

Exploring the cost-effectiveness of plant health surveys

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Not all surveys can be cost-effective

One aim of the official plant health surveys is to detect pest invasions at an early stage to enable eradication or containment. To meet this goal the surveys need to be intensive and thus they require a lot of resources.

At the same time plant health risk management is expected to be cost-effective, i.e. its costs should not exceed its expected benefits. Whether these goals can be met depends on several factors, such as the probability of a pest invasion and survey costs.

Cost-effectiveness of the Finnish surveys under scrutiny

I explore the cost-effectiveness potential of the Finnish plant health surveys, assuming that the intensity of surveys a) corresponds to that of the surveys carried out in 2011-2014, and b) is not limited by availability of resources.

I do not assess the exact cost-benefit ratio of the surveys. Instead, I analyze for which combinations of the pest's probability of invasion and expected crop loss the surveys would be cost-effective.

The objective is to gain an understanding of the limits of the cost-effectiveness potential of plant health surveys. This is done using realistic parameter values provided by three examples:

- 1) beet necrotic yellow vein virus (BNYVV) on sugar beet,
- 2) Colorado potato beetle (CPB) on potato, and
- 3) quarantine pests on strawberry.

Simple logic + simulations of invasions and inspections

The cost of a survey is the product of the cost of one inspection and the number of inspections.

The expected benefit of a survey is the product of the probability of pest invasion, the expected crop loss, and the probability of detecting the pest early enough in the survey.

The expected crop loss is the product of the total value of the threatened crops and the proportional crop loss that the pest is expected to cause.

The probability of detecting the pest early enough in the survey is assessed with a Monte Carlo simulation of pest invasions and inspections.

The simulation of invasions and inspections

Two scenarios are studied

- 1) **The pest spreads quickly & is difficult to eradicate:** Each year the pest spreads from each infested production site to 0-3 new sites. The pest is considered to have been detected early enough if it is detected before it has spread to more than 5 sites.
- 2) **The pest spreads slowly & is easy to eradicate:** Each year the pest spreads from each infested site to 0-1 new sites. The pest is considered to have been detected early enough if it is detected before it has spread to more than 20 sites.

For each year invasions and inspections are randomized to the sites (the sensitivity of a single inspection = 80%), and the simulation is continued until the pest is detected.

The simulation is repeated 5000 times, and the probability of "early enough detection" is calculated as the proportion of the simulations in which the pest was detected before spreading to the critical number of sites.

