IPM Blight 2.0 :
using pathogen population information to improve late blight control

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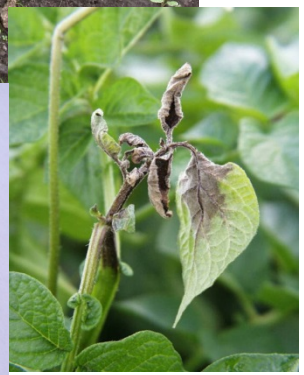
project coordinator
on behalf of all project partners

INRA
SCIENCE & IMPACT

C-IPM Coordinated Integrated Pest Management in Europe

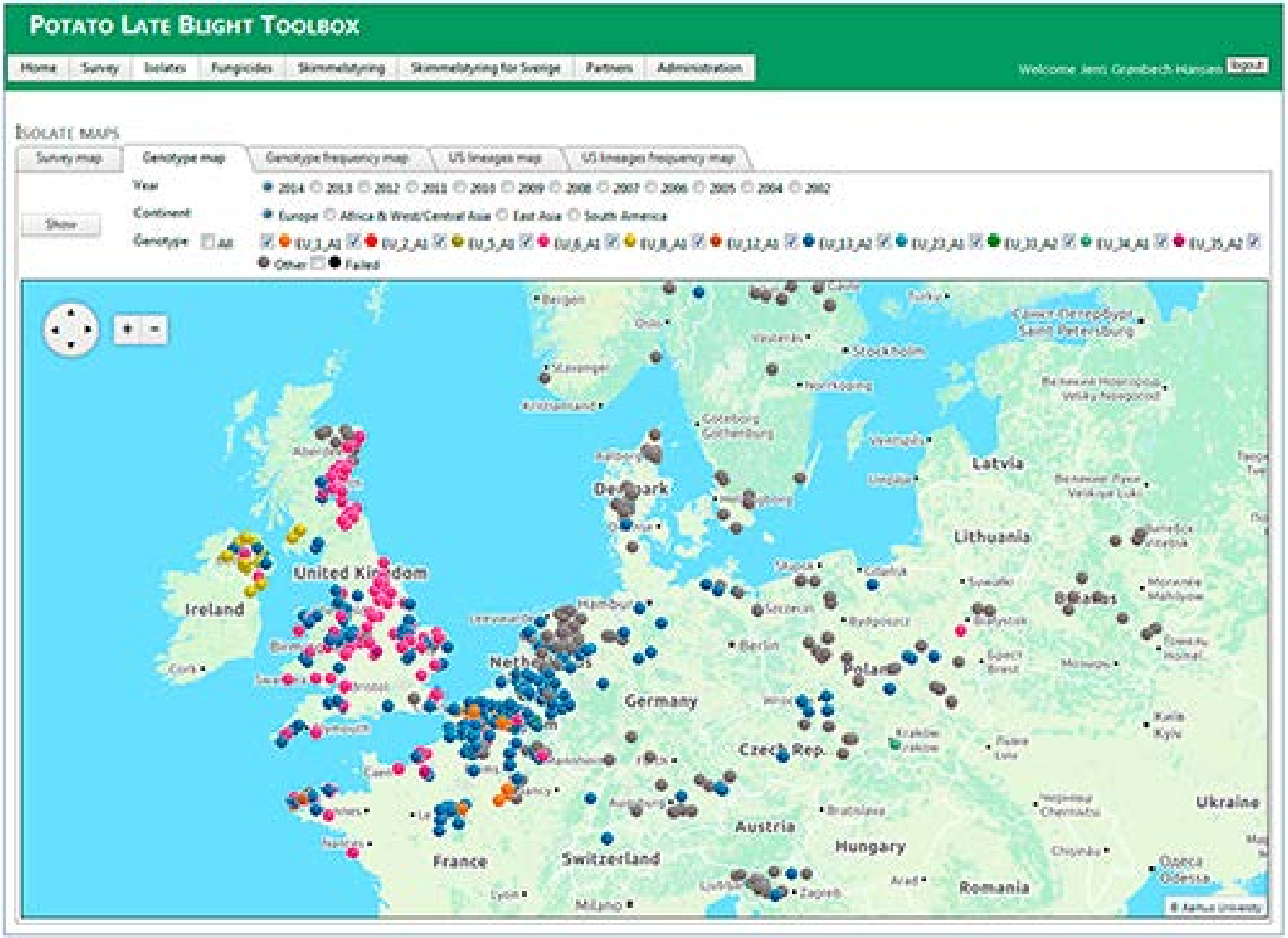
Phytophthora infestans on potato

- **A destructive…**
  - Strong defoliation
  - Fast epidemics
  - Over 900 M€ annual cost in Europe

