Crop Protection & Challenges Ahead

EU –China Expert seminar

27 October 2016

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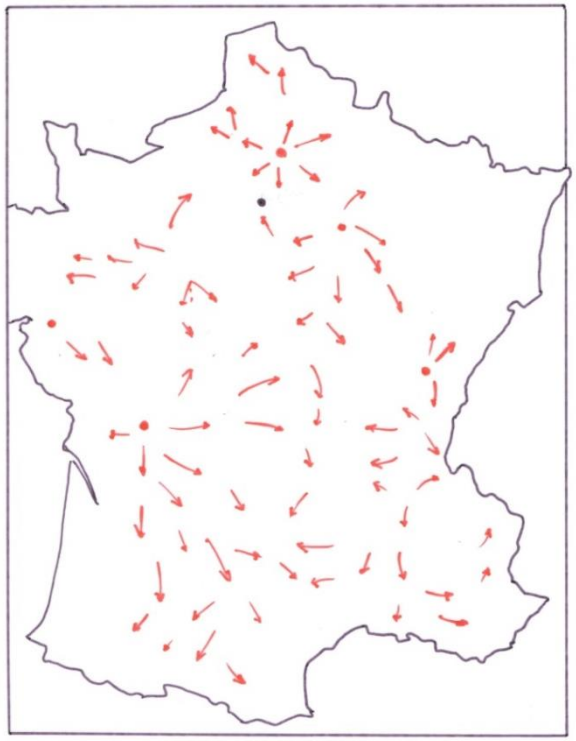
From 8000 BC untill 1850 great societal disasters by plant diseases



- **Many died**
- **Many migrated**

LA GRANDE PEUR
in 1789 by Ergot in cereals
(J.C. Zadocs 11 April 2016)

The Famine in Ireland in 1845 by Phytophhtora in potato

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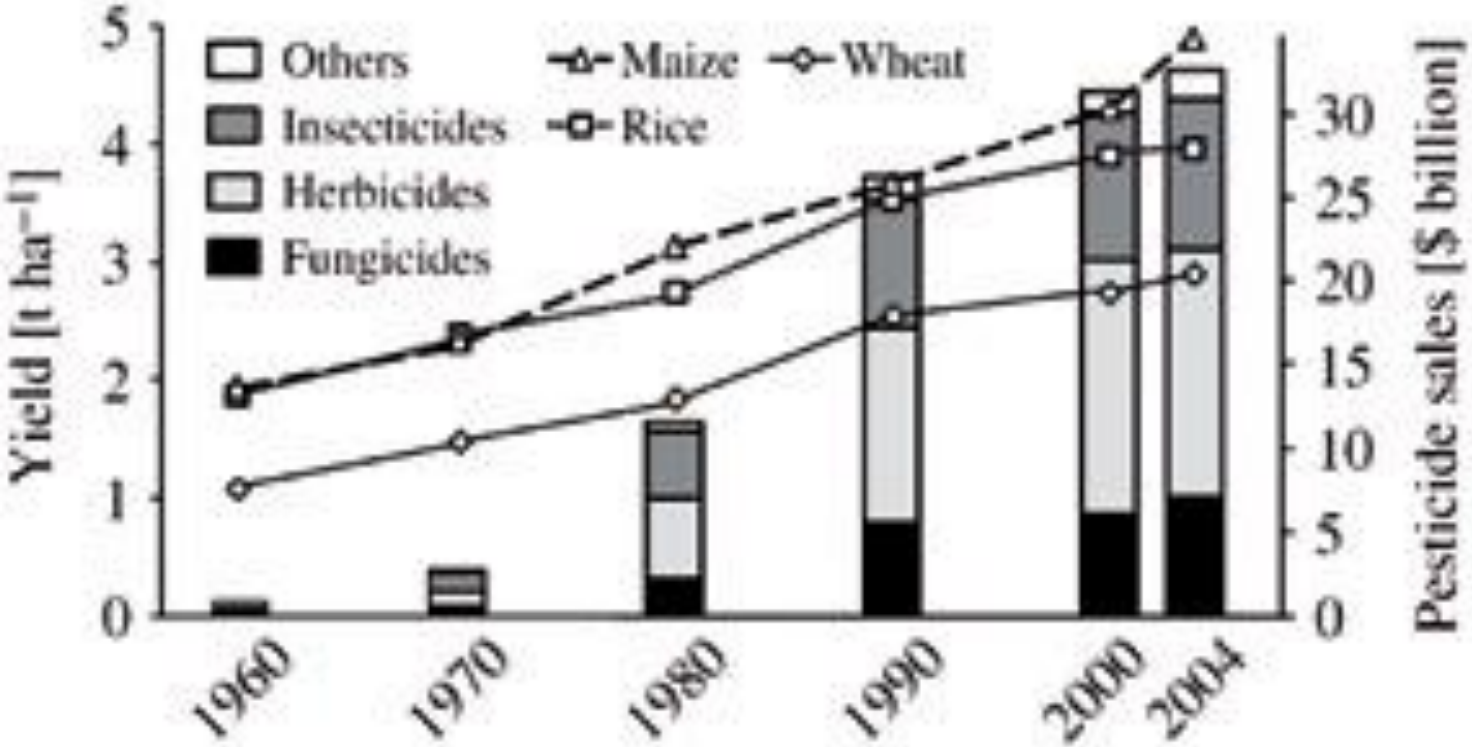
From 1850 onwards: modern crop protection – a Success story!



