

ENDURE Policy Brief: Biocontrol opportunities in the implementation of Integrated Pest Management

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BIOCONTROL: ITS ROLE IN INTEGRATED PRACTICES FOR CROP PROTECTION

“Member States shall establish or support the establishment of necessary conditions for the implementation of integrated pest management.” (Directive 2009/128/EC, Art. 14.2).

In support of this objective, the European Network of Excellence ENDURE brings insights into the conditions for successful implementation of integrated pest management (IPM).

Changing farmer practices depends not only on the initiative of individual farmers but also on the knowledge, economic and social networks to which they belong.

The protection of cultivated crops against pests (insect pests, diseases and weeds) requires the integration of different practices that also protect the environment and the health of the population, and ensure a satisfactory economic return to farmers

In reality, the concept of Integrated Pest Management (IPM) covers a variety of practices which ensure satisfactory plant health: agronomic practices, prophylaxis, use of tolerant or resistant varieties, landscape and field margin management, selection and use of control measures according to economic thresholds, education and training of users and operators, and the safe application of pesticides.

In a detailed analysis of the successes and failures in biocontrol in Europe, the ENDURE group on biocontrol focused on microbial control agents for plant pathogens and conservation biological control of invertebrate pests, and has identified some of the key biological and economic constraints to the evaluation and commercial development of biocontrol agents, and ways these may be overcome by research, technical improvements, industry initiatives and policy interventions.



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Main findings:

1. Biocontrol is one of the major IPM tools and should be rapidly developed in Europe, where growth in the use of biocontrols is well below that of the rest of the world.
2. Biocontrol agents are specific and well used for certain crops, particularly covered crops, but there are significant opportunities for their use in other sectors.
3. This specificity presents significant challenges for biocontrol producers, who do not enjoy the return on investment seen in the chemical control industry.
4. Increased use of biocontrols will require support from policy makers. In particular, support for research, education and extension, and in adapting the regulatory framework.

Biocontrol opportunities in IPM implementation

“IPM requires the implementation of practices adapted to regions, ecological conditions, crops and economic situations, and must take into consideration the crop protection practices already in local use”

1. Biocontrol in Europe

In the UK, arable farmers use different tools as part of Entry-Level Stewardship and agri-environmental programmes combined with the IPM concept, but according to the survey they express strong support for future adoption of biocontrol measures, including, for example, pheromone monitoring, using variety mixtures, introducing predators, pheromone control and using trap crops (see Figure 1).

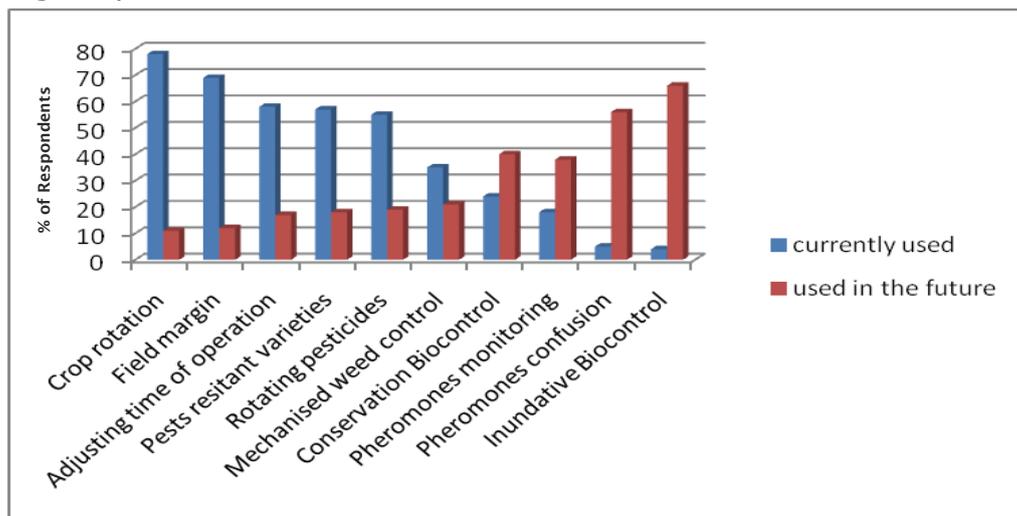


Figure 1: Survey crop protection practices in 571 arable farms in UK. Source: J. W. Gowin, Newcastle University, 2007.