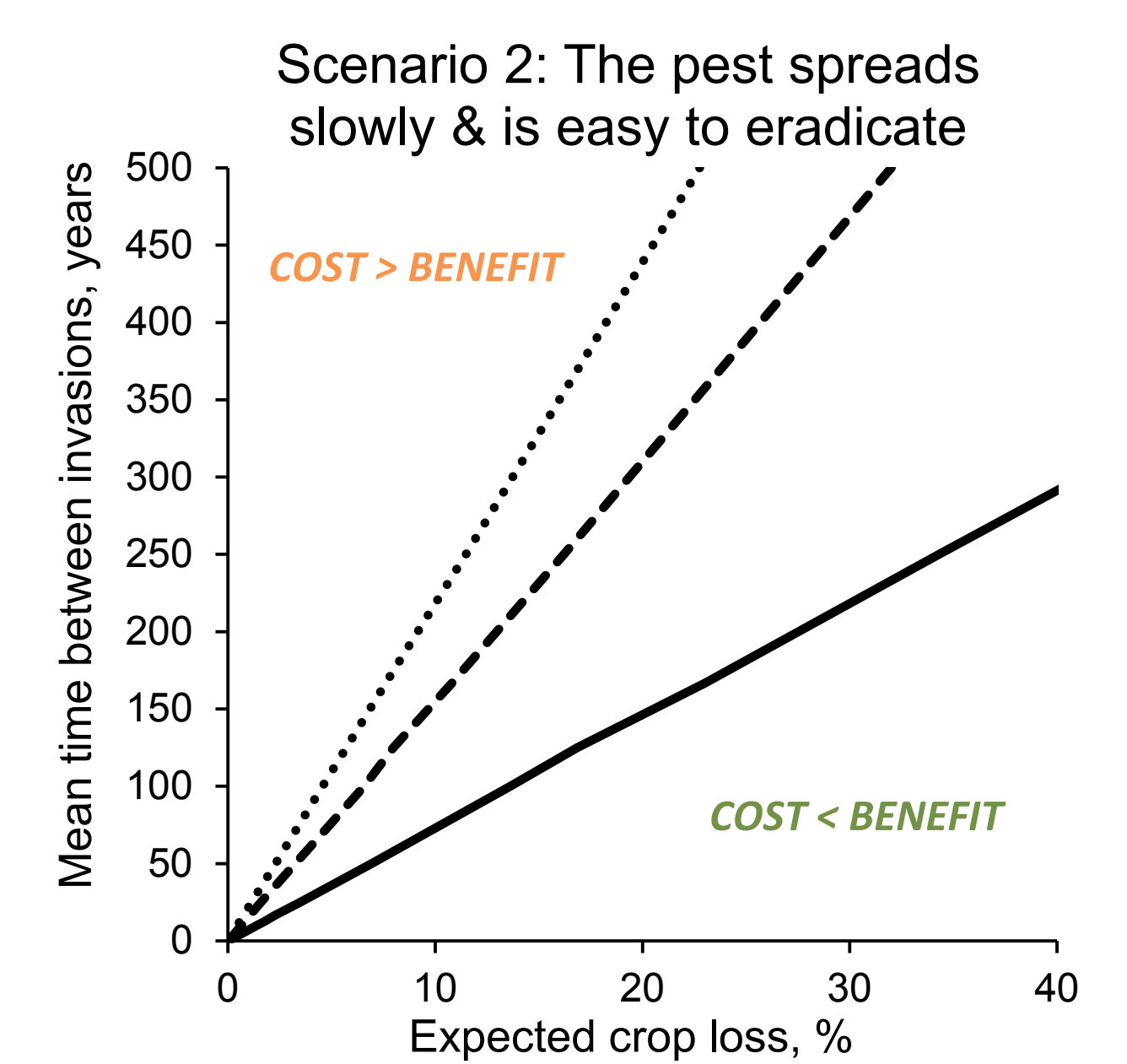
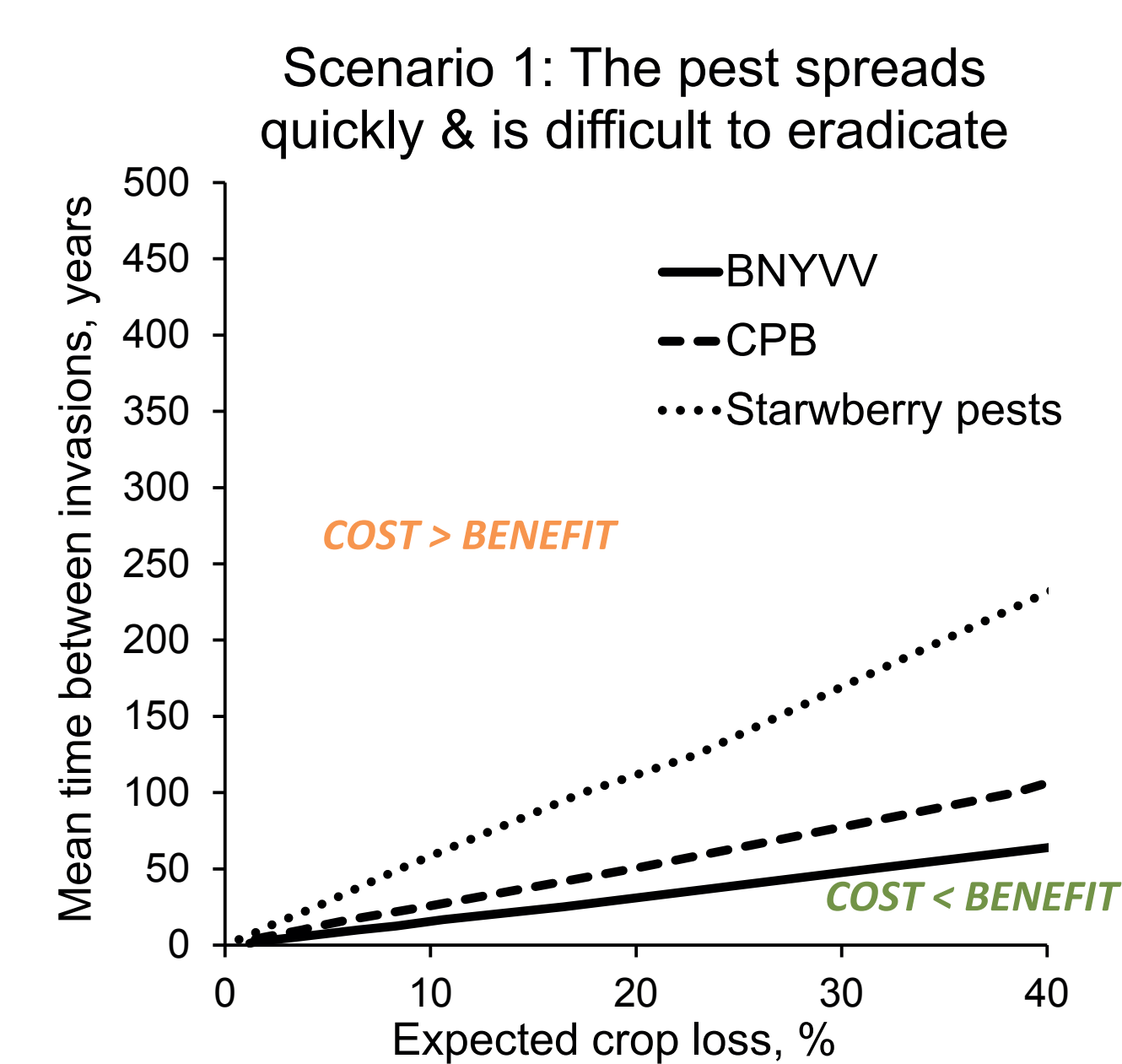
The parameter values that are estimated from data.

