THE USE OF TECHNOLOGY ASSESSMENT (TA) IN THE FOOD-CHAIN FROM "FARM TO FORK

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Abstract

The introduction of GMO crops in the EU has been and is a matter of severe controversy. First and foremost consumers, often represented by NGO's, have been known to be extremely negative towards the introduction. With the EU legislation in place allowing import of and tillage with GMO it is only a matter of time before farmers and food manufacturing companies are forced to relate their strategies to this new technology. This paper focuses on Technology Assessment (TA) in a food chain perspective. So far Technology Assessments have mainly been applied for targeted cases with partial stakeholders such as farmers or consumers but seldom in a holistic chain perspective from "farm to fork". Trough the food chain a main focus for enterprises and farmers are cost verses benefits but also assessment of opportunities for competitive advantage and outright threats will be of major importance in relation to this new GMO technology. Also the managers of the 21st century will need to be more aware of, and sensitive to, the social concerns related to developing and implementing gene technology within food products. If these matters are not addressed by decision makers GMO's in the EU is likely to fail as a commodity. By making an overall Technology Assessment, enterprises stand to make better informed choices regarding their optimal actions to secure their own future and gain a competitive advantage. If, for instance, the enterprise Monsanto had conducted holistic Technology Assessments in a chain perspective prior to a market introduction of GMO crops, it might have faired better. In matters concerning GMO's, failure to incorporate such aspects as social acceptance and politics can at best be expensive for the enterprise or individual farmer - in worst case it can be detrimental to the very existence of a company. The outcome of this paper is an overview of suitable methods that has been or in the future can be used for Technology Assessment in a food chain perspective. By combining the most suitable methods the concept is moved towards a dedicated common framework for Technology Assessment in food chains from "farm to fork". This framework includes social, ethical and political issues and can be utilised by farmers and enterprises as a tool in order to quickly and efficiently assess the consequences of actions and relate to food chains in an improved way. By conducting Technology Assessment in a chain perspective which integrates economy with social and political issues we believe that a powerful new and highly useful tool is provided to the farmers and enterprises of tomorrow.

Keywords: GMO crops, NGOs, Technology assessment , food chains

Introduction

The food chain is no longer local or even domestic. Several national and international stakeholders are involved. Decisions made by one stakeholder in the food chain may influence the possibilities and limits for the next stakeholder.

The food market has become more globalised with significant competition on a world scale. In the search for new products with lower cost of production or high value added, different types of genetically modified ingredients have been utilised in the food industry - and the development of functional foods with health benefits or improved taste are new product innovations that could be expanded. The development of such products are however slow and consumer acceptance seems to be limited. Developing new food products with low consumer acceptance is expensive for companies and for society

at large. The steering of the development needs to a larger extent to focus on the entire food chain and involve not only the economic aspects in each link of the chain, but also the social and ethical consequences.

In this paper it is argued that the concept of Technology assessment (TA) conducted in a chain perspective can be used by governments as well as private companies to steer the developments of new biotechnology related food products.

The objective of this study was to present different approaches for assessing the technical, ethical and socio-economic implications of biotechnology in a food chain perspective.

Technology Assessment as a methodology approach

New technology has played a central role in the western world for many decades. However not all technological developments have proved beneficial. The diffusion of the plant pesticide DDT[1] was for instance followed by severe and largely unknown negative consequences for the animal habitants - also the development of highly cost efficient animal production systems may cause negative consequences like mad cow diseases and avian bird flue.

As a result of the growing awareness of the consequences of new technologies in US, the Office of Technology Assessment (OTA) was established in 1972. The concept of conducting TA was originally conceived as an analytic activity, aimed at providing decision makers with an objective approach to analyse the consequences of a new technology (van Eijndhoven 1997). In the very beginning the main purpose of TA was to act as an early warning for unwanted effects. A common expectation on TA has been that it should reveal future consequences of technologies that otherwise would not have been recognised (Palm & Hansson 2006).

In its most basic form TA's can roughly be grouped into 3 categories;

1. Reactive TA
2. Proactive TA
3. User oriented TA

The reactive TA relates to already known problems or perceived problems with an emerging or already introduced technology. In that case a major contribution for the TA is to present different pathways to eliminate or reduce the negative effects of the technology in society. The proactive TA involves the assessment of technologies that are in its pre-commercial state and not yet fully implemented. In that case the assessment usually focuses on different technologies and pathways that can bring about the predetermined goal in an optimal way. In order to make proactive TA it is necessary to procure an objective for the needs in the future. Finally the user oriented approach narrows the scope of the TA down to a few very specific needs. By focusing on theses needs the technology should then be shaped according to these requirements. An example of such a TA could be to find a vaccine against diabetes. User oriented TAs are usually applied on major specific problems and are very costly to carry out.

