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Technology foresight as a tool for triggering and structuring long-term thinking about food security and sustainable development

The main aim of this paper is to outline the methodology of technology foresight in general and to present results of 'FutureFood6', a project finalized in early 2009 and based on technology foresight, in particular. The project addressed long-term aspects of food safety and security in six Central and Eastern European countries. The third part of the paper will embrace findings of the previous two parts. It will use the FutureFood6 project as the basis for drawing conclusions about the advantages and drawbacks of the technology foresight methodology as an analytical approach and tool for policy design.

1. Technology Foresight

Foresight is an activity that tries to anticipate future development tendencies and to identify policy requirements by bringing together the relevant stakeholders – market participants, researchers, policy-makers, and NGOs – in a participatory process. The methodology is quite new, first applications started in the nineties of the last century under the guidance of UNIDO.

Technology foresight is based on a specific methodology. It differs from analysis based on testing of hypotheses through experiments, whereby tests can be repeated any time. It also differs from those econometric approaches, which are using data from the past as bases for forecasting likely future short- or long-term developments. The approach that technology foresight uses starts with collecting information and assessments from all major categories of stakeholders and uses standard tools to analyse results. In a second step, a series of gatherings of the main stakeholders uses these results as a basis for formulating development scenarios and, ultimately, policy recommendations. This approach implies

that results would not be identical if different teams elaborated on the same topic in parallel, without exchanging information. In some teams, NGOs in the sphere of consumer protection could be more convincing than others, so that the results would reflect their strong influence. In other teams, something similar could be the case with food processing technicians, food marketing experts or farmers. As technology foresight projects get a large number of experts in different fields involved for a period of one to three years, managerial requirements are immense, so that the views of the project managers usually gain strong influence on the results.

The project that we are discussing here focused on expertise being collected from food quality and security stakeholders coming from Ministries, Research Institutes, Universities or Associations in the target countries; a feasible other approach would have been asking also experts from other countries how they assess the target countries with regard to food quality and security. For sure, including such experts would have had an influence on the results. Awareness about the categories of stakeholders and experts that were involved of the project makes it easier to interpret the projects' results.

The technology foresight methodology has a certain degree of freedom built in, a fact that enhances the debate-creating power of this approach. There is no better way to deal with future under very complex circumstances.

Within two decades, the technology foresight approach has experienced a remarkable upswing. In all parts of the world technology foresight programmes are on the way or have been completed. UK played a pioneer role (Georghiou 1996), and China and Korea have also made use of this approach (Schlossstein, Park 2006) To promote technology foresight, the European Commission so far has organized three international scientific gatherings in Seville conferences on future-oriented technology analysis: an international conference in 2008, a EU-seminar in 2006 and a EU-US seminar in 2004.

In a number of countries, technology foresight projects included the food sector, as for example in Finland (Elia Ahola 2003) and Ireland (Forfás 1999). Currently, the UK government is running a food-related foresight project (November 2008-October 2010) with a global perspective. It addresses the question of how in 2050 a global population of 9 billion people all can be nourished healthily and sustainably (Future, 2009). The project we are talking about today was ambitious too, as its aim was to mobilize food safety and security stakeholders from six countries, to elaborate on joint solutions and to raise awareness in the target countries.

2. FutureFood6 Project

We called technology foresight a tool for triggering and structuring long-term thinking about food security and sustainable development. The FutureFood 6 project **"Healthy and Safe Food for the Future – A Technology Foresight project in Bulgaria, Croatia, Czech Republic, Hungary, Romania and Slovakia''** will now serve as an example. The project was coordinated by the United Nations Industrial Development Organization (UNIDO) and co-financed by the European Commission's (EC) 6th Framework Programme. Two institutions acted as main advisers: OPTI (Spain)[1], working as a methodology adviser and wiiw (Austria)[2], as an economic adviser. Six foresight and innovation expert institutions covered the target countries: IEHAS (Hungary), TC AS CR (Czech Republic), BIC Group (Slovakia), NWMC (Croatia), UEFISCSU (Romania) and ARC Fund (Bulgaria)[3]. The project started on the 1 February 2007 and finished on the 31 January 2009 (Project Homepage: www.futurefood6.com[4]).

