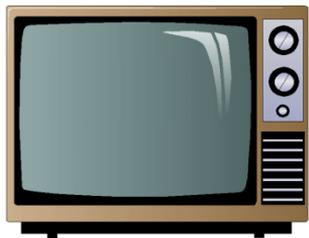


- Will consumers revisit food additives as food waste (and hence food security) becomes a greater consumer concern?
- Depends on the effectiveness of risk-benefit communication
- Link to technological innovation (e.g. better preservation)

A systematic review of the food risk communication literature

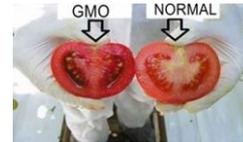
We are not that good at risk –benefit communication about food issues

- Fifty four papers identified
- Certain food issues were of greater interest to researchers (and *research sponsors*) than others
 - reflecting the occurrence of a crisis, or policy concern.
- Three broad themes relevant to the development of best practice in risk (benefit) communication identified
 - **The characteristics of the target population (CONCERNS)**
 - **The contents of the information (ACCURACY)**
 - **The characteristics of the information sources (TRUST)**

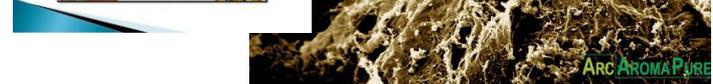


Technological interventions

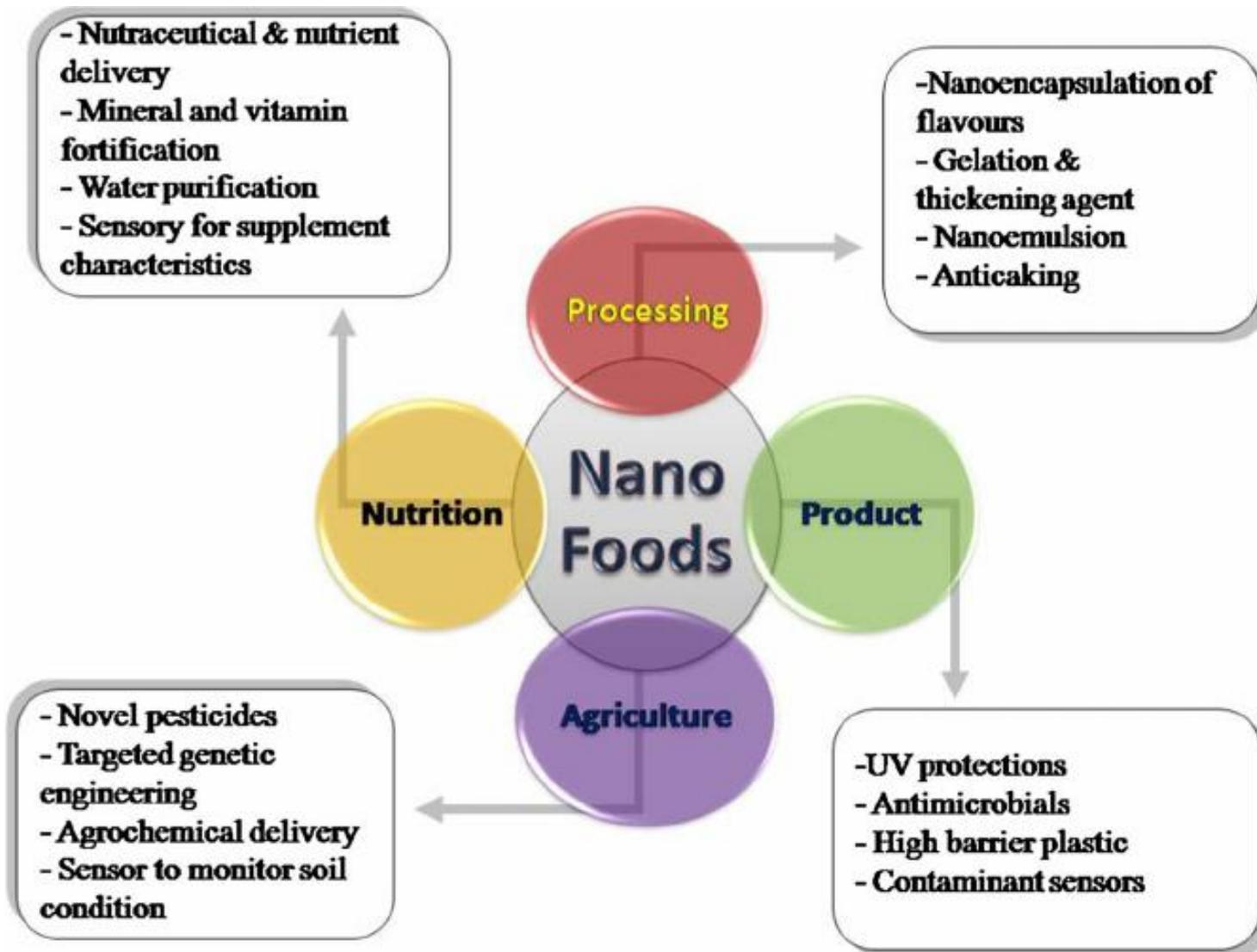
- Changing the food to increase shelf life or processing qualities (e.g. GM, food additives)
- Nanotechnology (e.g. Nanosilver, Nanofilters)
- Novel preservation techniques (e.g. Food irradiation or Pulsed Electric Fields)
- Smart fridges and ICT in the home
 - Cost and social exclusion?



