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Green Technological Foresight on Environmentally Friendly Agriculture 2024 Foresight Brief No. 13

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Sponsors: Danish Forest and Nature Agency, Ministry of the Environment
Type: A national foresight exercise focusing on technologies to manage the impact of agriculture on the environment and landscapes
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Duration: 9 months from 2003 to 2004 **Budget:** €94,000 **Time Horizon:** 2014-2024

Purpose

The purpose has been to thoroughly examine those environmental challenges which agriculture will face in the future - and make policy recommendations on the efforts required to develop and promote technological and structural solutions that can minimize the environmental impact of agricultural production on the surroundings, improve animal welfare and provide new methods and products for agriculture.

Green Technological Foresight Initiative

The Ministry of Science, Technology and Innovation was endowed with funds to carry out a Technological Foresight (TF) project during a three-year period (from 2001 to 2004). The plan was to complete approximately eight foresights during this period. One of these foresights was focused on green technologies in general. Agriculture was identified as sector with major impact on the environment, and a sector where new technologies could ease the environmental strain. The *Green Technological Foresight on Environmental Friendly Agriculture* was a spin off adopted by the Ministry of Environment.

Environmentally Friendly Agriculture

The objective has been to make a catalogue of promising green agricultural technologies and how to promote them.

The process was designed as a number of workshops where stakeholders gave input to an expert group. A professional facilitator helped the communication between stakeholders and experts.

Stakeholder workshops, roadmaps to communicate main trends, and a – rather unsuccessful – Delphi with only a few respondents were used as methods in this foresight project. Stakeholders were recruited continuously through nominations by those persons already involved in the project.

The exercise was organised with a steering group of 4 persons involving 3 ministries and the project leader. It was chaired by a scientific officer from the Forest and Nature Agency. An expert group of 5 persons including the project leader authored the working documents and the final report.

The management of the foresight exercises coordinated a loosely coupled system with focus on the following functions:

- Motivation factors based on visions on the project objectives

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- Communication in the planning with appropriate intermediate aims that can function as guideline in the following project process

- Pro-active leadership during the implementation of the project securing exploration of new possibilities that may appear during the project

Knowledge Based Agriculture

Future farming will orientate and base itself on knowledge and co-operation between farmers, research institutions and authorities. The aim of this co-operation is to create a dynamic and long-term farming policy that can secure that Danish agricultural products are competitive on the world market, without negative consequences for the environment and the nature landscapes. In the foresight there was a general agreement that while agriculture would have even less importance for the Danish GDP in the future, the importance of the sector would be significant for product innovation in the food industry in general and for preserving nature and landscapes.

Seven Recommendations on Future Environmentally Friendly Technologies in Agriculture

According to the foresight exercise, future agricultural systems will be based on the following technologies that have the potential to contribute to future environmental friendly agriculture:

- **Plant Gene Technology** is controversial, but a well-considered application can result in increased and environmental benign production as well as preserve landscape and nature values.
- **Information and Communication Technology (ICT)** includes both decision support systems and a more efficient communication of the latest knowledge about environmentally friendly farming production. The technology does at the same time give completely new possibilities for supervising, modeling and controlling biological environments.

- **Manure Technologies** include knowledge and techniques to handle manure as fertilizer from stable to plants aiming at reduced leaching to the environment.
- **Biomass Technology** consists of technologies that can effectively and cheaply convert biomass into energy and material of high quality.
- **Cultivation and soil preparation** implies intelligent utilisation of biological and agricultural knowledge and is an effective strategy to minimise environmental impact from agriculture. In short: **'good agricultural practice'** based on expert systems and ICT.
- **Precision Farming** uses GPS, GIS, sensors and robots to precisely adjust and eventually avoid the use of fertilizer, pesticides, etc., based on knowledge about variations in conditions of cultivation or environmental fragile areas.
- **New Stable Systems** focusing on low emission of odour and ammonium by means of stable design, new surface materials, feeding, ventilation, and chemical or biological absorption of odour and ammonium.

Potential for Systems Export on Green Technologies

The consideration to the environment and the development of farming and nature-related values as well as optimal utilisation of resources could be seen as a basis for being able to compete internationally for farming products. The reason was that even though the international market will not immediately pay for investments into Danish environment, landscape and nature-related values, there is great potential for exporting the environmental technology to the international agricultural sector. A green image is at the same time a good sales argument at several more markets.

Future Agricultural Technologies will Create a Balance on Three Bottom Lines

The conclusion of the foresight is that the future of agriculture, whether it is intensive (industry-based) or extensive (organic-based), has to be holistic and it will be based on knowledge and co-operation between agriculture, research institutions and authorities. This is to secure a dynamic and long-term

agricultural policy can be created, which will integrate consideration for the environment.

When the technologies of the future environmentally benign agriculture are assessed and selected, it will take place in relation to their contribution to three areas. This is known as 'The Agricultural Triple Bottom Line' (see Figure below).

