Pest-generic risk mapping based on spatial and temporal distribution of production

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Aim

- Develop a simple methodology
- that **ranks production sites** of a crop species according to the **relative probability of pest invasion**
- based on the **spatial distribution of the crop** species during the past 5-10 years

→ **enables more efficient targeting of the plant health surveys**

Framework

- Not pest specific – crop specific!
- Modelling is performed on a 0.5 × 0.5 km **grid** and the results are presented as **cell-specific risk indices**.
- Indices do not represent actual probabilities, but they allow comparison of the **relative probabilities**.

Relative probability of invasion

Assessed to each cell as follows

1. **Propagule pressure**
2. **Spread**
3. **Survival**

→ Relative probability of **invasion**

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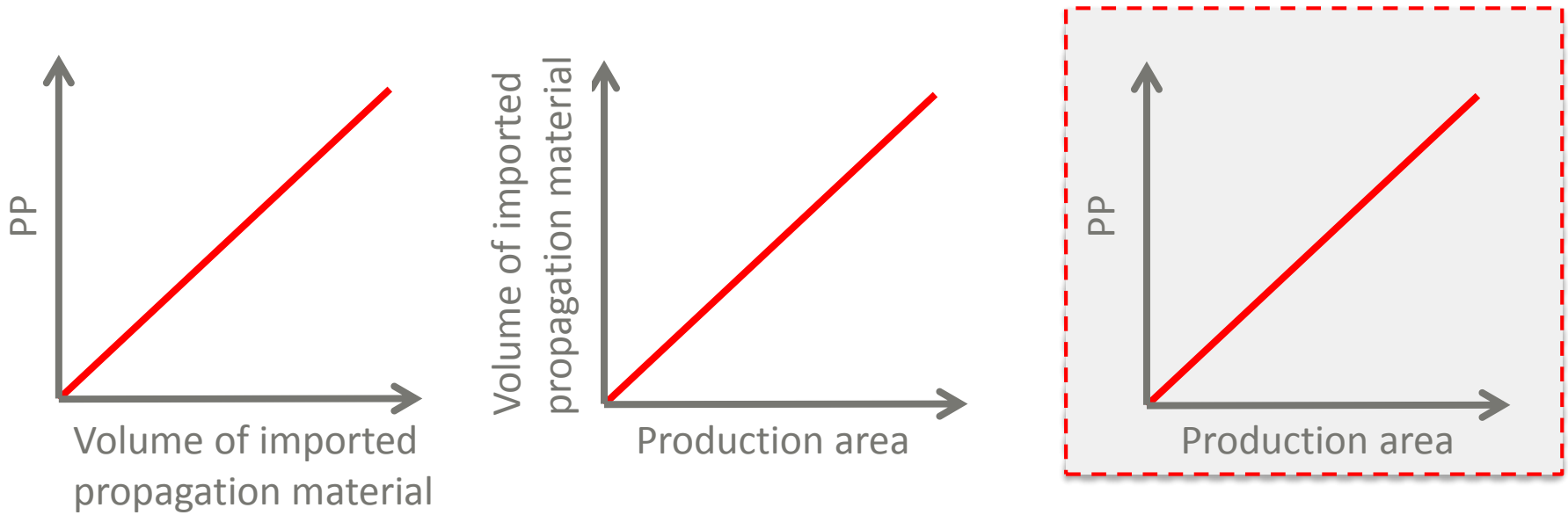
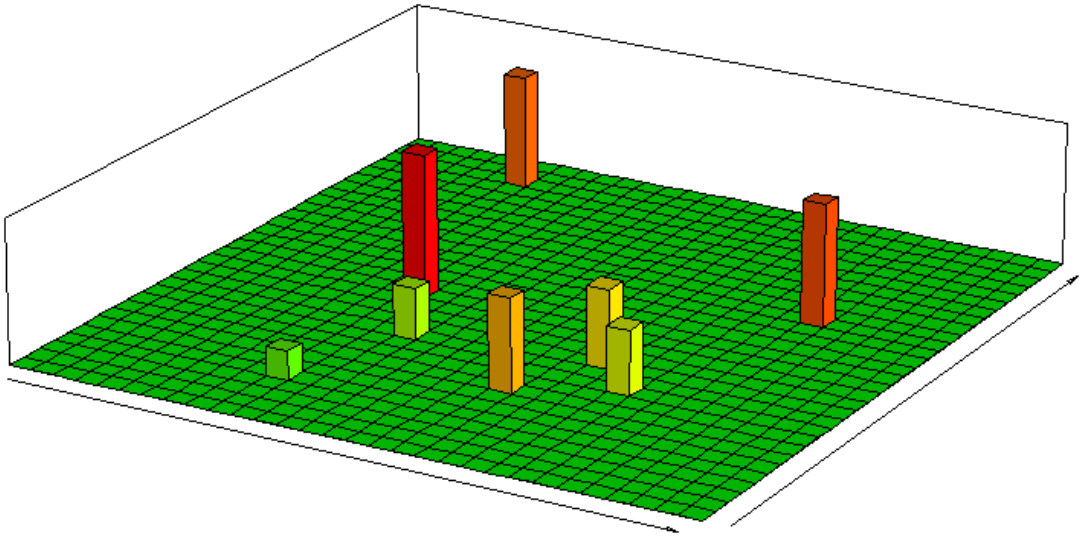
→ Relative probability of **invasion**