| | Sugar beet, BNYVV | Potato, CPB | Strawberry, quarantine pests |
|--|-------------------|-------------|------------------------------|
| The value of production, million € | 17.3 | 123.2 | 39.8 |
| The number of production sites | 780 | 7 535 | 1 551 |
| The cost of inspecting one site, € | 561 | 258 | 194 |
| The number of sites inspected per year | 34 | 195 | 95 |

Enablers of cost-effectiveness: Frequent invasions, high crop loss, slow spread & easy eradication

It appears that surveys can be cost-effective if invasions of the surveyed pest are very frequent or if the pest is expected to cause high crop losses.

If the pest spreads slowly and if its eradication is possible even when it has spread to a large number of production sites (scenario 2) surveys can be cost-effective also if invasions are less frequent.



The thresholds of cost-effectiveness for the surveys. The scenarios are explained in detail in the text box describing the simulations.

More resources does not mean improved cost-effectiveness

The analysis suggests that the cost-benefit ratio of the studied surveys cannot be improved by increasing survey intensity. Apparently, the increase in benefit achieved by doing more inspections is smaller than the cost of additional inspections. This is the case for all the studied surveys and scenarios.

Do quarantine pests fall below the thresholds?

Quarantine pests are typically expected to cause significant crop losses. Yet, they also spread quickly and are difficult to eradicate. Furthermore, if the import requirements aiming to prevent their introduction are effective, their probability of invasion is low. Thus, surveys aiming at early detection may be unlikely to be cost-effective for typical quarantine pests.

The results are too optimistic

The analysis is likely to overestimate the cost-effectiveness of surveys because 1) the sensitivity of inspections is assumed to be unrealistically high (80%), and 2) the costs and uncertainty of delimiting surveys, eradication and containment are not taken into account.