Science & Technology
FORESIGHT
from society to research

Background Document

"Nano for sustainable food"

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WG FOOD

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A Logical Framework to support DISCUSSION

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1. Introduction

The National Research Council (CNR) and the Trieste Area Science Park Consortium (AREA), with the support of the Ministry of Education, University and Research (MIUR), launched the *Science and Technology Foresight Project (STFP)* to strengthen the development of new technologies in the medium to long term to deal with important problems related to health, food, environment, energy, transportation, safety and security. This initiative is motivated by the need to develop new strategic directions.

A key aspect of the project is the involvement of scientists and experts from academia, government and the private sector, using a bottom-up approach to collective intelligence. It differs from the methods traditionally used by foresight institutions/bodies because it allows each expert involved to make his or her knowledge available to others, in a reciprocal way, developing a systemic, collective and integrated vision, essential in dealing with complexity. A series of "face-to-face" (F2F) workshops, each of them with its own focus on different, but correlated, sub-topics are being organized. Participants in the workshops will be able to share knowledge, to identify gaps in knowledge, to point out obstacles, to identify needs for more and better education as well as for more funding, and to outline market potential and social acceptability for activities and products.

One of the four S&T topics on which the STFP is concentrating its efforts is Food (http://foresight.cnr.it). In particular, "**Sustainability**" as the main challenge and "**Nanotechnology**" as the key enabling technology have been identified.

2. Problems and challenges

Food is a necessity for everyone and this fact makes every single one of us a stakeholder in this important sector. The implications of food availability and food quality are enormous and extend from health and wellbeing to development and the economy. While demand for food may increase by 70% by 2050, 60% of the world's major ecosystems that help produce these resources have already been degraded or are used unsustainably [1].

In Europe the food industry is the largest manufacturing sector and the leading employer. However, it generates only 2% of added value and it is responsible for only 0.37% of research expenditures [2] (EU-Report Food Security and Bio-based Economy). It has been recognized that a <u>new wave of innovation will be required to allow the economy to create more with less</u>. Food is an area where publicly-funded research

could make a difference but where the introduction of new technologies has been challenging. The need for improved innovation is present throughout the <u>food supply chain</u>, from production to packaging and distribution. In fact all aspects, starting from the choice of raw material to processing and preservation, as well as all environmental and technological factors involved in the food chain should be addressed. In addition, the food industry needs to take into account of the needs of consumers, which extend from food perception and pleasure to safety, nutrient bioavailability, health and nutrition.

Sustainability is the key issue for future development of global society. Research and Innovation, as well as the Political System, and Consumer behavior, may have a decisive role to make Sustainability at the heart of national and international development policies.
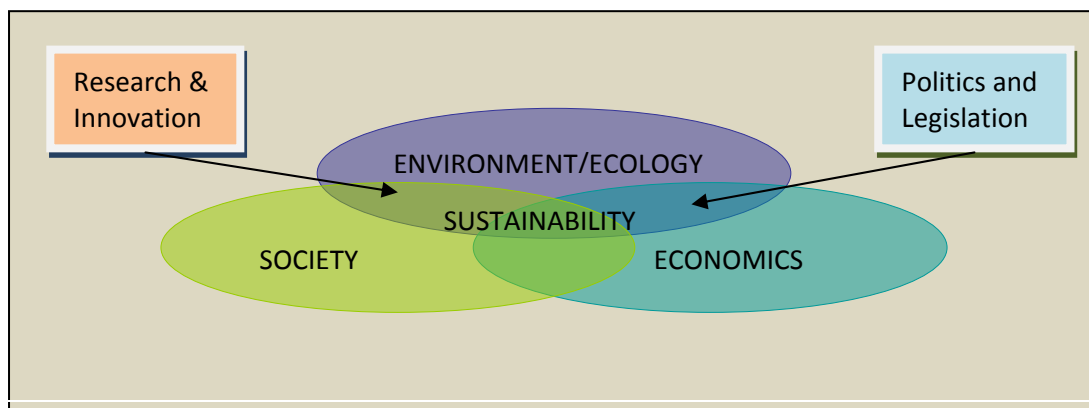

SUSTAINABILITY is an economic, social, and ecological concept. A sustainable food system is one that meets the economic and social needs of the present while minimizing the impact on the environment, and without compromising the ability of future generations to meet their own needs.