The ultimate goal of the project was to assist the total food chain in six selected Central and Eastern European countries (CEECs) to reach international quality and safety standards. The definitions used for these terms where as follows:

- *Food Quality:* The quality of a merchandise is defined as the commodity's ability to fulfil consumer expectations, needs and wants and producers promises. Quality includes all attributes that influence a product's value to the consumer.
- *Food Safety:* Involves consideration of all hazards, unintended or intended, arising along the farm-to-fork continuum, including but not limited to pathogens, toxins, chemicals, and physical objects. A product is considered to be safe, when it is consumed orally either by a human or an animal does not cause health risk to consumer.

Although the project targeted the whole food chain in the six Central and Eastern European Countries (CEE), it was mainly the food processing industry which was under consideration (in the following called 'food industry'). As in the rest of Europe, the food industry is of vital importance to the economies under investigation, being one of the largest manufacturing sectors (if not the largest) in terms of production and employment. In

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1 OPTI – Fundación Observatorio de Prospective Tecnológica Industrial (www.opti.org).

2 WIIW – The Vienna Institute for International Economic Studies (www.wiiw.ac.at)

3 IEHAS – Institute of Economics, Hungarian Academy of Sciences (www.econ.core.hu)
TC AS CR – Technology Centre of the Academy of Sciences CR (www.tc.cz)
BIC Group – BIC Group, s.r.o. (www.bicgroup.sk)
NWMC – National Wholesale Market Company Inc. (www.veletrznica.mps.hr)
UEFISCSU – Executive Agency for Higher Education and Research Funding (www.cncsis.ro)
ARC Fund – Applied Research and Communications Fund (www.arcfund.net)

4 The Final Report as well as Intermediate Reports can be downloaded there. Detailed information on partner institutions and persons can also be found there.

Croatia, Bulgaria and Romania the food industry accounts for 23%, 19% and 18% of manufacturing production, in Hungary, the Czech and Slovak Republic for 11%, 9% and 7% respectively (compared to 14% for the EU-27 average). Adding raw materials from agriculture (backward linkages) and products supplied to wholesalers, retailers and food service companies (forward linkages), the total food chain has a dominant role in our economies.

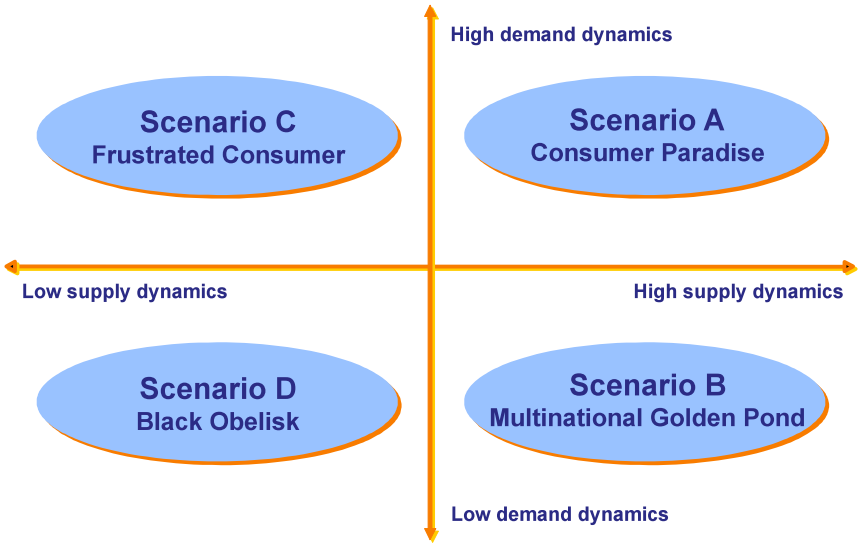
The Technology Foresight methodology used in the FutureFodo6 project employed the following set of tools: socio-economic future scenarios, interviews, key-technologies survey, future visions and road-mapping. The main results of each tool will now be highlighted; policy recommendations drawn from these findings are outlined thereafter.