1) Relative propagule pressure

to a cell is assumed to **depend linearly** on the **production area** of the studied crop plant in that cell



1. Propagule pressure



Relative probability of invasion

Assessed to each cell as follows

1. **Propagule pressure**
2. **Spread**
3. **Survival**

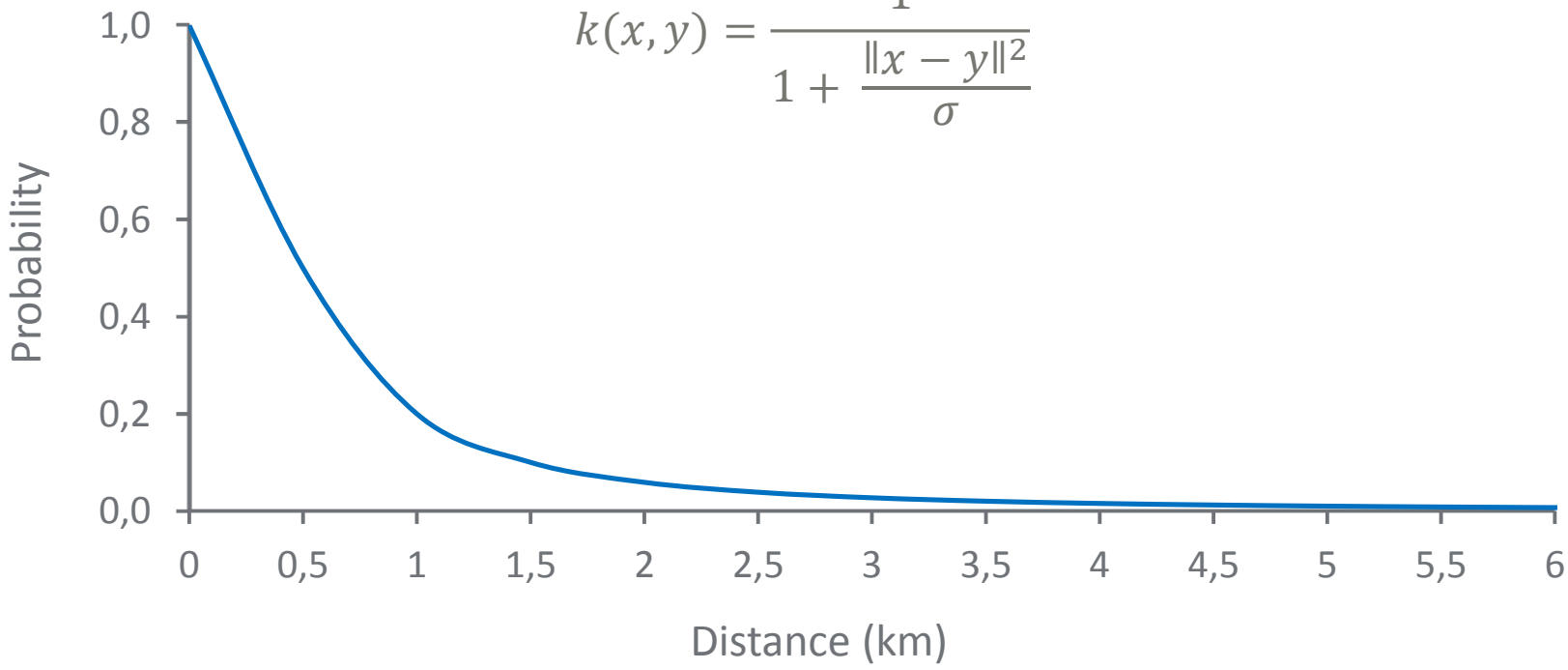
