From Science to Field
Maize Based Cropping Systems (MBCS) Case Study – Guide Number 1

Maize Based Cropping Systems in Four European Regions: SWOT Analysis and IPM Considerations

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Maize in four European regions. Clockwise from top: Spain (© Belén Lumbierres, UdL); Italy (© Maurizio Sattin, CNR); Netherlands (© Jos Groten, PPO); Hungary (© Jozsef Kiss, SZIE).

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Description of maize based cropping systems (MBCSs)

Maize is a key crop in maize based cropping systems (MBCSs) in many regions of the European Union whether it be in terms of acreages, frequency or role in the crop rotation system. However, depending on a region's climatic, farming and economic conditions, the role of maize is different. In order to characterise and evaluate various MBCSs in the EU, we selected four regions. In the **northern** region (Denmark, The Netherlands, Poland), maize is mostly cultivated as non-irrigated continuous silage maize or rotated with grasses. In the **central-eastern** region (Hungary), the major systems are non-irrigated continuous grain maize (Tolna County, Hungary) or in rotation mostly with winter wheat, or oilseed rape and sunflower (Békés County, Hungary). In the **south-western** region (Ebro Valley, Spain), irrigated grain and silage maize/winter wheat rotations as well as irrigated continuous grain maize are prevalent. In the **southern** region (Po Valley, Italy), grain maize irrigated and rotated (mainly with winter wheat or soybean) is the main system identified, while other important systems include silage maize rotated and irrigated, as well as continuous and irrigated grain maize. Other minor systems in this region are continuous irrigated silage maize as well as non-irrigated rotated grain maize.

SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of continuous and rotated MBCS in four European regions

SWOT analysis was used to identify the positive (strengths) and negative (weaknesses) agronomic, environmental and economic elements of continuous and rotated systems in four European regions, and possible conditions that can improve (opportunities) or negatively influence (threats) their sustainability. Strengths, weaknesses, opportunities and threats were identified as follows:

Strengths	
Rotated maize systems	**Continuous maize systems**
> Higher maize yields than in continuous maize systems (northern and southern regions) **> Better opportunities to control annual and perennial weed species (all regions)** **> Lower potential of mycotoxin contamination in grain (all)** **> Better prevention of certain pest and disease occurrences (all)** **> Limited chance for development of resistance to herbicides (all)** **> Diversification of the system and enhancement of natural enemies (all)** **> Improvement of soil structure and organic matter content (all)** **> Lower incidence of corn borers through the adoption of *Bt* maize (Ebro valley, Spain)** **> Rotation is the most important non-chemical tool to avoid damage by larvae of western corn rootworm (*Diabrotica virgifera virgifera* LeConte, WCR) (central-eastern and southern regions)**	**> Farmers are familiar with maize cultivation (all regions)** **> Favourable natural (climatic) cultivation conditions, high and stable yield levels (central-eastern, south-western and southern regions)** **> Market/demand for maize products (northern and southern regions)** **> Available infrastructure for irrigation (south-western and southern regions)** **> Experienced contractors with available equipment (northern and southern regions)** **> Lower incidence of corn borers due to the adoption of *Bt* maize (south-western region)**

> Reduction of nitrogen input when rotating with leguminous crops (south-western and southern region) > Available infrastructure for irrigation (south-western and southern regions) > Experienced contractors with available equipment (northern and southern regions)	

Weaknesses

Rotated maize systems	Continuous maize systems
> Fluctuating market prices and yields of different crops in rotation (all regions) > Higher cost of different types of equipment needed for crops in the rotation (all) > Maize / winter wheat rotation may increase *Fusarium* spp. and mycotoxin contamination on wheat (all) > Low ecological diversity of crops when only spring-summer crops are in rotation (southern region) > Crops in rotation may serve as virus reservoirs (south-western region) or increase *Rhizoctonia* spp. (northern region) > Many commercial extension agents (northern region) > Farmers less experienced in cultivating other crops (central-eastern and northern regions) > High N fertiliser inputs (south-western region)	> Intensification (high external inputs) of agricultural systems (all regions) > Fluctuating grain maize prices (all) > Soil erosion or compaction (all) > Relatively high pesticide inputs due to the occurrence of specific pests and diseases (all) > High risk of first generation of Mediterranean corn borer (*Sesamia nonagrioides* Lefèbvre, MCB) (south-western region) > High fertiliser inputs (all) > Nitrogen leaching (all) > Crop residue management needed (all) > Less diverse landscape and limited enhancement of natural enemies (all) > Farmers relying on contractors (northern and southern regions) > Many commercial extension agents (northern and southern regions)