Technology assessments have usually been conducted when new innovations cause "value dissent" among citizens. Value dissent expresses the sometime strong divergence between official public policies and the perception of the individuals. Such value dissents have been obvious in the case of GM crops but also on several other areas including the use of IT, surveillance, etc. In such cases, it is usually in a states

[1] **D**ichloro-**D**iphenyl-**T**richloroethane. Hihgly effective pesticide that turned out to have significant negative effect on the environment.

interest to include the divergence in the public policy making. Otherwise technologies may fail in society. Technology assessments can however be conducted on several levels from governmental over corporate chains and down to single a company. Private companies have a great interest in assessing the introduction of new technologies. In fact, the performance of new technologies in a company may be detrimental to it survival in the marketplace. TA conducted by private companies will mainly focus on economic performance of technologies including risk-assessments, impact assessment, feasibility study and different types of economic modelling.

The main difference between TAs conducted by governments or even at an over-national level is the focus on the broader welfare economic issues. In developing new technologies private companies do not have an incentive to include all the costs that may accrue to society because of its new introduction. Out of economic reasons companies can have a strong incentive to carry on with imposing new technologies even though they are unwanted in society. However from the lessons of GM crops companies will have to pay closer attention to public wants before developing new products if chances of failure are to be minimised.

Related to technology failure the timing is crucial in TA. The optimal timing for conducting TA is at the point of time where the knowledge about the technology is sufficient enough to discover the negative impacts and before the costs of changing direction is too high. A possibility is to build in TA at the very beginning of the development phases in food products.

It has not been possible to develop a single uniform technology assessment methodology (Smith 1990). TA is multidimensional in nature and it may involve several aspects. With the wide scope of possible impacts it is not possible to present one uniform method that can be applied to all new technologies. The kind of TA to be conducted depends on the technology in question and who will be affected by it. The first TA was highly expert oriented meaning the assessment was conducted by scientific experts that would pass judgement on the pros and cons of new technologies. Such assessments are known ass "Classical TA". For the purpose of this paper details of the various discourses in TA and methods that has been developed will not be discussed. It shall merely be conclude that today TA to a large extent includes the general public. As stated by (Skorupinski 2002) "If TA is expected to come up with answers about how technological options should be handled by society, these cannot be given by scientific experts alone". Examples of such TA methods include participatory TA, aiming at involving the public in the development phase of new technologies. Lately (Palm & Hansson 2006) suggested the use of Ethical TA to make sure that new technologies were ethically sound.

The exact method to be applied varies with the technology in question and at the level it is conducted. Private companies will tend to focus strictly on economic performance. However looking at the developing of new biotechnological products the scope needs to be widened. If ethics and the perception of the public (consumers) are not involved in the developments, new products will fail at large cost. Closer attention will have to be paid to other issues apart from strict economic performance in the development and implementation of new products.

TA in a food chain perspective

Up till this point, TA has not been widely used in the food industry. In the 80s some TAs were carried out in the food industry. Cronberg (1996) mentions "the good work" and the "the good slaughter house". Here labour unions in corporation with researchers carried out TA projects to reorganise work and utilize technology for the benefits of the workers (Cronberg 1996).

The concept of Participatory TAs was set up in order to get a better feeling with the public opinion. This resulted in several so-called Consensus Conferences that managed to spin off some major reflections on

the use of biotechnology. Such conferences revealed for instance that the concept of risk is very different in the minds of the public compared to the scientific experts. Such assessments also played a role in understanding where the use of biotechnology to a larger extent is acceptable. The use of biotechnology to produce medicine is several times more acceptable compared to the use in agriculture. Consumers are simply not willing to accept new technologies that serve only to provide benefits to the industry. A scientific and industrial sector that fails to engage with and take home messages from the public will not be able to guide research and development in a direction that is acceptable to the public; hence it will not be able avoid disputable applications of gene technology (Lassen, Madsen, & Sandoe 2002).