PRESERVATION PROCESS



New technologies will only reduce food waste if they are accepted by consumers



Technology adoption

How does risk perception influence societal acceptance of novel and potentially beneficial emerging technologies related to food additives?

Is effective risk-benefit communication the answer?



“Soil Association bans nanomaterials from organic products (Guardian January 2008)



**Protest against Minatec,
Grenoble, France**



**Anti-nanotechnology
protesters, Chicago**



Expert opinion- what will determine societal acceptance of nanotechnology?

- Repgrid interview
 - Stage 1: Construct elicitation
 - 3 applications of nanotechnology at a time (total 10 triadic combinations)
 - “which 2 applications of nanotechnology you find similar and why, in terms of societal response”
 - “why is the third application different from the other two in terms of societal response”
 - Stage 2: Rating the constructs
 - Rate each of the applications on each elicited construct
 - Each expert - a grid with rating of constructs on all applications
- Analysis
 - Grids were combined and submitted to GPA and PCA (Promax)
 - GPA group average perceptual map – relative positions of the applications

Results

Concern

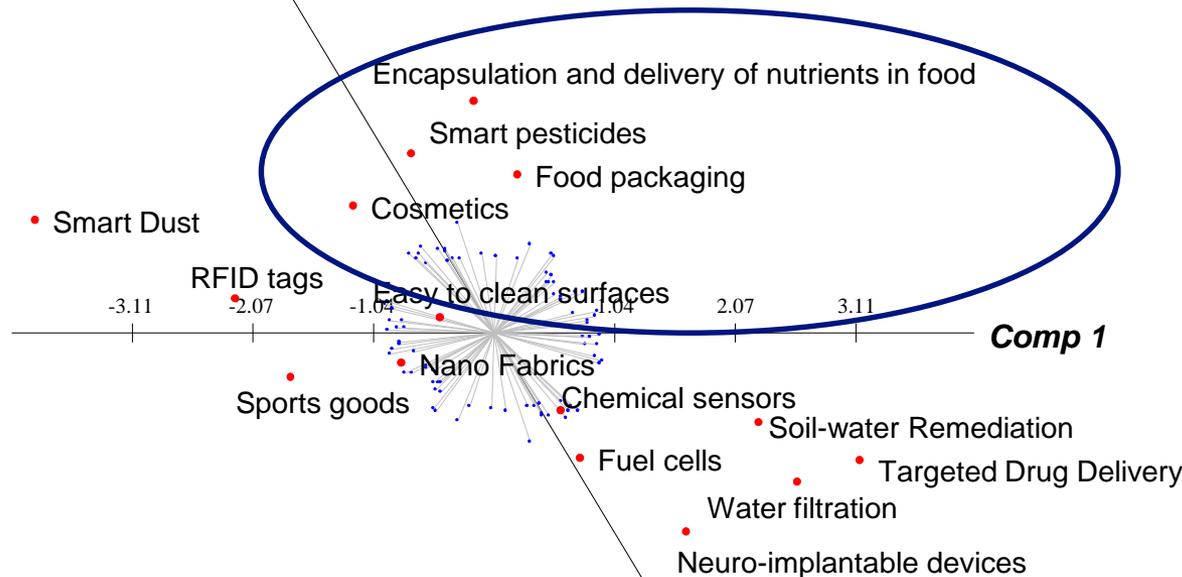
Can be misused / abused

Issue of whether benefits accrue to producer or public

Comp 2

Risk

Environmental
No benefits to
developing world
Less acceptable
to society
Ethical issues