Opportunities for rotated and continuous maize systems

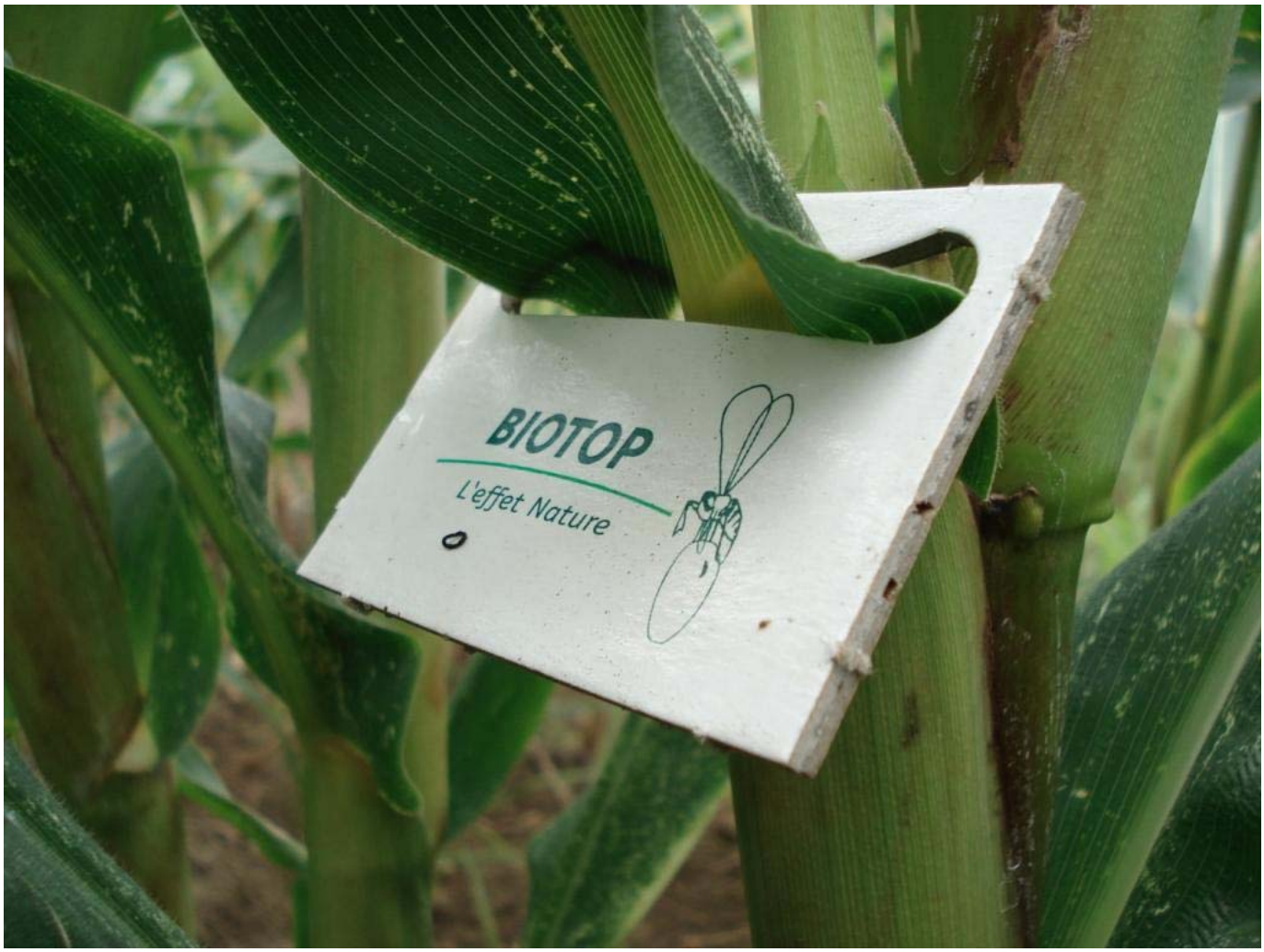
> Price stabilisation (all regions)
> *Bt* maize (central-eastern, south-western and southern regions)
> Improvement of irrigation systems for irrigated maize (south-western region)
> GM maize, for example against WCR, or herbicide tolerant crops (all)
> Reduction of pesticide use through Integrated Pest Management (IPM) strategies (all)
> Selection of hybrids (yield, drought, disease tolerance) (all)
> Biological control (*Trichogramma* spp. against European corn borer, *Ostrinia nubilalis* Hbn., ECB) (all)
> Informed decision making (pheromone and other field monitoring tools) and control of pests (all)
> Forecast and decision support systems for pests or diseases (all)
> Habitat management for the enhancement of natural enemies (all)
> Information and training directly or via regional agricultural extension services or other advisory services (all)
> Financial support to farmers to buy or adjust equipment (all)

Threats for rotated and continuous maize systems

> Build-up of specific weed, pest and disease populations in continuous systems (all regions)
> Mycotoxin contamination more probable in continuous systems and in maize/winter wheat rotation (all)
> Development of herbicide resistance in continuous systems (all)
> Support policy for agri-environmental programmes for crop rotation are limited or not available for all farmers or do not exist (all)
> Environmental and food safety concerns for both systems (all)
> Fluctuating product, input and fuel prices for both systems (all)

Advanced IPM solutions for MBCS

Advanced pest control practices (practices which already exist but are not exploited) such as optimising crops in the rotation system, efficient choice of hybrids (drought and/or disease tolerant), timing of planting, pesticide choice (including bio-pesticides), biological control (*Trichogramma* spp. against ECB) and pest forecast methods have been indicated as valuable tools for developing sustainable IPM systems. However, a systems approach that considers all the above tools is still relatively poorly developed at both research and farm level.



