Uncertainty from qualitative to quantitative pest risk assessment at EFSA


*Animal and plant health Unit, European Food Safety Authority (EFSA)

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Acknowledgements

Thanks to:

- Current (2015-2018) and previous (2006-2015) members of the EFSA Scientific Panel on Plant health (PLH Panel)
- EFSA PLH Panel Working Groups (WG): WG “R. similis pest risk assessment” and WG “Methods”
- EFSA Units ALPHA (Animal and plant health) and AMU (Assessment methodology)
Some abbreviations used in the slides

Plants for planting = P4P
Risk assessment = RA
Risk management = RM
Risk reducing option/ risk management option = RRO
A trip from qualitative to quantitative

2010 | EFSA PLH Panel Qualitative PRA guidance
---|---
2010-15 | 26 Qualitative PRAs
2014 | Two-steps approach agreed with RM (40 pest categorisations, only 20% go PRA)
2015- | EFSA SC Draft Uncertainty Guidance
2015- | PLH Panel WG on quantitative PRA method
2015-17 | 8 Quantitative Pest RAs, with @RISK
2018 | Public consultation quantitative PRA guidance
2018 | Quantitative PRA guidance and online tool
The 2 step approach

**STEP 1**
- Pest categorisation
- Interaction with Risk Managers
- Opinion 1

**STEP 2**
- Quantitative pest risk assessment
- Opinion 2

END
Qualitative:
Entry is very likely for plants intended for planting with soil. Cuttings pose a lower risk.
Spread is very likely as (i) the pest has numerous ways of spreading naturally and with human assistance, (ii) large quantities of propagation material are often transported within the EU, (…)
Impact is rated as minor on grafted plants, (…).
Impact is rated as massive on ungrafted plants, (…).

Quantitative:
The risk of new introductions of *C. platani* into the RA area by means of the main pathways for entry (…) is relatively limited, with less than 1 (median value) new established populations predicted in a 10-year period under the A0 scenario.

With the current measures in place, spread of FDp is likely to continue during the forthcoming period with a progression of between a few and ca. 20 newly contaminated NUTS 2 regions predicted for the 50% uncertainty interval.
Under scenario A0, impact of FDp represents only a very small fraction of the EU table grapes or wine production (in the order of 0.5 to 1%), (…)
Quantifying uncertainties

Qualitative:
Uncertainty is rated as low as the information available from the literature and the evidence obtained from the risk assessment area show that ..........................

Quantitative:
The uncertainty breakdown for the scenario A0 (...) shows that the most important factor contributing to uncertainty for all means of long-distance spread is the estimated growth rate of the pathogen per year.

More than 90% uncertainty in calculated entry is due to uncertainty about the proportion of infested potatoes harvested in infested fields. Other factors are of minor influence on uncertainty.

The uncertainties associated with these evaluations are however large, as indicated by 50% uncertainty intervals spanning roughly two orders of magnitude.

Indeed, while the consolidated median loss (...) is estimated at close to 8,000 tonnes of grapes, the 50% uncertainty interval spans a range of nearly two orders of magnitude, ranging from about 1,000 tonnes to close to 50,000 tonnes.

(...) the parameter that is associated with the largest uncertainties is the estimation of the average abundance of FDp in contaminated NUTS 2 regions.
Quantifying risk reductions

Qualitative:
The Panel identified several measures that could work effectively when combined in a systems approach (...)
The Panel considers that the Annex IIAII measures designed to prevent pest spread within the EU are ineffective for two main reasons. Firstly, they are based on inspection and the effectiveness of visual inspection in the field and of potted vines is low (though moderate for cuttings) and, secondly, (...)

Quantitative:
The infection was reduced from 16% to 1.1-1.8% with carbathion (...) and from 37.4% to 4.4-5.3% and 11.5% to 0.9-2.2% with dazomet (...). The Panel considers the effectiveness of soil fumigants against D. destructor between 60 and 95%.

The Panel confidently estimates that spread will be more restricted under these scenarios (...), with a 50% uncertainty interval between a stabilization in the number of affected NUTS 2 regions and 10-15 newly contaminated regions.