2.1. Socio-economic scenarios (under the lead of OPTI):

Here major social, economic, technological, environmental and political trends were identified in order to map the European food industry in the year 2020 horizon. As a result four socio-economic future scenarios were distinguished, which differ in the degree of development with regard to conditions on the demand and supply side. The individual country's influence on these scenarios is marginal at best. They support or hinder the realisation of future visions, which have been developed later. The four scenarios found were (see Figure 1):

- *Consumer Paradise:* In this scenario, a large proportion of the population can afford to act as quality-oriented food consumers, whereby preferences for quality food is high and knowledge about food and food producers is very developed. In this scenario, the core of consumers is satisfied with the response of the supply side, which is characterized by strong competition and high technological standards. Diversity on the supply side fits to multilayer demand.
- *Frustrated Consumer:* In this scenario, quality-oriented and sophisticated demand of consumers is not met by adequate supply. Neither domestically produced nor imported food fully meets expectations of the demand side. This is attributable to structural deficiencies and trade barriers.
- *Multinational Golden Pont:* In this scenario, the supply side would be quite capable, but faces poor challenge from the demand side, as the core of consumers have to content themselves with simple low-price food; gathering of information and more profound knowledge about food is hardly on their agenda. A few large transnational producers and distribution chains have an easy game.
- *Black Obelisk:* In this scenario, consumers have to content themselves with low-price food, whereby at the same time the supply side is also poorly developed. Main reasons for the latter could be inflexibility due to lack of competition, and technological backwardness because of poorly developed human resources and physical capital.

Figure 1: Food industry's scenarios



2.2. Interviews and key-technologies survey (under the lead of IE HAS)

Interviews addressed the present situation of certain aspects of food safety and healthiness, i.e. current concerns from the supply and demand side on food quality and safety ('awareness'), the current legal and physical infrastructure as well as socio-economic factors. The following answers were given:

- Experts stated that consumers' awareness about food quality and safety is less developed in CEE countries than in most of Western European countries – although, during recent years, it has been raised significantly. In all countries, experts stressed that compared to consumers, quality and safety awareness is higher among farmers, food processors and retailers. On the policy side, a long-term strategy is often lacking.
- As regards regulatory issues, the interviewees do not see differences between the new member states and the EU15 countries: All new member countries have adopted the EU acquis and regulations; Croatia is in the process of harmonization. However, the most important problem is the enforcement of these regulations.
- Experts from many CEECs think that the physical infrastructure for securing food quality and safety in laboratories is often insufficient. In Hungary, Slovakia and the Czech Republic, equipment in the private sector is on a sufficient level as regards food safety and control. However, a dual picture emerges from the answers: While big processors posses their own well-equipped laboratories with qualified personnel, smaller ones cannot afford to have their products *in situ* analysed and

certified. In Croatia as well, large food companies are well equipped, while SMEs lack equipment and well educated workforce.

- Experts identified two major socio-economic issues that will determine future food demand preferences and affordability in the region: Firstly, the ageing of population and thus changes in the demographic structure. Secondly, improvements in the socio-economic status of the majority of population will affect demand preferences and affordability and hence raise awareness of food quality and safety.

The key technologies survey investigated the development and application level of six broad technologies (test & measurement, food packaging, biotechnology, ICT, nanotechnology and functional food) and allowed for a classification into key, strategic and consolidated technologies for the region later on. As “key technologies” figure those from which the respondents expect strong positive impact on food quality, consumers’ health, employment, economic growth and food safety. “Strategic” is a technology, which is just emerging, whereby the country seems to be well-positioned. Finally, a technology is labelled as “consolidated”, if it has reached a level, which is regarded as sufficiently high.

Generally speaking, the development level of most technologies including test & measurement, ICT, nanotechnology and functional food is rather weak, of which ICT is the least developed. Only food packaging and biotechnology are a little bit better situated (see Figure 2). The current level of application of technologies exhibits a slightly better situation compared to the level of development. The least applied technologies are ICT, nanotechnology and functional food. Food packaging again, has a relatively good position (see Figure 3). Overall, it seems that the countries in the region focus more on the adoption of new, ready to be used technologies rather than developing them. Reasons seem to be manifold including the socialist past, late privatization procedure, lack of funds in the educational system, brain drain, and perhaps also the small country size mattered. However, one explanation seems to describe the situation best: Nationally owned companies are most frequently of smaller size, and very few possess the needed R&D infrastructure to be in the front line of technological development. At the same time, foreign owned companies mostly have their research base located in their home countries, and merely import sound research results, already ready to be applied on the local market.