→ Relative probability of **invasion**

2) Relative probability of spread

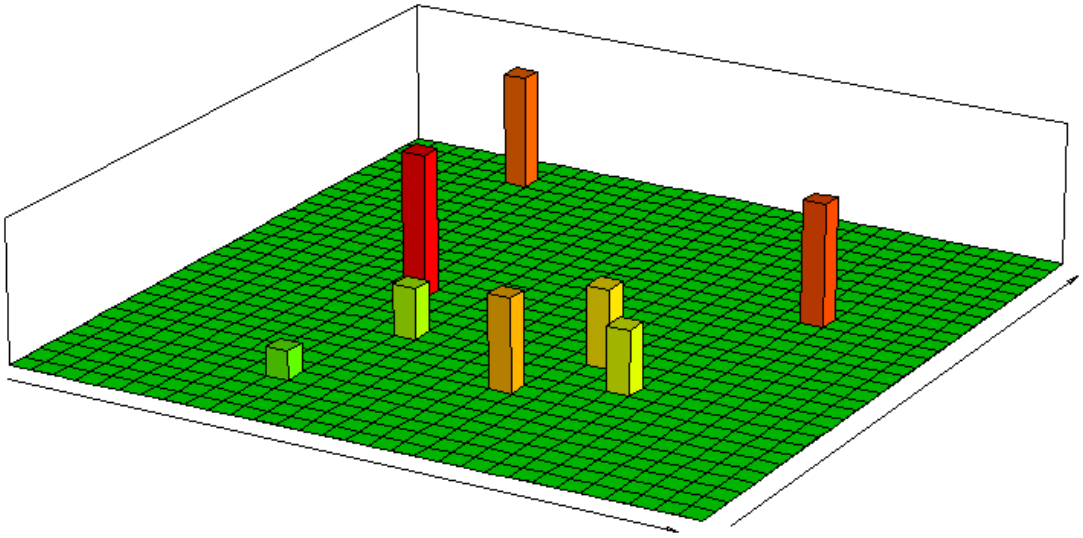
to the surrounding cells is assumed to be **distance-dependent**

- Modeled with a **Cauchy dispersal kernel**

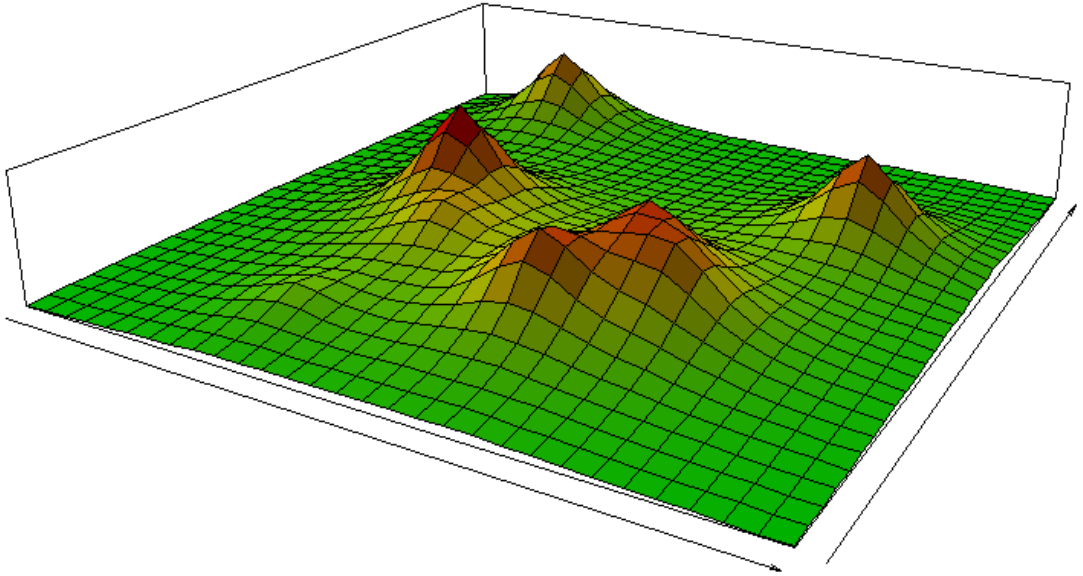
$$k(x,y) = \frac{1}{1 + \frac{\|x-y\|^2}{\sigma}}$$



