PROJECT TITLE

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

TOPIC

Topic A: Innovative and new pest monitoring tools and Decision Support Systems (DSS)

YOUR PROJECT IS RELATED TO

Topic A

PROJECT DURATION	TOTAL REQUESTED FUNDING	TOTAL COSTS
36 Months	895.129 €	1.229.210 €

CONSORTIUM

P 1	Dr Didier Andrivon Institut National de la Recherche Agronomique	Domaine de la Motte, BP35329, F-35653 Le Rheu Cedex France	Didier.Andrivon@rennes.inra.fr Tel.: 0033 223485193 Mobile: 0033 681903833 Fax: 0033 223485150
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P 3	Dr Ragnhild Naerstad NIBIO (formely Bioforsk)	Høyskoleveien 7, 1430 Ås Norway	ragnhild.naerstad@bioforsk.no Tel.: 0047 92068189 Mobile: 0047 92068189 Fax: 0047 64946110
P 4	Dr Eve Runno-Paurson Estonian University of Life Sciences	Kreutzwaldi 1a, EE- 51014 Tartu Estonia	Eve.Runno-Paurson@emu.ee Tel.: 00372 7313597 Mobile: 00372 55581322 Fax: 00372 731 3988
P 5	Mr Denis GAUCHER ARVALIS Institut du Végétal	Station Expérimentale de Boigneville, F-91720 BOIGNEVILLE France	d.gaucher@arvalisinstitutduvegetal.fr Tel.: 0033 1 64 99 22 64 Mobile: 0033 6 07 26 70 33 Fax: 0033 1 64 99 30 39
P 6	Dr Catherine Chatot Association des Créateurs de Variétés Nouvelles de Pomme de terre	Roudouhir, F-29460 HANVEC France	Catherine.CHATOT@germicopa.fr Tel.: 0033 298 818 581 Mobile: 0033 687 754 284 Fax: 0033 298 818 151
P 7	Dr Borghild Glorvigen Norwegian Agricultural Extension Service	Osloveien 1, 1430 Ås Norway	ragnhild.naerstad@bioforsk.no Tel.: 0047 90203317 Mobile: 0047 90203317
P 8	Dr Alison Lees James Hutton Institute	Invergowrie, DD2 5DA Dundee other	Alison.Lees@hutton.ac.uk Tel.: 44 1382568834 Mobile: 44 7561069158

KEYWORDS

Pre-defined keywords	Pest monitoring tools, Decision Support Systems (DSS), EU-wide harmonized monitoring and forecasting systems, development, improvement and validation of models and tools, crops and pests/weeds (life cycle data, Decision Support Systems into Integrated Cropping Systems, Monitoring virulence and population dynamics, sampling methods for accurate monitoring

PARTNER DATA

Partner 1 (Consortium Coordinator): Institut National de la Recherche Agronomique

FINANCE COMMENTS

Personnel	
Travel	
Consumables / Equipment	
Subcontracts	Subcontracting costs break down into: * 4000 € allocated to support travel and expenses of Advisory Borad members to project meetings * 3000 € for external supplies (e.g. in vitro plantlet multiplication/sanitary tests) * 3000 € for experimental Unit UE RGCO at INRA Ploudaniel for implanting trap nurseries (yr 2 and 3)
Other	

TASK(S)

(WP0- Coordination; WP leader)
WP1 - tasks 1.1, 1.2, 1.4, 1.5
WP2 (WP leader) - task 2.1

LITERATURE

- Andrivon D., Montarry J., Corbière R., Pasco C, Glais I., Marquer B., Clément J.A.J, Castel M.K., Hamelin F.M
  The hard life of Phytophthora infestans: when trade-offs shape evolution in a biotrophic plant pathogen
  Plant Pathology (62 - suppl. 1), 28-35 (2013)
- Glais I., Montarry J., Corbière R., Pasco C., Marquer B., Magalon H., Andrivon D.
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  Evolutionary Applications (7), 442-452 (2014)
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  Allee effects and the evolution of polymorphism in cyclical parthenogens
  American Naturalist (18), E75-E88 (2014)
- Clement J.A.J., Magalon H., Glais I., Jacquot E., Andrivon D.,
  To be or not to be solidary: Phytophthora infestans' dilemma for optimizing its reproductive fitness in intra- and intergenotype multiple infections
  PLoS One (7 (6)), e37838. ()
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  Dynamics of change in human-driven and natural systems: fast forward, slow motion, same movie? A case study from plant protection
  Sustainability (4), 384-393 (2012)
- Kröner A., Hamelin G., Andrivon D., Val F.
  Quantitative resistance of potato to Pectobacterium atrosepticum and Phytophthora infestans: integrating PAMP-triggered response and pathogen growth
  PLoS One (6 (8)), e23331 (2011)
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- Andrivon D., Avendaño-Corcoles J., Cameron A., Carnegie S., Cooke L.R., Corbière R., Detourné D., Forisekova K., Griffin D., Hannukkala A., Lebecka R., Lees A.K., Niepold F., Polgar Z., Shaw D.S., Thompson J., Trognitz B., van Raaij H., Zimnoch-Guzowska E.
  Stability and variability of virulence of Phytophthora infestans assessed in a ring test across European laboratories
  Plant Pathology (60), 556-565 (2011)
- Montarry J., Hamelin F.M., Glais I., Corbière R., Andrivon D.,
  Fitness costs associated with unnecessary virulence factors and life history traits: evolutionary insights from the potato late blight pathogen Phytophthora infestans.
  BMC Evolutionary Biology (10), 283 (2010)
- Montarry J., Andrivon D., Glais I., Corbière R., Mialdea G., Delmotte F.
  Microsatellite markers reveal two admixed genetic groups and an ongoing displacement within the French population of the invasive plant pathogen Phytophthora infestans

Molecular Ecology (19), 1965-1977 (2010)
- Clément J., Magalon H., Pellé R., Marquer B., Andrivon D.
  Alteration of pathogenicity-linked life history traits by resistance of its host Solanum tuberosum impacts sexual reproduction of the plant pathogenic oomycete Phytophthora infestans.
  Journal of Evolutionary Biology (23), 2668-2676 (2010)

Partner 2: Aarhus University

FINANCE COMMENTS

Personnel	
Travel	Travel: 95.000 Dkr (12838 €) A budget of 13000 Dkr (1760 €) allocated for Advisory Board to attend two project meetings
Consumables / Equipment	
Subcontracts	
Other	* SSR genotyping at JHI : 3*50isolates*20€): 22350 Dkr (3000 €). * FTA cards for sampling: 150*5€ = 5587 Dkr (750€). * Hosting and survey of Trap Nursery, AKV and KMC Starch companies in Denmark (583€ * 2 years*2 locations = 2331€:

TASK(S)

• Task 1.1. Establishing isolate collections in DK, FR, EE and NO
• Task 1.4. Data storage, management and display tools in EuroBlight database (leader)
• Task 1.5. Population genetic analysis.
• Task 3.1. Develop a simulation model for the integration of data on pathogen information, host resistance and weather.
• Task 3.2. Implement the simulation model as a web tool (leader)
• Task 3.3. Adapt existing DSSs based on results from the simulation model

LITERATURE

- Jørgensen, L.N.; Hovmøller, M.S.; Hansen, J.G.; Lassen, P.; Clark, B.; Bayles, R.; Rodemann, B.; Jahn, M.; Flath, K.; Goral, T.; Czembor, J.; Cheyron, P.; Maumene, C.; Pope, C.; Nielsen, G.C. Berg, G
  IPM strategies and their dilemmas including an introduction to www.Eurowheat.org
  Journal of Integrative Agriculture (13 (2)), 265-281 (2014)
  doi:10.1016/S2095-3119(13)60646-2
- Hansen Jens Grønbech, Lassen Poul
  Managing global crop disease data
  Proceedings from EFITA-WCCA-CIGR Conference, Torino, Italy, 2013: Sustainable Agriculture through ICT Innovation. (), (2013)
- M. S. Hovmøller1, S. Walter, R. A. Bayles, A. Hubbard, K. Flath, N. Sommerfeldt, M. Leconte, P. Czembor, J. Rodriguez-Algaba, T. Thach, J. G. Hansen, P. Lassen, A. F. Justesen, S. Ali, andC. de Vallavieille-Pope
  Replacement of the European wheat yellow rust population by new races from the centre of diversity in the near-Himalayan region
  Plant Pathology (Early view), Early view ()
  DOI: 10.1111/ppa.12433
- Cooke, L. R. , Schepers, H. T. A. M. , Hermansen, A. , Bain, R. A. , Bradshaw, N. J. , Shaw, D. S. , Evenhuis, A. , Kessel, G. J. T. , Wander, J. G. N. , Anderson, B. , Hansen, J. G. , Nukkala, A. , Nærstad, R. & Nielsen, B. J.
  Epidemiology and integrated control of potato late blight in Europe
  Potato Research (54), 183-222 (2011)
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  Aggressiveness of Phytophthora infestans on detached potato leaflets in four Nordic countries
  Plant Pathology (58 (4)), 690-702 (2009)
  DOI: 10.1111/j.1365-3059.2009.02038.x
- Hansen, JG, Colon, LT, Cooke, DEL, Lassen, P, Nielsen, BJ, Cooke, LR, Andrivon, D & Lees, AK
  Eucablight - collating and analysing pathogenicity and resistance data on a European scale
  Bulletin OEPP -EPPO Bulletin (37), 383-390 (2007)
  DOI: 10.1111/j.1365-2338.2007.01141.x

- Hansen JG, Koppel M, Valskyte A, Turka I, Kapsa J
  Evaluation of foliar resistance in potato to Phytophthora infestans based on an international field trial network
  Plant Pathology (54), 169-179 (2005)
  DOI: 10.1111/j.1365-3059.2005.01166.x
- Hodson D. P. , Hansen J. G. , Lassen P. , Alemayehu Y. , Arista J. , Sonder K. , Kosina P. , Moncada P. , Nazari K. , Park R. F. , Pretorius Z. A. , Szabo L. J. , Fetch T., Jin Y.
  Tracking the Wheat Rust Pathogen
  Proceedings from BGRI technical meeting, Beijing, 2012 (), 11-22 (2012)
  ISBN: 13: 978-0-615-70429-6
- Brurberg, M. B. , Elameen, A. , Le, V. H. , Nærstad, R. , Hermansen, A. , Lehtinen, A. , Hannukkala, A. , Nielsen, B. J. , Hansen, J. G. , Andersson, B. & Yuen, J
  Genetic analysis of Phytophthora infestans populations in the Nordic European countries reveals high genetic variability
  Fungal Biology (115), 335-42 (4-5)
  doi: 10.1016/j.funbio.2011.01.003

Partner 3: NIBIO (formely Bioforsk)

FINANCE COMMENTS

Personnel	
Travel	
Consumables / Equipment	
Subcontracts	
Other	

TASK(S)

o Sampling isolates from Norway, isolation on agar and on FTA card (Task 1.1.);
o Develop a simulation model for integration of new data on pathogen information, host resistance and weather. (Task 3.1.);
o Adapt existing DSSs based on results from the simulation model. Output: Report. Task lead: Ragnhild Nærstad (Task 3.3.)

LITERATURE

- Nærstad R, Sharma SS, Le VH, Hermansen A & Bruberg MB
  Potato late blight forecasting and initial inoculum sources in Norway
  Proceedings of the fourteenth EuroBlight Workshop (16), 41-50 (2014)
- Brurberg MB, Elameen A, Le VH, Nærstad R, Hermansen A, Lehtinen A, Hannukkala A, Nielsen B, Hansen J, Andersson B & Yuen J
  Genetic Analysis Of Phytophthora Infestans Populations In The Nordic European Countries Reveals High Genetic Variability
  Fungal Biology (), 335-342 (2011)
- Cooke LR, Schepers HTAM, Hermansen A, Bain RA, Bradshaw NJ, Ritchie F, Shaw DS, Evenhuis A, Kessel GJT, Wander JGN, Andersson B, Hansen JG, Hannukkala A, Nærstad R & Nielsen BJ
  Epidemiology and integrated control of potato late blight in Europe
  Potato Research (54 (2)), 183-222 (2011)
- Nærstad R, Le VH & Hermansen A
  Reduced fungicide input in late blight control (REDUCE 2007-2011) – Preliminary results from 2007 to 2009
  PPO-Special Report (14), 193-198 (2010)
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  Aggressiveness of Phytophthora infestans on detached potato leaflets in four Nordic countries
  Plant Pathology (58), 690-702 (2009)
- Nærstad R, Le VH, Hermansen A, Hannukkala A, Nielsen B, Hansen J, Grönberg L, Andersson B & Yuen J
  Improvement of potato late blight forecasting
  PPO-Special Report (13), 103-105 (2009)
- Lehtinen A, Hannukkala A, Andersson B, Hermansen A, Le VH, Nærstad R, Brurberg MB, Nielsen BJ, Hansen JG & Yuen J
  Phenotypic variation in Nordic populations of Phytophthora infestans in 2003
  Plant Pathology (57), 227-234 (2008)
- Nærstad R, Hermansen A & Bjor T

Effect of Cultivar Resistance and Haulm Killing Method on Tuber Infection by Phytophthora infestans
Potato Research (50), 157-173 (2007)
- Nærstad R, Hermansen A & Bjor T
Exploiting host resistance to reduce the use of fungicides to control potato late blight.
Plant Pathology (56), 156-166 (2007)
- Hermansen A, Hannukkala A, Nærstad R & Brurberg MB
Variation in populations of Phytophthora infestans in Finland and Norway: mating type, metalaxyl resistance and virulence phenotype.
Plant Pathology (49), 11-22 (2000)

Partner 4: Estonian University of Life Sciences

FINANCE COMMENTS

Personnel	
Travel	
Consumables / Equipment	
Subcontracts	
Other	

TASK(S)

o Sampling isolates from Estonia, samples on live cultures and on FTA card (Task 1.1.);
o Intra/interclone fungicide resistance. Metalaxyl, propamocarp, fluazinam (Task lead: Eve Runno-Paurson) (Task 2.2.);
o Intra/interclone virulence test. (Task lead: Eve Runno-Paurson). Conventional and GM differential set from WUR. (Task 2.3.)

