# CHAPTER 1:

# General Introduction and Background to the problem

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Late blight (caused by *Phytophthora infestans*) is the most devastating disease affecting organic and conventional potato production in the EU. Under suitable environmental conditions (i.e. temperatures between 15 and 23ºC coupled with high humidity and prolonged leaf wetness) the disease spreads very rapidly with 3-4 days between infection and sporulation. Unchecked, it can cause complete crop losses because the foliage is killed prematurely and infected tubers are unmarketable and if stored, can cause widespread rotting. Fungicides can delay and slow down the spread of disease. However, their efficacy is variable and they rarely give complete control. Applications of protective, copper-based fungicides have been allowed for late blight control in organic production systems for many years and are 'considered to be traditional organic farming practices' (Anonymous, 2002). In many situations they can be used in organic crops where the need is justified, with the permission of the relevant certifying authority. However, there are restrictions and national legislation or organic certification standards may either limit or forbid their use and some growers elect not to use them for various reasons (Anonymous, 2002; IFOAM, 2000; Tamm *et al.*, 2004). This reflects the concerns about the potential toxic effects of copper-based fungicides on plants, beneficial soil and other organisms, biodiversity and human health and recognizes widespread opinion that their use in organic farming is not compatible with the underlying principles.

In the EU replacement of copper-based fungicides with other methods for disease control is a priority in organic farming policy (Anonymous, 2002). In accordance with EU Regulation No. 2092/91, they were due to be prohibited for use in organic farming from March 2002, but the ban was delayed because of the increased risk of crop diseases and associated economic losses of organic producers in the medium to long term without effective alternative control methods in place. A maximum application of 8 kg of elemental copper/ha/year was imposed for annual crops until the end of 2005, decreasing to 6 kg per year thereafter. (Regulations may be changed at any time as viable alternatives are developed or if approval for use of copper-based fungicides is withdrawn on safety grounds under the EC Review programme for existing active substances).

Potato is a major cash crop in many European organic farming businesses and profitability is determined primarily by marketable yield. On average, yields of organic potato crops that are treated with copper-based fungicides for late blight control are estimated to outyield untreated ones by about 25% (with a range from 0 to 100%). Yields are higher because the fungicides extend the growing period (from the start of growth until the foliage is killed off, either by the disease or by the grower to prevent it spreading from infected leaves to the tubers and to neighbouring potato crops) by the order of 2 to 4 weeks. In financial terms, the additional growing period (and hence extra yield) resulting from copper-based fungicide protection is worth between 15 and 45 million EUROS per year to EU organic-potato growers (calculated on the basis of 10000 ha of organic potato production, a tuber growth rate of 0.5 t/ha/day and a price of 270 EUROS/t). Without these fungicides or effective alternative control methods, this income would be lost and threaten the economic viability of organic potato production and/or whole organic farming businesses (especially those which rely heavily on the income from potato crops) in many areas of the EU. Since EU policies are aimed at supporting an expansion of organic production, a replacement for copper containing and other chemical fungicides is urgently required to avoid such consequences. In addition, any increase in late blight incidence on organic farms resulting from poorer control could also influence blight epidemics in neighbouring conventional farms and threaten conventional production systems.

An integrated systems approach to late blight management in organic systems that eliminates or reduces the need for copper-based fungicides could solve these problems. Such an approach integrates use of (i) resistant varieties, (ii) available agronomic control strategies (iii) alternative treatments (e.g. organically-based fungicides, plant 'strengtheners' and biocontrol agents which can replace synthetic and copper-based fungicides) and (iv) optimisation of blight control treatments utilising existing blight forecasting systems with the aim of maximising synergistic interactions between (i), (ii), (iii) and (iv).

**Aims and Objectives**

Blight-MOP was a multi-disciplinary, pan-European project on **Blight:** the aim was 'Development of a systems approach for the **M**anagement of potato late blight (caused by *Phytophthora infestans*) in EU **O**rganic **P**otato production in the absence of copper-based fungicides. The quantitative target was to maintain potato yields and quality at levels currently obtained with the use of copper-based fungicides.

To achieve this, the following individual project objectives were set (see also Figure 1):

***1.1 Assessment of socio-economic impact of late blight and 'state of the art' blight management practices in EU organic potato production systems.***

The effect of EU Regulation No. 2092/91 banning the use of copper-based fungicides in organic potato production was difficult to assess, due to a lack of reliable data on: (i) blight incidence and resulting yield losses in organic potato production (ii) blight management strategies currently used in organic potato production in different regions of the EU and (iii) the potential socio-economic impact of the ban on copper-based fungicides on EU organic potato production and its competitiveness in an international market.

At the outset of the project therefore, Blight-MOP surveyed the currently used blight management systems in organic potato production and assessed the agronomic and socio-economic impact of the disease on organic potato production in different regions of the EU, in order to quantify the:

(i) extent to which existing late blight control strategies are implemented in organic potato production in different regions of the EU
(ii) reliance on copper fungicides of existing organic production systems (the effect of such fungicides on profit margins) and the potential economic effect of the ban on copper-based fungicides
(iii) efficacy required from alternative blight management strategies to maintain the economic viability of EU organic potato production systems.