It addresses all main **societal challenges** within the area Food:

- **Food Availability and Security**
- **Food Safety**
- **Nutrition** and **Health**
- **Climate Change**
- **Environment** (Biodiversity and Ecosystem)

Furthermore, **sustainability** should be a major goal within all **macro application areas**:

| Consumption | Packaging, Distribution and Storage | Processing | Agriculture |
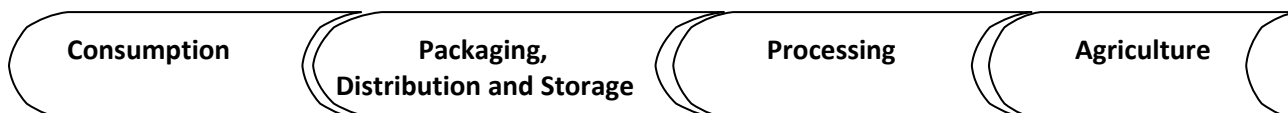
R&I - NANO

Within all identified **application areas** of the food chain, **Nanotechnology** is a key enabling technology, which could have a strong impact on scientific innovation, economy and society, including industrial competitiveness, creation of wealth and quality of life. The application of nanotechnology to the food sector has yet to be exploited. Compared to other areas such as medicine and energy, even research in this field has lagged behind. One reason for the lack of development could be the reluctance to address social

and economic issues connected to the application of nanotechnologies in this sector. This attitude however, will only hamper progress.

The **Impact** would be on: - **Health** (Protection, Prevention)
    - **Bio-economy** (Food, Energy, Water, Land, Waste)
    - **Security**
    - **Safety**

The successful development and the application of nanotechnology in the food sector are based on certain conditions. One of them is a generally accepted basic definition of the term "**nano**" referring to nanotechnology, nanomaterial, nano-objects, nanoparticles etc.

In October 2011 the EU issued a recommendation[3] on the definition of nanomaterial but in the era of globalization an internationally accepted definition would be necessary, especially for the appropriate assessment and management of risk.

Another essential factor is the development of **Enabling Technologies** as well as the transfer of knowledge from **Converging Technologies**. In particular all technologies which allow analysis and imaging as well as biotechnologies (sensors, delivery, nutrients), material science (packaging, processing) and ICT (tracing, tracking, design of functional/personal food) will be essential to promote the advancement of nanotechnology and its safe introduction in all aspects of the food chain.

The following table lists of potential uses of nano-material in the food sector. A few, mainly related to packaging and coating, have been applied already.

Potential uses of Nano-material in the food sector

		APPLICATION AREAS			
		Consumption	**Packaging, Distribution, Storage**	**Processing**	**Agriculture**
CHALLENGES	**HEALTH**	-Functional Food -Personalized Food -Improved bioavailability of nutrients	-Quality Monitoring, Real Time Testing of: Contaminants, Pathogens -Spoilage Indicators	-Addition of (natural) functional ingredients -Less sugar, salt, fats -Fewer allergens -Improved preservation	
	BIO-ECONOMY and SECURITY	- Alternative feeding - Special food e.g. space food	Waste Reduction through: - Biodegradable packaging material - Better food chain management (Tracking, Tracing) - Bacterial/Spoilage detection - Longer shelf life - Edible packaging	-Reduction of food waste during production; -Recycling of waste	-Plant protection agents with nanocomponents -Wastewater treatment -Improved (and differentiated) agricultural spaces -Nano-formulated fertilizers and pesticides
	SAFETY		Better food chain management/ surveillance through:		-Delivery of nanovaccines -Monitoring of soil and

		Tracking, Traceability - Match durability with product shelf life -Quality Monitoring, Real Time Testing of: Contaminants, Pathogens -Spoilage Indicators		water -Detection of plant and animal pathogens

POLICY ISSUES should be considered and **Social Acceptance** as well as **Consumer Trust** need to be gained through better information, transparency and willingness to communicate with stakeholders and the public.