1. Propagule pressure



2. Spread



Relative probability of invasion

Assessed to each cell as follows

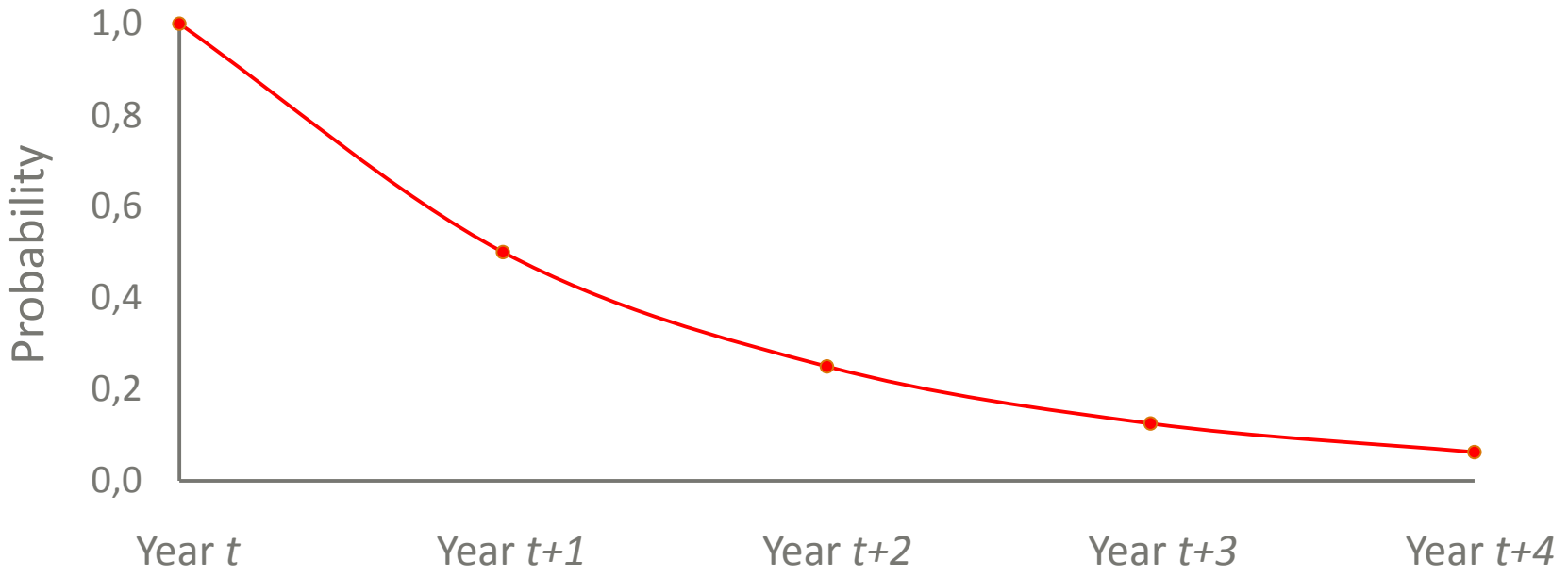
1. **Propagule pressure**
2. **Spread**
3. **Survival**