***1.2 Assessment of varietal performance in organic production systems in different EU regions and interactions with local blight populations.***

Potato varieties with race specific (highly effective resistance based on R-genes) and race non-specific resistance (partial resistance/tolerance) are available. However, their suitability as part of a blight management strategy has mainly been evaluated in conventional production systems which rely on multiple applications of a range of synthetic fungicides with different modes of action e.g. contact, translaminar and systemic. Such results may be misleading because overall resistance may be influenced by other components of the production system apart from the disease control regimes, such as differences in nutrient availability to the crop. Breakdown of resistance is also an important issue to consider: if the same resistant potato varieties are grown frequently in the same geographic area, new races or more aggressive strains of *P. infestans* develop/accumulate that overcome their resistance.

This assessment involved detailed field characterisation of the:

(i) agronomic and economic suitability of a range of varieties for organic potato production in different areas of the EU

(ii) race structure and aggressiveness of local *P. infestans* populations (to assess the risk for breakdown in variety performance in different EU-regions)

(iii) potential suitability of varieties for within field diversification strategies to prevent/delay blight epidemics

### *1.3 Development of within field diversification strategies to prevent/delay blight epidemics*

Evidence suggests that blight epidemics can be prevented or at least delayed by growing potato varieties with different forms of resistance as mixtures or in alternating rows. Intercropping is another approach where other crops that can provide physical barriers for spore dispersal are grown between rows or beds of potatoes. Potential disadvantages of using variety mixtures are increased costs associated with the establishment, harvest and processing of crops. Effects of these three different diversification strategies on late blight incidence and crop yield and quality were assessed in different countries within the EU.

### *1.4 Optimisation of agronomic strategies for the management of late blight*

In addition to the use of resistant/tolerant varieties, a range of other agronomic strategies have been shown to reduce the incidence or at least the severity of late blight development. These include the following:

(i) effective methods for removal of volunteer or groundkeeper potatoes which are a primary inoculum source of *P. infestans* that can infect newly-planted crops
(ii) Pre-sprouting of seed tubers, crop planting dates, seed densities and irrigation schedules (to avoid periods of high blight pressure in the growing season)
(iii) nutritional regimes (to avoid susceptibility or increase resistance to late blight) and
(iv) methods and timing of defoliation (to maximise yield while avoiding tuber infection).

By assessing and seeking to optimise these treatments, the aim was to develop "locally adapted" agronomic management systems for late blight in EU-organic potato production.

### *1.5 Development of alternative control treatments to copper fungicides, which comply with organic farming standards*

Various alternative treatments have been developed for control of fungal pathogens including microbial antagonists, plant and compost extracts, which have (i) effects on the fungus (direct antifungal effects or stimulation of competitor micro-organisms) and/or (ii) effects on the plant via resistance inducing/"plant strengthening" activities. However, there are few reports of successful alternative control approaches using these treatments against late blight and few methods have been evaluated in field trials. The suitability of alternatives including microbial preparations, plant, seaweed and compost extracts and other materials for late blight control was assessed. The intention was to develop any preparations showing incontrovertible evidence of effectiveness further for field evaluation and potential commercial exploitation after completion of the project.

### *1.6. Evaluation of novel application and formulation strategies for copper-free / alternative and copper- based late blight treatments.*

Compared with conventional overhead hydraulic sprayers, other systems such as directed, air-assisted and electrostatic, offer a more complete and more uniform spread of the active ingredient on leaves. This has led to reductions in pesticide application rates in conventional agriculture. Directed applications of alternative treatments with potential to reduce the quantities of copper released from spraying into the environment and costs (alternative treatments are more expensive than copper-based fungicides) were compared with overhead application. Efficacy of reduced inputs and different formulations of alternative and copper-based fungicides (i.e. less than 8 or 6kg/ha/yr) was also investigated. This was in case the regulatory authorities should decide to extend the current derogation to apply reduced doses (but with further reductions below the current 6kg/ha/yr of elemental copper limit), until effective alternative treatments are registered and licensed for commercial use.

### *1.7. Integration of optimised resistance management, diversification, agronomic and alternative treatment strategies into existing organic potato management systems*

The systems approach to late blight management involves integrating components of variety resistance, agronomic practices and/or novel treatments. Through survey and laboratory and field evaluations Blight-MOP project identified the major components with potential to contribute to an effective disease management system in the absence of copper-based fungicides (or with much reduced doses). Some have direct effects on the onset and severity of disease; others advance tuber-bulking so that an acceptable marketable yield can be achieved before it results in the death of the crop.
In the final year of the project, in each of the seven participating countries, the aim was to evaluate the physical and financial performance of crops grown with most effective combinations in field experiments on ‘MODEL’ (Research) Farms. On commercial or ‘LINK’ farms, optimised blight management systems were compared with existing systems. This approach was designed to construct blight management systems that are customised / adapted to organic production systems in different regions of the EU.