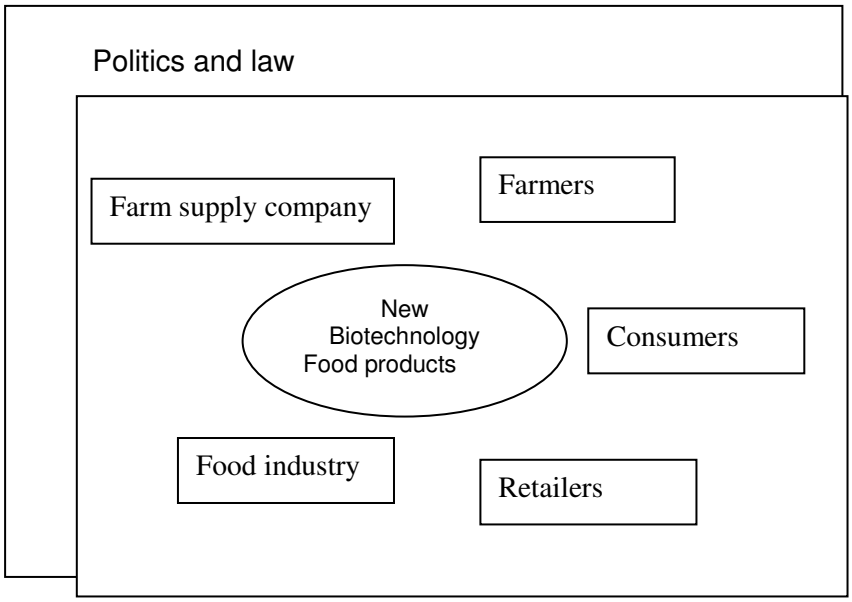
In the food industry the concept of LCA (Life Cycle Assessment), which is a method involved in TAs, been used quite frequently. With the major impact food production has on the environment it seems natural to assess the impact of a product over its whole life time. Such LCA has procured interesting results clearly showing what products are presenting the heaviest burden on the environment. Such assessments have been the starting point of a proactive TA where different strategies are tested in order to reduce the environmental impact. Not surprisingly farmers are keen to point out the virtues of biotechnology which has been done on several occasions. One outspoken possibility is to breed animals that can reduce negative agricultural effects on the environment. The most known example of these is the so called Enviropig^{TM}: a pig that has the capacity to digest plant phytate, leading to less phosphate in the manure and thus less environmental pollution (Vajta & Gjerris 2006). In the area of introducing new genetic traits into animals it seems indeed to be only the imagination that limits the range possibilities. The economic potential of such new technologies seams just as high as the consumers' acceptance seems low. Such commodities are likely to fail because they are unacceptable to most consumers. The point is that it is not sufficient that only parts of the food chain can se the benefit in a new technology. If consumers cannot see the benefit the commodity will fail.

It can be argued that in order to develop new successful products, they have to present net benefits for every single stakeholder in the food chain from farm to fork. If the cost for one stakeholder exceeds the benefits, the product should either be dropped or the stakeholder should be compensated by the potential winners (see Kaldor Hicks criteria). Such a concept requires an understanding of the stakeholders and their perceptions of costs and benefits.

Stakeholders in the food chain

To successfully introduce a new product, every stakeholder has to see a benefit and be motivated to take part of the chain. In agriculture, biotechnology has this far been a "push strategy" where only the first part of the food chain has been presented with benefits in the form of reduced costs. There has been a lack of benefits for the consumers. Therefore the coherence in the food chain is week and developed products are likely to fail. Understanding and assessing the impacts in terms of costs and benefits for each stakeholder is crucial to the development of new products. In the remains of this section every stakeholder in the food chain is presented see figure 1.

Figure 1. Simple presentation of the central actors in food supply chain and the framework in which it operates.



The figure presents a simplification of the system in which the agri-food industry operates. **Politics and law** are the main frame in which the agri-food industry operates. With the significant influence food production has on the environment and rural job creation the food industry plays a special role compared to other industries. Within this framework politicians have to procure legislation that is in concordance with criterias for sustainable development balancing the need for a prosperous growing industry with environmental concerns. In this balancing act, politicians have to pay attention to the public and cannot ignore the opposition against certain products. The moratorium in the EU against the GM crop serves to prove this point.

The consumers obviously play a significant role in the food chain. If there is no interest in buying a product the product will fail on all levels. Consumers quite naturally have an interest in the price of a food product. But there is also a growing concern over ethical issues related to food production which has also been very clearly demonstrated with the introduction of GM food. As food production depends on the exploitation of living resources the ethical issues in this industry are not hard to find. Several of the products that have been or are being developed are not in concordance with the ethical standard of many western consumers. Food producers will in the future have to pay close attention to ethical standards and realise that not every technology that is possible should be pursued. New developments have to be in line with the consumers' wants and needs. Stopping or altering unacceptable products early in the development phase is important not only for ethical reasons but also for economic reasons.