- > Chemical Crop protection → > > production/ha (Oerke, 2006) → feeding increased world population
- **But: too much CP not sustainable**

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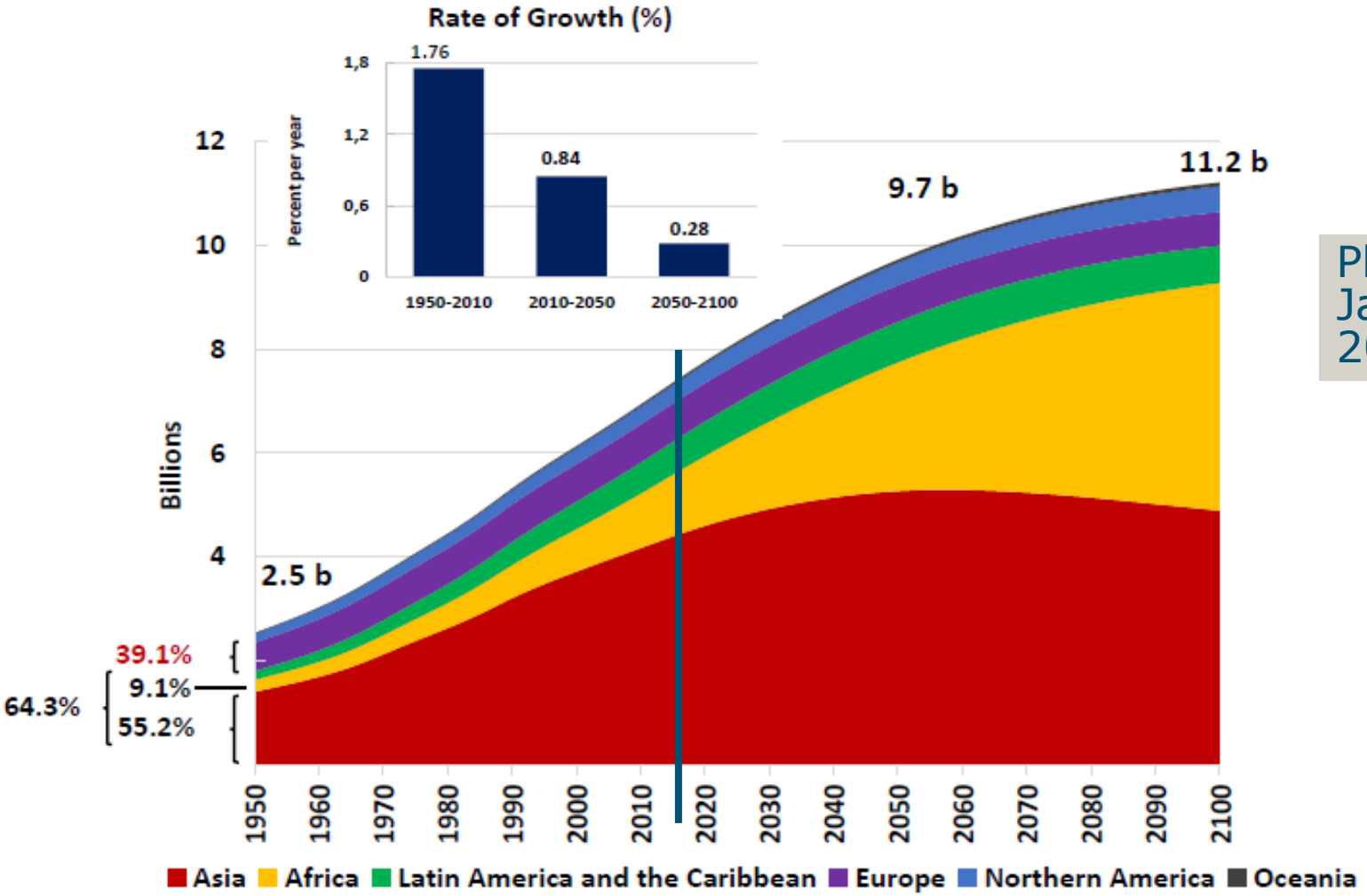
… while the population is increasing?

