ENDURE

European Network for Durable Exploitation of crop protection strategies

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PU Public	**X**
PP Restricted to other programme participants (including the Commission Services)	
RE Restricted to a group specified by the consortium (including the Commission Services)	
CO Confidential, only for members of the consortium (including the Commission Services)	

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Summary

This intermediary report presents the second deliverable of the IA 1.2 ENDURE sub-activity "Foresight study". It reflects the discussion process (M18-27) which followed the scenario building phase (M13-M18).

A preliminary version of the scenarios was delivered at M19. Between M19 and M24, these scenarios were deepened by in-depth interviews with various crop protection stakeholders (members of ENDURE External Advisory Board, external researchers, etc.). In addition, they were further enriched by regional discussion meetings with other ENDURE members: JKI and IHAR in Germany, SSSUP and CNR in Pisa.

A final scenario development meeting was held in Paris at M25, providing the final expert input needed to wrap-up the study. During this meeting, the Expert Group also identified several challenges and opportunities for future research on crop protection, as well as important messages to pass to policy makers.

These outputs were delivered at M27, during a presentation of the foresight study in Brussels, targeting a European-level audience.

→ The D1.10 deliverable contains all the elements presented during this April 15th presentation:

- An introductive part explaining the general context of European crop protection
- A small chapter on the methodology used for this foresight study
- A description of the five scenarios
- And their implications for the European research and policy agendas

ENDURE foresight exercise intends to be further enriched in the following months. An additional discussion meeting, aiming at considering the regional heterogeneity across Europe is planned before publishing the complete study at the end of 2009.

1. Introduction

1.1. General context and current challenges for crop protection

Regarding crop protection, we all know here that we are at a turning point.
For some 40 years, European agriculture has been relying mostly on pesticides for controlling pests, weeds and diseases.
Now, the EU wants to reduce the risks imposed by pesticides on human health and on the environment.
This has been translated into a new legislation, the so-called 'pesticides package'.
This legislation calls for an in-depth reconsideration of crop protection solutions throughout Europe.

We cannot overlook that crop production is essential for the sustainable future of the world, and in order to face the needs of its growing population.
Land-based industries fuelled by crop production are important for Europe.
Pests, weeds and diseases affect crop production, resulting in loss of resources (water, energy, labour) and impact negatively on sustainability.

Then, how are we going to reconcile the objectives of pesticide risk reduction and of sustained crop production?

To address this question, we have pooled a large part of the expertise and scientific knowledge that is available at the European scale:
ENDURE has been launched 2 years ago as a NoE. We intend to boost research and extension needed to reduce the reliance of European agriculture on the use of pesticides.
ENDURE gathers 18 members (research, teaching, extension and industrial institutions) from 10 countries spanning through the EU, from West to East and from North to South. It involves some 300 scientists.
Currently, we are conducting studies on arable, perennial and protected crops, looking at the main pests, weeds and diseases problems that are responsible for the highest use of pesticides throughout Europe.
Our results indicate that there is a potential for reducing pesticide risks and moving towards IPM. Some progress can be achieved rapidly.
But we also see that many of the resources, knowledge and technologies required are not yet available and that we cannot expect to reduce the dependence on pesticides to a significant extent without considering and redesigning whole farming systems.

Therefore, it was also part of our job, in ENDURE, to explore what opportunities science and technologies could offer in the next 20 years to move in this direction, and what research agenda should be set right away to exploit these opportunities.
We have also considered how the various stakeholders could contribute to create the appropriate conditions for farmers to adopt innovative farming systems less dependant on pesticides,
And what kind of political decisions, beyond the pesticides package, would support these changes.

We have performed this exploration in the form of a Foresight exercise. Today, we would like to share our conclusions with you, especially as regards

- the potential offered by some areas of research
- and the possible contribution of policy makers.

1.2. The ENDURE Foresight study

This foresight exercise has been conducted very intensively over more than one year. It has been coordinated by a project team and elaborated by a group of 10 experts coming from 4 of the ENDURE members and covering a large range of disciplines.

We used classical methods: identifying key drivers, making assumptions on it and combining these assumptions into coherent scenarios.
But the scenarios we will present you were also subject to early debates in the course of their construction and have been strongly influenced by a participatory process, involving:

- nearly all the other institutions members of ENDURE
- and also non-research stakeholders (Industry, NGOs…) who are represented in the ENDURE's Advisory Board, some of which are present here today.

Many foresight studies related to agricultural topics have been issued recently. We know of no other foresight devoted to crop protection per se.
Naturally, I don't have to remind you that foresight is not forecast. We have not attempted to guess what crop protection in Europe will look like in 2030.