Elsewhere in Europe, IPM practices are being adopted with the same intensity in similar cropping conditions, and we can observe:

- With the use of chemical pesticides considered excessive, prophylaxis, education and training of users, use of decision support tools and, naturally, biocontrol agents (only 3% of the market) need to be strongly reinforced.
- Because the increased use of mechanisation on large plots eliminated unplanted areas and borders, more attention should also be given to landscape management in order to create refuges or safeguard biodiversity.
- In general it is also considered that farmers have adopted satisfactory cultural practices, though substantial improvements can be achieved in several regions (notably some Mediterranean and new Member States).

“IPM requires the use of several tools, preventive and curative. They should lead to the reduction of chemical pesticide use and the promotion of biocontrol systems.”

Recommended measures to better implement IPM

- Take heed of crop rotation to avoid the presence of soil pathogens for the crop to be planted. If possible, use a decision support system (DSS) based on soil sampling to control the pathogen-free status of the soil
- Start with healthy planting material
- Give preference to the use of preventive methods
- Give preference to the use of resistant planting material
- General adoption of landscape management in order to build up refuges for beneficials (conservation biocontrol), to reduce erosion etc.
- Use of forecasting models and decision support tools
- Strong reduction in the use of chemical pesticides
- Development and promotion of biocontrol
- Education and training of farmers and others involved in crop protection

“Biocontrol is one of the major IPM tools and therefore requires rapid development in Europe. Contrary to other parts of the world, regulatory and political conditions in Europe create important obstacles for the development of biocontrol”

2. Biocontrol and biological control agents (BCAs)

In contrast to the past, when farmers tried to eradicate pests with synthetic chemical pesticides, biocontrol aims to best exploit the use of biodiversity, promoting the natural interaction between living organisms, natural extracts and bioactive molecules, ultimately ensuring the health of the plants. Although a few BCAs have a curative effect (for example, *Bacillus thuringiensis* against insect pests) most should be used as preventive methods. The basic strategies are:

Augmentative/inundative biological control: Beneficial invertebrates or micro-organisms are periodically released in order to colonise and suppress specific pests. Bio-active molecules such as insect pheromones, kairomones or low-risk natural extracts are also considered in biocontrol strategies.

Classical (also 'importation') biological control: Intentional introduction of exotic BCAs for permanent establishment and long-term pest control.

Conservation biological control: Maintenance or manipulation of the environment to enhance the survival, fecundity, longevity, and behaviour of natural enemies to increase their effectiveness.

3. Biocontrol situation in 2010 and prospects for the future

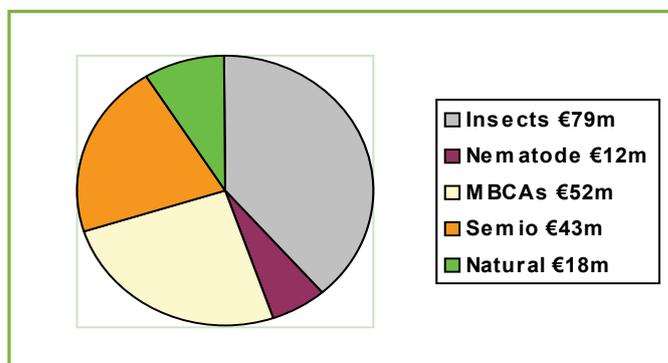
An ENDURE research team dedicated to the exploitation of natural biological processes has produced a comprehensive study (“Review of factors influencing the success or failure of biocontrol and recommended orientation for new R&D projects”) with the following findings on the biocontrol market:

- Total sales in Europe in 2008 were €204m (3% of the total plant protection market) (Figure 2).

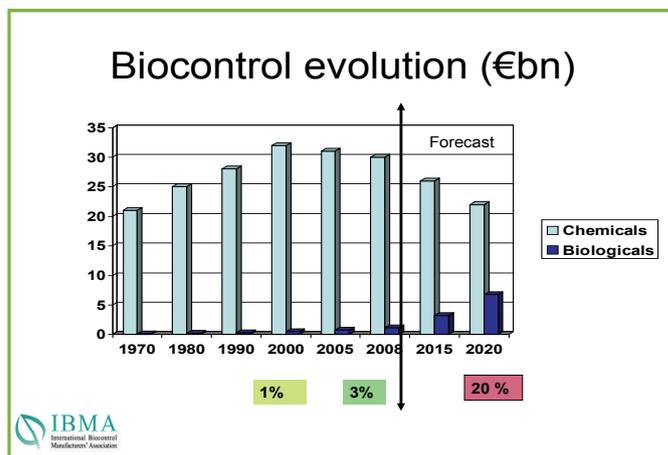
- Biological control agents (BCAs) are mostly used in protected crops and to a much lesser extent in fruit crops and grapevine.