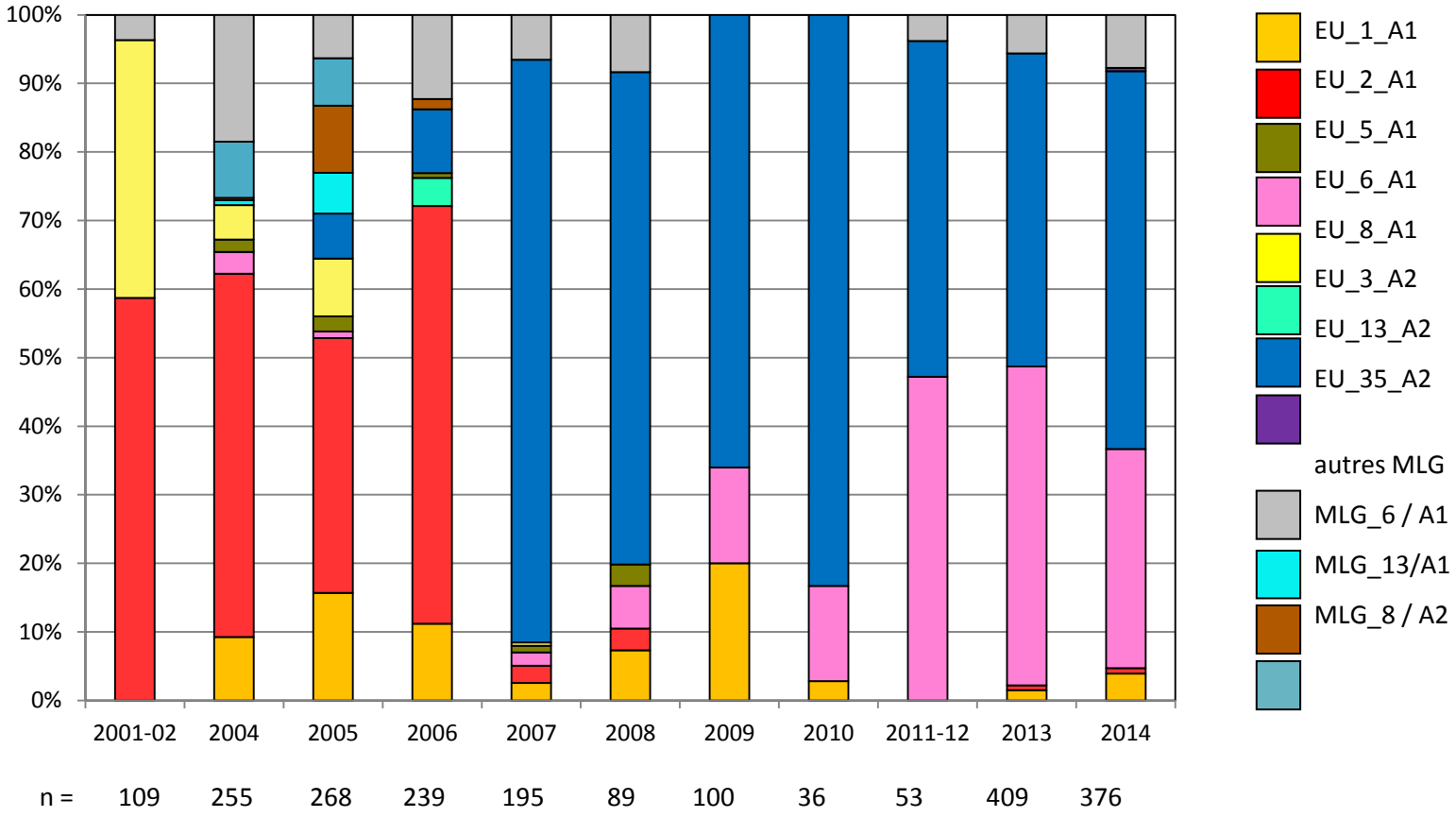


- **… and re-emerging pathogen**

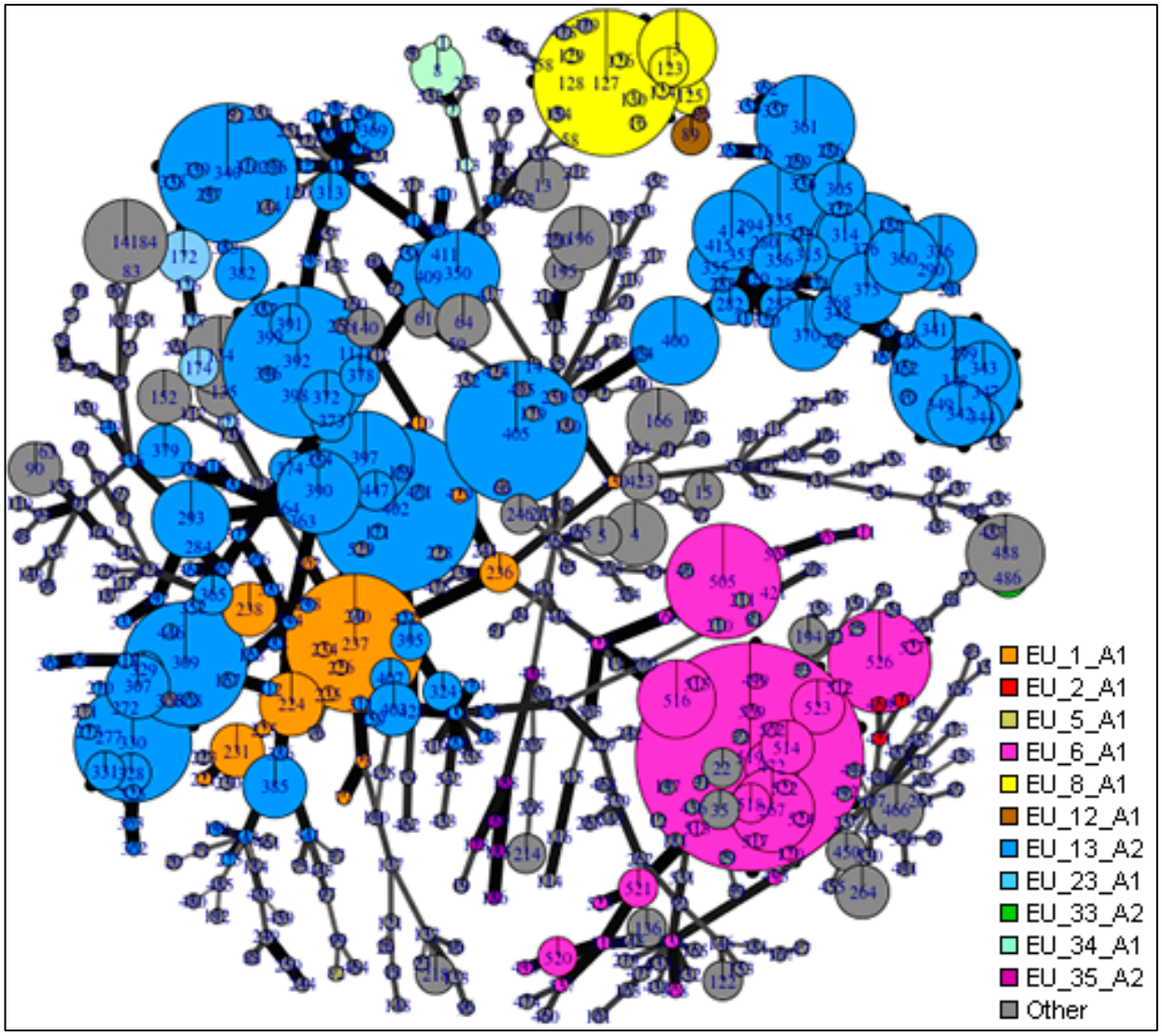
Genotype diversity and distribution in Europe