Social Benefits

Socioeconomic
Environmental
Human health
Acceptable to
society

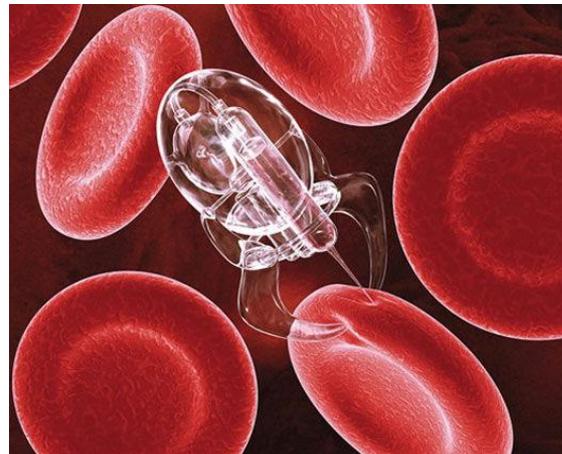
No Concern

Necessary
useful

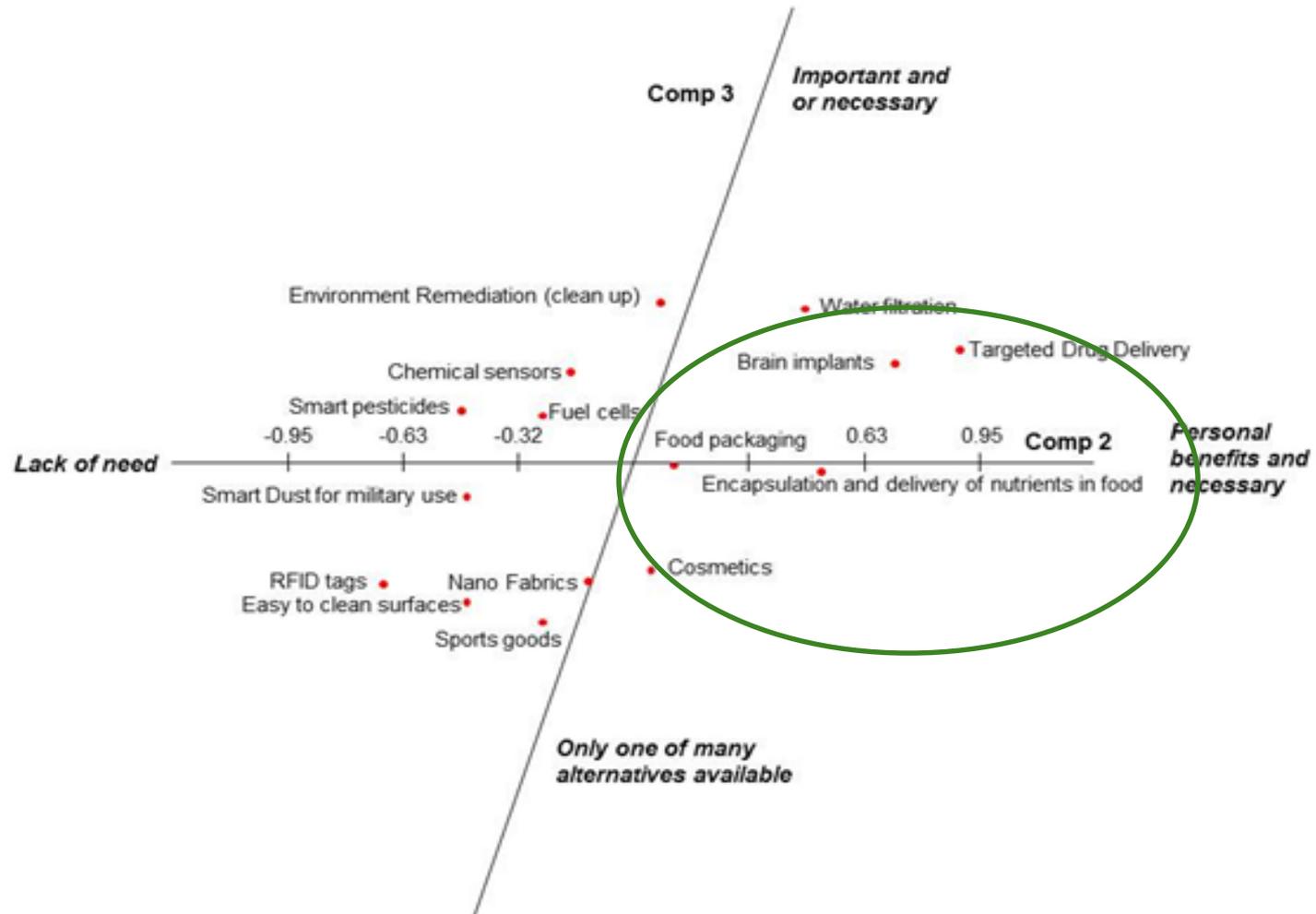
Conclusions – expert perceptions

- Perceived need will major determinant of societal acceptance
- Social benefits and risks