Retailers are the first to feel the unhappiness of consumers and they have to pay close attention to consumers wants to stay in business. The retailers are very powerful stakeholders in the food chain. Any new product has to be accepted by them before a product can find its way to the consumer. If they are not willing to spend sufficient time to market or sell a product, it will fail.

In developing new products the industry has to take into consideration that the retailers have strict demands to logistics. (Jørgensen 1993) describes how a new organically grown bread product failed as a product because raising time required was too long to fit into the existing food chain. Such problems have to be thought of early in the developing phrase. Similar logistical problems are generally known for fresh food products. Using biotechnology to stop the ripening process seams genius from an industry point of view. A later part of the food chain, the consumers, may not share this view and thus the product will fail.

The **Food industry** is also experiencing the challenges of globalisation. Competing on labour intensive work is not a viable strategy for many western food companies. This has led to a strong focus on knowledge intensive, high value added products such as GM crops with improved health quality or functional foods etc. These products involve higher profits and are seen as a plausible path in the future to gain business and stay competitive. There has been a strong lobbyism for the introduction of these new products into the EU, so far without much success.

The **primary agriculture** is under increased pressure from several sides. The sector has experienced falling prices on agricultural products and subsidies are reduced in many countries. At the same time agriculture is moving away from a production orientation towards market orientation based upon consumer wants and needs (Boon 2001).

With the increased international competition a common strategy to stay competitive is to maximise production and reduce costs. The farmer has seldom an influence on the price, so he will often have to reduce costs to be competitive. For the agricultural sector the use of GM crops seems attractive because it presents an option to produce crops at lower costs. Other products of interest is medical or other non-food products with high value characteristics as a strategy for the future (Bedsted 2005).

In the **farm supply business** there is a close connection between the primary farmer and this industry but not much attention has been paid to the end-users of agricultural products. This has led to unacceptable products that are only lead to benefits for the farm supply and the farmers. Such products are not likely to succeed in the market. Further attention will have to be paid to the remaining part of the food chain if new developments are to succeed.

Technology Assessment in a Chain Perspective

To be successful in the food industry it is important to be innovative and continuously seek new markets. But being innovative does not guarantee that a new product is successful. A success may depend on whether or not the retailer will give a product sufficient time on the shelves to be noticed by costumers. In other words a producer is highly dependent on the decisions being made downstream in the food chain. A succesful product introduction allows all stakeholders in the whole food chain to make a profit which satisfies the ethical and moral standards of the consumers. Just one weak link in the chain and the product may fail. Many new products never enter the market because it does not fit into the current food supply chain.

When developing new products or processes it is increasingly important to have a thorough understanding of the whole chain and the motives of each part of the chain. In many TA's the process leads up to a conclusion on which one decision maker will have to act. In a chain perspective there is not only one decision maker, every partner or potential partner in the chain makes a decision. This decision has an influence on all the other decisions. This makes the TA both more complicated but also more realistic in the big picture. Global firm decisions depend not only on their own decisions but also the decisions made by other actors in the whole supply chain.

By conducting TA in a chain perspective new developments can be steered in a better cost-efficient way. New products can be assessed in each part of the chain and if week links are spotted it can be dealt with quickly. This is a benefit for policy making purpose for the governments as new technologies can be aligned with the wants and needs in society. For private companies such an assessment can be used to stay competitive by having better control of the elements in the food chain. This is a benefit for strategic purposes when designing and introducing new products. Furthermore understanding the consequences of new biotechnological products in a chain perspective may be a good starting point for a public debate on of biotechnology.

Conclusion

The agrifood market is undergoing globalisation. The food chains are no longer local or domestic in character, they operate worldwide. The globalisation contains positive aspects as well as challenges that have to be overcome. On the positive side, globalisation has created new markets for the industry and cheaper products for the consumers. On the downside the agrifood industry in the western world cannot compete on cost of labour and operates under strict environmental regulations. The industry is forced to develop high value added products in order to stay competitive on the world market. This has led the attention to the use of biotechnology. This area seams to hold great potentials for the industry but the technology needs to be effectively steered because several aspects of the technology is unacceptable to many stakeholders in the food chain from.

Any chain is only as strong as its weakest link. In this paper a thorough assessment for costs and benefits in each part of the chain supplemented by an ethical and environmental assessment is suggested. Such and assessment will reveal week or strong spots in the chain upon which responsible decisions can be made. It is also argued that such an assessment can be a beneficial tool in the public debate. Technology Assessment in a chain perspective will not guarantee a successful introduction but it will greatly enhance the chances.

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