What we have done is to consider how different global contexts and different options on the role of agriculture in Europe would impact the solutions adopted to control pests, weeds and diseases.
In doing so, we have explored what would be, under different circumstances, the technical and scientific challenges to meet, but also the organisational, social and political implications.

The scenarios we are going to present are considering three different contexts according to the type of governance shaping European agriculture:

- in the first context, the rules are set by a globalised and free market
- in the second, Europe organises its agriculture with the goal of answering global challenges: food self-sufficiency or energy-saving
- in the third, governance of agriculture is handed over to local communities

2. Five scenarios on Crop protection in Europe in 2030

2.1. Globalised free market

2.1.1. The Commodity Market Player

In this scenario, agriculture and farmers are back in the limelight as important actors of the European economy.

General context
Facing the growing world demand for food, a consensus has emerged that the best response is in a globalised and free market.
Agricultural subsidies have been eliminated in WTO negotiations, but demand for food pushes commodity prices to high levels.
Despite climate change, conditions still provide European agriculture with a competitive advantage over other continents.

European agriculture
In this context, European farmers choose to compete on the commodity markets for basic crops such as grain, maize and OSR, increasing their competitiveness by reducing manpower and production costs.
This creates an agriculture of large farms, homogeneous cropping systems with low crop diversity and uniform landscapes.

At one point, farmers faced a lot of hostility from civil society. Civil society raised environmental concerns and expressed a demand for "nature".
Eventually the conflict was resolved by partitioning land use.

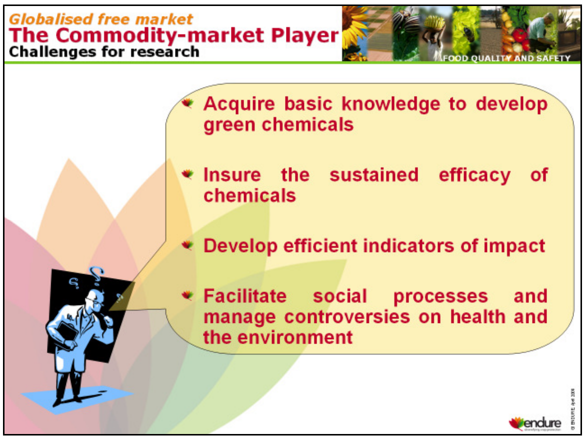
- On the one hand, large areas devoted to intensive agriculture, but including ecological compensation areas;
- and on the other hand areas devoted to conservation and recreation.

Crop protection

To protect their crops, farmers look for solutions with the best cost/benefit ratio and which are easy to implement on large farms. They have argued that chemical control still remains the best option when it comes to competing with countries that have not taken a strict position on pesticides, and their view has been generally accepted.

Research in ecotoxicology has improved the ability to detect, monitor and trace residues in food and to measure impacts on ecosystems. This has made it possible to shift to a regime where all stakeholders are held legally accountable for any damage caused by pesticides, rather than relying on upstream regulatory constraints.
Therefore farmers have very good reasons to reduce the risks linked to pesticide use.
And this is also the case for the agrochemical industry: it continues to find European agriculture a highly rewarding market. However, it faces the challenges of:

- Developing new molecules with safer modes of action,
- and contributing to cautious and parsimonious use of their products.



Innovation and Research

- Private industry remains the major innovator in crop protection. Academic research is called on to provide the range of basic knowledge needed to develop green chemicals (stimulating plant defence, reducing virulence, etc.)
- Researchers also address the durability of these chemically based solutions, for instance combining chemicals with less susceptible cultivars
- Policy makers rely on public research to provide efficient indicators of impact and monitoring schemes
- Social scientists contribute to facilitate social processes / manage controversies on health and the environment

Policy

- The development of green molecules should be accelerated by a specific fast-track registration process and should benefit minor as well as major crops
- Develop the legislation to make users accountable of their environmental impacts

2.1.2. The Specialised High-tech Grower

Agriculture and farmers are part of a successful web of economic activities.

General context
We are in the same context as in the previous scenario: a free and globalised market. European farmers have become entrepreneurs in the knowledge-based bioeconomy advocated in the Lisbon strategy.

As innovation is key to maintaining a competitive advantage, farmers have given up selling large quantities of basic commodities. They concentrate on specialised high-quality products for export, generating high added value.

European agriculture
European agriculture is highly diversified and produces a large range of goods for a diversity of uses:

- unique food products (champagne, saffron, Jersey Royal potatoes)
- plants designed for green chemistry
- top grade products that sell throughout the world (ornamentals)

Crop production is fully integrated in a vertical chain that also includes

- designing of specific genotypes,
- processing using patented technology,
- marketing along well identified distribution channels.