### The Blight-MOP programme

The Blight-MOP consortium included 13 partners from 7 European countries (Table 1) representing a range of environmental conditions and approaches to potato production in organic systems. Commercial growers were closely involved in each country throughout the programme providing information and sites and facilities for field experiments. Additional inputs were received inputs from advisors, certifying authorities, processors, retailers and Potato industry organisations.
Details of the individual Workpackages comprising Blight-MOP are shown in Figure 1 and their results are presented in this Final Report.

Table 1. Blight-MOP partners

| Country | Code | Partner | URL |
|---|---|---|---|
| | | | |
| UK-United Kingdom | UNEW | Nafferton Ecological Farming Group, University of Newcastle, Nafferton Farm, Stocksfield, Northumberland, NE43 7XD, England,UK | http://www.ncl.ac.uk/tcoa/producers/ |
| | EFRC | Elm Farm Research Centre, Hamstead Marshall, Newbury, RG20 0HR, England, UK | http://www.efrc.com/ |
| | | | |
| CH-Switzerland | FiBL | Swiss Research Institute of Organic Agriculture, Ackerstrasse, Postfach CH-5070 Frick, Switzerland,CH. | http://www.fibl.org/ |
| | FAL | Agroscope FAL Reckenholz<br>Swiss Federal Research Station of Agroecology and Agriculture, Postfach191, Reckenholzstrasse, 8046 Zurich, CH. | http://www.reckenholz.ch/doc/en/ |
| | | | |
| F-France | INRA | Unite Mixte de Recherches, INRA/ENSAR Bio3P ( Biologie des Organismes Et des Populations appliquee a la Protection des Plantes,<br>INRA Centre de Rennes, Domaine de la Motte,<br>BP 35327, F-35653 LE RHEU Cedex, F. | http://www.rennes.inra.fr/umrbio3p/ |
| | GRAB | Groupe de Recherche en Agriculture Biologique, Site Agroparc, BP1222, 84911 Avignon, cedex 9, F. | ________________________ |
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| D-Germany | KU | Department of Ecological Plant Protection, University of Kassel, Nordbahnhofstr. 1 a<br>D-37 213 Witzenhausen, D. | http://www.wiz.uni-kassel.de/phytomed/index_e.html |
| | BBA | Federal Biological Research Centre for | http://www.bba.de/ |

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| | | Agriculture and Forestry, Institute for Biological Control, Heinrichstrasse 243, 64287 Darmstadt, D | |
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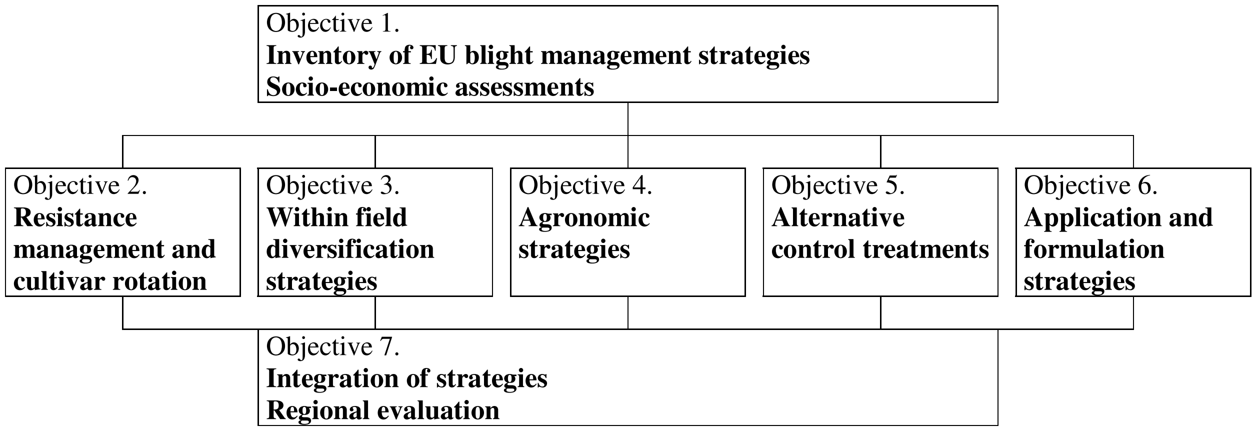
| DK-Denmark | DIAS | Danish Institute of Agricultural Sciences Research Centre Flakkebjerg, D-4200,DK. | http://www.agrsci.org/ |
| | | | |
| N-Norway | NCEA | Norwegian Centre for Ecological Agriculture, Tingvoll Gard, N-6630 Tingvoll, N. | http://www.norsok.no/indexe.htm |
| | | | |
| NL-Netherlands | LBI | Louis Bolk Instituut, Hoofdstraat 24, NL-3972 LA Driebergen, NL. | http://www.louisbolk.nl/ |
| | Plant-Ri | Plant Research International BV, Postbus 16, Droevendaalsesteeg 1, 6700 AA Wageningen, NL. | http://www.plant.wageningen-ur.nl/ |
| | LEI | Agricultural Economics Research Institute, PO Box 29703, Burgemeester Patijnlaan No 19, NL-2502 LS, The Hague, NL | http://www.lei.dlo.nl/uk/ |

Figure 1. Blight-MOP structure and interdependency of project objectives




## References

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