- The worldwide biocontrol market continues to grow by 15% per year and should reach €7bn in 2020 (Figure 3).

- However, under prevailing conditions growth is predicted to be much slower in Europe, with growth of 4%, creating a market worth only €300m in 2020 if the obstacles identified in this Policy Brief are not overcome.



Above: Figure 2: Sales of BCAs in Europe (2008). Source: ENDURE. Below: Figure 3: Evolution of world sales of chemical pesticides and biologicals. Source: IBMA.



Biocontrol opportunities in IPM implementation

“Safety for public health and the environment are the major benefits attached to semiochemicals and biocontrol agents.”

4. Identified obstacles

A. Few research results are transmitted into practice

For 50 years, research institutions and academia have identified a huge quantity of biologicals and demonstrated their potential interest. These results have been the subject of publications in scientific journals, but most of them concerned small or niche markets and very few have been put into practice. There remain many important gaps to be filled in order to address the most important pests.

	Toxicity	Environment	Efficacy	Ease of use	Economy	Societal benefits
Micro biologicals	xxxx	xxxx	xxx	xx	xx	xxxx
Macro biologicals	xxxx	xxx	xx	xx	xx	xxx
Semio-chemicals	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
Botanicals	xx	xx	xxx	xxxx	xxx	xxx
Synthetic pesticides	x	x	xxxx	xxxx	xxxx	xx

Table 1: Comparative performance of biologicals (x=low performance, xxxxx=high performance. Source: IBMA.

C. Discovery of BCAs of scientific interest without commercial perspectives

The ENDURE Deliverable “Guidelines for the screening of new microbial biocontrol agents for commercial use”, revealed that many scientific investigations have been made by public research organisations with little heed to their practical use. To enable their economic potential to be assessed, it is important to screen potential biocontrol agents for commercial exploitation. Similar to chemical pesticides, a screening system should be used which, early enough, considers the economic, technical and legal requirements which will enable their production, commercialisation and use.

D. Formulation and delivery technologies

This aspect is often neglected. Biocontrol agents, especially living organisms, need a specific and careful delivery system unlike that used for chemical pesticides.

E. BCAs are specific and cannot cover all crop protection needs in Europe

Some very important opportunities can be quantified, but many crops and problems remain to be tackled (see Table 2 on page 5). Biologicals are available and adopted in several sectors, such as the control of pests and diseases in covered crops or sex confusion of codling moth in orchards, but in other sectors crop protection needs are not currently met. This, however, can be addressed by one of the virtues of IPM: one can use the best of what is available and request R&D to search for what is missing.



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Biocontrol opportunities in IPM implementation

“The development and commercial success of bio-control agents is constrained by the size of the companies involved and the fact it is a young, relatively undeveloped market”

F. Regulation of BCAs

While EU and national policies clearly support the replacement of chemical pesticides with biologicals, the current regulations for BCAs are not well adapted. Adapting authorisation procedures for BCAs could promote the development efforts of the companies involved (mostly small and medium size enterprises). Currently, these companies often find investment difficult because of the relatively small target market. Currently already available or identified solutions in biocontrol for wider implementation are listed in Table 2.



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Crop	Problem	PPP used (tonnes Ai) Eurostat 2005	Identified opportunities with BCAs (X=low – XXX=high)			
			MBCAs	IBCA s	Semio-chemicals	Naturals
Cereals	Soil-borne diseases	52,000	XX			X
	Foliar diseases		XXX			XXX
	Pests		X	XX	XXX	XX
	Weeds		X dicots	X		X
Maize	Pests	17,500	XX	XXX		X
	Diseases		X			XX
	Weeds		X	X		X
Potatoes	Diseases	10,000	XXX			XX
	Weeds		X			X
Orchards	Fungal diseases	18,000	XX			XX
	Bacterial diseases		XXX			XX
	Pests		X	X	XXX	XX
	Weeds		XXX			X
Grapevine	Pests	116,000	X	X	XXX	XXX
	Diseases		XXX			XXX
	Weeds		X			X
Covered crops	Insects	3,000	XXX	XXX	XXX	XXX
	Diseases		XXX			XXX

Table 2: Current (2010) opportunities for BCAs on the EU’s most important crops. Source: Agri-data, Qualitative Survey on Plant Protection in Europe, 2009.