→ Relative probability of **invasion**

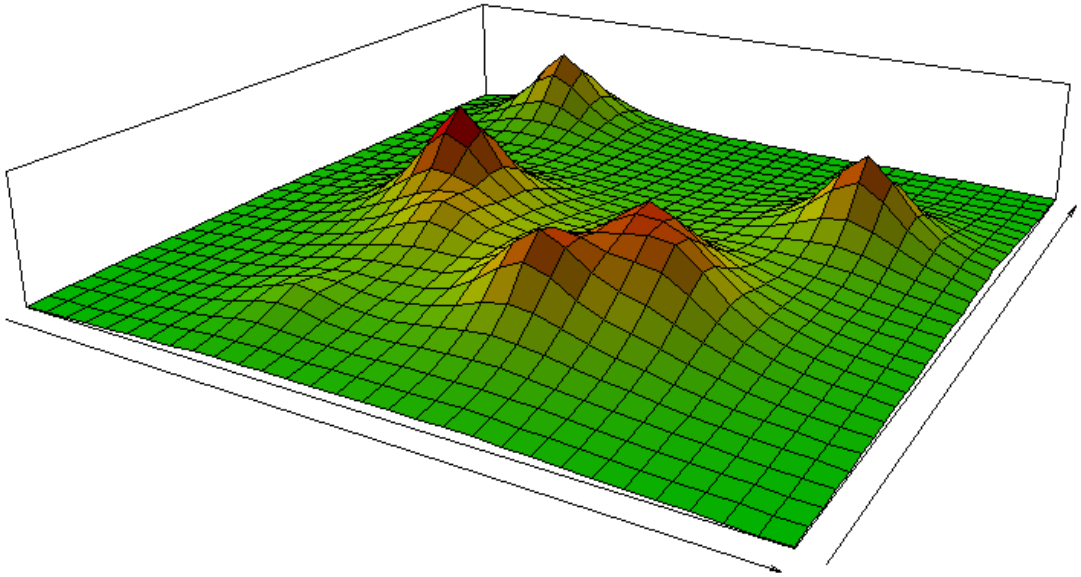
3) Relative probability of survival

in a cell is assumed to depend on the **presence of the studied crop** species in that cell

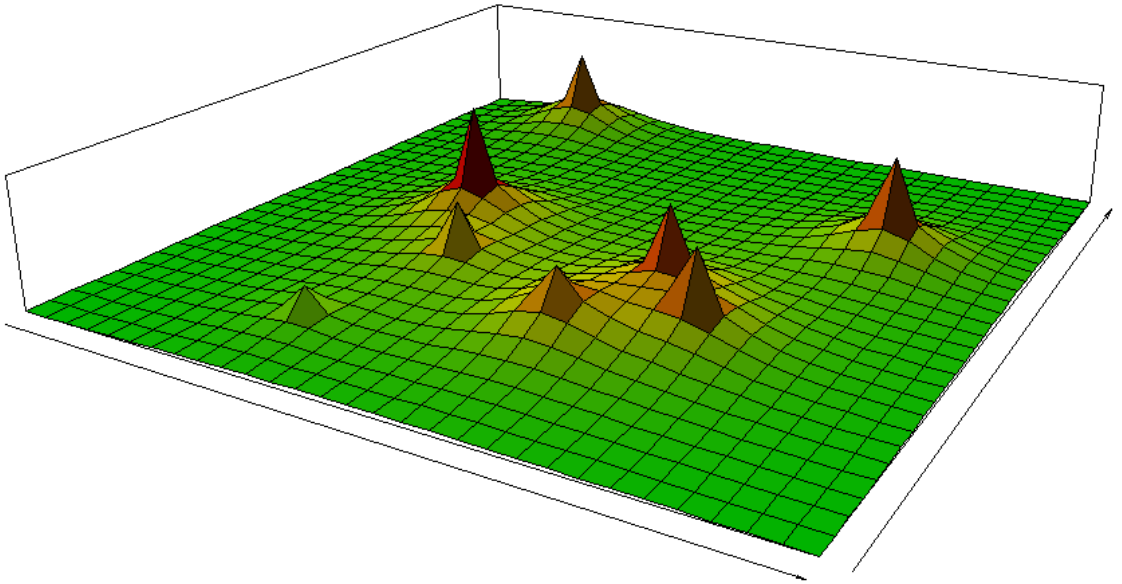
- If host plants are cultivated in the cell, the index remains unchanged
- If host plants are not cultivated in the cell, the index decreases according to a predetermined proportion