Relevant **Policy Issues,** concerning all application areas and challenges, can be identified as follows:

1. Health	2. Nanotoxicology	3. Sustainability and Ethics	4. Economy and Business
a) healthier food b) improved food safety c) evidence-based functional food	a) for consumers b) for the environment	a) reduction of energy and water consumption, waste b) food security	a) affordability and quality b) new markets (societal changes) c)multi-disciplinarity and cooperation d) data regulation

3. The way forward

It is important to consider that up until now a lack of concerted development regarding the food system and the sustainability challenge prevented synergies and economies of scale from being exploited. It is clear that there are many issues at stake, which are all linked to each other. If we keep focusing on one single aspect, the solution to one problem may result in the aggravation of another while we should learn to consider them as a set of interlinked and mutually reinforcing set of challenges. In order to enable knowledge assessment and identification of potential applications and socio-economic impacts and to point out obstacles, gaps in knowledge, education, funding needs, market potential and social acceptability "face-to-face" workshops will be organized, which will have a focus on different, but correlated sub-topics.
An "on topic roadmap" of the face-to-face workshops, which appeals to researchers, policy makers, industry and consumers and encourages the cooperation in the assessment of risks and benefits should be the result of this holistic approach.

To face the future challenges some key issues and questions should be considered:

- *Suitable and reliable test and validation methods, as well as standardized procedures in nano-food applications are not fully developed.*
    *Do we know the real current **exposure** to nanomaterials and how it may change in the medium to long term future?*
    Can it be determined, quantified using currently available instrumentation?
    *Are we developing appropriate **methods** to do so in the future?*
    *Is the background noise due to naturally occurring NMs considered? (**Calibration**)*

- *How will the scientific community go about overcoming these gaps and how will we **acquire** the extensive **knowledge** required?*
    - *Are "no results" results reported?*

- *Which could be the practical **application** of nano-food in your specific sector in the coming years?*
    - *Who would **benefit** (e.g. agriculture, industry, consumer)?*
    - *What are the critical **enabling steps**?*

- *Food has traditionally been a low margin enterprise, so new technology has had to be **cheap/high value**.*
    - *Does nanotechnology fit these requirements?*
    - *Is nanotechnology an "easy" technology?*
    - *What are the current technology limitations that refrain from present applications and how might these change in the future?*
    - *Will food remain a low margin enterprise or might this also change in the future for some segments?*

- *What will be the **societal implications** of the application of nanoscience and nanotechnology in the food industry?*
    - *What benefits could nano-food provide to humanity in the medium term?*
    - *What conceivable problems might it cause?*
    - *Could nano-food have a "dual use" so that both, developed as well as developing economies could benefit from it?*

- *The uncertainty about regulatory **risk management** and fear of public resistance (OGMs!) contributes to the hesitation which accompany the application of nanotechnology in the food sector.*
    - *How will we overcome the obvious lack of enabling leadership through R&D policies?*
    - *How will we encourage the dialogue between all parties involved?*

- *Social **acceptance** is key to the **adoption** of a new technology. How should we involve/inform the consumers?*

- ***Safety** is a key issue to acceptance. Regarding food safety consumers have ZERO tolerance.*
    - *How safe is safe enough?*
    - *Should standards be set on public health risks?*

References

1.) Roadmap to a Resource Efficient Europe , COM(2011) 571

2.) Report of stakeholder workshops concerning the Common Strategic Framework (CSF) and Horizon 2020 for Research and Innovation: FOOD SECURITY & BIOBASED ECONOMY

3.) EU, 2001a. Directive 2001/83/EC of the European parliament and of the council of 6 November 2001 on the community code relating to medicinal products for human use. Official Journal L 311, 67–128.