Rapid changes in clones

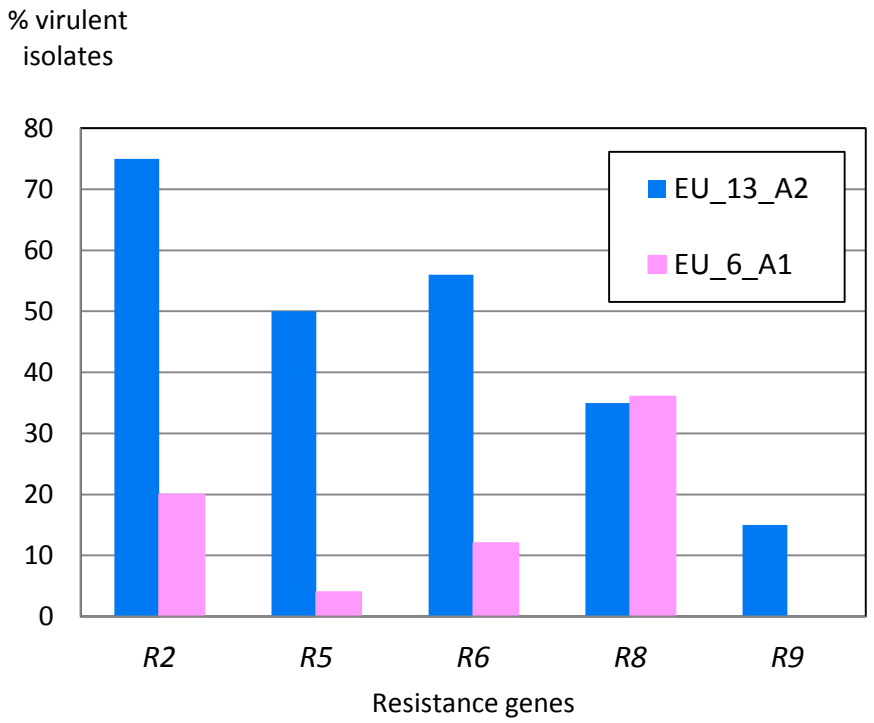


Clone diversity: between and within



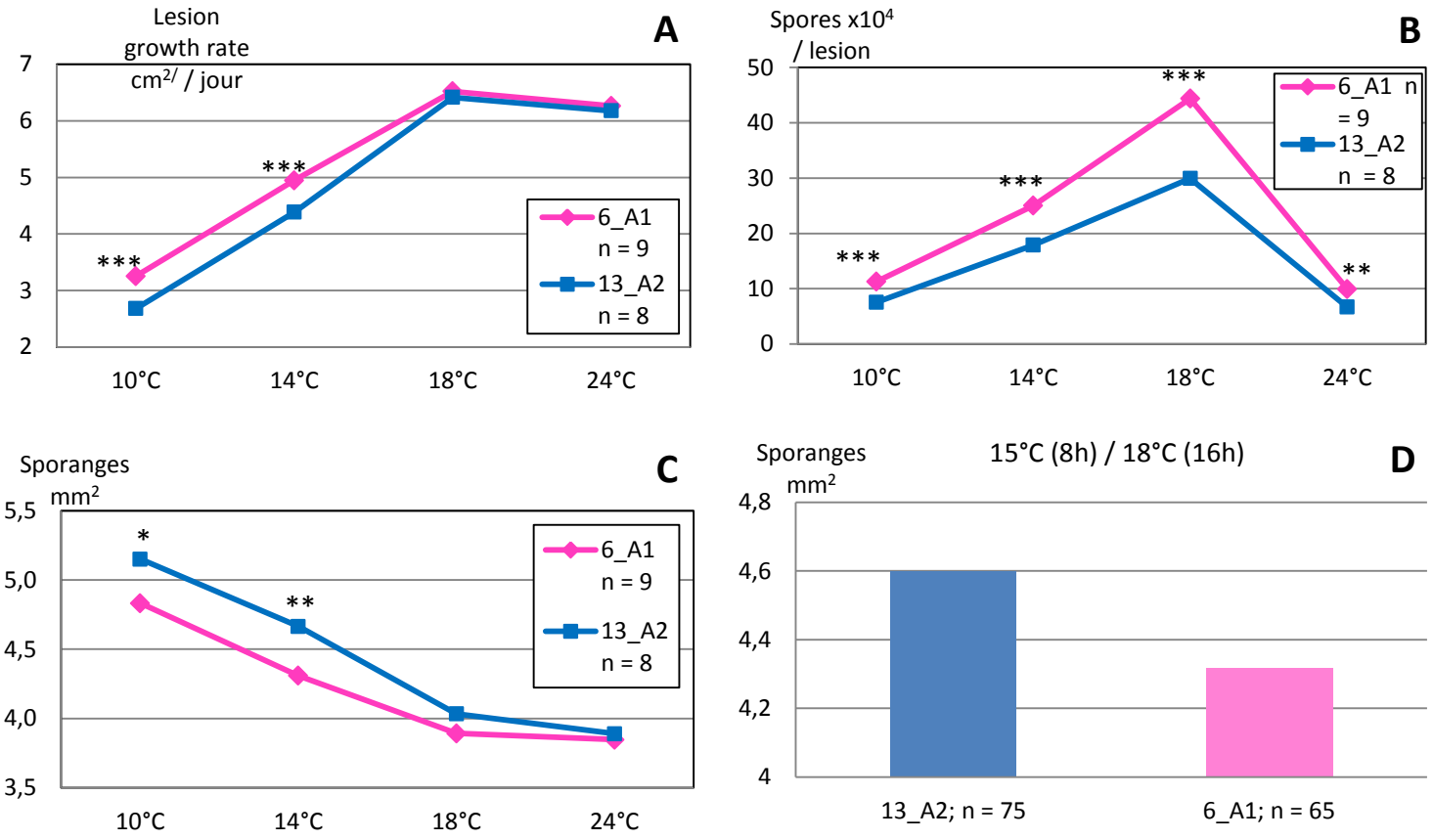
Understanding population changes

Problem 1: Genotypes may not predict phenotypes

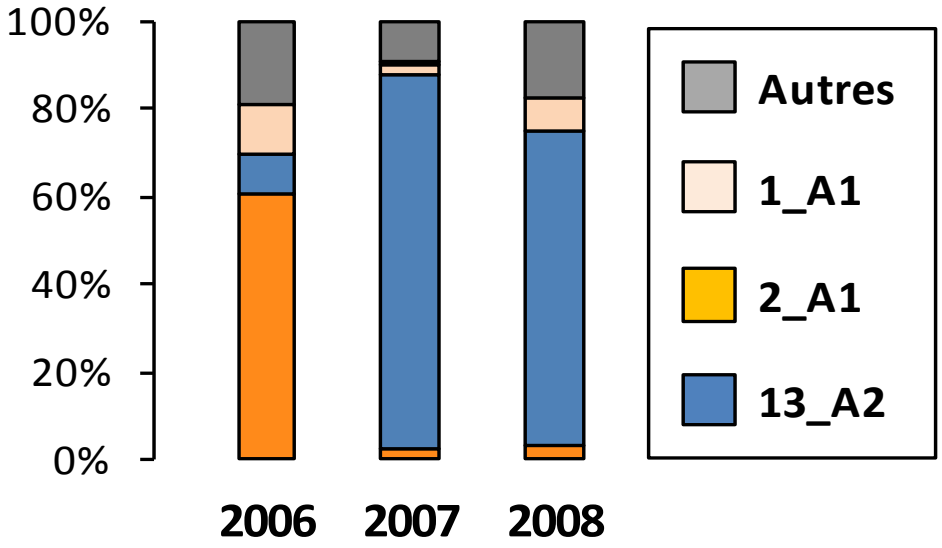


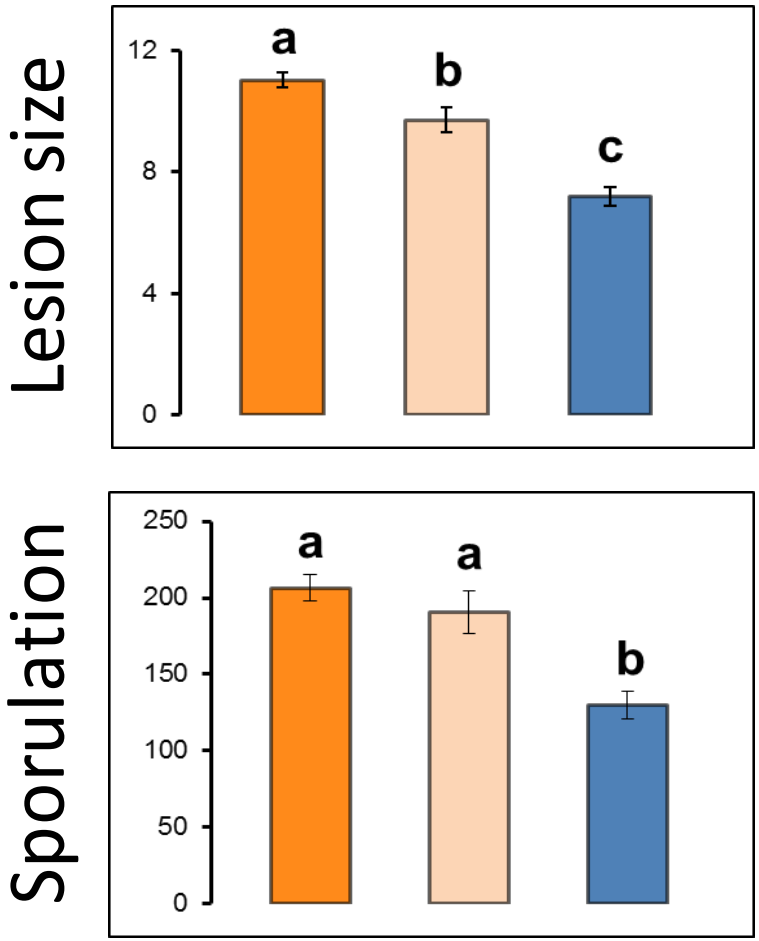
Understanding population changes

Problem 2: All clones do not respond equally to climate



One good news:
the nastiest ones do not (always) win





Open issues

- We can quite accurately describe and explain past changes…
- … and we can follow current evolutions…

- But:
  - we still have a hard time predicting future changes
    - > when will the next change occur?
    - > who is going to be the next invader?
    - > What are the key traits behind invasive success and/or lasting presence in populations?
  - Population data are ignored in current DSS

The needs –
EuroBlight Statement – 2015, Brasov

EuroBlight
A potato late blight network for Europe

15th EuroBlight Workshop - Statement
Brasov, Romania 10-13 May 2015
'Designing sustainable management strategies of early and late blight in potato'

Coordinators: Jens G. Hansen, Alison Lees and Huub Schepers — 25 June 2015

Potato late blight (*Phytophthora infestans*) and Early blight (*Alternaria* spp.) continue to severely damage both the foliage and tubers of potato crops, and also to cause severe losses in other important food crops, such as tomato.