 - Societal risk and concern
 - Physical proximity of application to end-user
- Food not seen as a priority development
- (Perceived) benefit an important determinant of acceptance

Consumer views about which nanotechnology applications will be accepted by society



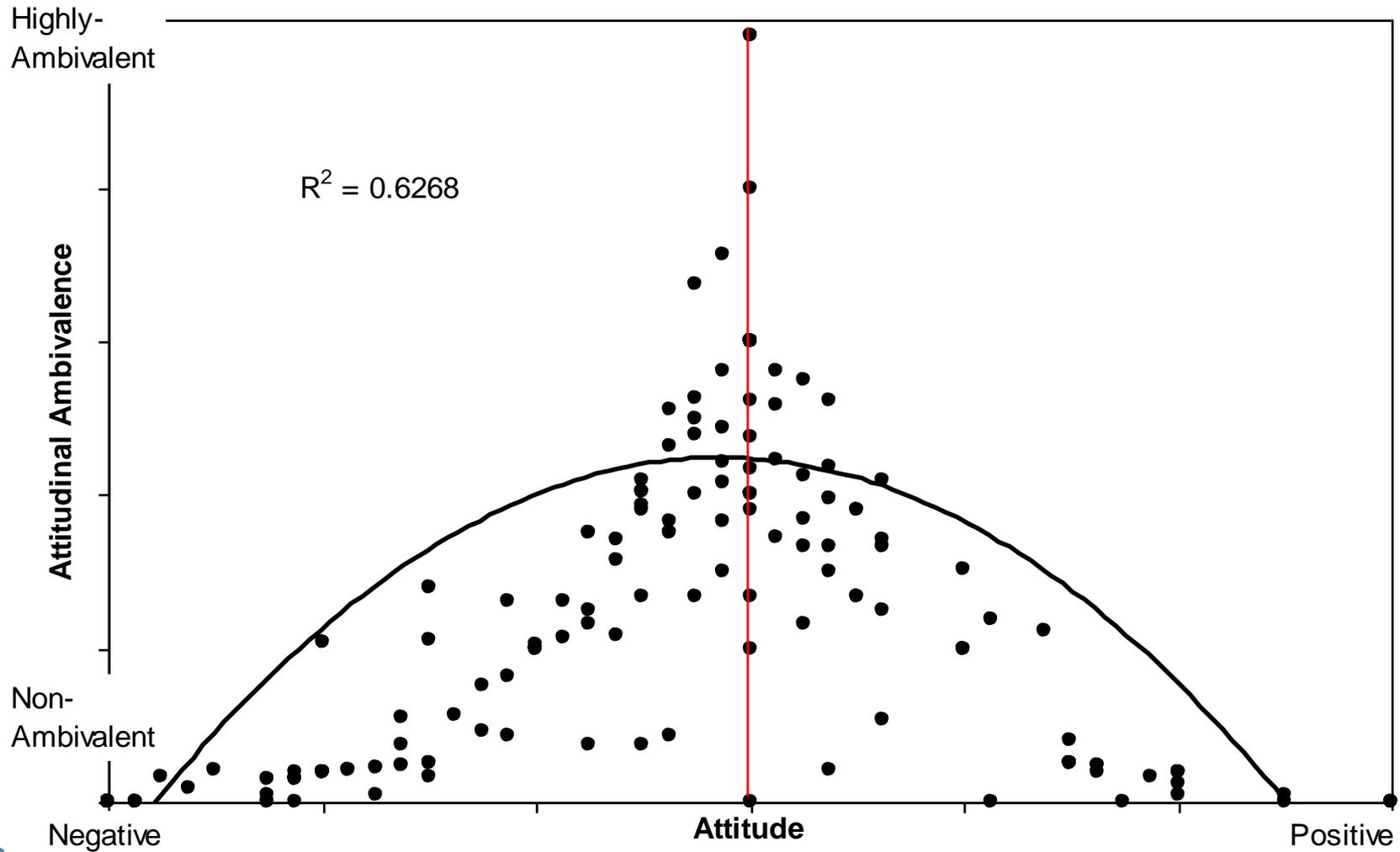
What do consumers think?