LITERATURE

- Runno-Paurson E., Ronis A., Hansen M., Aav A., Williams I. H.
Lithuanian populations of Phytophthora infestans revealed a high phenotypic diversity.
Journal of Plant Diseases and Protection (122 (2)), 57-65 (2015)
10.1080/09064710.2015.1017003
- Runno-Paurson E., Loit K., Hansen M., Tein B., Williams I.H., Mänd M
Early blight destroys potato foliage in the northern Baltic region
Acta Agriculturae Scandinavica Section B – Soil and Plant Science (65(5)), , 422-432 (2015)
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Population changes and phenotypic diversity of Phytophthora infestans isolates from Estonia and Finland.
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Cultivation technology influences the occurrence of potato early blight in an organic farming system.
Žemdirbyste-Agriculture (101 (2)), 199-204 (2014)
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Impact of phytosanitary quality of seed potato and temporal epidemic progress on the phenotypic diversity of Phytophthora infestans populations.
American Journal of Potato Research (90 (3)), 245-254 (2013)
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  Temporal changes in phenotypic diversity of Phytophthora infestans in northern Estonia
  Žemdirbyste-Agriculture (98 (2)), 205-212 (2011)
  http://www.cabdirect.org/abstracts/20113272764.html;jsessionid=7F9D6E4332C5D5F590A9B9E8C5E5035D
- Runno-Paurson E., Remmel T., Ojarand A., Aav A., Mänd M
  The structure of the Phytophthora infestans population in organic and conventional crops in Estonia
  European Journal of Plant Pathology (128 (3)), 373-383 (2010)
  10.1007/s10658-010-9659-0
- Runno-Paurson E., Fry W.E., Remmel T., Mänd M., Myers K.L.
  Phenotypic and genotypic characterisation of Estonian isolates of Phytophthora infestans in 2004-2007
  Journal of Plant Pathology (92 (2)), 375-384 (2010)
  10.4454/jpp.v92i2.181

Partner 5: ARVALIS Institut du Végétal

FINANCE COMMENTS

Personnel	
Travel	
Consumables / Equipment	
Subcontracts	
Other	

TASK(S)

WP1, T1.1.
WP3, T3.3

LITERATURE

- Gaucher D., Dubois L., Chatot C.
  Mileos®, the French potato late blight DSS : continuous improvement over past decade !
  PPO-Special Report (16), 209-210 (2014)
- Gaucher D., Ponthonne S.
  Outils d'aide à la décision : MILEOS® évolue.
  La pomme de terre française (585), 38-39 (2013)
- Gaucher D., Taupin P.
  Réduire les risques de bioagresseurs grâce à la prophylaxie.
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  Perspectives Agricoles (392), 26-28 (2012)
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  Perspectives Agricoles (374), 64-65 (2011)
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  Abstracts of papers and posters, EAPR, July 25-29 2011, Oulu (Finland) (), (2011)

Partner 6: Association des Créateurs de Variétés Nouvelles de Pomme de terre

FINANCE COMMENTS

Personnel	
Travel	
Consumables / Equipment	
Subcontracts	
Other	

TASK(S)

WP1 - Tasks 1.1 and 1.5
WP2 - Task 2.3
WP3 - Task 3.3

LITERATURE

- RAKOTONINDRAINA, T., CHAUVIN, J. É., PELLE, R., FAIVRE, R., CHATOT, C., SAVARY, S., & AUBERTOT, J. N.
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  PLANT DISEASE (96), 935-942 (2012)
- Gaucher D., Dubois L., Chatot C.
  Mileos®, the French potato late blight DSS : continuous improvement over the past decade !
  PPO-Special Report (16), 209-2010 (2014)
- CHATOT C, GUTMANN S, LEFEVRE L & S MEVEL,
  Monitoring of potato late blight for seed potato production : preliminary field validation,
  PPO Special Report (8), 39-46 (2002)
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  Potato Research (45), 177-185 (2002)
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  Potato Research (42), 107-111 (1999)
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  A genetic analysis of quantitative resistance to late blight in potato: towards marker-assisted selection
  Molecular Breeding (5), 399-415 (1999)
- CHATOT C., D ANDRIVON, D GAUCHER & R. CORBIERE
  Epidémio-surveillance du mildiou de la pomme de terre en France : enjeux actuels et acquis récents
  9ème Colloque de la Société Française de Phytopathologie (), (2015)
- CORBIERE R, CHATOT C
  Avec la protection intégrée, la surveillance des populations de mildiou s'impose
  Potato Planet (47), 38-43 (2014)
- CHATOT C, BERSIHAND S,
  A new challenge for DSS improvement : more accurate foliage late blight assessment for commercial cultivars.
  PPO Special Report (10), 223-231 (2004)

Partner 7: Norwegian Agricultural Extension Service

FINANCE COMMENTS

Personnel	
Travel	

Consumables / Equipment	
Subcontracts	
Other	

TASK(S)

o Sampling potato late blight isolates from Norway together with field information (Task 1.1.);
o Specifying requirements for user friendly DSSs and test demo versions of adapted DSSs (Task 3.3.)
o Field experiment- field validation of the IPM 2.0 DSS model based on a EuroBlight trial plan (Task 3.4)

LITERATURE

- Klingen, I, TE Sagen Eklo, CJ Spetz og B Glorvigen
  Virusoverførende bladlus – et problem i norsk potetproduksjon
  Bioforsk Fokus (9), 101-102 (2014)
- Steinsholt PY, B Glorvigen, EL Molteberg
  Fagforum potet
  Bioforsk FOKUS (7), 273 (2012)
- Glorvigen, B
  Jord på ville veier – om PCN og jordsmitte
  Bioforsk FOKUS (7), 124-126 (2012)
- Molteberg, E, B Glorvigen og PY Steinsholt
  Fagforum Potet
  Bioforsk FOKUS (6), 139 (2011)
- Eklo, OM, R Bolli, J Kværner, T Sveistrup, F Hofmeister, E Solbakken, N Jarvis, F Stenemo,, E Romstad, B Glorvigen, TA Guren, S Sorknes, I Solberg og T Haraldsen
  Miljørisiko ved bruk av plantevernmidler — hjelpemiddel til å lage miljøplaner
  Bioforsk Fokus (4), 60-61 (2009)

Partner 8: James Hutton Institute

FINANCE COMMENTS

Personnel	
Travel	
Consumables / Equipment	
Subcontracts	
Other	

TASK(S)

WP1 - tasks 1.1, 1.2, 1.3, 1.4, 1.5

LITERATURE

- Cooke DEL, Cano LM, Raffaele S, Bain RA, Cooke LR, et al.
  Genome Analyses of an Aggressive and Invasive Lineage of the Irish Potato Famine
  PLoS Pathogen (8), (2012)
  doi:10.1371/journal.ppat.1002940
- Lees, A. K., Sullivan, L., Lynott, J. S. and Cullen, D. W.
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Plant Pathology (61), 867-876 (2012)
doi: 10.1111/j.1365-3059.2012.02649.x

- Lees, AK, Stewart, JA, Lynott, JS, Carnegie, SF, Campbell, H, Roberts, AMI
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  Potato Research (55), 125-134 (2012)
- Gilroy, E. M., Breen, S., Whisson, S. C., Squires, J., Hein, I., Kaczmarek, M., Turnbull, D., Boevink, P. C., Lokossou, A., Cano, L. M., Morales, J., Avrova, A. O., Pritchard, L., Randall, E., Lees, A., Govers, F., van West, P., Kamoun, S., Vleeshouwers, V. G. A. A., Cooke, D. E. L. and Birch, P. R. J.
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  New Phytologist (191), 763-776 (2011)
- Andrivon D., Avendaño-Córcoles J., Cameron A.M., Carnegie S.F., Cooke L.R., Corbière R., Detourné D., Dowley L.J., Evans D., Forisekova K., Griffin D.G., Hannukkala A., Lees A.K., Lebecka R., Niepold F., Polgar Z., Shaw D.S., Thompson J., Trognitz B., van Raaij H.M.G., Zimnoch-Guzowska E.
  Stability and variability of virulence of Phytophthora infestans assessed in a ring test across European laboratories
  Plant Pathology (60), 556-565 (2011)

ABSTRACT

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 will analyze genotypic (WP1) and phenotypic (WP2) variation in reference collections of the pathogen sampled from sexual and clonal populations collected in partner countries, and develop new DSS models while adjusting existing ones to offer risk assessment based on both epidemiological, weather-driven infection likelihood and pathogen phenotypes (WP3). The new DSS modules will therefore be able to best inform tactical choices (‘should I spray now?’) and strategic decisions (‘can I trust this resistant cultivar? how can I adjust my spraying schedule accordingly?) for improved late blight control.

The project builds on the monitoring activities carried out within EuroBlight, and complements them by providing critical, but currently unavailable phenotypic data. EuroBlight is a large collaborative network of scientists, breeders, agrochemical industries, DSS developers and extension specialists dedicated to improved blight control, which has been active for over 20 years. IPMBlight 2.0 will use the IT platforms and population typing protocols, developed and validated within EuroBlight, to generate and disseminate original 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.

BACKGROUND

State of the art

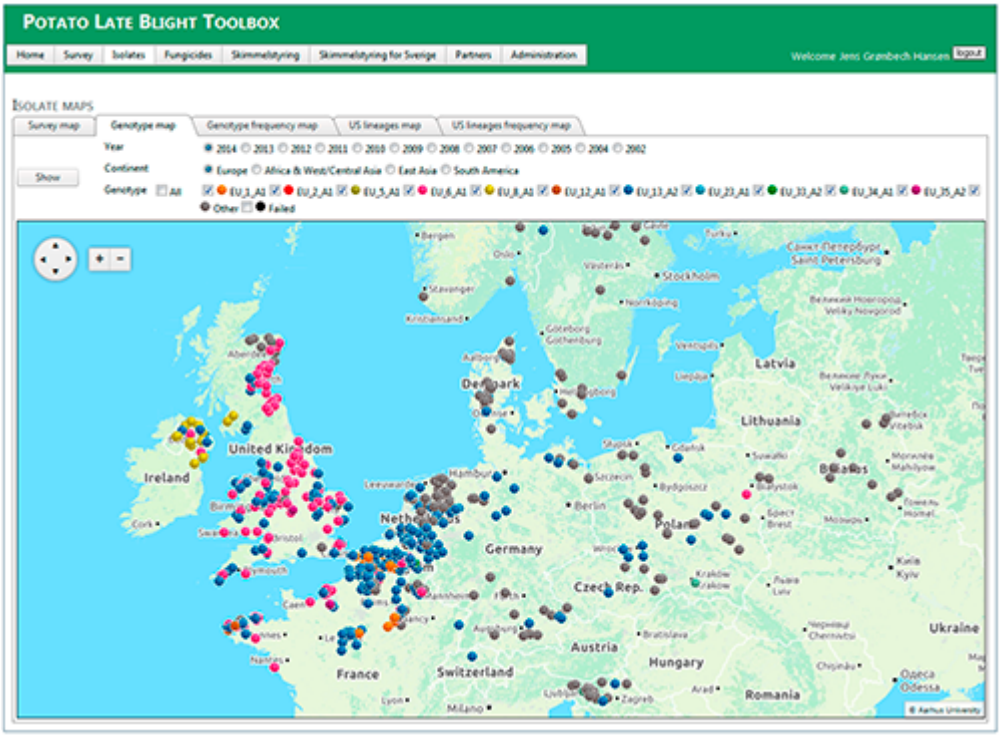
Late blight, caused by the oomycete *Phytophthora infestans*, remains the main threat to European potato crops, almost two centuries after its first introduction in Europe. In severe blight years, such as 2007, up to 25 sprays are used per season in some countries (Hansen et al. 2009), and fungicide insensitivity is evolving in parts of Europe (Nielsen 2014). Haverkoort et al. (2009) estimated the annual direct and indirect costs of late blight control for the Dutch industry at 124.9 M€, *i.e.* 16 % of the farm gate price of the potato crop. Extrapolated to an annual potato production of 63,000 Mt and average economic value of 6 Bn€, the cost of late blight in Europe would reach ca. 1 Bn€ per year.

Despite active research and many breakthroughs, efficient and environmentally-friendly management practices play only a small part of current late blight IPM. Why?

Changing genetic structures: a key feature of European P. infestans populations

The genetic instability of its populations is one reason making *P. infestans* so hard to control. Microsatellite (SSR) markers indeed showed that European pathogen populations evolve fast: some are subject to repeated biological invasions by novel genotypes (Montarry et al. 2010; Cooke et al. 2012) whereas others are remarkably diverse (Brurberg et al. 2011; Runno-Paurson et al. 2015). Such genetic adaptability jeopardize the deployment of durably resistant cultivars and sustainable fungicide management. It is therefore crucial to characterize and understand the mechanisms driving population changes.