Under both scenarios A1 and A2, (...) FDp impact on wine and table grapes production is predicted to be reduced by approximately one third (A1) and by two thirds (A2) as compared to scenario A0.
An example of quantitative PRA


*R. similis* is a migratory endoparasitic and highly polyphagous nematode, reported and/or intercepted from 97 (sub-) tropical countries
Hosts and pathways

PLANTS PATHWAYS
1. Rooted plants (h ≤ 1 m) of Araceae, Marantaceae, Musaceae, Strelitziaceae, Heliconiaceae, Persea, Musa (REGULATED SMALL PLANTS)
2. Rooted plants (h ≤ 1 m) of other host species (NON-REGULATED SMALL PLANTS)
3. Rooted plants (h > 1 m) of Araceae, Marantaceae, Musaceae, Strelitziaceae, Heliconiaceae, Persea, Musa (REGULATED LARGE PLANTS)
4. Rooted plants for planting (h >1 m) of other host species (NON-REGULATED LARGE PLANTS)
5. Aquatic plants (eg Anubias, Vallisneria)
6. Citrus plants for planting
7. Banana plants for planting

SOIL PATHWAYS:
8. Soil or growing media attached to plants with roots
9. Soil adhering to machinery, packaging material, tools, shoes and animals
10. Soil and growing media

WATER PATHWAYS:
11. Surface waters (run-off rains) in fields, ditches, streams and rivers
Conceptual models

- Separate models for each PRA step
- The conceptual models connecting:

  - Trade from third countries
  - Potential founder populations
  - Established founder populations
  - Infested area
  - Production or quality loss

The conceptual models are:
- following the **pathway** of the pest
- modelling the **changes of infestation**
- allowing **quantification**, including **uncertainty**
- separating different steps, processes etc. (sub-steps)
- allowing **evaluation of RRO**

**Pros**: Transparent, possible refinements

**Cons**: Simplified representation, more work
**Conceptual models: Example “Entry of Radopholus similis”**

- Trade volume P4P from infested countries
- Proportion of suitable hosts
- Proportion of infested consignments
- Effectiveness of import inspection
- Number of potential founder populations

**A sensitivity analysis shows that 83-93% of the total uncertainty results from this parameter**

**Second example by Alan McLeod**

**Pathway**

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Median</th>
<th>50%UncInt</th>
<th>98%UncInt</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of infected packs entering EU</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small non-reg. plants</td>
<td>333</td>
<td>58-1163</td>
<td>0-8783</td>
</tr>
<tr>
<td>Small reg. plants</td>
<td>24</td>
<td>6-67</td>
<td>0-380</td>
</tr>
<tr>
<td>Large non-reg. plants</td>
<td>87</td>
<td>87-389</td>
<td>0-3407</td>
</tr>
<tr>
<td>Large reg. plants</td>
<td>6</td>
<td>1-26</td>
<td>0-275</td>
</tr>
</tbody>
</table>

The figures are showing the uncertainty distributions (cdf, pdf) of numbers of infested packs (log-scale) per pathway.

RRO scenarios

- The baseline scenario (A0) analyses the current legislation

- The scenarios analysis connects
  - Phytosanitary measures in the legislation
  - Combination of Risk Reduction Options
  - Control measures and supporting measures
  - Affected sub-steps in the conceptual models

- identifies missing/additional measures
- allows quantification of the effectiveness
- allows comparison between different scenarios:
  - Scenario A1 represents a hypothetical situation where the existing phytosanitary measures, specific to *R. similis* are withdrawn. All other phytosanitary measures remain in place.
  - Scenario A2 represents a situation where more strict phytosanitary measures are in place to prevent entry, establishment and spread of *R. similis*.

**Pros:** Structured approach, comparison between scenarios

**Cons:** Limited number of scenarios feasible
RRO scenarios: Example “Impact of *Radopholus similis*”

Loss in production (number of small plants):

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Median</th>
<th>50%UncInt</th>
<th>98%UncInt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of lost reg. small plants in production units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current regulation</td>
<td>27 537</td>
<td>6 479 - 92 035</td>
<td>25 - 1 247 136</td>
</tr>
<tr>
<td>Withdrawn reg.</td>
<td>95 248</td>
<td>15 590 - 377 850</td>
<td>6 - 5 908 241</td>
</tr>
<tr>
<td>More strict reg.</td>
<td>3 180</td>
<td>715 - 11 229</td>
<td>3 - 171 895</td>
</tr>
</tbody>
</table>

Relative change of loss:

<table>
<thead>
<tr>
<th>Change in regulation</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withdraw regulation</td>
<td>68% chance of higher loss</td>
</tr>
<tr>
<td>More strict regulation</td>
<td>&gt;99.9% chance of lower loss</td>
</tr>
</tbody>
</table>

Isolated events: Example “Spread of *Radopholus similis*

- Isolated events can happen beside the normal pathways:
  
  "The shift of the nematode from ornamental plants to citrus nurseries is considered possible as ornamentals and citrus could coexist in a few greenhouses, (...). They certainly coexist at retailer level, in garden centres etc. Fields for outdoor production of citrus plants could be sequentially planted with citrus and ornamentals (...)."