Despite active research and recent breakthroughs, further investigations are still needed to fully achieve integrated pest management (IPM) strategies. Remaining questions include: what are the genotypic (DNA) and phenotypic (behavioural) diversity and the mechanisms of evolution of the European meta-population of *P. infestans?* how can we use this information to develop new innovative and more effective IPM strategies (IPM2.0)? why are these diseases so difficult to control sustainably? how can we sustain the use of both efficient fungicide active ingredients and host resistance genes whilst simultaneously minimising the risk that the pathogen overcomes the efficacy of these important control measures? These, and other, questions were the rationale for establishing 'EuroBlight', a network of European scientists, with initial funding by the European Union.

What is Euroblight?

EuroBlight is a very active consortium of scientists and industry representatives, which has met regularly since 2006 with a simple overall objective: to identify, evaluate and combine the best possible tools to predict, manage and control blight diseases in the field. EuroBlight is a unique collaborative platform to tackle the challenges that early and late blights pose in Europe and worldwide. Its biennial workshops allow key research and extension priorities to be identified and formulated into collective Statements that can serve as the core principles of joint actions and international collaborations to improve IPM strategies.

The 15th EuroBlight Workshop, held in Brasov, Romania in May 2015, brought together over 100 participants from all parts of Europe, South America, USA, Israel and China to achieve this aim.

Major achievements and breakthroughs on past EuroBlight statements