Figure 2: Current position in the *development* of the technology at regional level, in % of answers

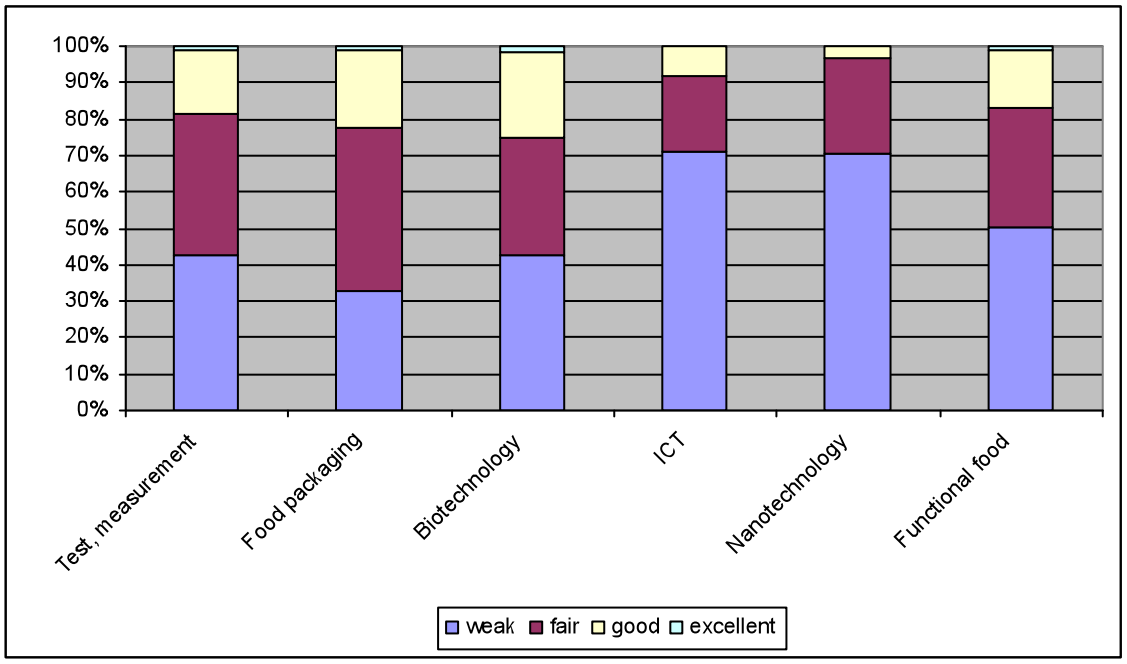
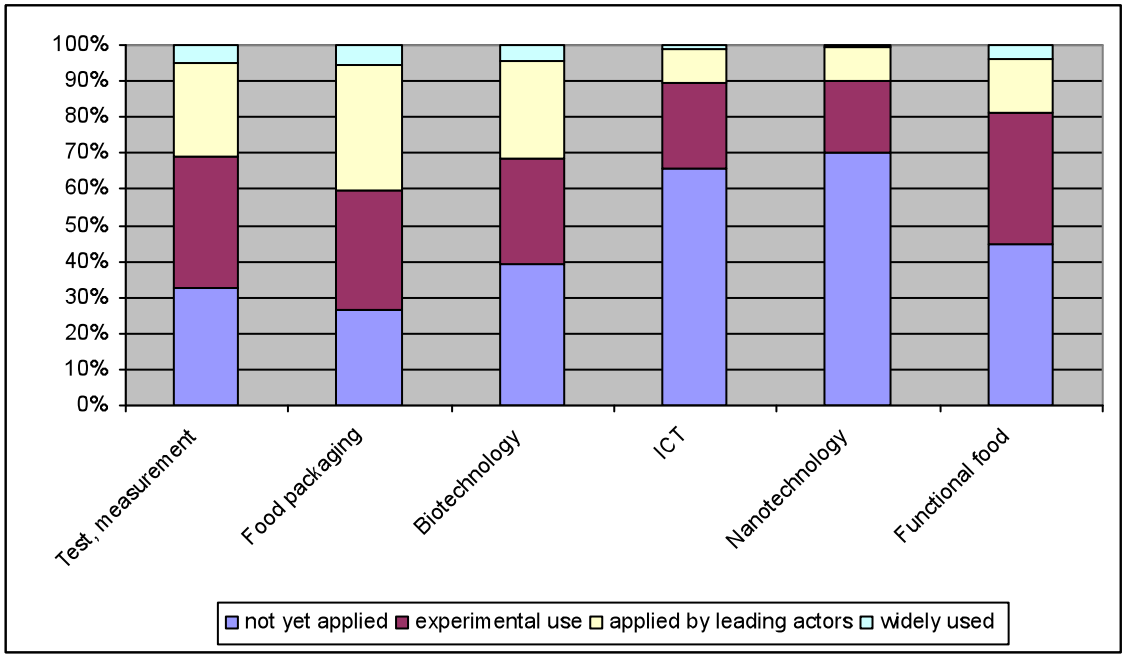