- The likelihood of one shift in the next year is judged as

<table>
<thead>
<tr>
<th>Shift to nursery via infested pathway</th>
<th>Probability</th>
<th>One single event in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infested small, ornamental plants</td>
<td>2%</td>
<td>50 years</td>
</tr>
<tr>
<td>Infested big, ornamental plants</td>
<td>1%</td>
<td>100 years</td>
</tr>
<tr>
<td>Infested aquatic plants</td>
<td>0.5%</td>
<td>200 years</td>
</tr>
<tr>
<td>Infested growing media / soil</td>
<td>1%</td>
<td>100 years</td>
</tr>
<tr>
<td>Infested waste</td>
<td>1%</td>
<td>100 years</td>
</tr>
<tr>
<td>Infested water</td>
<td>0%</td>
<td>Not considered</td>
</tr>
<tr>
<td>Summary of all infested pathways</td>
<td>5.5%</td>
<td>18 years</td>
</tr>
</tbody>
</table>

Climate change: Example “Establishment *R. similis*”

Climate suitability for citrus growing areas in EU

Locations with known pest status:

<table>
<thead>
<tr>
<th>Location</th>
<th>Polk county, Florida, USA</th>
<th>Kyadondo, central Uganda</th>
<th>Bushenyi, central Uganda</th>
<th>Onderberg, Mpumalanga, South Africa</th>
<th>Hazyview, Mpumalanga, South Africa</th>
<th>South Coast of Kwazulu-Natal, South Africa</th>
<th>Huntington beach, California, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status <em>R. similis</em></td>
<td>Present</td>
<td>Present</td>
<td>Absent</td>
<td>Present, low density</td>
<td>Present, low density</td>
<td>Present, low density</td>
<td>Eradicated</td>
</tr>
<tr>
<td>Status on citrus</td>
<td>Severe impact</td>
<td>Impact on banana</td>
<td></td>
<td>No impact</td>
<td>No impact</td>
<td>No impact</td>
<td>No impact</td>
</tr>
</tbody>
</table>

**Current climate**

**Climate change +2°C**

<table>
<thead>
<tr>
<th>Temperature sums &gt; 21°C</th>
<th>Temperature sums &gt; 21°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Unsuitable for <em>Radopholus similis</em> establishment</td>
<td>0: Unsuitable for <em>Radopholus similis</em> establishment</td>
</tr>
<tr>
<td>0.1 - 40: Unsuitable for <em>Radopholus similis</em> establishment</td>
<td>0.1 - 40: Unsuitable for <em>Radopholus similis</em> establishment</td>
</tr>
<tr>
<td>40 - 253: <em>Radopholus similis</em> may establish in low densities</td>
<td>40 - 253: <em>Radopholus similis</em> may establish in low densities</td>
</tr>
<tr>
<td>254 - 992: <em>Radopholus similis</em> may establish in low densities</td>
<td>254 - 992: <em>Radopholus similis</em> may establish in low densities</td>
</tr>
<tr>
<td>&gt; 992: <em>Radopholus similis</em> may establish with high density</td>
<td>&gt; 992: <em>Radopholus similis</em> may establish with high density</td>
</tr>
</tbody>
</table>

RM feedback and interactions

Two steps approach: pest categorisation → RM → quantitative RA

Definition of key scenarios by RM in ToR (e.g. the “shift” of *R. similis* from ornamentals to citrus)

ToR interpretation and scenarios definition: interaction between RA and RM at first WG meeting and later when needed

Workshop/training on quantitative RA for risk assessors and risk managers

Presentation of quantitative RAs to risk managers (4 of the 8 risk assessment presented already; 4 in October 2017)

Positive feedback, RM recommended to clearly express uncertainties
Some points for discussion

Quantitative RA concludes in terms of “real world” values
Precise numerical values may give a false sense of “certainty”
Communication of uncertainty is essential
Communication by median, quantiles and/or uncertainty curves
Quantitative RA quantifies effects of RROs under ≠ scenarios
Time limits to assess (RA) and review (RM) RROs scenarios
RA-RM interaction on scenarios definition is essential

(more details on quantitative assessment of entry
by Alan MacLeod Wednesday h 14,40)