Extensive sampling efforts and standardized methodologies allowed to compare the genetic composition of *P. infestans* populations in Europe. An IT infrastructure (database and data import tools), developed within the EUCABLIGHT project, was used to collate information on ca. 20 000 isolates sampled across Europe and more than a decade. These data showed two types of reproduction regimes. Western and Southern populations are mainly clonal and subject to frequent selective sweeps, the most recent being the development of genotype 13_A2 (aka Blue13) since 2004 and the subsequent emergence of another clonal lineage, 6_A1 (aka Pink 6) in westernmost countries since 2011 (Cooke et al. 2012). By contrast, populations from northern and northeastern Europe (Scandinavia, Baltic States, Poland) are highly diverse genetically, and probably sexually reproducing (Yuen & Andersson 2013).



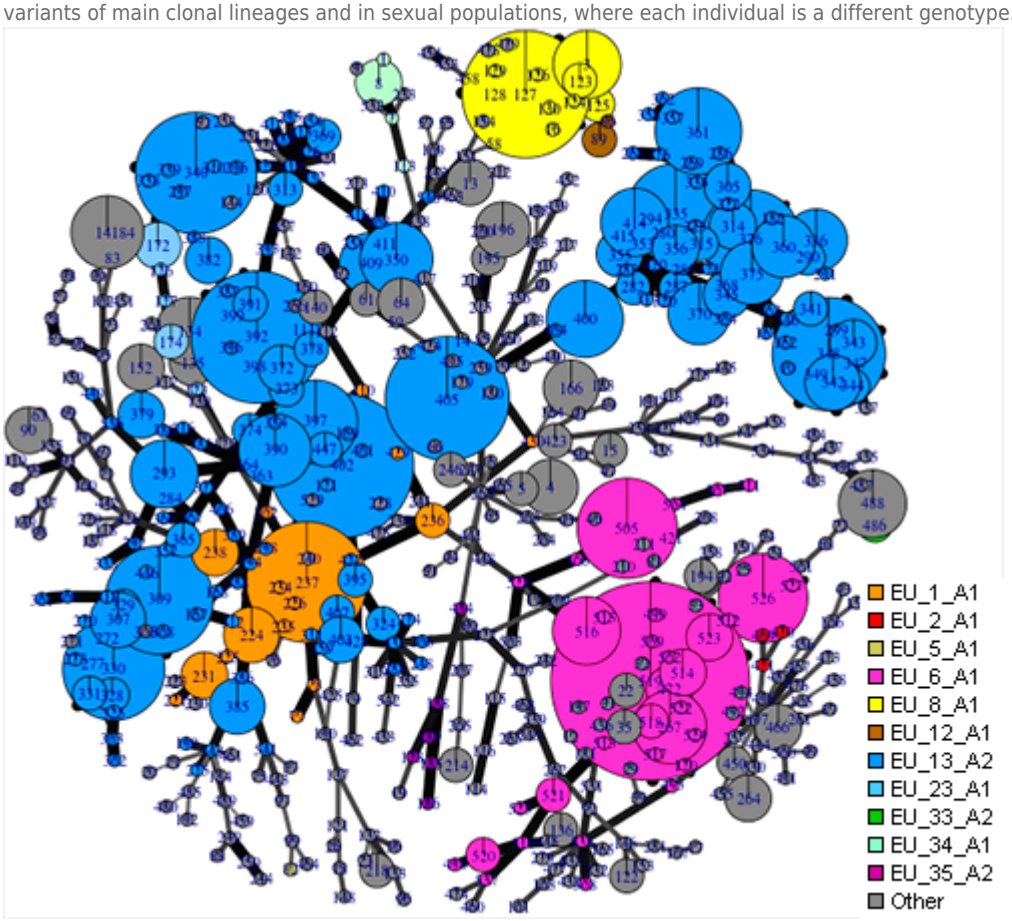
Both situations are problematic for disease control, but for different reasons. The high diversity and constant presence of sexual inoculum in Nordic countries generate faster and earlier epidemics (Hannukkala et al. 2007), while the rapid spread of new genotypes in clonal populations favours the fast development of new virulence or fungicide insensitivity, as shown with genotype 13_A2 (details below). While suspicion exists about the causes of these genetic structures (clonal vs sexual primary inoculum, long distance migration, etc…), we still miss the knowledge to anticipate when the next changes will occur and the likely characteristics of the next invasive genotypes. Understanding population set-up and evolution in both situations is therefore critical to promote sustainable control of late blight, e.g. through better prophylactic management of primary inoculum sources (oospores, refuse piles, volunteers…), adjusted spraying schedules based on cultivar resistance and virulence distribution in the pathogen, etc… This calls for a united European approach that involves all stakeholders: breeding companies, chemical industry, scientists, extension specialists and growers' unions.

Very recent results show that Europe probably “exports” aggressive genotypes to other continents: the destructive US-23 lineage, now invasive in North America (Fry et al., 2015), is genetically identical to the European 23-A1 clone present mainly on tomatoes in Europe and the Mediterranean area. Conversely, we expect future “imports” of new strains to Europe, as in the mid-1970s (Fry et al., 2015). The global reemergence of late blight prompted EuroBlight to initiate a global tracking action: first steps to establish similar networks in the US, Latin America and Asia have been taken (http://euroblight.net/currently/news), and will be further strengthened through IPMBlight2.0.

From genotypes to phenotypes: the key to more accurate predictions

A large Europe-wide survey in 2013-2014, based on genetic fingerprinting of *P. infestans* DNA pressed from disease lesions, confirmed that genotype 13_A2 is now widespread (ca. 35 % of the P. infestans samples collected). Other studies have shown that 13_A2 resists the fungicide metalaxyl, and overcomes many potato resistance genes (Corbière et al. 2010; Lees et al. 2012). The survey also detected a new genotype, 33_A2, with reduced sensitivity to another major late blight fungicide, fluazinam. Although 33_A2 has not spread widely in Europe so far, it poses a big threat for farmers and the agrochemical industry: as the repertoire of commercially available active ingredients is shrinking, it is vital to preserve the performance of those remaining as much as possible.

These examples highlight the need for continuous monitoring of adaptive traits of *P. infestans* isolates. Such phenotypic data will form a pillar of “smart control strategies” that reduce the risk of fungicide resistance, keep host resistance durable and ensure that potato production stays sustainable. We however still miss a general appreciation of genotypes as predictors of phenotypic traits, both among variants of main clonal lineages and in sexual populations, where each individual is a different genotype.



IPM2.0: exploiting population information for better DSS

EuroBlight estimates that the combined use of resistant cultivars, inclusion of anti-resistance fungicide control strategies and pathogen population monitoring has the potential to reduce the fungicide input and any detrimental environmental effects by up to 70% in starch potatoes and up to 30% in seed and ware potatoes. This relies heavily on durable host resistance and fungicide anti-resistance strategies.

Pathogen population monitoring (epidemiovigilance) provides insight into pathogen population changes. It also allows adaptations in populations to be identified: where new virulent races or fungicide resistant genotypes are detected, this information can then be directly used to inform and modify control strategies. This new approach to disease control, coupling epidemiovigilance and decision support and called IPM 2.0, forms the backbone of IPMBlight2.0.

Expected impacts
IPMBlight2.0 will provide efficient new tools for the epidemiovigilance of European populations of *P. infestans* and the real-time dissemination of data to end-users. These tools being largely generic and user-friendly (population analysis software, IT infrastructure), they

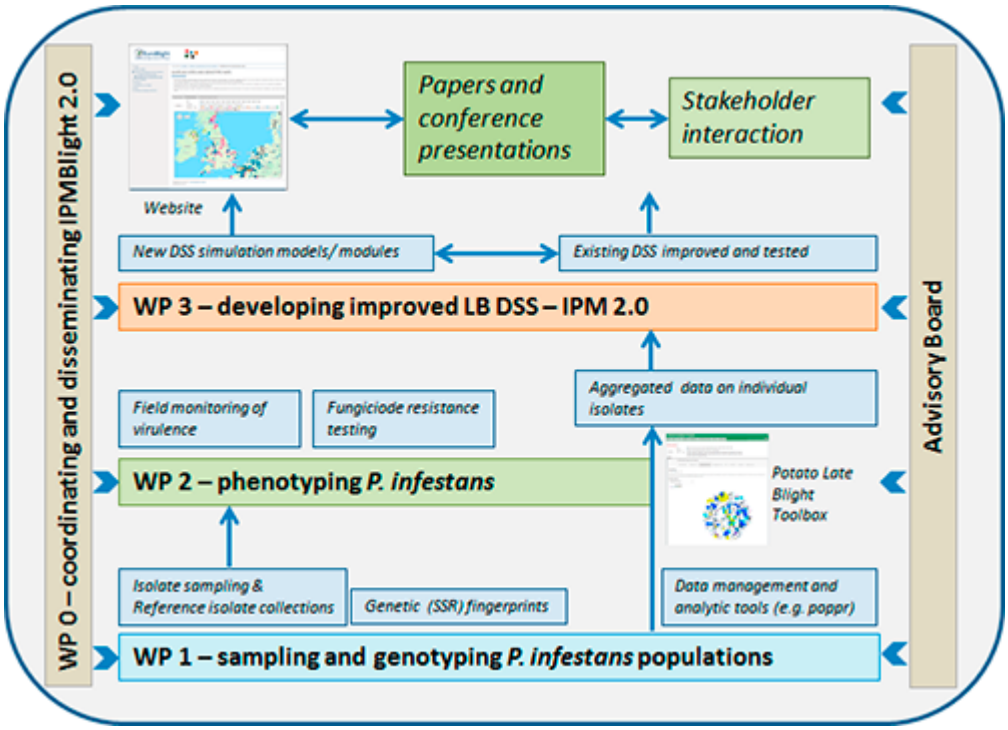
will be transferable to other pathosystems. It will also provide a proof of concept of the IPM 2.0 approach, *i.e.* the integration of pathogen characteristics with weather-based infection risk assessments to better tailor control strategies (fungicide husbandry, resistant cultivar deployment, etc...). Finally, it will develop infrastructures and methods that will form the basis for a global epidemiovigilance network, able to trace emerging pathogen variants worldwide.

Brurberg MB et al. 2011. Fungal Biol. 115: 335-42
Cooke DEL et al. 2012. PLoS Pathogens 8: e1002940
Corbière R et al. 2010. PPO Special Report 14:133-46
Fry WE et al. 2015. Phytopathology 105: 966-81
Hannukkala AO et al. 2007. Plant Pathol 56: 167-76
Hansen JG et al. 2009. PPO Special Report 13:11-30
Haverkoort AJ et al. 2009. Potato Res 52:249-64
Lees AK et al. 2012. Potato Res 55: 125-3
Montarry J et al. 2010. Mol Ecol 19: 1965-77
Nielsen BJ 2014. PPO Special Report 16: 113-6
Runno-Paurson E et al. 2015. J Plant Dis Prot 122: 57-65
Yuen JE & Anderson B 2013. Plant Pathol 62: 485-91

WORK PLAN AND WORK PACKAGES

• Objectives

IPMBlight2.0 has two goals: i) to improve late blight IPM options, and ii) as a case study, to validate the concept of IPM 2.0, already at work in human medicine (e.g. vaccination strategies against influenza), but yet to be implemented in plant pathology. To this end, IPMBlight2.0 will tackle three questions: 1) what are the important characteristics of European P. infestans populations and how are they evolving? 2) are genotypes good predictors of phenotypic characteristics? 3) How can information on pathogen populations be used to improve decision support systems? The three research workpackages (WP1-3) each address one of these questions, whereas an additional workpackage (WP0) will ensure coordination and dissemination.



• Workpackages and task description

WP0. Coordinating and disseminating IPMBlight2.0 activities – WP leader: D. Andrivon, INRA

The management structure and decision making procedures

Body	Members	Main responsibilities	Meeting frequency
Project coordinator	INRA	Overall project responsibility, day-to-day management	Continuous
Project Management Board	Coordinator + WP leaders	WP-coordination, research, staffing, milestones, evaluation	Quarterly via web meetings
Project consortium	All project members	WP-coordination, research, staffing, milestone, evaluation	• Kickoff meeting 2016, • EuroBlight workshop 2017 • Final meeting 2018
Advisory Board	4 external experts	Monitoring, criticism, advice on dissemination and impact, perspectives	• Kickoff meeting, 2016 • EuroBlight workshop, 2017 • Final meeting, 2018

have been established to fit the following objectives:

1. Equality and collective responsibility of all participants,
2. Efficiency and transparency of the overall management,
3. Realization of professional monitoring and administration to prevent time delays and ensure best scientific practice.

Project operation. Overall project management and responsibility will be carried out by the project coordinator, Didier Andrivon, and the Project Management Board composed of the project coordinator and Workpackage (WP) leaders. WP and Task leaders will supervise the scientific and technical tasks within WPs, while the Project Management Board will make sure WPs interact as planned. Since most project partners have previously worked together in national and international projects, are members of EuroBlight and meet at EuroBlight workshops, no major problems are foreseen in partner interactionsA project management tool (project intranet and project web page) will be established in the first quarter of the project.

Advisory Board. We will set-up an Advisory Board (AB) comprising one expert from each sector: science, extension, breeding and the chemical industry. All AB members will be external to the project, so as to provide independent advice and assessments. Prospective AB members include Dr Lars Bødker (Head of the Danish Extension Service), Dr Ragnhild Naerstad (former research scientist at NIBIO, now farm owner and market manager for Syngenta in Norway), Dr Jadwiga Sliwska (plant geneticist and breeder, IHAR Poland), and Dr. Albert Schirring (Bayer Crop Science, Germany). All have been approached and agreed to serve as AB members. The AB will provide advice on critical steps of the project, help for the dissemination to larger circles, and ideas for impact assessment. It will also ensure that national and international decision makers' views and needs are taken into account throughout the duration of the project.