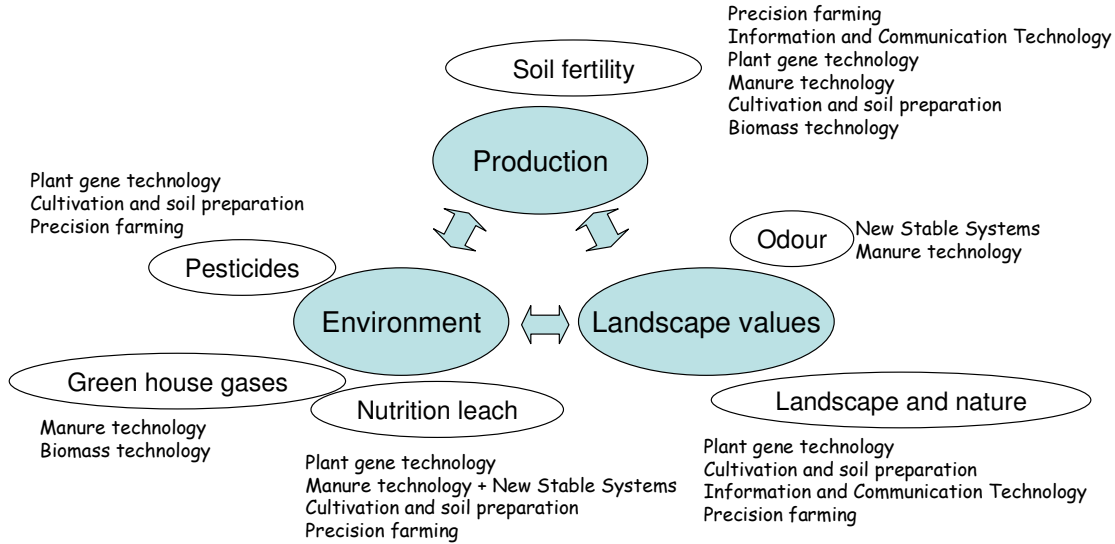


Figure - The Agricultural Triple Bottom Line: The figure demonstrates how the three bottom lines – production, environment, and landscape and nature values – constitute a unity when green technologies are selected for future agricultural systems

The three bottom lines are:

- **Production:** The industry must be able to maintain a profitable and healthy plant and animal production. This is achieved by placing weight on technologies that ensure the soil’s fertility, give operational economical advantages, ensure an improved quality of nutrition and feedstuff and include energy crops and non-food crops.
- **Environment:** The agricultures' activities must be able to be carried out without negative consequences for the environmental physical frames, including space, water and air that can be influenced by wastage from agricultural production.
- **Landscape and Nature-Related Values:** Agriculture needs to be part of managing and creating beautiful landscapes, a versatile nature with many high quality habitats for wild flowers and animals, clean drinking water and recreational values.

A Variety of New Agricultural Concepts

Different agricultural concepts will utilise the technologies differently. Two tracks of agricultural concepts will mutually challenge one another in the future:

- In **industrial-based agriculture** we speak about intensive commercial enterprise, where technologies first and foremost are utilized with a view to production yield and effective environmental solutions.

- In the **organic-based agriculture** the technologies are assessed in proportion to three central principles - precaution, re-circulation and subsidiarity.

	Industrially Oriented Production	Organically Oriented Production
Genetic Technologies	Total use of GMOs and crossing of arts boundaries	Limited to the utilisation of bio-markers in traditional processing
Bio-Energy Technologies	Straw and energy crops for centralised power stations, ethanol and RME factories	Domestic animal fertilizer and N-fixing energy crops for de-centralised bio-gas and thermal gasification
Automation	Milking robots in the stable	Milking robots in the field

Table: An illustration of future uses of green technologies within the two generic production paradigms that can be envisaged for Danish farming.

New technologies can be utilized in both forms of farming with a view to lessening the environmental effect. However, there can be a difference in how the technologies are used as the examples show in the table. The technologies within organic farming are assessed in accordance with three principles: cautionary, re-circulation and subsidiary. Certain technologies, such as genetic engineering, are completely rejected by the organic farming whilst diverted techniques can be used to improve organic crop processing.

Green Technologies – Inside and Outside Agriculture

Green technologies alone are not enough to make agriculture environmentally sustainable. According to the results of this foresight exercise, education and the introduction of new concepts are needed to promote green technologies in the food industry. After all, agricultural production is just the first link in the food production chain. At the other end of this chain, retail and wholesale will have an important role in communicating consumer preferences down stream.

In order for future green technologies to have the maximum impact on the agricultural sector greater collaboration between

the Ministry of Food, Agriculture and Fisheries and the Ministry of the Environment will be required.

Considering that the agricultural sector will become a net producer of energy the Ministry of Transport and Energy should also be involved. The reason is that the major potential synergies between the recommended technologies can be achieved if a systemic and holistic approach governs innovation policy. Finally an infrastructure that can support energy production from biomass will need to be developed. Steps to investigate how manure technologies can be promoted to reduce nitrogen pollution and odour from pigmeat production have been made by the Ministry for the Environment.

Sources and References

'Green Technological Foresight on Environmental Friendly Agriculture' the executive summary is available at www.risoe.dk/rispubl/SYS/ris-r-1512.htm

About the EFMN: Policy Professionals dealing with RTD, Innovation and Economic Development increasingly recognize a need to base decisions on broadly based participative processes of deliberation and consultation with stakeholders. One of the most important tools they apply is FORESIGHT. The EFMN or European Foresight Monitoring Network supports policy professionals by monitoring and analyzing Foresight activities in the European Union, its neighbours and the world. The EFMN helps those involved in policy development to stay up to date on current practice in Foresight. It helps them to tap into a network of know-how and experience on issues related to the day to day design, management and execution of Foresight and Foresight related processes.