2. Spread



3. Survival



Relative probability of invasion

Assessed to each cell as follows

1. **Propagule pressure**
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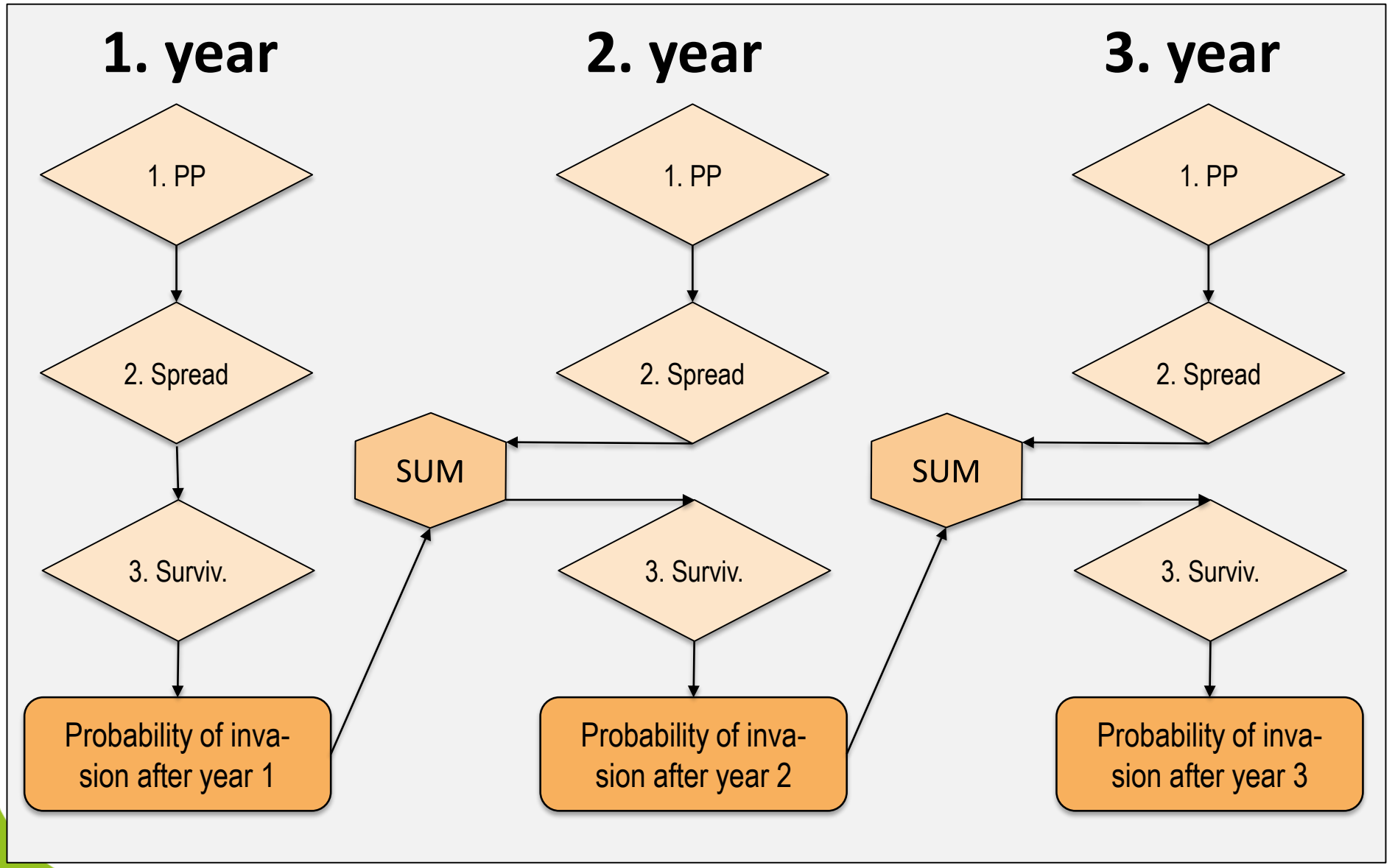
3. **Survival**

→ Relative probability of **invasion**

Accumulation of the probability over the years



Accounting pest specific traits

Pest generic approach!

- "fit for all purpose" parameters of **spread** and **survival** cannot be set

→ Probability distributions of the **spread behavior parameter (dispersal)** and **survival parameter** values are defined

→ **Monte Carlo simulation** is used to obtain **a distribution of risk index values** for each cell

Ranking of the cells

- Results need to be presented in a **simple**, **user friendly** form

  → **Ranking** of the cell-specific probability distributions

- Probability distributions need to be ranked in a way that **takes into account the whole distributions**

  → Distributions are ranked with a **pairwise stochastic dominance rule**

  → **Hypervolume indicator** denotes the quantitative position of each rank

Potato as an example (2012-2016)

Summary

- **Spatial and temporal distribution** of places of production is used to map the **invasion probability of pests** with risk indices
- Indices do not represent actual probabilities, but they allow comparison of the **relative probabilities**
- Simple methodology for a practical problem, i.e. targeting phytosanitary surveys
- Results are published in an easy-to-use web mapping service for risk managers in Finland

Kiitos!