Internal communication. An active internal communication strategy will be developed to ensure coherence and effectiveness in the daily exchange of information and cooperation between all project partners. The administrative responsibility for carrying out this strategy lies with the project coordinator. Communication within this project will be based on the following communication facilities: i) e-mail and Skype correspondence as the primary means of day-to-day communication; ii) an internet server hosting the members area of the project, with download areas providing reports, paper, templates, agenda and minutes of the meetings and internal circulars with restricted access, and with an easy overview of status of milestones and deliverables; and iii) Web meetings through Skype and/or Adobe Connect. Physical meetings between project members, together with the Advisory Board, will be concentrated to a project kick-off meeting in spring 2016, a mid-term meeting in conjunction with the already planned EuroBlight workshop in Aarhus (DK) in May 2017, and a final meeting in May 2018.

IPR and contractual issues. A Consortium Agreement will be prepared and signed in the first month of the project, to secure an open and transparent process about research agenda, use of data and IPR related issues.

Reporting. Synthetic annual reports will be produced by each partner, and collated into a project report delivered to all funding bodies at the end of the project (M36). Meetings and workshop decisions will be included in these reports, together with WP progress and outstanding results.

WP1. Monitoring European P. infestans populations. WP leader: DEL Cooke, JHI

WP1 complements the survey undertaken by EuroBlight, and will enable Europe to track emerging populations. The work will build on existing achievements by the EuroBlight network and associated global partners with regard to monitoring of *P. infestans* in Europe and beyond. The WP work will answer questions like: What are the dominant clonal lineages (genotypes) in Europe over time and across countries? What is their relatedness to global populations? How can we quickly and reliably identify new emerging populations? This WP will build the foundations for a global service enabling Europe to track and trace new emerging populations originating from Europe itself or from other continents.

Task 1.1. Sampling isolates in DK, EE, FR, and NO. We will collect representative samples from potato crops in partner countries, as well as samples from field trials where the risk for emerging fungicide resistance or virulence is higher. In years 2 and 3 of the project, sampling will thus concentrate on trap nurseries established to monitor virulence changes (task 2.4). The aim is to collect 40-50 isolates /country and year. The collections will be used in the genotyping (task 1.2) and phenotyping tests (WP2). We will also collect reference isolates from other continents (e.g. 23_A1 /US23 or 13_A2 from northern Africa).

Task lead: David Cooke, JHI; participants: AU (Bent J. Nielsen), NIBIO (Håvard Eikemo, Vinh Hong Le), NAES (Borghild Glorvigen), EULS (Eve Runno-Paurson, Kaire Loit), ACVNPT (Catherine Chatot), ARVALIS (Denis Gaucher).
Milestone M1.1.1 – Protocol for sampling isolates validated and distributed (M2)
Deliverable D.1.1.1 – yearly sample collections on FTA cards and live samples complete (M6, M18, M30)

Task 1.2. SSR genotyping will take place at JHI. INRA and NIBIO will also provide genotype fingerprints for the French and Norwegian samples using the set of Euroblight markers and reference isolates if needed. We will harmonize SSR protocols with regional labs in US (USABlight, Bill Fry), Asia and Africa (CIP, Greg Forbes) and Latin America (LatinBlight, Ivette Acuna).

Task lead: David Cooke, JHI; participants: INRA (Roselyne Corbière, Romain Mabon), NIBIO (Vinh Hong Le).
Milestone M.1.2.1 - Genotyping scheme decided and validated M.1.2.1 (M6)
Deliverable D.1.2.1 - SSR fingerprints determined (M11, M23, M35)

Task 1.3. Liquid Nitrogen storage of reference isolates. After genotyping of isolates a reference collection is stored, multiplied and distributed for analysis in WP2.

Task lead: Vinh Hong Le, NIBIO
Deliverable 1.3.1: Reference collection of isolates stored in liquid nitrogen and distributed to participants

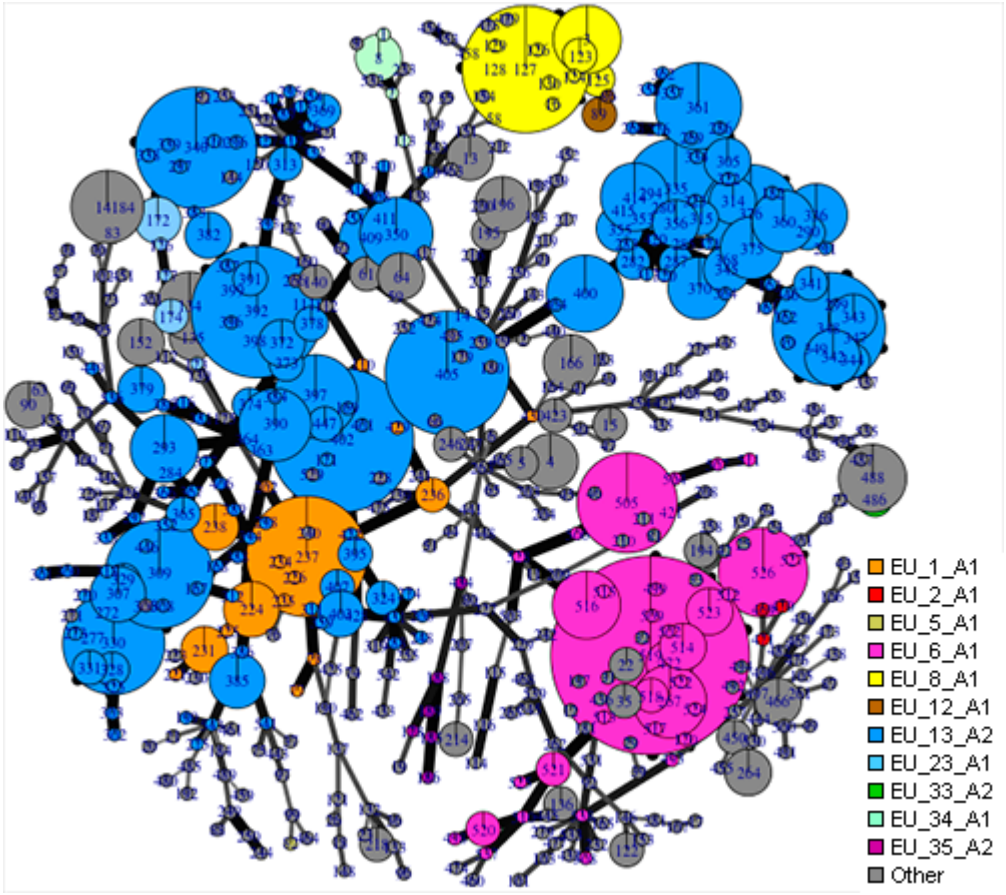
Task 1.4. Data storage, management and display tools, EuroBlight database. The existing EuroBlight data management, analysis and display system will be further elaborated to meet the project data storage and analysis requirements, i.e. DB tables and tools for handling phenotypic data from WP2 and data management and data access for the model development in WP3. Historical SSR data 2004-2012 from earlier or companion projects will be quality controlled and imported into the new EuroBlight database, which holds P. infestans data mainly from 2013 and 2014 samplings.

Task lead: Jens G. Hansen, AU; participants: AU (Sanmohan Baby), JHI (D Cooke), INRA (R Corbière, R Mabon), ACVNPT (C Chatot).
Deliverable D.1.4.1 - Historical SSR data 2004-2012 quality controlled and imported into the new EuroBlight Database (M10)
Deliverable D.1.4.2: isolate information and SSR fingerprints inserted into Euroblight database (M12, M24, M36)
Deliverable D.1.4.3: Data management and display system in place for use in task 2.4 (M12)

Task 1.5. Population genetic analysis. The R package poppr (Kamvar et al. 2014) provides unique tools for analysis of data from admixed, clonal, mixed, and/or sexual populations. Most recently, EuroBlight has implemented a Shiny-R version of the poppr tool linked to the EuroBlight database for analysis of the SSR genotypic data. Further upgrades will be supported in this project, with new functions to examine the spatio-temporal diversity of *P. infestans* populations based on Bruvo's distance for microsatellites and an assimilation of genotypic and phenotypic data.The upgraded poppr will then be put to full use to analyse the metapopulation structure of *P. infestans* in Europe, in particular to infer emerging genotypes and possible migration/displacement routes within and between populations.

Task lead: David Cooke, JHI; participants: AU (S Baby, JG Hansen), INRA (D Andrivon, R Corbière)
Milestone M.1.5.1 - Technical workshop on data management analysis and display of genotypic and phenotypic data (M12)
Deliverable D.1.5.1: upgraded version of poppr platform (M12)
Deliverable D.1.5.2: Population genetic analysis of the European metapopulation 2004-2016 - peer reviewed paper (M18)

WP2. Linking phenotypes to genotypes. WP leader: Eve Runno-Paurson, EULS
This WP aims to analyse key phenotypic traits (aggressiveness – *i.e.* quantitative pathogenicity; sensitivity to major active ingredients currently in use in Europe for late blight control; virulence – *i.e.* ability to infect breeding material or in European potato cultivars possessing race-specific resistance genes) from the isolate collections established and genotyped in WP 1. The comparison of genotypic and phenotypic data will be carried out to determine the possibilities of inferring phenotypic characteristics from genotypic markers, in both clonal and sexual populations of the pathogen. If possible, this inference will be very useful for prediction and strategy design purposes, as the genotypic fingerprinting is much quicker than phenotypic testing. We will therefore analyse variation both between genotypes and within clonal lineages, as these lineages often consist of numerous variants.



Task 2.1. Intra/interclone variation for aggressiveness. This task will test aggressiveness differences between genotypes, and between individuals/clonal variants within clonal lineages. Isolates tested will thus be chosen based on the results of genotyping (task 1.2). The tests will be carried out on a susceptible potato cultivar, according to methods already described (Montarry et al. 2010). Traits measured will be components of quantitative pathogenicity: latent period, lesion growth and spore production.

Task lead: Roselyne Corbière, INRA; participant: INRA (R Mabon)
Deliverable D.2.1.1 - Aggressiveness measured for reference isolates from yearly collections (M12, M24, M36)

Task 2.2. Intra/interclone variation for fungicide resistance. Live *P. infestans* isolates from task 1.1 will be tested for sensitivity to major late blight fungicides, for which resistance as been detected previously in natural isolates, or which are widely used to control late blight in Europe and are thus at risk of resistance development. Based on modes of action/chemical families and current use in the EU, we selected four active ingredients to test: cyazofamid (medium to high risk of resistance), dimethomorph (low to medium risk), fluazinam (low intrinsic risk but less sensitive clones -33_A2 - identified already), and propamocarb (low to medium risk). All fungicide tests will be done with the floating leaf discs method (Hermansen et al. 2000), using fungicide-treated greenhouse grown plants to avoid unwanted infections.

Task lead: Eve Runno-Paurson, EULS; other participants: NIBIO (VH Le), EULS (M Hansen, K Loit)
Milestone M.2.2.1. Technical workshop: differential set and protocols for virulence, fungicide and trap nurseries agreed (M6)
Deliverable D.2.2.1. Fungicide resistance phenotypes in refence collections identified (M12; M24; M36)

Task 2.3. Intra/interclone variation for virulence. Live *P. infestans* isolates from task 1.1 will be tested according to the methodology for virulence testing with detached leaflets standardized during the Eucablight project and validated though an European ring test (Andrivon et al. 2011). Due to immediate availability and to ensure comparisons, the EuroBlight R-gene differential set (derived from the Black/Mastenbroek set) will be used. For clonal lineages distributed across Europe, isolates from different origins and genotypic subgroups will be assayed.

Task lead: Eve Runno-Paurson, EULS; other participants: ACVNPT (C Chatot, F Aurousseau), EULS (M Hansen, K Loit).
Milestone M.2.2.1. Technical workshop: differential set and protocols for virulence, fungicide and trap nurseries agreed (M6)
Deliverable D.2.3.1: isolate information and virulence profiles inserted into Euroblight database (M 12, 24 and 36)

Task 2.4. Trap nurseries and real-time P. infestans population virulence profiling. In 2016, a new set of differential hybrids (Zhu et al. 2015) will be obtained from WUR as *in vitro* cuttings and multiplied to mini tubers at four sites (ACVNPT; NIBIO; SASA for UK and DK partners; EULS). In 2017 and 2018, open field nurseries will be planted in dedicated, specific potato growing areas across Europe. Nurseries will be scored for infection at frequent intervals (once a week minimum) during epidemics to monitor the first date and development of infection in differential clones. Observation data will be implemented in real time into the IT infrastructure, to establish virulence maps across the network of field nurseries. These maps will be displayed on the EuroBlight website (task 1.4). Nurseries will serve as isolate sampling sites (task 1.1), so the virulence dynamics in nurseries and virulence profiles in isolates from these nurseries (task 2.3) can be compared. Retrospective analysis of data from older nurseries (INRA) will be used to complement this analysis.

Task leader: C. Chatot, ACVNPT; participants: EULS, NIBIO, NAES, ARVALIS, AU, INRA, JHI.
Milestone M.2.2.1. Technical workshop : differential set and protocols for virulence, fungicide and trap nurseries (M6)
Milestone M.2.4.1. differential host set obtained from Wageningen University Research and multiplied (M10)
Deliverable D.2.4.1. local/national populations phenotypic data inserted into EuroBlight database (M24 and 36)
Deliverable D.2.4.2. comparison of virulence dynamics in field nurseries and isolate race structure (M36)

WP3. Developing innovative DSS integrating epidemiological and population knowledge. WP leader Jens G. Hansen, AU

The objective is to develop a new, quantitative approach to integrate knowledge on weather-based infection risk, epidemiological parameters, and pathogen phenotype and genotype characteristics (IPM2.0 concept). A suite of new on-line simulation models, making use of the phenotypic and genotypic data, weather data, and trap nurseries data from WP1 and WP2, will be designed (task 3.1) and implemented as web-based tools (task 3.2). Existing DSSs in partner countries will then be adjusted based on results from step 1, and improved DSSs will be tested in field experimental trials (task 3.3).