Figure 3: Current position in the *application* of the technology at regional level, in % of answers



Having analysed technologies on this broad level, a closer look was then made on 28 individual technologies. Four technologies were identified as 'key technologies' in all six countries: one referred to control systems, two belonged to the group of package

technologies and the forth one was nanotechnology applicable as instrument of dosage control (see below). None of these four technologies did, however, also reach the 'strategic' status, whereas three of them qualified as at least 'consolidated'. This means that in many aspects the Central and East European food industry is still characterized by technological backwardness and will have a long way to go to fully catch up with western European standards.

In more detail, the following key technologies had been found for the region:

- **KT-2** (belonging to the test and measurement technologies category) - New in line non-destructive methods and control systems, integrated and pervasive sensor networks throughout factories for assessing the quality and safety and recording their fluctuations during processing.
- **KT-6** (belonging to the food packaging technologies) - Active packaging capable of changing either package permeation properties or the concentration of various volatiles and gases in the package headspace during storage, or adding small amounts of microbial, anti-oxidative or other quality improving agents via packaging material.
- **KT-8** (belonging to the food packaging technologies) - Development and application of new packaging systems allowing to fully utilise benefits of new food packaging technologies and better food packaging materials used in modern food processing.
- **KT-23** (belonging to nanotechnology) - Nanomaterials to control the dosage of growth hormones in livestock.

2.3. Future visions and road-mapping (under the lead of OPTI and TC AS CR).

Four future visions were identified for the region, describing a set of desirable prospects for the food industry in the next 10 to 15 years. In addition, also barriers were discussed which hinder the realisation of these visions, especially those relevant for small and medium sized-enterprises (SMEs).

Future Vision 1: Increased availability of high-quality region-specific and traditional food products in the region. In this vision, the supply of traditional high-quality food products is boosted and regional demand needs - an unexploited market segment toady – are satisfied. In addition, existing community values and perspectives are reinforced. Local production helps to protect the environment thanks to short transportation journeys, supports cultural diversity and strengthens local economies. Local producers benefit from EU promotion of Protected Designation of Origin (PDO), Protected Geographical Indication (PGI) and Traditional Speciality Guaranteed (TSG). However, for realisation of this vision,

higher technological levels are needed; stricter quality & safety standards are required, with the harmonization of standards being a must. In addition, SMEs reinforcement and modernization is essential and a greater degree of support to local production is basic. Higher cooperation at the regional level is needed. A number of barriers will have to be overcome such as high costs of production, distribution and brand development, or an inadequate regulatory framework in its own country as well as in potential export destinations.

Future Vision 2: The region will be one of the leading producers of healthy and safe food in Europe. In this vision, a regional agri-food industry producing nourishing, secure and first-class food products has become true and the industry is competitive at the European level. In this case, the regional industry will have to supply a much more demanding European market. The industry will have to pay special attention to traceability throughout the whole food chain. In addition, it will have to develop and implement new and emerging technologies which facilitate the production of novel food products. Factors, which might hinder the vision's realisation, include the predominance of small and medium-sized local producers, whereby they have difficulty to gain shares in international food markets. Main reasons for that could be complex and costly certification requirements or difficulties to make it to the shelves of large retail chains in an oligopolistic market.

Future Vision 3: Research support will be a priority in national development strategies and higher cooperation levels within the food chain will be achieved (paying special attention to functional food). In this vision, reinforced and increased regional R&D expenditure on agri-food are available, cooperation activities within the value chain are achieved and a technologically advanced regional industry is developed. Clear R&D priorities at the national level taking into account possible regional synergies are established. One of the fields to focus R&D efforts within the agri-food industry is that of Functional Food. Functional food is considered to be of special importance to improve citizens' health and well-being and to help fighting some of the diseases of new and modern life styles. For this purpose, innovative technologies and improved information mechanisms to the consumer will be needed. In order to achieve Vision 3, a number of barriers have to be overcome, such as week lobbying, brain drain, inadequate R&D infrastructure, inefficient technology transfer mechanisms or the lack of interest from the industry.