Gupta, N. (2013) The views of experts and the public regarding societal preferences for innovation in nanotechnology. Wageningen University press, Wageningen).

How are attitudes towards nanotechnology
distributed *post risk-benefit information
provision?*

Inverse U-shape relation between attitude and attitudinal ambivalence



Individual differences in attitude

Three “segments” of consumers

- *Group 1 (42%) became more negative*
 - *Less / average education*
- *Group 2 (46 %) didn't change but became MORE ambivalent*
 - *Less / average education*
- *Group 3 (12%) became more positive*
 - *Younger or older*
 - *Male*
 - *Highly educated*

- Food irradiation



This is what we're up against. Sigh.

- Food nanotechnology



- Pulsed electric field



Consumers perceptions of food technologies in general, and food additives in particular

- Will Perceptions of RISK, BENEFIT or MORAL CONCERNS drive consumer acceptance or rejection of novel food technologies?
- **Communication MUST address consumer concerns as well as technical risk issues**
 - Concerns about *animal welfare*, and **potential environmental impacts**
 - ***Economic functioning of households***



Innovating the food chain: introducing co-production of technological innovation

**Risk/benefit communication:
Protecting the public from risk and delivering societal benefits**

Harnessing food technology to improve publically acceptable public health policies

Developing interventions to make reduced food waste choices the easy ones

Assuring equity of access to innovation for ALL consumers

From farm....



...to fork

Societal/consumer inputs into the design of agri-food technologies and products

Knowledge exchange and public participation regarding food technology innovation processes

Improving food security by tackling societal and environmental drivers simultaneously across the entire food chain



Using food additives to improve food security

- Improving food security may introduce policy conflict (e.g. between reduced waste and food safety or optimal nutrition)
- Policies must consider both technological innovation AND consumer behaviour
- Technological innovations are acceptable to consumers if their design and outcomes align with *their* priorities
 - Concerns need to be addressed in innovation trajectories
 - Ethical, emotional economic or related to social structures?
 - Communication about benefits and risks
 - “Co-production” of innovations and technologies
- Each consumer is located in a different social environment
 - Needs to be taken into account as part of the process of technological innovation addressing food additives and their purpose
 - Consumer health
 - Reduced food waste

Key results

- Research focused on GM applied to crops or general agrifood applications of GM, rather than public acceptance of GM animals.
- **Consumers intention to use the products of GM**
 - animals were lower than for plants or for GM applications in general.
- **Europeans** expressed *lower intentions* to purchase the products GM organisms compared to ***SE Asia and North America***.
- No differences were observed with **time** in any region.
- Similar results were observed for **overall attitude** towards GM

Frewer et al, in press



SAFE FOODS Risk Analysis Framework