The European-wide monitoring initiative of *P. infestans* populations carried out by EuroBlight partners in 2013 and 2014 (> 2200 isolates collected and genotyped using SSR markers) confirmed that the populations are constantly evolving and that some of them are subject to repeated biological invasions by novel genotypes (read news story about this). Such genetic changes may jeopardize the ability to develop durably resistant cultivars and the sustainability of other control measures. It is thus essential to understand the mechanisms behind the changes and also to their relation to human intervention (e.g. pathogen transportation with plant material or cropping practice) and to the changing climate.

Together with the comprehensive web-based resource developed within EuroBlight i.e. hosting harmonized research protocols and extensive databases allowing the compilation and sharing of data on pathogen populations, host resistance and fungicide characteristics, the research and extension efforts carried out within the network pave the way for the set-up and adoption of 'smart control', IPM strategies for early and late blight in Europe.

Major issues of relevance to policy making in Europe

The recent Europe-wide late blight monitoring initiative demonstrated the value and necessity of constant monitoring of populations and characterization of invasive genotypes in order to understand and predict changes. It directly influences the development and deployment of resistant cultivars, the performance of disease warning systems and the efficacy of plant protection products. A coordinated and continuous monitoring effort would be best supported through National Action Plans relating to IPM implementation in EU member states.