Task 3.1. Develop a suite of simulation models for the integration of new data on pathogen information, host resistance and weather, will run in three steps: i) identify existing models and applications relevant for the IPMBlight 2.0 model development; ii) system description such as architecture, parameters to be included, management of data, model performance and sensitivity analysis; iii) data collation, storage, quality control and access from task 1.4.

Task lead: Anne-Grete Roer Hjelkrem, NIBIO; participants: AU (JG Hansen), INRA (D Andrivon, R Corbière), JHI (AK Lees), Arvalis (D Gaucher), ACVNPT (C Chatot, F Aurousseau)
Milestone M.3.1.1 existing models and applications relevant for the IPMBlight 2.0 model development identified and evaluated (M5)
Deliverable D.3.1.1 System description of models and applications to be implemented on the EuroBlight platform (needed for task 3.2; M10)

Task 3.2. Implement the simulation model (from task 3.1) as a web tool that can be used by all partners on the EuroBlight platform. The web tool will be a version where all parameters can be changed by the user. The web tool will be an integral part of the login protected part of the EuroBlight platform. On this platform, a Potato Late Blight Toolbox will control models and databases, holding weather data from all partner countries 2010-2015, historical and new *P. infestans* phenotypic and genotypic data from WP1 and 2, and trap nurseries observation data.

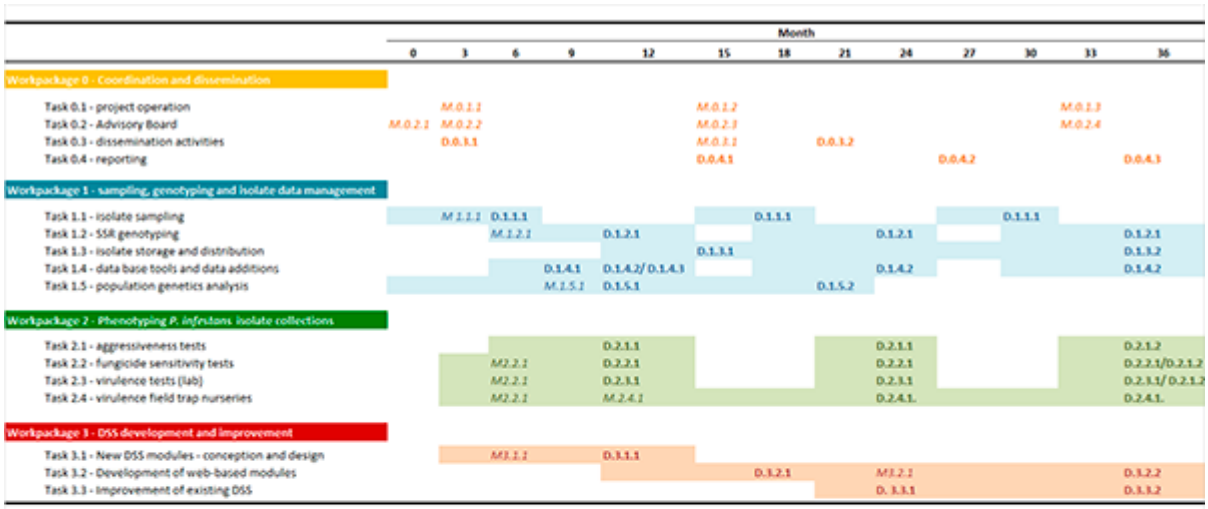
Task lead: Jens G. Hansen & Poul Lassen, AU; participant: NIBIO (A-G Roer Hjelkrem)
Milestone M.3.2.1. WP 3 technical workshop: Simulation model implemented as a web tool incl. features for automatic integrated with all data from WP1 and WP2 (M16)
Milestone M.3.2.2 Simulation model updated based on simulations with new data from the project (M22)
Deliverable D.3.2.1 Peer reviewed paper about IPMBlight 2.0 modelling approach and simulations with historical and new data (M36)

Task 3.3. Adapt existing DSSs based on results from the simulation model. Existing national DSS (will be modfied based on tasks 3.1 and 3.2 outputs by additon of specific modules for population characteristics and/or parameter adjustments. These adapted DSS will be field tested in 2018 at sites in NO & FR and possibly in DK, 2018 pending additional, external funding can be levied.

Task lead: Håvard Eikemo, NIBIO; participants: AU (JG Hansen), JHI (AK Lees), ARVALIS (D Gaucher), ACVNPT (C Chatot).

Milestone M.3.3.1 Existing national DSSs adjusted according to IPMBlight 2.0 approach (M24)
Deliverable D.3.3.1 Review article on test of adjusted DSSs in national field experiments (M36)

• **Gantt Chart**



List of milestones

- *M.0.1.1 - Kick Off meeting*
- *M.0.1.2 - Intermediate meeting (with Eurobligth Workshop) Aarhus*
- *M.0.1.3 - Final meeting*
- *M.0.2.1 - Advisory Board established*
- *M.0.2.2 - Project & Advisory Board meeting (together with kick-Off meeting)*
- *M.0.2.3 - Project & Advisory Board meeting (with Eurobligth Workshop)*
- *M.0.2.4 - Project & Advisory Board meeting (with final meeting)*
- *M.0.3.1 - IPMBligth 2.0 Presentations at Eurobligth workshop*
- *M.1.1.1 - Sampling protocol validated and distributed*
- *M.1.2.1 - Genotyping scheme decided and validated*
- *M.1.5.1 - Technical workshop on data management analysis and display of genotypic & phenotypic data*
- *M.2.2.1. Technical workshop : differential set and protocols for virulence, fungicide and trap nurseries*
- *M.2.4.1. Differential host set obtained from Wageningen University Research and multiplied*
- *M.3.1.1. Existing models and applications relevant for the IPMBligt 2.0 identified and evaluated*
- *M.3.2.1. Simulation model updated based on simulations with new data from the project*

List of deliverables

- D.0.1.1 - Project web page established
- D.0.1.2 - Books of contributions to Eurobligth workshop issued
- D.0.4.1 - First year report
- D.0.4.2- Second year report
- D.0.4.3 - Third year and final report
- D.1.1.1 - yearly sample collections on FTA cards and live samples complete
- D.1.2.1 - yearly sample collections genotyped
- D.1.3.1 - reference collection established and stored
- D.1.3.2 - reference collection supplemented with additionnal isolates -if relevant
- D.1.4.1 - Historical SSR data 2004-2012 quality controlled and imported into EuroBlight Database
- D.1.4.2 - Isolate information and SSR fingerprints inserted into Eurobligth database
- D.1.4.3 - Data mananagement and display system in place for use in task 2.4
- D.1.5.1 - upgraded version of PoPPR platform
- D 1.5.2 - Population genetic analysis of the European metapopulation 2004-2016 - peer reviewed paper
- D.2.1.1. Agressiveness measured for reference isolates from yearly collections
- D.2.1.2. Draft paper on phenotype/genotype comparison.
- D.2.2.1. Fungicide sensitivity phenotypes determined and in Eurobligth database
- D.2.3.1. Virulence phenotypes determined and in Eurobligth database
- D.2.4.1. Virulence trap nursery data implemented in Potato late Blight Toolbox
- D3.1.1 - System description of models and applications to be implemented on the EuroBlight platform
- D.3.2.1 - Simulation model implemented as a web tool incl. integration with all data from WP1 and WP
- D.3.2.2 - Peer-Reviewed article about BlightIPM 2.0 modelling approach
- D.3.3.1 - Existing national DSSs adjusted for IPM 2.0 approach
- D.3.3.2 - paper on test of adjusted DSSs in national field experiments

• **Skills, methods and involvement of partners**
IPMBlight 2.0 will mobilise conceptual and technical skills in:
> plant pathology & *P. infestans* biology: E Runno-Paurson, M Hansen, K Loit (EULS), VH Le (NIBIO), D Andrivon, R Corbière (INRA), BJ Nielsen (AU), AK Lees (JHI), C Chatot (ACVNPT)
> population genetics and evolution: DEL Cooke (JHI), D Andrivon, R Corbière, R Mabon (INRA), S Baby (AU), E Runno-Paurson (EULS)
> epidemiology: DEL Cooke, AK Lees (JHI), BJ Nielsen, JG Hansen (AU), H Eikemo (NIBIO) D Andrivon, R Corbiere (INRA), D Gaucher (ARVALIS), B Glorvigen (NAES)
> plant genetics and breeding: C Chatot, F Aurousseau (ACVNPT)

> modelling, DSS development and operation: A-G Roer Hjelkrem, H Eikemo (NIBIO), JG Hansen, S Baby (AU), D Gaucher (ARVALIS), B Glorvigen (NAES)

> information technology and data management: JG Hansen, P Lassen (AU),

> project management: all 4 WP leaders are senior scientists with portfolios of coordinated national or international projects (see CVs). D. Andrivon coordinates PoH-MED, an ARIMNET project built within another ERANET.

Overall, IPMBlight 2.0 will use **68,9 person–months** (PM), broken down as:
INRA - 10 PM: WP0- 2.5, WP1- 1.5, WP2- 5.5, WP3- 0.5
AU -16.5 PM: WP1- 8.5, WP2- 1.7, WP3- 6.7
EULS - 4.4 PM: WP1- 1, WP2- 3.4
NIBIO - 14 PM: WP1- 4.5, WP2- 3, WP3- 6.5
NAES - 4.7 PM; WP1 - 1.5, WP2 -1.7, WP3- 1.5
ARVALIS - 6.3 PM: WP1-0.3, WP2- 0.7, WP3- 5.3
ACVNPT - 8.3 PM : WP1-0.6, WP2- 6, WP3- 1.7
JHI (associated partner): **4.7 PM**.

Andrivon D et al. 2011 Plant Pathol 60:556-565.
Hermansen A et al., 2000. Plant Pathol 49: 11-22
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RELATED PROJECTS

“Phenotypic and genotypic characterisation of Baltic and Russian Pskov region populations of *Phytophthora infestans*; the role of oospores as a source of primary inoculum to late blight pathogen epidemiology” - Estonian Foundation grant project No 9432, leader E. Runno-Paurson. No direct overlap with IPMBlight 2.0, except possibly joint sampling campaigns.

"Sustainable crop protection: harnessing ecosystem services for plant production” - Institutional research funding IUT36-2, E. Runno-Paurson, senior scientist involved. Project including late blight, but orientated towards ecosystem services, which are not directly addressed in IPMBlight 2.0, so no direct overlap.

PoH -MED (Potato Health, Managed for Efficacy and Durability) - ARIMNET Call 1 project (2012-2016). INRA coordinator (D. Andrivon), 11 partners including ACVNPT. Project targeting the whole potato disease complex in Mediterranean potato production systems, including late blight. No direct overlap with IPMBlight 2.0, but PoH-MED will contribute genotypic data on north African populations collected during this project to the Euroblight database.

EuroBlight -A potato late blight network for Europe. Active for over 20 years and involving the whole chain of stakeholers dealing with late blight control, EuroBlight is organised in subgroups: host resistance to *P. infestans*; pathogen characteristics, population biology and genetics, epidemiology; integrated control and decision support systems; fungicides; epidemiology and control of *Alternaria* spp (recent extension of EuroBlight to early blight, another potato disease). The network meets every second year for a workshop (> 100 participants): the next ones are planned in May 2017 in Aarhus, Denmark, and 2019 in the UK. EuroBlight runs on partners sponsorship for the meetings and projects it coordinates, such as the EU late blight genotyping initiative using FTA cards, operated 2013-2015 and hoped to continue after that date. EuroBlight has developed and/or vaidated methodologies to andle and characterise *P. infestans* samples, that will be put to use in IPMBlight2.0. It also develped an IT platform that will serve as the primary tool for project dissemination and management. The network and stakeholder engagement in EuroBlight has been a very effective dissemination channel but also beyond, because on a global scale other networks “follow us”. Through EuroBlight, the IPMBlight 2.0 consortium will coordinate and integrate its activities with relevant partners from USABlight, AsiaBlight and LatinBlight.

GB Late Blight Populations: receipt and evaluation of field-collected samples and provision of an outbreak reporting service. AHDB Potatoes funded project in the UK (2015-2017). Complements current project by providing samples from British potato crops.

DISSEMINATION

IPMBlight2.0 will be run in the EuroBlight Virtual Research Environment, an IT framework operated by AU and based on i) a website, AU typo3 CMS, used for dissemination of project information and results, and ii) a Potato Late Blight Toolbox that hosts the SQL databases and web-based tools (Microsoft.NET, SHINY-R etc.) supporting the EuroBlight consortium and website. It uses test and production servers, professional web hosting and backup, and its tools will store, analyse and display data and results from the project, and to reach stakeholders in real time.

Since stakeholders (scientists, decision makers, chemical and breeding industry, growers and advisors) use different IT, we will design a differentiated set of dissemination tools to update them about the project aims, progress and achievements.

• Scientists
  > Papers in scientific journals on late blight monitoring, epidemiology and population changes.
  > Active participation in conferences, workshops and seminars.
• Industry and decision makers
  > In April 2016, we will launch a public page on the EuroBlight website (www.euroblight.net). This page, with both a public access area and a restricted access area for partners, will be regularly updated with project results.
  > Input to Policy Briefs from EuroBlight, which summarize at 12-18 month intervals the results from major national and international projects in view to policy needs, and are distributed to regional, national, and European policy makers.
  > Press releases on the project launch, main results and events will be included in EuroBlight newsletters.
• Growers and advisors
  > Technical papers presenting major results and consequences for disease management
  > EuroBlight workshops planned in Aarhus, DK, 2017 and UK in 2019.