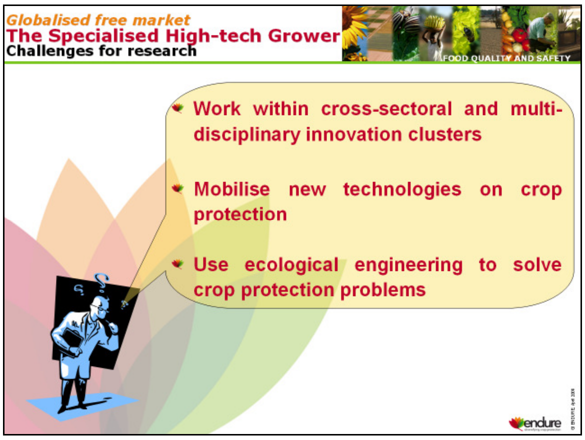
Crop protection

Europe's decision to adopt more cautious regulations on pesticide use than other regions of the world incited European farmers to shift away from basic commodities.

With high added value products, they can afford sophisticated crop protection strategies:

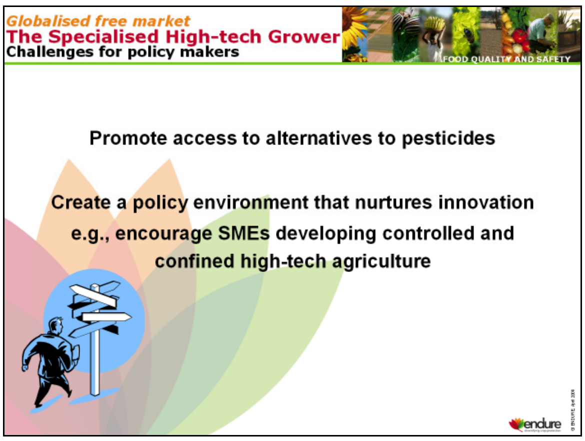
- starting with resistant and sanitised plant material,
- producing under controlled conditions that minimise pest occurrence (for instance protected agriculture),
- using pesticides in a targeted way, fully exploiting the options offered by precision agriculture and information technologies,
- quickly sorting and processing products.

Crop protection is treated as an integral part of the production process, just as risk management is in industry.



Innovation and Research

- Researchers are part of R&D teams which devise production processes. They interact with a wide range of other technological disciplines in cross-sectoral innovation clusters
- New technologies such as information technologies, nanotechnologies and robotics are mobilised on crop protection
- Ecological engineering is used to solve some crop protection problems and, alongside other knowledge-based advances, becomes economically valuable



Policy

- Ease the development of and the access to alternatives to pesticides
- Create a policy environment that nurtures innovation, e.g. encourage SMEs developing controlled and confined high-tech agriculture

2.2. European response to global challenges

2.2.1. The Sustainable Food provider

Fear of food crises. That's what drives this scenario.

General context
Food availability is a worldwide issue. High food prices, unequal access to resources, geopolitical tensions and uncertainties about climate change drive policy choices.

Self-sufficiency in food and feed is now the main goal ascribed to European agriculture. Consumers are pushed to choose local products, limiting imports. Agricultural production is encouraged for domestic consumption and becomes a priority land use.

European agriculture
Authorities influence planning of agriculture activities across Europe, through economic incentives and extension services.
To optimise overall production, crops are allocated according to the most favourable growing conditions (soil, climate, pest pressure).

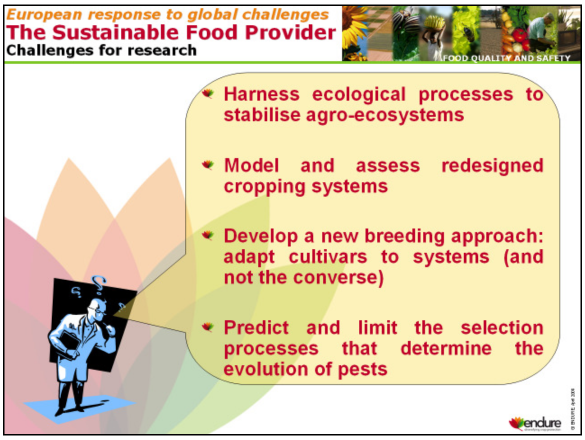
People are concerned with the risk of harming future production. Conserving those resources that are essential for production (soil, water, genetic diversity) is given priority.

Farmers are expected to manage robust cropping systems designed to deliver reliable and stable production even under unfavourable conditions.

Crop protection

To ensure reliability and stability over the long term, farmers seek cropping systems inherently less vulnerable to pests. Stakeholders work together to redesign production systems.
Ecological engineering, landscape ecology and varieties adapted to regional conditions are used to meet this goal. To stabilise losses due to pests, each farmer grows a diversity of crops (mixed cultivar stands, rotations) in a complex and diverse system.