G. Technical support, extension and education

Staff in technical institutions may currently find it easier and more rewarding to promote chemical pesticides. Therefore extension services have very little support for the promotion of biological and farmers have very little information and education.

Biocontrol opportunities in IPM implementation

“Due to the high specificity of biologicals, the size of the target markets is a critical factor and the anticipated return on investment is lower than in the conventional plant protection industry”

H. Industry perspectives

The biocontrol business is mostly in the hands of small and often very small companies. A few have reached a size which enables them to produce and sell their products with a reasonable return (economies of scale). Some are daughter companies of larger firms (mostly Japanese). More recently, large chemical companies such as Bayer, BASF and Syngenta have begun to reinvestigate biologicals



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which can be integrated into IPM programmes. Due to the high specificity of biologicals, the size of the target markets is a critical factor and the anticipated return on investment is lower than in the conventional plant protection industry. Comparing estimated production and other costs relative to the sales value at plateau level, highlights large differences between chemical pesticides and microbial biocontrol agents. The gap between the two in terms of estimated profit is nearly 10-fold in favour of chemical pesticide (see Table 3).

	Chemicals	MBCAs
Earnings before investments, taxes and amortisation (EBITA)	54	14
Profit after taxes, provisions and amortisation	18	2

Table 3: Earnings and profit: comparison between chemicals and microbial BCAs (expressed as percentage of the sales value of the commercial product). Source: ENDURE DR4.7.

5. Benefits of biocontrol

The use of biocontrol provides substantial benefits which justify the efforts needed for their adoption.

- Generally very low human toxicity
- Environmentally friendly
- Insignificant or no residues in the food
- Enables pesticide use to be reduced
- In several cases, provides economic performance similar to or better than chemical pesticides (see Table 4)

	Confusion	Insecticides
Number of treatments	2	5
Product costs	145	325
Manpower	79	96
Amortisation material	41	205
Fuel/energy (direct)	16	8
TOTAL	281	634

Table 4: Economic balance of pheromone sex confusion technique versus insecticide to control *Cochylis* and *Endemis* in a vineyard in Champagne, France. Figures are annual and expressed in €/ha. Source: Auge Fils, Reims, France.

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About ENDURE

ENDURE is the European Network for the Durable Exploitation of Crop Protection Strategies bringing together more than 300 researchers from 18 organisations in 10 European countries. ENDURE is:

- Building an international multi-disciplinary research community with a shared vision
- Interacting with advisers and extension services to ensure research advances become a field reality
- Providing scientific support to policy makers for the implementation of the European Union's new pesticide legislation.

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6. Conclusions and recommendations

Biologicals are major elements to be considered in sustainable agriculture and IPM. They will not completely replace chemicals but offer a safe alternative for protecting and enhancing plant health rather than to eradicate pests and pathogens.



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The main technical conclusions of the study and perspectives for future R&D projects highlight the need to improve the screening of biocontrol agents, to improve knowledge on efficacy-related issues, to promote multi-disciplinary approaches to integrate biocontrol with IPM, to develop adapted delivery technologies and to safeguard the durability of biocontrol.

For CBC the priority is for research on ecological interactions, especially at large scales, and to demonstrate the effect on pest suppression. Other key issues relate to the training of advisers and farmers, the development of decision support systems and the establishment of farmers' networks. Future issues for industry include quality control and the improvement of distribution systems.

Avenues for the development of biological control in IPM:

1. Identify and develop at field level those biocontrol solutions which have already been successfully identified (a role for technical institutes and extension services).
2. Joint public and private research projects for the main crops and problems not yet solved.
3. Adaptation of the regulations for biological controls.
4. Strong promotion of biologicals through education, demonstrations, decision support systems etc, delivered by cooperatives, farmers' organisations and the industry.
5. Incentives for the creation of a strong biocontrol industry, encompassing small companies to serve local and niche markets, and larger industries formed through the cooperation and concentration of SMEs to serve larger regional and global markets.