Population Projections, 1950-2100



Philip Pardey, January 26, 2016, Brussel

Source: UN Population Division (2015).

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…and unpredictable effect **climatic changes** on diseases

- Trend for pests and diseases:
  - Insects more abundant, and migration → more and new viruses
  - Fungi more aggressive, timely control more difficult
  - Bacteria becomes a bigger problem by > T
  - Nematodes move according to soil temperature
- New pest and disease arrive by trade and might come in a perfect niche to survive
- **More risks of disease outbreaks and crop failure**
- **→ present IPM is NOT CC-proof!**

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Paradigm change:More **resilient** crops and systems needed in 21st century:

- **Now:** most Crop protection is reactive

  →Diseases occur and need to be treated (chemical/biological/physical)

- **Future: towards resilient plants and systems**

  → **Less chances** for pests and diseases!!

The resilient crops of the 21st century

1) Resilient Plant Genome = 1st genome

- **Resistance breeding (conventional, trans-, cis genesis)**
- **Gene editing (awaken R genes, knock out helper genes for infection)**

→ Induction of resilient genes

Resilient Plants
And
Cropping systems

2) Resilient Microbiome = 2nd genome

- **Discover optimum microbiome for specific plant**
- **Optimize around roots, leaves, seeds and plantlets**

→ The 'good' microbiomes prevent the 'bad' pathogens

3) Resilient culture systems

- **Towards LRP chemicals, biocontrol: 'greening'**
- **Big data + monitoring → precision crop protection**
- **Protected culture + soil-less outside**
- **Resilient biodiverse soils**

→ Diseases less chance

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Sustainable resistance effect against blight by stacking R-genes (cisgenesis) in potato

S, yes spray > R, no spray

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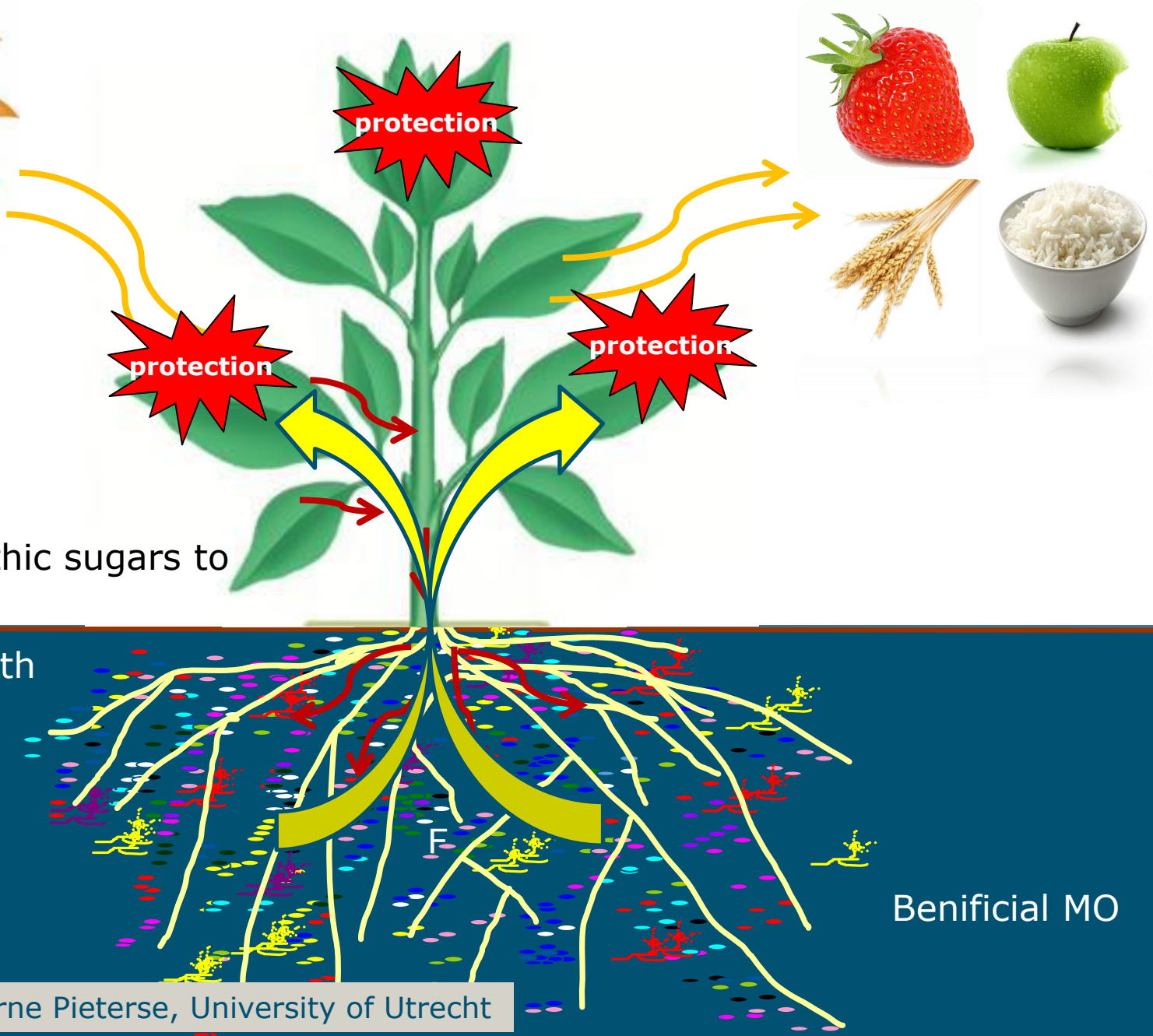
DuRPh duurzame resistentie tegen *Phytophthora* in aardappel door cisgene merkervrije modificatie