Farmers address pest problems by drawing from a diverse array of approaches. They create synergies by integrating complementary methods: biocontrol agents, plant genetics, cultural and mechanical methods, biotechnologies, and IT.
Chemicals are still used to address problematic pests in critical situations.



Innovation & Research

Agricultural research is strong and coordinated at the European level. Society has high expectations of research and researchers enjoy strong public support. Rather than managing pest outbreaks, they tackle the underlying causes of crop loss. Their aim is to make production more stable and predictable.
The challenges for research include:

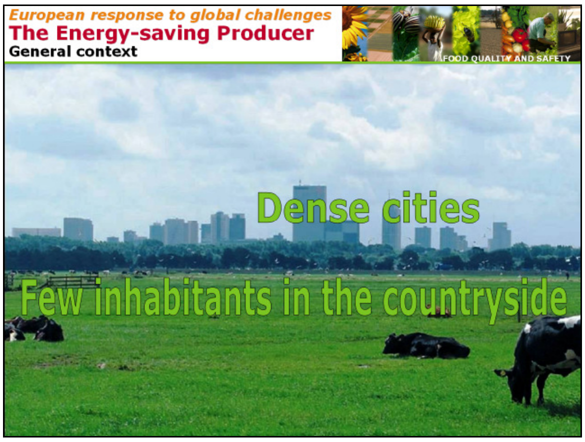
- Harnessing ecological processes to stabilise agroecosystems
- Modelling and assessing redesigned cropping systems
- Develop a new breeding approach: adapt cultivars to systems
- Predicting and limiting the selection processes that determine the evolution of pests

Policy

This scenario relies on strong supporting policies:

- New registration process for adapted cultivars
- Harmonised pest surveillance and warning systems
- Pilot farms and training networks to promote innovation
- Stabilisation policy to promote long-term strategies
- Targeted incentives to support farmers in transition phase

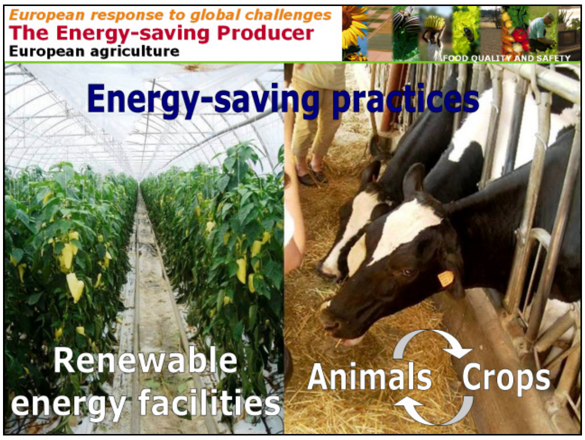
2.2.2. The Energy-saving Producer



Global context

We are really doing something about energy**.** Global energy consumption has continued to rise, yet fossil energy is scarce and costly. There is a global desire to reduce energy use. Concerns over climate change are fuelling this desire. The EU makes a radical political choice: limit transportation, reduce imports and favour domestic production.

Limited individual mobility is greatly modifying the European landscape: people concentrate in cities. Few inhabitants are left in the countryside. In cities and peri-urban areas, housing, industry, leisure and farming compete for land.



European agriculture

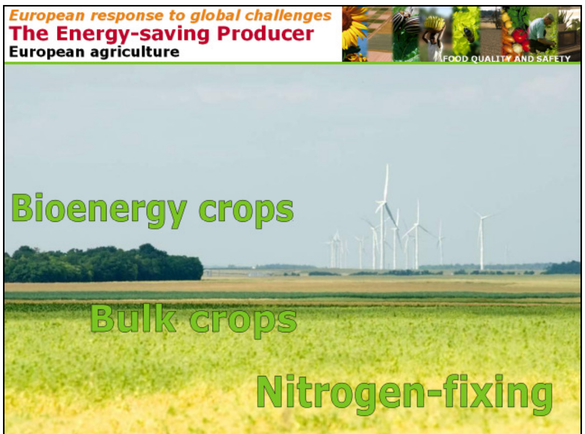
European agricultural policy is integrated into a broader policy on energy and carbon. In addition to producing food locally, farmers are required to reduce energy consumption and even generate energy. In both cities and the countryside, farmers are encouraged to adopt energy-saving practices.

Low-energy agriculture is implemented. This means:

- Limited use of non-renewable inputs (nitrogen fixation rather than synthetic fertilisers)
- Integrated renewable energy facilities (energy-positive glasshouses)
- Integrated animal and crop systems (manure is used to save synthetic nitrogen and produce energy)

There are two distinct types of agriculture. One based in urban and peri-urban areas, the other in rural areas.