Future Vision 4: Towards a knowledge-intensive agri-food sector. In this vision, a regional agri-food industry which is based on knowledge and intellectual assets to create added value products has come true. The necessary core technological and related competencies, in conjunction with the development of human capital, are available. For achieving this vision, the educational system will be updated and a properly trained workforce capable to operate the new knowledge-based systems will be developed. In addition, entrepreneurship knowledge will be increased; the support mechanisms for

innovation intermediates, start-ups and young and promising growth firms improved. Strong public-private partnerships well be created and new business models based on knowledge will be developed. To develop in such direction, the region will have to remove barriers such as deficiencies in the educational system, in training-on-the-job schemes, in access to information; barriers such as continued underdevelopment of rural areas and of the SME sector; and barriers between research and its practical application.

In a next effort, road-maps leading to the realization of the four visions were elaborated, showing measures and actions for the short-term (from now until 2011), the medium term (until 2014) and the long-term (until 2020). Here the main conclusions will be highlighted (for the detailed road-maps please see the Final Future Food Report available at www.futurefood6.com).

Vision 1 – the increased availability of high-quality region-specific and traditional food products in the region – might be reached trough the following stages: The first stage is the identification and consequent promotion of traditional food. The second phase focuses on the increased selling of traditional food. The final phase is the adjustment of traditional food and its production to the emerging new life-style and social changes. According to the experts, the main measures for this Vision are: the definition of specific requirements for products to be acknowledged as traditional; the protection of traditional food by law; new support programmes for SMEs producing traditional food; the promotion of local and international labels; and the funding of research on new technologies able to produce traditional food at larger scale.

For Vision 2 – the region will be one of the leading producers of healthy and safe food in Europe – three major fields of activity were identified: to increase the awareness of consumers as well as producers, to improve production processes and to conduct specialised research and development in the field of healthy and safe food. According to the experts, governments should play a key role in all three fields and countries should take advantage as much as possible of relevant existing EU programmes. According to the experts, the main measures for this Vision are: public awareness training programmes; incentives for quality certification; the development of infrastructure; risk assessment and communication; and a tax incentive system supporting research.

Vision 3 – research support will be a priority in national development strategies and higher cooperation levels within the food chain will be achieved (paying special attention to functional food) – stresses measures to improve education in order to reduce brain drain and the lack of R&D managers (courses and education for the actors in the food chain, scholarship programmes, support to university research excellence). More cooperation between business and R&D could be achieved through organizing conferences and meetings by business associations, providing tax reductions for higher cooperation or

setting up intermediary agencies as well as technology parks. Functional food might be promoted by awareness creation, by supporting national health and nutrition laboratories as well as companies producing functional food.

The realization of Vision 4 – towards a knowledge-intensive agri-food sector –starts off with a thorough analysis of the current situation of the agro-food industry in the CEE through a status analysis accompanied by a feasibility study, which will then form the basis for a regional joint technology and action plan for the CEE region. According to the experts, the main measures for this Vision are: special funding and guarantee schemes for the agri-food industry (venture capital schemes); special innovation services like a "market and technology watch" (database containing marketing and technology information on subjects of the agro-food sector); a joint technology and action plan on development of knowledge infrastructure for the region; tax incentives for businesses and R&D organizations; as well as the development of a common methodology for a survey of knowledge and financial needs in the region.

2.4. Policy recommendations

Policy recommendations, which the CEEC-6 experts have formulated in the course of the different stages of the project, are addressing three important aspects:

(1) *Recommendations aimed at improving the CEEC-6' capacity to produce high-quality food:* As expressed in one of the visions, the CEE-6 food experts regard it as feasible that their region will become one of the leading producers of healthy and safe food in Europe. Whether the food industry will develop the ability to reach high quality standards especially in terms of food security, safety, diversity and taste depends on a number of factors. Companies will need to equip themselves with human and physical capital of adequate quality. This means *availability of advanced technology and expert knowledge*. An additional precondition is availability of high quality supply of raw material, intermediary products and services supportive to food production. Measures here include a reform of the region's systems of both education and Research and Development, to foster the integration of research institutes into EU networks and to create favourable conditions for the start of new self-financing institutes, homologation centres, tech-transfer centres and innovation incubators. In addition, policies have to adjust to the structure of the food industry: The CEE-6's food industry is characterized by a coexistence of larger domestically owned companies, which went through a process of restructuring; large companies, which at some point of time were taken over by foreign investors; small and medium-sized enterprises (SMEs); and micro companies, which frequently work on subsistence level. Here the flexibility and diversity of the SME-sector should be strengthened as well as obstacles removed or at least reduced.