Rhizosphere microbiome and plant health



20-40% fotosynthic sugars to rhizosphere

Supporting growth and protection

Benificial MO

From Prof. Corne Pieterse, University of Utrecht

How to obtain the right microbiome compostion around the roots?

Diagnostics:

- Metagenomics: determine the right MO rhizosphere composition for that crop grown in that specific environment

Measures leading towards the ideal composition:

- Add (gene-edited) MO cocktail to the root system: survive??
- Isolate right MO from the plant's own rhizosphere niche, multiply in fermenters and add again: risk??
- Change plant genome to produce signals and exudates to attract/build-up its right MO consortium: fitness costs??
- Substrate amendments (compost, biostimulants...) help to change MO composition in the right stable direction)?
- Seeds and plantlets coating with right MO consortium

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4) Present EU-regulations (SUD, 1107, fertilizers, GMO, biostimulants etc.) <u>don't fit</u> in resilient concept

Towards ONE integrated regulation

to support resilience???

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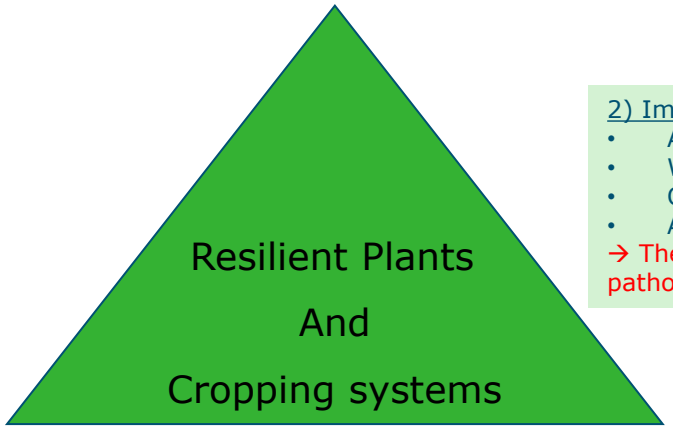
For paradigm change towards resilience needed:

- R&D for all sides of triangle (public/private funding)
- Innovative (I) pilots by farmers (public/private funding)
- Acceptation of new genomic techniques (by society)
- Speeding-up registration procedures LRPs (chem. or bio) and integrate regulations (by EU-policy)

1) Improve Plant Genome = 1st genome
- Resistance breeding (conventional, trans-, cis genesis)
- Gene editing (awaken R genes, knock out helper genes for infection)
- Gene editing (changing phenotype of plant)

→ Induction of resilient genes



2) Improve Microbiome = 2nd genome
- Around the roots (rhizomicrobiome)
- Within de plant (endophytes community)
- On the leaves (Phyllomicrobiome)
- Around seeds and plantlets

→ The 'good' microbiomes prevent the 'bad' pathogens

3) Improve culture conditions
- From chemical to biocontrol
- Big data + remote sensing
- Precision monitoring and sprayings
- Protected culture
- Resilient soils (soil-less)
- Biodiverse environment

→ Diseases less chance

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