The project will be coordinated with relevant national and international projects. The Advisory Board will be asked to offer insights and ideas on ways to maximize and measure the impact of our scientific advances.

SOCIETAL AND ETHICAL ASPECTS

• Ethical concerns

The proposed research raises no societal or ethical concerns. The research involves no experiments on human or animal subjects, no genetically manipulated organisms and no deliberate release into the environment of non-indigenous organisms. Only *P. infestans* isolates of European origin will be used under natural field conditions. Both INRA, James Hutton Institute and Estonian University of Life Sciences have many years of experience working with plant pathogenic fungi and have state-of-the-art facilities classified for undertaking DNA techniques as well as normal greenhouses and semi-field facilities for plant cultivation. All relevant European and international guidelines, regulations and laws will be followed in carrying out the research.

• Sustainability issues

All relevant data and web tools from the project will be stored and implemented in the EuroBlight virtual research environment. This environment is shared with other long lasting activities. For instance, *P. infestans* data are stored in the same database and with the exact same structure as the wheat rust isolate data. This means that many tools and new applications re. data management, display on maps and charts etc. can be shared or reused with minor adaptations. Via the Consortium agreement, AU will commit to keep the databases and web tools developed by the project for at least 5 years after the project has ended. The data collected in this project will be merged with similar historical data and usability of data and results will gain considerably by the inclusion in the existing EuroBlight context.

FINANCES

Requested funding

Organisation name	Personnel	Travel	Consumables / Equipment	Subcontracts	Requested Funding	Total Own Contribution	Total Costs
Institut National de la Recherche Agronomique	30000	8000	125000	10000	179920	197506	377426
Overhead	1200	320	5000	400			
Aarhus University	113300	12755	3020	6040	194569	0	194569
Overhead	49852	5615	1329	2658			
NIBIO (formely Bioforsk)	225000	19000	11000	6100	261100	0	261100
Overhead							
Estonian University of Life Sciences	56800	8000	15200		100000	0	100000
Overhead	14200	2000	3800				
ARVALIS Institut du Végétal	39340	3360			44420	28580	73000
Overhead	1574	146					
Association des Créateurs de Variétés Nouvelles de Pomme de terre	46500	1200	2100		50120	33200	83320
Overhead	320						
Norwegian Agricultural Extension Service	55000	10000			65000	0	65000
Overhead							
James Hutton Institute					0	74795	74795
Overhead							

Organisation name	Personnel	Travel	Consumables / Equipment	Subcontracts	Requested Funding	Total Own Contribution	Total Costs
TOTAL	633086	70396	166449	25198	895129	334081	1229210

Own contribution

Organisation name	Personnel	Travel	Consumables / Equipment	Subcontracts	Other	Total Own Contribution
Institut National de la Recherche Agronomique	197506					197506
Aarhus University						0
NIBIO (formely Bioforsk)						0
Estonian University of Life Sciences						0
ARVALIS Institut du Végétal	23586	2194	2800			28580
Association des Créateurs de Variétés Nouvelles de Pomme de terre	31000	800	1400			33200
Norwegian Agricultural Extension Service						0
James Hutton Institute	30085	6125	10200		28385	74795
TOTAL	282177	9119	14400	0	28385	334081

ANDRIVON DIDIER,
Research Director, Plant Pathology

Born March 29, 1962
Married, two sons

Professional adress

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Education

1985: **Ingénieur Agronome,** Ecole Nationale Supérieure Agronomique de Rennes
1991: **Ph.D Agronomic Sciences, Institut National Agronomique Paris** ('cum laude')
1998: **Habilitation à Diriger les Recherches** (Sciences de la Vie), University Rennes I

Foreign languages (read, written and spoken): English, German, Spanish

Research Carrier

Scientific papers

- Papers in international refereed journals (ISI Web of Science; 1987-2014) ;
  As of 03.06.2015: **75 papers**, **1203 citations ; h=22**
- 9 book chapters; 10 invited conferences in national or international congresses or symposia.

National and international projects

Europe & international

- Participant in 8 EU projects since 1992, and one F-GB bilateral project -INRA-BBSRC 'Invasion and persistence of plant pathogens' (2007-2011); WP leader in EU Projects EUCABLIGHT and CO-FREE
- French coordinator of two bilateral Franco-Moroccan projects PRAD (1999-2001 & 2003-2005)
- Coordinator, ARIMNET PoH-MED (2013-2016)

National

- Leader of 6 research contracts funded by the French Ministry of Agriculture
- Participant /WP leader in numerous projects, including ACC Sciences du Vivant (MRE), 1996-1997; Action Biodiversité MRE, 1997-1999; Contrats de branche 1998, 2003 ; ANR-ADD CEDRE, 2005-2009 ; ANR EMERFUNDIS, 2007-2011; ANR SYSTERRA ARCHIDEMIO 2009-2012.
- WP leader in INRA-ACCAF project CLIF (2012-2016)

Research administration

- Leader, team 'Characterisation and durable management of plant resistance to diseases', UMR BiO3P
- Head, UMR BiO3P (2005-2007)
- Deputy-head, INRA Plant Health and Environment Division (2007-2014)
  http://www.inra.fr/sante_plantes_environnement/

Expertise

- Associate editor, *Plant Pathology* (since 1996); *Phytopathology* (1999-2001).
- Referee (*Oecologia, New Phytologist, Journal of Evolutionary Biology, Phytopathology, Plant Disease, Mycological Research, European Journal of Plant Pathology, Journal of Phytopathology*…): 8 - 10 papers a yr since 1995.
- External referee for research projects – FR, UK, Norway, Israël.

Curriculum Vitae for Jens Grønbech Hansen

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Current research:
Basic and applied research in the area of agrometeorology and plant protection, wheat rust and late blight epidemiology and population biology, soil carbon management and crop modelling, development of web based decision support systems for agriculture on Internet, e.g.: www.EuroBlight.net, www.wheatrust.org, www.smartsoil.eu,

Computer software and web based research platforms:
Responsible for the EuroBlight virtual research environment including the EuroBlight website (www.euroblight.net) and the Potato late blight toolbox that controls databases and web tools including the PoPPR based pop genetics platform. Database manager and responsible for a similar Wheat Rust Toolbox (http://wheatrust.org/wheat-rust-toolbox/) hosting global data and pop genetics analysing and display tools on rust diseases on wheat. Development of the SmartSOIL DST (smartsoil.eu/tool)

Project management
Coordinator of EuroBlight (www.euroblight.net). Project Manager and Web site responsible of several research platforms and databases. Experiences from appr. 20 international projects.

Selected publications

M. S. Hovmøller, S. Walter, R. Bayles, A.Hubbard, K. Flath, N. Sommerfeldt, M. Leconte,P. Czembor, J. Rodriguez-Algaba, T. Thach, J. G. Hansen, P. Lassen, A. F. Justesen, S. Ali and C. de Vallavieille-Pope (2015). **Replacement of the European wheat yellow rust population by new races from centre of diversity in the near-Himalayan region,** *Plant Pathology (early online)*

Jørgensen, L.N.; Hovmøller, M.S.; Hansen, J.G.; Lassen, P.; Clark, B.; Bayles, R.; Rodemann, B.; Jahn, M.; Flath, K.; Goral, T.; Czembor, J.; Cheyron, P.; Maumene, C.; Pope, C.; Nielsen, G.C. Berg, G (2014)**. IPM strategies and their dilemmas including an introduction to www.Eurowheat.org**. *Journal of Integrative Agriculture*, Vol. 13, Nr. 2, 2014, s. 265-281.

Hansen, Jens Grønbech &; Lassen, Poul (2013). **Managing global crop disease data.**.
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Cooke, L. R. , Schepers, H. T. A. M. , Hermansen, A. , Bain, R. A. , Bradshaw, N. J. , Shaw, D. S. , Evenhuis, A. , Kessel, G. J. T. , Wander, J. G. N. , Anderson, B. , Hansen, J. G. , Nukkala, A. , Nærstad, R. & Nielsen, B. J. (2011) **Epidemiology and integrated control of potato late blight in Europe**
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Brurberg, M. B. , Elameen, A. , Le, V. H. , Nærstad, R. , Hermansen, A. , Lehtinen, A. , Hannukkala, A. , Nielsen, B. J. , Hansen, J. G. , Andersson, B. & Yuen, J. (2011). **Genetic analysis of *Phytophthora infestans* populations in the Nordic European countries reveals high genetic variability**
Fungal Biology. 115, 4-5, s. 335-342.

Bioforsk, Norwegian Institute for
Agricultural and Environmental research

Curriculum vitae

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Date of birth: 19 July 1971
Address: Bioforsk, Norwegian Insttitute for Agricultural and Environmental Research, Høyskoleveien 7, 1430 Ås, NORWAY (www.bioforsk.no)
Phone: +47 92 06 81 89
E-mail: ragnhild.naerstad@bioforsk.no

Degrees:

- 1995: Master of science at Agricultural University of Norway, Department of Horticulture and Crop Science.
- 2002: Dr. scient. at Agricultural University of Norway, Department of Horticulture and Crop Science.

Career:

- 1991 to present: Linnes Gård. Owns and run a vegetable farm (100ha vegetables + 8 ha cereals) together with my husband.
- 1995-2002: Doctoral student, Agricultural University of Norway, Department of Horticulture and Crop Science.
- 2000 - 2002 Scientist at Bioforsk, Norwegian Institute for Agricultural and Environmental Research, Plant Health and Plant Protection Division, Høgskolevegen 7, N-1432 Ås, Norway.
- 2002 to present: Senior researcher in plant pathology, fungal diseases in potato and vegetables at Bioforsk, Norwegian Institute for Agricultural and Environmental Research, Plant Health and Plant Protection Division, Høgskolevegen 7, N-1432 Ås, Norway.

Research and extension work:
Main responsibility: Research and advisory (extention) of fungal diseases in potatoes and vegetables. The work has included basic and applied research to improve disease management with main specialty on late blight (Phytophthora infestans) and fungal skin blemishing diseases (*Rhizoctonia solani, Helminthosporium solani, Colletotrichum coccodes, Polyscytalum pustulans*) on potatoes. In vegetables the main diseases has been *Sclerotinia sclerotiorum, Botrytis cinerea* in several crops, liquorice rot (*Mycocentrospora acerina*), crater rot (*Fibularhizoctonia carotae*) and cavity spot (different *Pythium* species) in carrots, downy mildew (Bremia lactucae) and *Septoria lactucae* in Lettuce, downy mildew in crusifers (*Hyaloperonospora parasitica*), leaf spots in brassicas (*Alternaria brassicae, Alternaria brassicicola, Pseudocercosporella capsellae*), downy mildew in onion (*Peronospora destructor*) and onion white rot (*Sclerotium cepivorum*) and late blight in celery (*Septoria apiicola*).

- Developed the potato late blight forecasting model currently used in Norway (www.vips-landbruk.no).
- Involved in the black scurf part of the bilateral project "Effective surveillance and control of potato soil-borne pathogens and pests" financed by MOST in China.
- Leading the POTTIFRISK – Improved potato seed tuber quality through better disease control methods- project. 2015- to present
- Leading the potato late blight WP in POTPAT, an EEA financed project with Poland.
- Coordinates the testing for approval of fungicides in Norway. 2009 – to present
- Coordinates the fungicide resistance work at Bioforsk. 2010 – 2015.

Networks and international responsibilities:

- Coordinator of the working group on potato late blight of the Nordic Association of agricultural workers (NJF) 2010 to present
- Participation in NORBARAC, Nordic Baltic resistance action group, for fungicide resistance 2007- to present
- Participation in the European network for development of an integrated control strategy of potato late blight, first EU.ICP.NET continuing into Eucablight and now EuroBlight. 1997- to present.
- Participate in the EPPO(European and Mediterranean plant protection organization) Ad hoc expert working group on extrapolation tables for minor uses. 2012- to present
- Participate in EPPO fungicide resistance panel. 2014- to present

Publications with referee:

Nærstad R, Dees MW, Le VH, Holgado R.& Hermansen A, 2012. Occurrence of skin blemish diseases (Scab and Scurf) in Norwegian potato production. Potato Research: Volume 55, Issue 3 (2012), Page 225-239

Hermansen A, Wanner L, Nærstad R. & Klemsdal S. 2011. Detection and prediction of postharvest carrot diseases. European Journal of Plant Pathology (2012) 133: 211-228.

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Lehtinen A, Andersson B, Le VH, Nærstad R, Rastas M, Ketoja E, Hannukkala AO, Hermansen A, Nielsen BJ, Hansen JG & Yuen J. 2009. Aggressiveness of Phytophthora infestans on detached potato leaflets in four Nordic countries. Plant Pathology 58:690-702.

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Hermansen A, Hannukkala A, Nærstad R & Brurberg MB. 2000. Variation in populations of Phytophthora infestans in Finland and Norway: mating type, metalaxyl resistance and virulence phenotype. Plant Pathology 49 p 11-22

Other publications:

Nærstad R, Le VH, Strømeng GM, Tadessa BA & Ficke A. 2015. Eksempler på fungicidresistensproblemer i Norge. Bioforsk Fokus 10(2): 79.

Nærstad R, Shiva SS, & Le VH. 2015. Potettørråte- kartlegging av fungicidresistens i tidlige tørråte funn. Gartneryrket (2) 2015: 13-17.