Recommendations:

Monitoring of the meta population of P. infestans in Europe and beyond

Linking genotypes to phenotypes

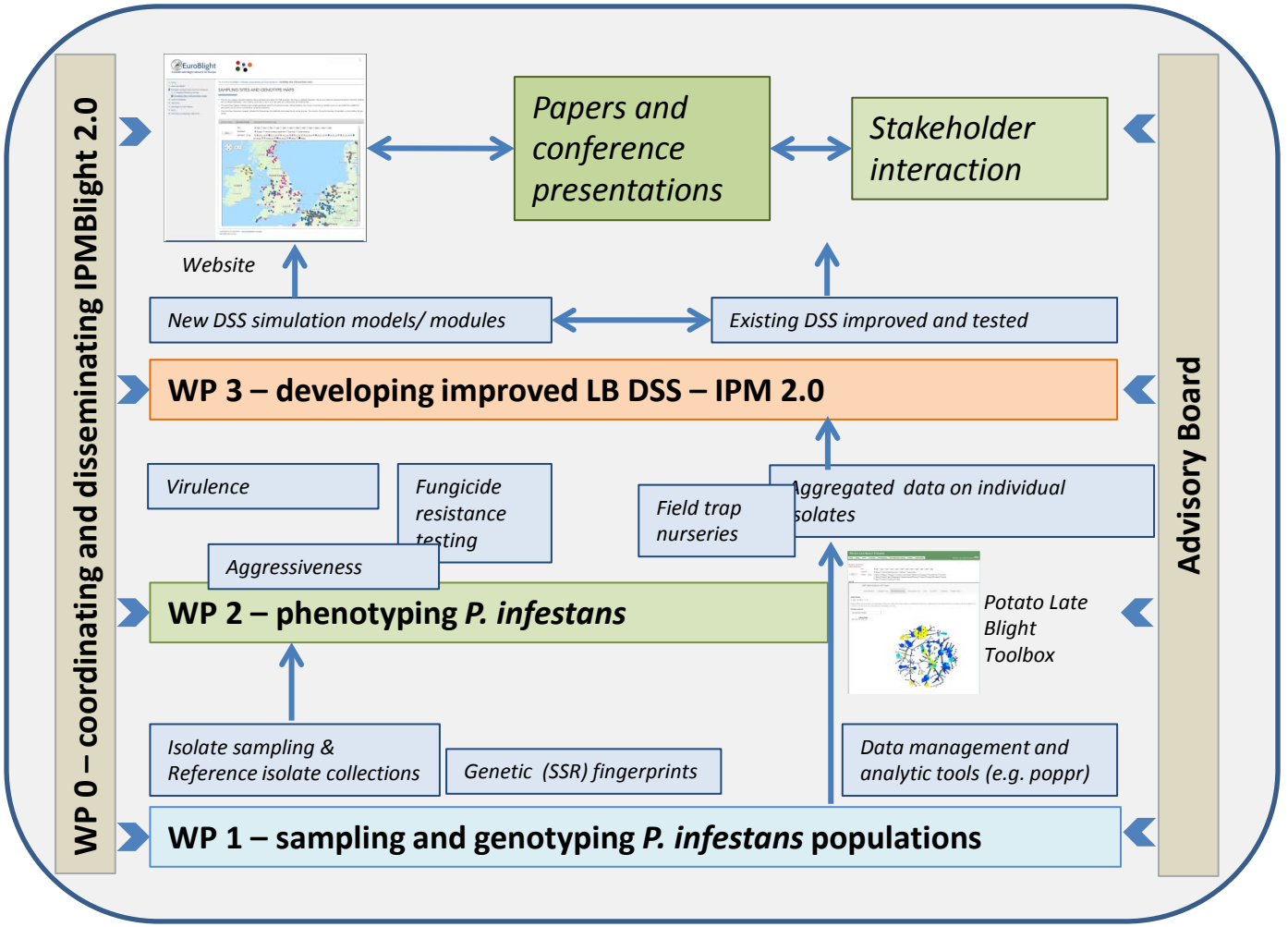
EuroBlight engages in the development and improvement of DSS adapted to IPM2.0

Fostering international collaboration

An answer : IPMBlight2.0

IPM2.0 for sustainable control of potato late blight - exploiting pathogen population data for optimized Decisions Support Systems

C-IPM Coordinated Integrated Pest Management in Europe



IPMBlight 2.0 – partners

NAES

IPMBlight 2.0 – deliverables and communication

- **New knowledge**
  - Population structures
    Population phenotypes and variability
    Phenotype x genotype connections
  - Methods and protocols
- **Operational tools**
  - New/improved open DSS modules
  - Network of reference labs for efficient epidemiovigilance (connected to Euroblight)

What have we done already?