To limit transportation, fruits and vegetables are grown within micro-farms or industrial units in or near cities. This includes: vertical agriculture, highly controlled hydroponics, intensive organic, composting and recycling.



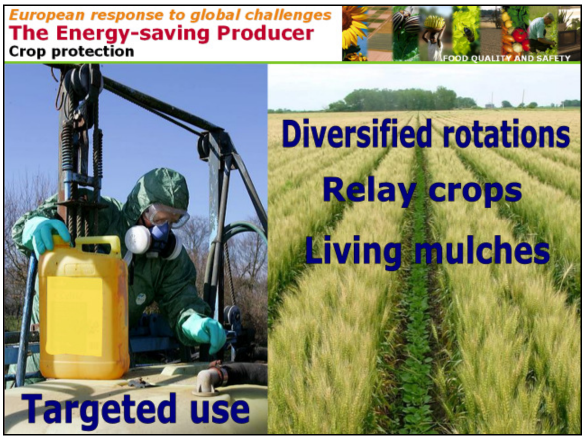
Arable crops are produced in the countryside on large farms integrating livestock, bulk crops and nitrogen-fixing crops, either in rotation or as cover crops. Machinery use is limited, with preference given to no-till practices. Perennial bioenergy crops cover large areas.

Crop protection

Farmers face the challenge of managing pests using low-energy methods.

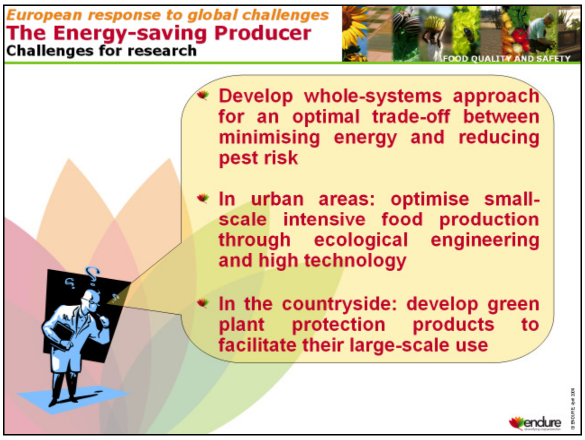
A zero-pesticides approach is adopted in cities, because of the high-population density. To deal with pests, urban farmers rely on:

- Crop diversity to spread the risk
- Healthy planting material and sanitation
- Resistant varieties
- Biocontrol agents



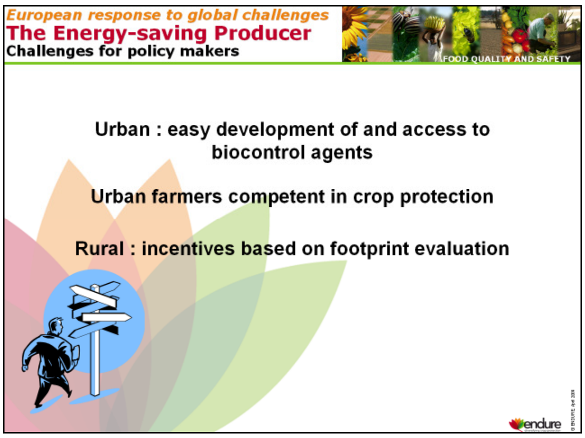
In the countryside crop protection must be very efficient to ensure that investment in precious inputs is not wasted. Therefore farmers rely heavily on plant protection products. They are used in a targeted way, exploiting the options offered by precision agriculture and information technologies.

The use of no-till practices can lead to heavy weed pressure; this is alleviated by the use of diversified rotations, relay crops and living mulches. New pests tend to emerge in large areas covered with bioenergy crops.



Research

Researchers focus on minimising energy inputs. They develop comprehensive approaches to assess the energy balance of the food system. The goal is to find an optimal trade-off between minimising energy inputs and reducing pest risks.
In cities, crop protection for small-scale intensive food production is optimised through ecological engineering and high technology
The development of green plant protection products facilitates their large-scale use in the countryside.



Policy

- Urban: easy development of and access to biocontrol agents
- Urban farmers competent in crop protection
- Rural : incentives based on footprint evaluation

2.3. Local development of *territoires:* The Community-conscious Farmer

This is not a crisis scenario.

Global context

The world produces all the food it needs. Europe both produces some of its own food and feed, and imports some to supplement its own production.

Export of manufactured goods is the major foreign income earner for Europe. And Europe continues to be the region of the world that is most visited by foreign tourists.