Nærstad, R. 2014. Biologisk godkjenningsprøving og utviklingsprøving 2014. Soppmidler Bioforsk RAPPORT 9(181):99pp

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Nærstad R. 2012. Biologisk godkjenningsprøving og utviklingsprøving 2012. Bioforsk RAPPORT 7(175):128pp.
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Hermansen A, Abrahamsen S, Brurberg MB & Nærstad R.. 2012. Tørrflekksyke – blir det er problem i Norge. Bioforsk FOKUS 7 (2): 119-120.
Nærstad R, Brurberg MB & Hermansen A. 2012. Nytt fra tørråteforskningen og erfaringer fra sesongen 2011. Bioforsk FOKUS 7(2): 117-118.
Hermansen A, Wiken Dees M, Holgado R, Le V & Nærstad R. 2011. Survey of skin blemish diseases in Norwegian potato production in 2008 and 2009. Bioforsk Fokus 6(10):6.
Hermansen A, Nærstad R & Le VH. 2011. Potato late blight in Norway. NJF Report 7(9):83.
Nærstad R. 2011. Biologisk godkjenningsprøving og utviklingsprøving 2011. Bioforsk RAPPORT 6(158):140pp.
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Nordskog B, Rafoss T, Nærstad R, Hofgaard I, Hole H, Elen O & Brodal G. 2011. Developing a farm scale forecasting service for pests and diseases. NJF Report 7(9):51.
Hermansen A, Abrahamsen S, Brurberg MB & Nærstad R. 2011. Tørrflekksjuke i potet. Gartneryrket 109(7):14-15.
Hermansen A & Nærstad R. 2011. Potettørråte-bekjemping 2011. Gartneryrket 109(7):12-13.
Rafoss T, Nordskog B, Nærstad R, Hofgaard IS, Hole H, Elen O & Brodal G. 2011. Gårdsvarsling. Utvikling av plantevernvarsler på gårdsnivå. Bioforsk TEMA 6(8):4s.
Rafoss T, Nærstad R, Hofgaard IS, Hole H, Elen O & Brodal G. 2011. Plantevernvarsel på gårdsnivå – rapport fra en pilotstudie for potet og korn i Solør-Odal. Bioforsk FOKUS 6(1):91-97
Hermansen A, Lund G, Gauslaa E, Elameen A, Nærstad R & Klemsdal S. PCR-based detection of pathogens in carrot soil samples to predict development of carrot cavity spot and post harvest diseases. Book of abstracts. 9th Conference of the European Foundation for Plant Pathology, Évora, Portugal, 15-18 November 2010:s111.
Hansen JG, Hermansen A, Nærstad R & al, 2010. The development and control of Late Blight (Phytophtora infestans) in Europe in 2009. Proceedings of the Twelfth EuroBlight Workshop, Arras, France, 3-6 May 2010. PPO-Special Report no. 14, December 2010 :17-34.
Nærstad R, Le VH & Hermansen A. 2010. Reduced fungicide input in late blight control (REDUCE 2007-2011) – Preliminary results from 2007 to 2009. Proceedings of the Twelfth EuroBlight Workshop, Arras, France, 3-6 May 2010. PPO-Special Report no. 14, December 2010 (14):193-198.
Nærstad R. 2010. Biologisk godkjenningsprøving og utviklingsprøving 2010. Bioforsk RAPPORT 5(185):141.
Hermansen A & Nærstad R. 2010. Potettørråtebekjemping i 2010. Gartneryrket 108(7):26-27.
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Sundbye A, Tørresen K & Nærstad R. 2010. Utprøving av plantevernmidler i Norge. Gartneryrket 108(4):23-26.
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Nærstad R, Le VH, Hermansen A, Hannukkala A, Nielsen B, Hansen J, Grönberg L, Andersson B & Yuen J. 2009. Improvement of potato late blight forecasting. H.T.A.M. Schepers (ed) Proceedings of the Eleventh EuroBlight Workshop, Hamar, Norway, 28-31 October 2008. PPO-Special Report no.13, July 2009:103-105.
Le VH, Nordskog B, Nærstad R, Gadoury D & Hermansen A. 2009. Solar radiation and spore survival in Phytophthora infestans, Bremia lactucae and Pseudoperonospora cubensis. Proceedings of the Eleventh EuroBlight Workshop, Hamar, Norway, 28-31 October 2008. PPO-Special Report no.13, July 2009:307-308.
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Nærstad R, Le VH & Hermansen A. 2009. Arbeid med forbedring av tørråtevraslingen. Bioforsk FOKUS 4(2):182-183.

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Hermansen A, Brurberg MB, Le VH, Elameen A, Nærstad R, Andersson B, Hannukkala A, Lehtinen A, Nielsen B, Hansen JG & Yuen J. 2008. Variability of the Nordic Phytophthora infestans population. The Third International Late Blight Conference, Beijing, China, 03-05 April, 2008. Program and Abstracts. p 19
Nielsen BJ, Hansen JG, Pinnschmidt H, Nærstad R, Hermansen A, Le VH & Hannukkala A. 2008. Studies of Release and Infectivity of Phytophthora infestans Spores. ICPP 2008, 9th International Congress of Plant Pathology, Torino Italy. Journal of Plant Pathology 90 (2 Suplement): 167
Nielsen BJ, Hansen JG, Pinnschmidt H, Bødker L, Nærstad R, Le VH, Hermansen A & Hannukala A. 2008. Release and infectivity of Phytophthora infestans sporangia under field conditions. GILB 2008 Conferance. The Third International Late Blight Conference, Beijing, China, 03-05 April 2008

CV Associate Professor Eve Runno-Paurson, PhD
Estonian University of Life Sciences

Personal data

Born: 30.04.1978; in Tartu, Estonia, female

Citizenship: Estonian

Residential address: Põldmarja str 19, Tartu, 50411 Estonia

Present employment:

Associate Professor of plant pathology, Estonian University of Life Sciences

Degree information:

2010 – PhD in Plant Pathology, (sup) Marika Mänd, Mati Koppel, William E. Fry (Cornell University, USA) "Phenotypic and genotypic characterisation of potato late blight pathogen *Phytophthora infestans* in Estonian populations", Estonian University of Life Sciences, Estonia

2002 – MSc in Plant Protection, Estonian Agricultural University, Estonia

2000 - Estonian Agricultural University, Faculty of Agronomy, plant pathologist (*cum laude*)

Professional appointments:

2013 to date: Associate Professor, EULS

2010-2013: Lecturer, EULS

2009-2010: Specialist, EULS

2005-2009: Researcher, Jõgeva Plant Breeding Institute

2000-2005: Plant Pathologist, Jõgeva Plant Breeding Institute

Administrative responsibilities:

Invited member of the Doctoral Committee of the Agricultural Sciences of the EULS, Member of American Phytopathological Society, Estonian Academic Agricultural Society, Estonian Naturalists Society, Estonian Plant Protection Society, Estonian Rye Society

Field of research: plant pathology, plant protection strategies, oomycetes, pathogen population biology and epidemiology, sustainable and organic farming

Trainee supervisor:

Supervisor of 6 Master theses;

5 PhD projects running;

Awards:

2011 - Young scientist's award of Research Centre of Organic Farming by Estonian University of Life Sciences

2010 - Second prize in the category of biological and environmental sciences (doctoral level) at the Contest of Students' Research Studies held by the Ministry of Education and Research of Estonia

Publication indices (Web of Science):

11 publications, 46 citations, H index 5

Publications (last five years): 10 publications (internationally peer reviewed) in Acat Agr Scand B-S P, AmJ Potato Res, Eur J Plant Pathol, J Plant Pathol, J Plant Dis Prot, Zemdirbyste-Agriculture

Home page for further details: http://pk.emu.ee/en/structure/plantprotection/

GAUCHER Denis
Born May 24, 1966 (Dijon, France)
Married, two sons (22 and 19 years old)

PROFESSIONAL ADDRESS

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EDUCATION

1989 **Ingénieur agronome**, Ecole Nationale Supérieure d'Agronomie et des Industries Alimentaires de Nancy (**ENSAIA**), spécialisation **« Sciences et Techniques des Productions Végétales »**

Foreign languages: English, German: read, written and spoken

PROFESSIONAL CAREER

2014 to date **Head of « Diseases control » team**
Responsible for research on potato diseases at ARVALIS – Institut du végétal (Boigneville), applied research institute.
↳ To conduct activities and research programs for different crops: cereals, corn, lin, potato, tobacco.
↳ To manage a team: to define a budget, establish annual reports, …
↳ To realize training sessions and information meetings for French potato technicians and growers.
↳ To implement and improve a decision support system for late blight control (DSS Mileos®, more than 500 users, 2000 fields).
↳Member of European Association of Potato Research (EAPR) and Euroblight network.

1995 - 2014 **In charge of applied research on potato diseases at ARVALIS – Institut du végétal (Boigneville)**
↳To conceive experimental protocols and to manage experimental networks.
↳To manage research programs.
↳Conception and realization of training sessions and information meetings for French potato technicians and growers.
↳To create a decision support system for late blight control (DSS Mileos®).
↳Member of European Association of Potato Research (EAPR) and Euroblight network.
↳To contribute to ENDURE project (European Network for Durable Exploitation of crop protection strategies).

1991 - 1995 **Supervisor of studies and training at Institut Supérieur Agricole de Beauvais (ISAB - Oise)**.

↳ In charge of studies on starch potato (seed density plant-ing, irrigation, cultivars).

↳To organize training sessions: agrometeorology, agronomy and statistic.

TECHNICAL AND SCIENTIFIC PUBLICATIONS

Gaucher D., Dubois L., Chatot C. (2014) – Mileos®, the French potato late blight DSS : continuous improvement over past decade ! *Proceedings of the 14 th Euroblight Workshop*, Limassol, Cyprus, May 12-15 2013, PPO-Special Report no 16, H.T.A.M. Schepers (editor), pp 209-210.

Gaucher D., Ponthonne S. (2013). Outils d'aide à la décision : MILEOS® évolue. *La pomme de terre française*, 585 : 38-39.

Gaucher D., Taupin P. (2012) – Réduire les risques de bioagresseurs grâce à la prophylaxie. ARVALIS-Infos, 10/09/2012, 1p. http://www.arvalis-infos.fr

Gaucher D., Taupin P. (2012) – Dossier protection intégrée : De la prophylaxie et de l'anticipation face au mildiou de la pomme de terre. *Perspectives Agricoles*, 392 : 26-28.

Jaunâtre V., Gaucher D., Hannon C., Vannetzel E. (2011) – Mildiou de la pomme de terre – Comment bien protéger ses parcelles ? *Perspectives Agricoles*, 374, 64-65.

Jaunâtre V., Gaucher D. (2011) – MILEOS®, un outil d'aide à la décision qui évolue. *Recueil de communications, AFPP – Quatrième conférence internationale sur les méthodes alternatives en protection des cultures,* Lille, 8-10 mars 2011, pp 104-108.

Le Hingrat Y., Laty P., Glais L., Boulard F., Jacquot E., Gaucher D., Golaz F., Molot B., Giovinazzo R., Boisgontier D. (2011) - Can spatial meteorological data improve disease forecasting and crop management ?. *Abstracts of papers and posters, EAPR*, July 25-29 2011, Oulu (Finland), 1p.

Catherine CHATOT-BALANDRAS

catherine.chatot@germicopa.fr

Specialist R&D for Potato Pests & Diseases

Education

Doctorate Degree - Majors: Potato Genetics, Plant Protection & Nematology ; FRANCE, Rennes
Master of Agriculture - Major: Applied & Urban Entomology ; USA, Texas A&M
Agricultural Engineer - Majors: Agronomy & Plant Physiology / Potato Crop ; FRANCE, Rennes

Professional Experiences

- **Plant Pathology & Breeding Activity**

- Implementation of new assessment tools for resistance to major potato diseases (*Phytophthora infestans, Fusarium, Streptomyces* and viruses) for breeding purposes

- Implementation of field trials for tolerance to potato cyst & root knot nematods

- Specific field screening trials for the Potato Tuber Ring Virus, Tobacco Rattle Virus and its nematode vectors and to powdery scab, *Spongospora subterranea*

- **Plant Pathology & Expertise Activity**

- Internal pests & diseases diagnosic Lab for Germicopa Seed Production & Seed Trading activities

- Technical Expert for EPPO Pest Risk Analysis (PRA) for the Potato Tuber Flea Beetle (*Epitrix* spp)

- **Plant Pathology & Extension Activity**

- Management of tuber black scurf (*Rhizoctonia solani*): tuber symptom variability in connection with anastomosis groups and evaluation of new biocontrol measures

- Management of late blight: contribution to the development of the French LB DSS's (Mil-PV, Mildilis and Mileos®

- Major scientific contribution to the 2011 updated English version of the book:
A Practical Guide to Diseases, Pests and Disorders of the Potato
Edited by FN3PT-GNIS-Arvalis-Institut du Végétal

- Scientific contribution to the website specific for superficial tuber blemishes, help for diagnosis:
https://www6.inra.fr/potato-tuber-blemishes

Miscellaneous

- Internal Auditor for Quality Management ISO 9001: version 2008
- Active Member of the following professional and scholarly organisations:
  SFP - Société Française de Phytopathologie, ,
  EAPR - European Association for Potato Research (Councillor)
  PAA - Potato Association of America
- Active Participant to the ***European network for development of an integrated control strategy of potato late blight*** – EU NET ICP, Eucablight and EuroBlight networks.