(2) *Recommendations aimed at improving quality incentives, control and information*: The Ability to reach highest quality standards alone is no guarantee that actual performance will always reach this level. Even in the case of the potential being in place, the food producers may or may not continuously strive for actual high quality levels. This will depend on incentives, especially those from the markets, as well as on negative consequences they have to face if missing the standards. Both incentives and negative consequences will be stronger in the case of a *highly developed control and information culture*, something the EU is heading for. The aim is making sure that a large proportion of the population, and not merely experts, will be able to assess the different aspects of food quality. Such a culture is in the best interest of the food industry, as it will strengthen its international competitiveness. Main measures here include the improvement of the consumers' knowledge base, the improvement of the quality assessment and control system; avoiding implicit protectionism and to allow for intensive competition.

(3) *Recommendations aiming at better synchronisation*: In order to reach certain visions, actions should not contradict each other and *synchronisation* is needed in a number of areas: On the policy side, a clear formulation of targets should be sought and endeavours combined into bundles. On the practical level, regulations should not be contradictory. Furthermore linkages should be created in order to increase effectiveness and facilitate technological progress. Here it would be good to unify standards and norms, increase co-operation between all main stakeholders of the food chain as well as enhance co-operation among producers, again with a special attention on SMEs.

The CEE-6 experts mentioned 'competitiveness' much more frequently than 'competition'. For a realisation of the experts' long-term visions, however, it is important that their food industry will be fully exposed to competition.

3. Conclusions regarding the technology foresight methodology

For an economist with training-as-usual, a first confrontation with technology foresight can be puzzling. As a rule, her or his empirical work consists in analysing what has happened in the more recent past as reflected in data sets. Such data are also the basis for predictions how some variable – or some set of variables in a model framework - may develop during the next few months or years. Such an approach can take into account a limited number of variables and therefore has to be selective. Technology foresight does not need to be that selective, but this has its price – the outcome is of different nature. Technology foresight is both a social construction, and a mechanism for social construction; by acknowledging the socially constructed nature of their process and outcomes, projects can achieve greater rigour and legitimacy (Fulleer and Loogma, 2009).

Technology foresight may have the potential of wiring up national innovation systems (Martin and Johnston, 1999) and of serving as a social shaping approach (Jørgensen,

Jørgensen, and Clausen 2009). Besides this, another aspect is important as well. Within many countries, there is widespread consensus that the society can choose between different technologies to be used in the future. This perception of a choice increases the likelihood of diverging preferences. Technologies such as nuclear power generation or genetically modified agricultural products have provoked fierce controversies. People all over the globe are becoming more alert of environmental pollution and climate change, and not only new technologies, but also existing ones can come under heavy attack. For example, more and more people are scrutinizing combustion-based technologies.

Technology foresight projects try to give a response to those new challenges by getting all major stakeholders involved in discussions related to technology choices and by putting emphasis on raising awareness of the public opinion or at least opinion leaders. The aim is to reach a consensus, which also includes policy recommendations. The inclusion of a vast number of people and the process of consensus building generally increases the sustainability of results. For technology foresight as a whole, we see two temptations. One is that the organizers of such projects may feel tempted to exclude the most vehement zealots and opponents of certain technologies; another one is temptation to factor out more controversial topics in the course of the project. Both approaches will increase the likelihood of washy results with poor influence on public opinion as well as on policy makers. This is a caveat, but this does not diminish the potential merits of the technology foresight approach. There is no reasonable alternative to giving all major stakeholders a voice, and provoking them to engage in structured thinking about longer-term future scenarios. Whether or not this leads to compromises in each case is of minor importance. Much more important is to find ways of perpetuating this structured thinking and in this way to mitigate the stop and go character that is inherent to project-based activities.

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