Agriculture is not a major export sector, as Europe is no longer as competitive as other heavyweight food exporters.

People, companies, and economic activity in general have returned to the countryside, driven by the search for a better quality of life.
The result is a blurring of differences between rural and urban areas.

The concept of *territoire* is a major building block for Europe. It is a combination of a physical area, its community and its economic activities.

The EU uses it as an instrument for economic growth and hands over to *territoires* the responsibility for their own development.

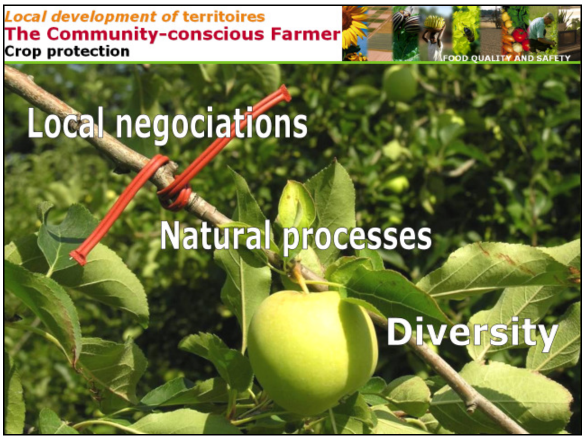
Territoires find themselves competing for residents, visitors, investors and businesses. It is in their interest to gain recognition that they are different and attractive.

European agriculture

Agriculture is understood as essential to making these *territoires* more attractive. Agriculture is now accepted as a provider of a multiplicity of services:

- Producing both quality food for local consumption and regional foods to strengthen local identity
- Managing large areas of land cheaply
- Creating and maintaining landscapes
- Increasing wild and cultivated biodiversity
- Protecting natural resources
- Creating amenities for tourism and recreation
- Contributing to healthy food and a healthy environment

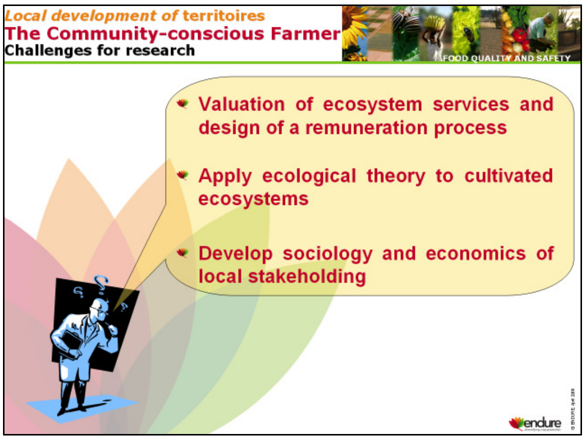
Agriculture is diverse, defined by and adjusted to diverse local demands of territoire stakeholders.



Crop protection

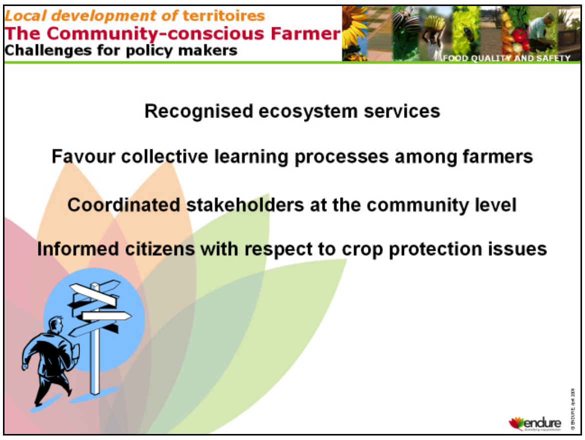
Pests must be managed with means that are compatible with the new priorities placed on agriculture:

- Local negotiations determine the choice of plant protection strategies
- Natural processes are used as alternatives to less-acceptable control methods
- Spatial, temporal and genetic diversity is a tool to manage pests communities



Research

- Valuation of ecosystem services and designing a remuneration process
- Apply ecological theory to cultivated ecosystems. Understand how ecological factors affect pest populations
- Sociology and economics of local stakeholding



Policy

- Recognised multiple services rendered by agriculture, including ecosystem services
- Favour collective learning processes among farmers
- Coordinated stakeholders at the community level
- Informed citizens regarding crop protection issues

2.4. Conclusion

This is a very condensed presentation of the five scenarios in their three different contexts. I hope you see that each scenario favours a different sort of agriculture with different priorities for crop protection.

One reminder: Foresight studies are neither predictive nor prescriptive.
That means, we don't want to discuss which is the most likely to come about, and we don't want to discuss the merits of any particular scenario. And, in fact, because we don't have much time, we don't really want to discuss the scenarios per se.