June 2015

Borghild Glorvigen

Address: Glorvigen søndre
2280 Gjesåsen
Norway
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Personal

- Marital status: Married
- Born: 30.10.1962
- Children: Andrea 23 years, Guro 20 years and Pernille 16 years

Education

- Colorado State University, USA, plant physiology, 1990-1991.
- Norwegian University of Agriculture, ph.d-studies plant pathology, August 1989 – May 1996, defense May 30, mai 1996.
- Norwegian University of Agriculture, soil- & plant science,1984-88.
- Jønsberg School og Agriculture, agronomy, 1982-1983
- Marshfield High school, Oregon, USA, 1979-1980
- Åsnes High school, allmennfag, 1978-1982

Working experience

- Norwegian Agricultural Extension Service, potato coordinator (75%), and project manager in Potato Forum (25%), 01/05/2009– present
- Solør-Odal Extension Service, advisor, 21/08/2001 – 01/05/2009
- Farmers Union, Norway (Felleskjøpet Øst Vest), head of pesticide division, 01/08/1999 – 20/08/2001.
- Ph.D student, Plant Pathology, potatoes. Research Council of Norway, 01/08/1989 - November 1995.
- Norwegian Institute of Crop Research (Planteforsk Plantevernet), State consultant plant protection, August 1993 – 31/07/1999.
- Statens fagtjeneste for landbruket (SFFL), consultant, 01/11/1988 – 01/08/1989.
- Statens Planteavlsråd, consultant, 15/05/ - 01/11/1988.
- Solør-Odal Extension Service, summer work 1985 and 1986.
- Internship at two farms in Normandie, France (one organic farm and one vegetable farm), 14/03/1984-1/8/1984.

Publications:

- Redaktør av www.potet.no fra 1. mai 2009.
- Klingen, I, TE Sagen Eklo, CJ Spetz og B Glorvigen, 2014. Virusoverførende bladlus – et problem i norsk potetproduksjon. Bioforsk Fokus 9 (2), side 101-102
- Glorvigen, B, PY Steinsholt, EL Molteberg, O Galtvik, JG Nærland, M Tømte, T Brauter, M Opsahl, 2012. New Standard of Cultivation Practices for Reducing Problems with Potato Cyst Nematodes. Poster, World Potato Conference 2012, Edinburgh, Storbritannia.
- Steinsholt PY, B Glorvigen, EL Molteberg, 2012. Fagforum potet. Bioforsk FOKUS 7(2), s. 273.
- Glorvigen, B, 2012. Jord på ville veier – om PCN og jordsmitte. Bioforsk FOKUS 7(2), s. 124-126.

- Molteberg, E, B Glorvigen og PY Steinsholt, 2011. Fagforum Potet. Plakat på Bioforskkonferansen 2011. Bioforsk FOKUS 6(2), s. 139.
- Glorvigen, B, 2010. Potato production in Hedmark County in Norway. Bioforsk Fokus vol 5 nr 5 2010, s. 25. (14.th Triennial Meeting of Virology Section of EAPR, Hamar, Norway.)
- Glorvigen B, 2009. Poteten – en fantastisk vekst. Artikkel i boka Skoglandet Solør-Odal, s 244-255.
- Eklo, OM, R Bolli, J Kværner, T Sveistrup, F Hofmeister, E Solbakken, N Jarvis, F Stenemo,, E Romstad, B Glorvigen, TA Guren, S Sorknes, I Solberg og T Haraldsen, 2009. Miljørisiko ved bruk av plantevernmidler — hjelpemiddel til å lage miljøplaner, Bioforsk Fokus vol 4 nr 2 2009, s 60-61.
- Glorvigen, B & OS Dahlen, 2008. Flere nyheter i årets tørråtekamp. Samvirke mai/2008.
- Hermansen A, R Nærstad, B Glorvigen, H Alm,. K Sørensen, 2008. Forecasting potato late blight in Norway. Euroblight workshop (poster), Hamar 28-31 October 2008.
- Glorvigen B, S Abrahamsen, A Bjerkan og JO Forbord, 2008. Startgjødsling til ulike potetsorter. Bioforsk Fokus vol 3 nr 1 2008, s 136-137
- Glorvigen B, 2008. Den vidunderlige poteten. Tidsskriftet Solør-Odal, 4/2008
- Molteberg, EL, R Nybråten, B Glorvigen & TA Guren, 2006. Får vi god nok skallkvalitet uten Reglone? Bioforsk Fokus vol 1 (3) 2006, s. 130-131.
- Molteberg, EL, R Nybråten, B Glorvigen & TA Guren, 2006. Betydningen av vekstavslutning for modning og kvalitet av potet. Bioforsk Fokus vol 1 (2) 2006, s 211-219.
- Glorvigen i samarbeid med andre: Ulike artikler i Samvirke i tiden 1999-2001.
- Glorvigen. Foredrag på ulike møter og artikler i SOFAGRO, medlemsbladet til Solør-Odal forsøksring, i perioden 2001-2008. Artiklene er ikke publisert med forfatter.
- Glorvigen B (red), 1997. Informasjonsmøte i plantevern. Grønn forskning 2/97, Planteforsk.
- Glorvigen B og OS Dahlen, 1997. Invasjon av gammafly sommeren 1996. Samvirke 4/97.
- Glorvigen B, 1997. Tiltak mot skadegjørere i forsøksarbeidet. Håndbok for forsøksringer, kap. Administrasjon og gjennomføring av forsøk.
- Glorvigen B og KU Bracklo (red), 1997. Plantevern. Kjemiske og biologiske midler 97/98. Landbruksforlaget.
- Glorvigen, B, AH Bjerke, U Bång and V Næss, 1996. Enzyme-linked immunosorbent assay (ELISA) for the detection of *Phoma foveata* in artificially inoculated potato tubers using polyclonal and monoclonal antibodies. Doctor Scientiarum Theses 1996:8, NLH.
- Glorvigen, B and PJ Møllerhagen, 1996. Influence of potato tuber maturity at harvest on latent infection of *Phoma foveata*. Doctor Scientiarum Theses 1996:8, NLH.
- Glorvigen, B, 1996. Reaction of Colorado potato varieties to *Fusarium* spp. In the field and in storage. Doctor Scientiarum Theses 1996:8, NLH.

- Glorvigen B and T Bjor, 1996. Differences in pathogenicity among isolates of *Phoma foveata* and *Phoma exigu*a on potato tubers. Doctor Scientiarum Theses 1996:8, NLH.
- Bjor, T, B Glorvigen and H Skinnes, 1996. Heritability of selection for resistance to *Phoma foveata* in potatoes. Doctor Scientiarum Theses 1996:8, NLH.
- Glorvigen, B, 1993. Sporadiske problemer i potetdyrkinga. Informasjonsmøte i jord- og plantekultur 1993. SFFL Faginfo nr. 1/93, s. 73-80.
- Glorvigen, B, U Bång and V Næss. Monoclonal antibodies against *Phoma foveata*. Poster på nordisk forskerkurs i molekylær plantepatologi, Danmark, 1992.
- Glorvigen, B, 1991. Potato production in Norway. Problem. Gangrene. Foredrag i seminarserie ved Department of Horticulture, CSU. Manuskript, 10 s., ikke publisert.
- Glorvigen, B, U Bång and V Næss. Monoclonal antibodies against *Phoma foveata*. Poster på møtet "Advances in Potato Crop Protection", Nederland, 1991.
- Glorvigen, B, 1990. Fomaråte i potet. Småskrift 11/90, 8 s.
- Glorvigen, B, 1988. Potet virus S. Spredning og avlingsreduksjon. Hovedoppgave ved NLH, 1988.

Language skills

- Norwegian: Native language.
- English: Fluent in both spoken and written.
- Frendh: Some spoken.
- German: Some both spoken and written.

Dr Alison Lees

Institute

The James Hutton Institute

Qualifications

BSc Hons Biology (1991); PhD Plant Pathology (1995)

Employment history *(including current grade)*

2005 - present	Grade F, Potato Pathologist, SCRI/JHI
1999 - 2005	Band 5, Potato Pathologist, SCRI
1995 -1999	Band 6, Potato Pathologist, SCRI
1995	Research Assistant, John Innes Centre, Norwich.

Role and responsibilities

- To conduct research on the epidemiology, population biology, diagnostics and control of potato diseases.
- To manage the Scottish Government commissioned research (WP6.4) 'Prevention and Control of Important Endemic and New Diseases of Plants', within Theme 6 – 'Animal/Plant Health and Disease and Animal Welfare' of The Scottish Government Strategic Research Programme 'Food Land and People'
- To identify and develop research areas through targeting of funding and collaborations.
- To contribute to knowledge transfer activities.
- To contribute to management (including CMS management group, Co-lead CMS sub-group 'Epidemiology and control', Media Kitchen management), internal and external committees, editorial boards, learned societies, examining and peer review.

Synopsis of current and future research interests

I have an independent research programme which covers several aspects of applied potato pathology. Late Blight research currently focuses on a) the epidemiology of late blight and b) host resistance to late blight and its deployment as part of an integrated control strategy. Following the initial development of SSR markers to genotype *P. infestans* populations (Lees et al, 2006), phenotypic characterisation showed that some dominant clonal genotypes have several traits that directly affect disease management. Currently, work on the epidemiology of late blight focuses on temperature and humidity requirements of dominant clones, as this directly affects epidemic rates and the accuracy of disease forecasting models. Approaches to the sustainable control of late blight were investigated in a DEFRA LINK project and a current BBSRC/HAPI grant aims to understand the effect of host resistance and fungicide application on selection in *P. infestans* populations for fungicide insensitivity and virulence respectively. Two newly funded (2015) Innovate UK projects will investigate early in-field sensing of *P. infestans* and *A. solani* to inform late and early blight control. Commonwealth Potato Collection accessions and breeding populations are assessed for resistance to contemporary *P. infestans* isolates - this work forms the basis of many projects and is a pre-requisite for potato breeding.

I have a long-standing programme of research in potato pathogen diagnostics and disease risk assessment. Molecular diagnostic assays for many potato pathogens have been developed in conjunction with improved soil DNA extraction and sampling methods. The assays have been used as tools to elucidate the epidemiology of soil-borne diseases, and subsequently employed to manage disease risk as part of an integrated control strategy. Strong collaborations with researchers in Australasia and Norway are ongoing (e.g. 2015-2018 collaborative project with Bioforsk). I envisage that this approach will be increasingly used in the future to study rotations and system effects on plant pathogens of various crops or other plant hosts. I also maintain an interest in the evaluation of host resistance to a range of fungal and bacterial potato diseases.

Through the management of CWP6.4 I have gained an overview of the science delivery pipeline and continue to develop links with policy makers and industry representatives. I have many national and international collaborations and work closely with potato industry and advisory colleagues to ensure that knowledge transfer is appropriate and timely.

Measures of esteem

- Leader of Scottish Government Plant Health Research Programme CWP6.4 (2011-2016)
- Cell & Molecular Sciences management group, Co-lead Epidemiology sub-group CMS.
- Coordinator, EUCABLIGHT, a 24 partner EU Concerted Action, (2003-2007).
- Management committee of EUROBLIGHT- a European Late Blight Network (2006-present)
- Winner Peter Massalski Prize (2006)
- Editorial Board of 'Plant Pathology' (2004-present)
- Session organiser/standing committee Crop Protection in Northern Britain Conference (2006-)
- Expert Reviewer for Research Council of Norway, USDA, EU.
- Journal reviewer including: Plant Pathology, Potato Research, European Journal of Plant Pathology, Australasian Plant Pathology, Applied & Environmental Microbiology, Fungal Biology.
- Invited lecturer and speaker including ICPP Beijing 2013, EAPR Jerusalem 2013, Australasian soil-borne disease symposium 2014.
- PhD Examiner, Heriot Watt Univ., Murdoch Univ., Univ. Pretoria, Univ. Tasmania.

Recent refereed publications *(maximum of six)*

1. Brierley, J. L., Hilton, A. J., Wale, S. J., Peters, J. C., Gladders, P., Bradshaw, N. J., Ritchie, F., MacKenzie, K. and Lees, A. K. (2015), Factors affecting the development and control of black dot on potato tubers. *Plant Pathology* 64, 167–177.

2. Brierley, J. L., Sullivan, L., Wale, S. J., Hilton, A. J., Kiezebrink, D. T. and Lees, A. K. (2013), Relationship between *Spongospora subterranea* f. sp. *subterranea* soil inoculum level, host resistance and powdery scab on potato tubers in the field. *Plant Pathology*, 62: 413–420.

3. Cooke, D.E.L., Cano L.M., Raffaele, S., Bain, R.A., Cooke, L.R., Etherington, G.J., Deahl, K.L., Farrer, R.A., Gilroy, E.M., Goss, E.M., Grunwald, N.J., Hein, I., MacLean, D., McNicol, J.W., Randall, E., Oliva, R.F., Pel, M.A., Shaw, D.S., Squires, J.N., Taylor, M.C., Vleeshouwers, V.G.A.A., Birch, P.R.J., Lees, A.K., Kamoun, S. 2012. Genome Analyses of an Aggressive and Invasive Lineage of the Irish Potato Famine Pathogen PLoS Pathogen 8 (10): e1002940.

4. Lees, A. K., Sullivan, L., Lynott, J. S. and Cullen, D. W. (2012), Development of a quantitative real-time PCR assay for *Phytophthora infestans* and its applicability to leaf, tuber and soil samples. *Plant Pathology*, 61: 867–876.

5. Lees, AK, Stewart, JA, Lynott, JS, Carnegie, SF, Campbell, H, Roberts, AMI (2012). The Effect of a Dominant *Phytophthora infestans* Genotype (13_A2) in Great Britain on Host Resistance to Foliar Late Blight in Commercial Potato Cultivars. *Potato Research* 55, 125-134.

6. Merz, U., Lees, A. K., Sullivan, L., Schwärzel, R., Hebeisen, T., Kirk, H. G., Bouchek-Mechiche, K. and Hofferbert, H. R. (2012), Powdery scab resistance in *Solanum tuberosum*: an assessment of cultivar × environment effect. *Plant Pathology*, 61: 29–36.