The use of *Trichogramma* spp. against ECB is one of a range of tools that can be employed, but we need a systems approach to advanced IPM. © Biotop, Valbonne, France.

Our view:

> Comprehensive evaluation methods for IPM options and strategies for MBCS are still missing and should be developed. These methods should consider various (environmental, agronomic, technical, economic, etc.) aspects and be supported with policy aims at the regional level.

> Research on and implementation of a systems approach (i.e. at cropping or even farming level), according to different regions, should be encouraged and adopted at various levels.

Innovative IPM solutions for MBCS

The introduction of innovative practices (those that could be implemented in the next 5-10 years) such as *Bt* maize resistant to ECB and WCR, or herbicide tolerant hybrids, precision spraying, improved decision support systems and pest forecasting methods in IPM strategies can better address the EU's strategic commitment to the sustainable use of pesticides and, consequently, more environmentally sustainable MBCS. However, constraints and challenges for their development and implementation should be tackled.

***Bt* maize, resistant to WCR and Lepidoptera and tolerant to certain herbicides, in field tests. © Jozsef Kiss, SZIE, Hungary.**

Our view:

> Applied multi-disciplinary research and farmer incentives to encourage the adoption of new IPM strategies in MBCS are essential.

> Regional policies that allow the use of GM maize in areas with heavy and difficult-to-control infestations could contribute to reducing the pesticide load.

> The improved links between stakeholders (i.e. research, industry, consultants, contractors and farmers) can be the basis for a better understanding and efficient use of innovative IPM strategies through mutual recognition and information sharing.

Considerations for IPM development in MBCS

Across the analysed MBCSs in selected regions, we conclude that economic driving forces are key factors for triggering farmers' decisions, including those related to crop protection issues. Because of this, a multi-year approach (i.e. involving more diverse crops in rotation) is not frequently considered by farmers or is not even available for implementation.

Our view:

> The adoption of more diversified crop rotations in MBCS is essential to develop 'new' systems that break the life cycle of certain pests. However, differences among regions should be considered.

> Regional policies to encourage sustainable systems based on crop rotation and advanced/innovative pest control strategies should be developed. These systems should have longer term benefits and be economically competitive with the current ones. The new Framework Directive on the sustainable use of pesticides can provide a solid basis for this purpose.

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Summary

Maize based cropping systems (MBCSs), with different shares of maize crop in the rotations, are dominant in European arable systems. Maize cultivation (either grain or green crop) itself covered an area of 14-15 million hectares in European Union Member States between 2007 and 2009. The pesticide load is different in types of active ingredients and target organisms depending on the region. These systems may involve other crops (for example, winter cereals, sunflower, soybean) and are infested by certain pests such as weeds (i.e. competitive species), aphids, soil insects, the quarantine pest western corn rootworm (*Diabrotica virgifera virgifera* LeConte, WCR), corn borers and pathogens such as *Fusarium* species. Mycotoxins potentially produced by phytopathogenic fungi have serious food and feed safety implications. New challenges (availability of resources, economic aspects, knowledge and training, etc.) should also be considered when implementing Integrated Pest Management (IPM). The MBCS group analysed crop protection issues in maize based cropping systems of four reasonably homogeneous (from the maize cropping systems point of view) European regions. Building on the work done in the Maize Case Study, pests of economic importance as well as the current and advanced pest control practices were identified and a SWOT analysis performed on these systems.

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About ENDURE

ENDURE is the European Network for the Durable Exploitation of Crop Protection Strategies. ENDURE is a Network of Excellence (NoE) with two key objectives: restructuring European research and development on the use of plant protection products, and establishing ENDURE as a world leader in the development and implementation of sustainable pest control strategies through:

- Building a lasting crop protection research community
- Providing end-users with a broader range of short-term solutions
- Developing a holistic approach to sustainable pest management
- Taking stock of and informing plant protection policy changes.

Eighteen organisations in 10 European countries are committed to ENDURE for four years (2007-2010), with financial support from the European Commission's Sixth Framework Programme, priority 5: Food Quality and Security.

Website and ENDURE Information Centre:

www.endure-network.eu

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