But we do hope that each scenario carries some element of truth, some internal logic, that you consider relevant for the future, but also, relevant today.
The scenarios should serve as a tool for reflection and debate. We'd like to move away from dualistic and overly simplistic points of view. The scenarios should open up new vistas and allow you to imagine completely new possibilities and come to the conclusion that we are not at all stuck in the current situation.

There are new roles to be taken up by a variety of stakeholders. And if these new roles and responsibilities are really taken up by the various players, this will drive change. Society is ready.

- We've heard farmers say they are ready and that they actually look forward to becoming (or to continue to be) agents of change, drivers of innovation.
- We've heard that chemical industry people are ready to adopt the concept of IPM.
- We're seeing that new demands are placed on researchers in crop protection who can once again become key players in the innovation process.
- Policy makers at the European level have begun to create a policy environment that facilitates the changes desired.

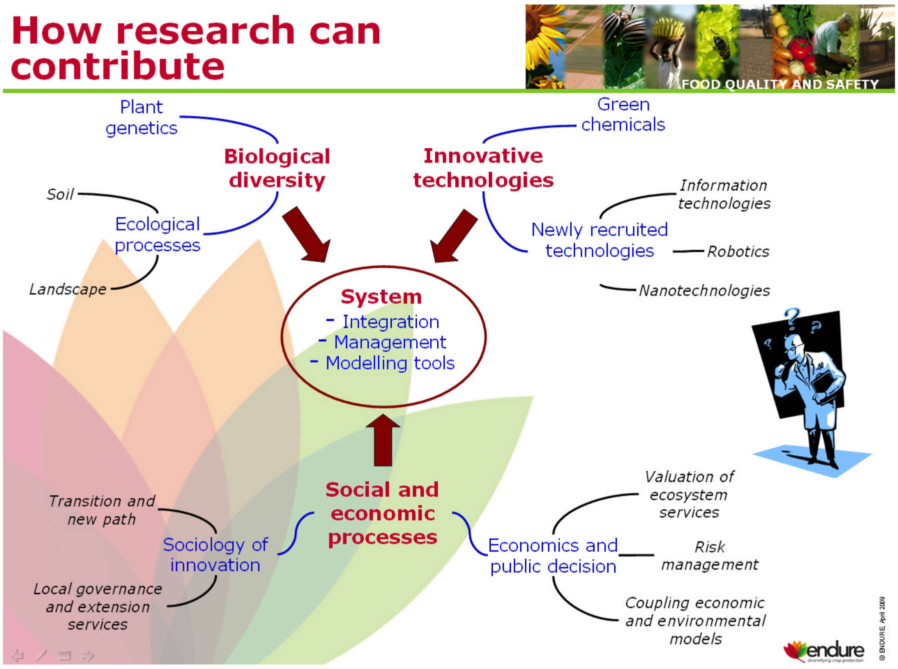
So it's an opportunity, but it is also a challenge:
There is talk about futuristic capabilities of new technologies or new approaches, but is research really ready to deliver on these? We have to make sure the research agenda is adapted to the new expectations. We have to make sure that the institutions, organisations, the incentives needed for this change are there.

So let's share our ideas on the implications of the future of crop protection on the research agenda, on policies regarding inputs, agriculture, health and the environment, and education.

3. Setting up agendas for meeting the challenges posed by crop protection in the years to come

3.1. Research agenda

Working on the scenarios, we have identified challenges to crop protection, but also technological and science-based opportunities to meet these challenges.



3.1.1. Biological diversity

Conventional agriculture has been based on concepts of uniformity and simplification, including attempts to eradicate pests. Science has now stressed the importance of biological diversity and, more importantly, is learning how to deal with it. Biological diversity is not only a resource to be protected; it is also a tool which can be used to manage pest populations.

Soil, which is so important for crop production, is a good example.
Until recently, it was a complete black box for biologists. Now, with the introduction of metagenomics, we are discovering the tens of thousands of different microbial species that inhabit a single soil sample. This will have tremendous implications on managing soil pests and pathogens, as well as weeds.

The same is true for above ground ecosystems. We already exploit them to some extent in biocontrol. But we still have a lot to learn, if we want to take better advantage of, for instance, landscape ecology.

Diversity also applies to cultivated plants. New cropping systems require new adapted varieties. Plant breeding is making considerable progress in its ability to exploit a larger basis of the natural diversity of cultivated species (for example using association genetics). It offers the possibility of defining new breeding objectives, but also of introducing new breeding processes.