Outlines for 3 papers drafted

Presentations prepared for Euroblight 2017 workshop

Advisory Board appointed

Kick Off meeting, Paris, 04.2016

Contracts signed

Web meeting room

Project announced

Submodels in MatLab

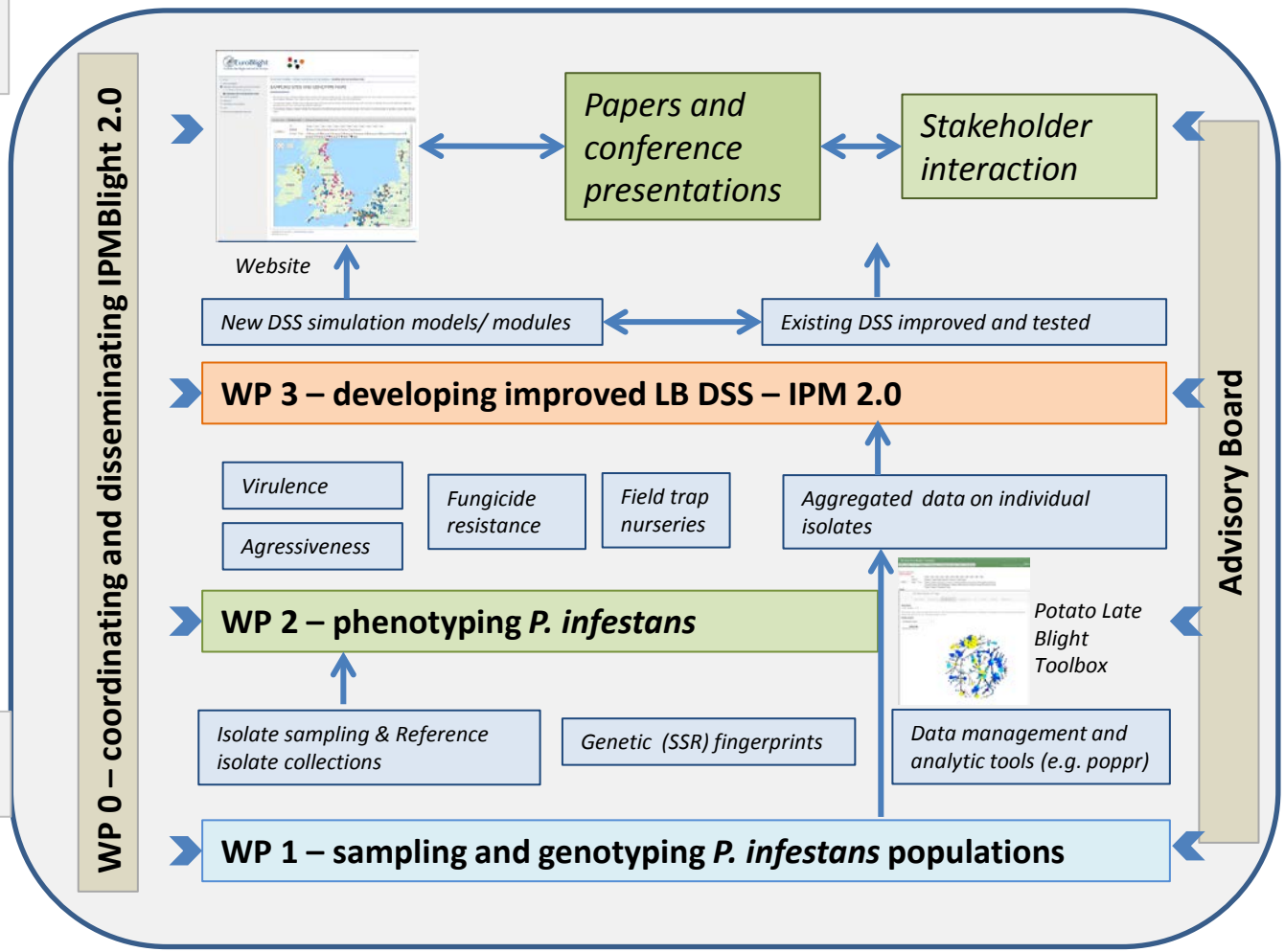
DSS modules inventory

Trap nurseries established

Phenotyping 2016 collection underway

R set OK

Test methods agreed



2016 collection established

2016 isolates genotyped

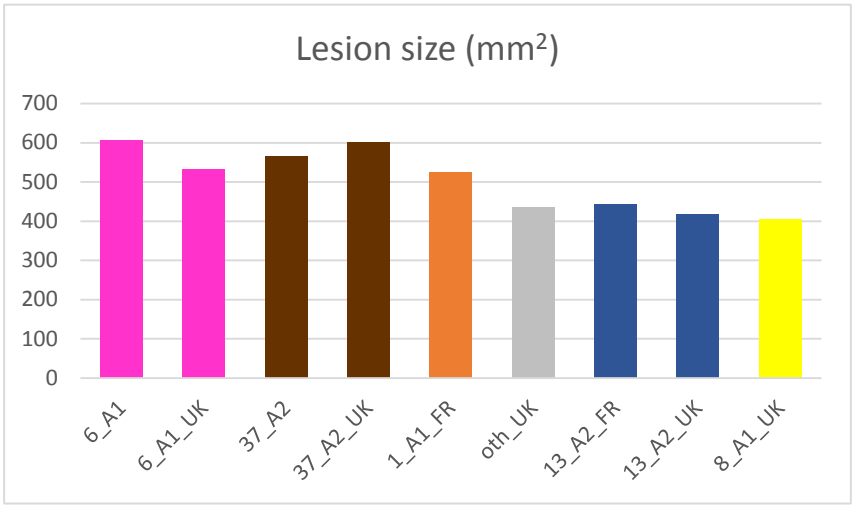
Data upload started

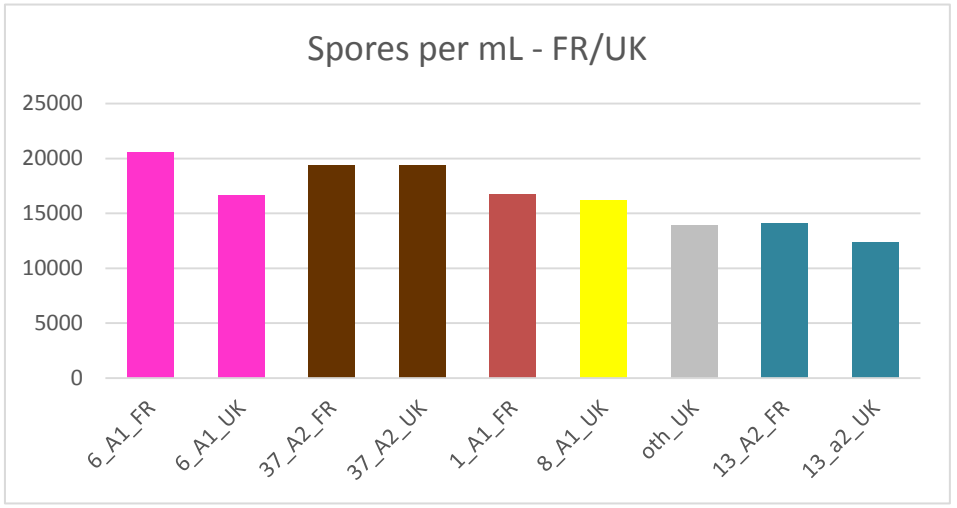
First achievements

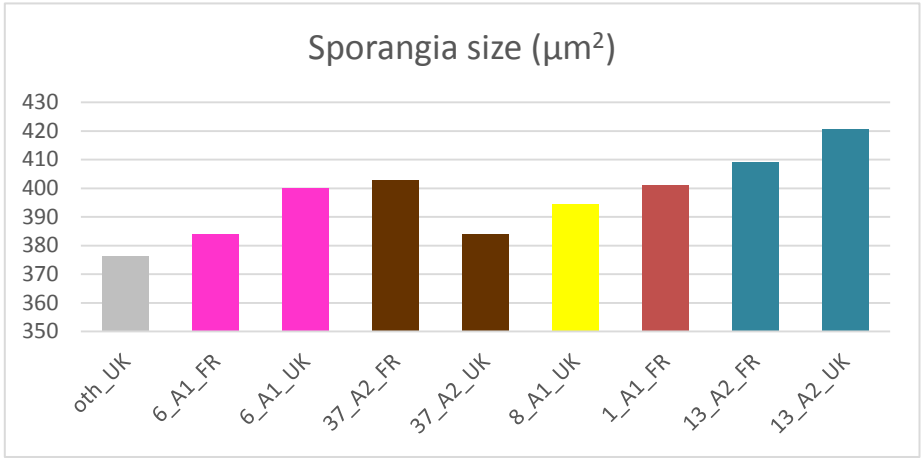
- **Population structures**
  - > emergence of 36_A2, 37_A2 and 38_A1
    - Talk D Cooke
    - Poster R Corbière et al

- **Pathogen phenotypes**
  - Fungicide sensitivity
    - Talk Britt Puidet et al
  - Agressiveness

‘Hunting the new’ :
First hints on 37_A2 aggressiveness







Early conclusions...

- **'Hunting the new' ...**
  - Infrastructures
  - Fast reaction
  - ➢ value of an EU wide (and global) epidemiovigilance scheme

- **... knowing the old**
  - Large subclonal variation
  - Genotypes alone do not predict everything right

- **Network strength**
  - Population surveys
    - Sampling
    - Databases
  - Complementary expertises
    - Protocols

... and questions still pending

- **From population knowledge to improved control?**
  - Proof of concept still to be made
  - Integration in DSS underway
- **Faster phenotyping?**
  - Is important
  - How to do it best?
- **How much will global change jeopardize LB control?**
  - Better characterisation of climate response needed
  - Will cultivars select as much/more than did fungicides
  - One world, one health
    - Time to get LB research global?

EuroBlight
A potato late blight network for Europe

IPMBLIGHT2.0