3.1.2. Technological innovations

We can also count on the development of a range of technological innovations
In nearly all the scenarios, chemical control remains a component of the crop protection tool box, to be used to a lesser or greater extent. The role these chemicals will play depends on the discovery of plant protection products posing little toxicological and ecotoxicological concerns, what we have termed “green chemicals”**.**

There is indeed a whole range of possibilities for modes of action drastically differing from that of conventional pesticides seeking to kill pests: for instance, compounds that interfere with the virulence of pathogens or with their toxin production, or that increase plant defense mechanisms.

Currently, scientists are rapidly unravelling the genomics of pests and pathogens, and the genes involved in their interactions with plants. This will provide a rich source for innovative targets for these chemicals.

Some other technologies have not yet been much mobilised in agriculture. ENDURE has identified a significant potential in the application of information technologies, nanotechnologies, and robotics to monitoring and control of pests, weeds and diseases. These developments are in progress, but practical applications might not be ready for another ten years.

3.1.3. Systems approach

The future of crop protection is no longer in single “silver bullet” solutions. Over the recent years, science has given increasing attention room to holistic approaches in order to understand the functioning of organisms (systems biology) as well as that of ecosystems (systems ecology).

It means that research will be increasingly able to integrate the discoveries occurring in the above new fields, together with more classical knowledge in biology and agronomy, to get an overall understanding of the functioning of a cultivated ecosystem.

Systems approaches supported by powerful modelling tools will generate a better understanding of the dynamics of pests and other biological components, integrating the temporal dimension of cropping systems and the spatial dimension of landscapes. It will be more feasible to simulate the complex interrelations among populations and with abiotic processes and to test the multiple consequences of cultural practices, on the crop as well as on the environment, as a basis for management recommendations.

Supporting multidisciplinary research programs will be key to these developments, and needed, whatever scenario is considered.

3.1.4. Social and human sciences contributions

Working on the concept of sustainable development has led research realise that social scientists must be an integrate part of these multidisciplinary programs.
Crop protection is an issue that involves a wide range of actors. In all scenarios, these actors have to evolve and modify their relationships relative to the present situation. Very often, solving social, economic or organisational problems is a prerequisite to technological change.

Economy and sociology of innovation, relationships between science and society and the organisation of all stakeholders (researchers, advisors, farmers, consumers) along the knowledge chain, valuation of ecosystem services from agriculture beyond food production, systems for risk management: sociologists and economists must further explore these fields if we are to understand how to facilitate the transition towards new forms of crop protection in 2030.

3.2. Policy agenda

The scenarios highlight a number of areas where policy-making has an important role to play in reducing pesticide reliance or risks in agricultural systems in Europe. Policy efforts in these areas would help to respond to current societal demands as well as facilitate changes toward the 2030 situations described in the scenarios.

Regarding agricultural inputs, policies that favour the development and access to biopesticides and biological control agents are needed. A new process of registration of cultivars will make it easier to develop and gain access to resistant varieties, to increase plant genetic diversity and in general, to provide plant material better adapted to IPM. The development of alternative strategies in minor crops would benefit from the ability to resort to pesticides when all else fails. Policies limiting access to pesticides need to take this into account.

Environmental and health impact indicators as well as pesticide use indicators are obviously needed to evaluate progress. Work on these indicators, however, should not overshadow the fact that agriculture also generates positive environmental impacts. In this regard, the recognition of the ecosystem services provided by agriculture calls for ways to measure and pay for these services. Beyond their use in monitoring policy implementation, field data also have an important role to play in promoting innovation. Surveillance data coupled with information systems will judiciously inform on-farm decisions. Data and knowledge acquired from pilot farms and made available in reference guides or via other dissemination strategies are important learning tools for innovation in crop protection. With respect to environmental demands, crop protection must satisfy a wide variety of constraints related to water quality and availability, pesticides, energy, greenhouse gases, and biodiversity. Overall coherence between these demands must be found to avoid unwanted contradictions or overly complex policy environments.

Changes in the knowledge-to-practice chain are required. Innovation toward IPM emerges from a learning process rather than as a result of a transfer of a ready-to-use technological package. Farmer-to-farmer and farmer-advisor-researcher-industry innovation networks are important in this respect. Promoting these interactions require changes in advisory systems, and more generally, the development of policies that favour collective learning processes.

On the time dimension, crop protection that better fits the requirements of sustainable development will benefit from stabilisation policies of agricultural prices that favour long-term approaches and behaviours. Similarly, on the spatial dimension, concerted action on scales larger than the farm needs to be favoured. This entails creating the conditions allowing stakeholders to coordinate their behaviours for the development of Community IPM.

And lastly, beyond specific recommendations on the research agenda that will best enable change, we need to recognise and support the creation of those synergies that emerge from European-level research and exchange. Such initiatives provide significant added-value relative to purely national outlooks on crop protection strategies.