Late blight, caused by *Phytophthora infestans*, remains the major threat to potato crops in Europe, and a main reason for pesticide use. Despite the release of resistant cultivars and the implementation of modern DSS operated from web platforms or mobile apps, integrated management of late blight still relies heavily on many fungicide applications (up to 25 per season in some regions). The need is thus obvious to develop strategies that take full advantage of alternative options for more sustainable crop protection and better fungicide stewardship. To be sustainable and adopted, such strategies must be tailored to the variability of *P. infestans* populations and their rapid evolution - the IPM 2.0 concept. This in turn supposes that pathogen populations be monitored for both genotypes and phenotypes, including virulence, aggressiveness and fungicide sensitivity.

IPMBlight 2.0 aims at validating the IPM 2.0 concept, with potato late blight as a case study. To this end, it
genotypic (WP1) and phenotypic (WP2)
collections of the pathogen
populations collected
DSS models while adjusting existing ones to offer risk
weather-driven infection likelihood and path
will therefore be able to best inform tactical choi
sions ('can I trust this resistant cultivar? how
') for improved late blight control.

The proj
out within EuroBlight, and complements them by
phenotypic data. EuroBlight is a large collaborative network of
industries, DSS developers and extension specialists dedicated to
which has been active for over 20 years. IPMBlight 2.0 will use the IT platforms
typing protocols, developed and validated within EuroBlight, to generate and disseminate
data and analyses on pathogen evolution, improved open-source DSS models and to establish a reference network of laboratories able to track new emergences within European *P. infestans* populations. Through its international links, IPMBlight 2.0 will also provide updated information regarding the connections between European and global populations of the late blight pathogen.

COMMENTS ON CONTENT: JENS GRØNBECH HANSEN
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3. NIBIO (formely Bioforsk)
4. Estonian University of Life Sciences
5. ARVALIS Institut du Végétal
6. Association des Créateurs de Variétés Nouvelles de Pomme de terre
7. Norwegian Agricultural Extension Service
8. James Hutton Institute