Promising directions in Integrated Pest & Disease Management that require further research

Karel Bolckmans

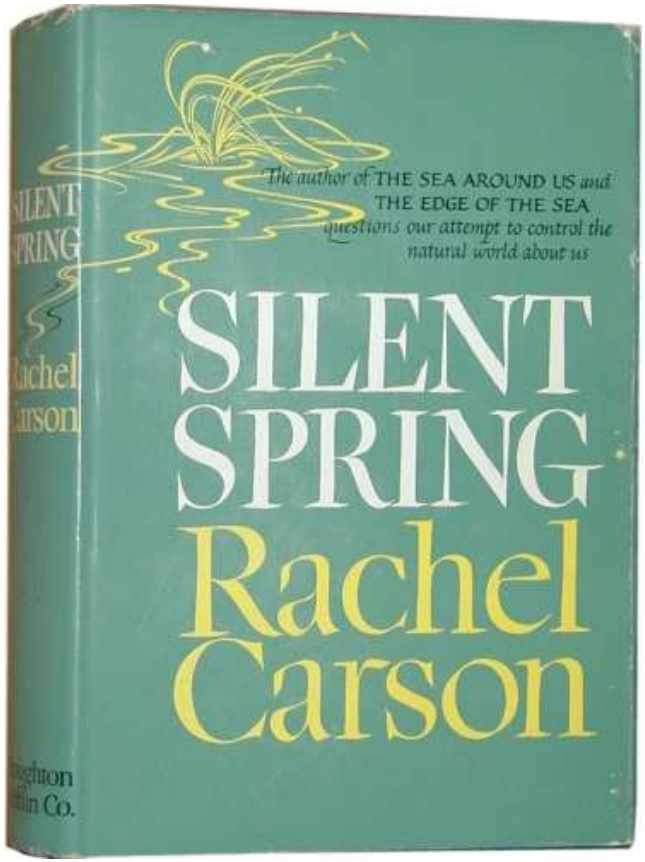
Integrated Pest Management
the way forward to Sustainable Agricultural Production
Brussels, June 19th, 2012

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

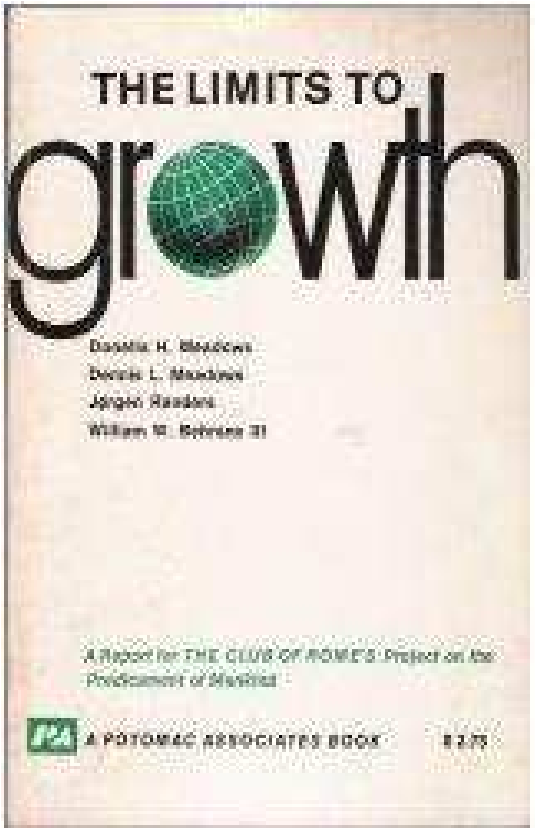
KOPPERT
BIOLOGICAL SYSTEMS

"Good forecasts are not those that occur, but those that lead to action."

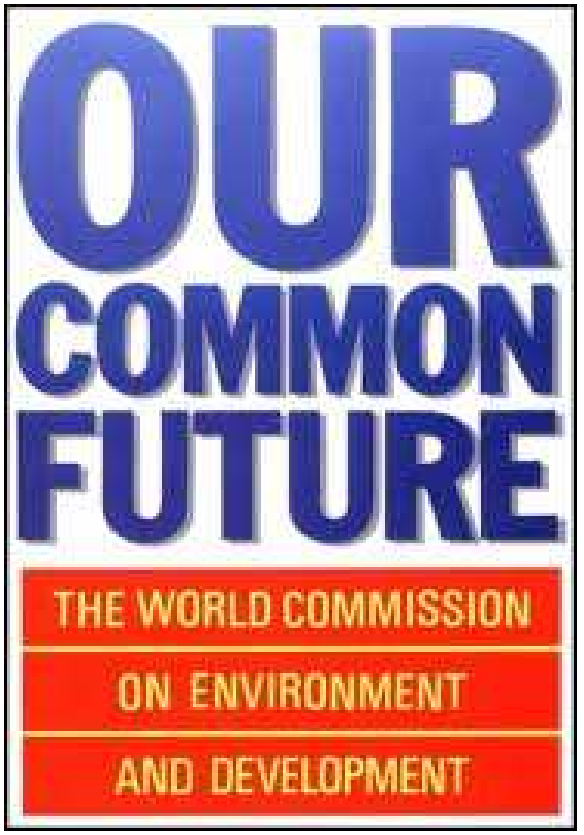
Michel Godet, 2012



1962



1972



1987

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

New Roads to New Goals

- ✓ The **Market** demands *residue*-poor or even residu-free produce (food safety)
  - **Retailers** impose extra-legal requirements on farmers
- ✓ More attention for *worker safety* of the farmer and his **personel**
- ✓ **Society** and **Legislator** want less impact on the *environment* and *public health*
  - Stronger regulatory requirements have lead to less and safer pesticides
  - IPM has to lead to reduced use of pesticides (National Action Plans)
  - No emission of pesticides into the environment (Water Framework)
- ✓ **Sustainable Food Production :** more **production** with less **input** and less **impact**.

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

Challenges for **sustainable crop protection**

- ✓ **Residue Management**
  - license to supply
- ✓ **Resistance Management**
  - relying only on pesticides will lead to pesticide resistance problems
  - pesticide resistance leads to more intensive usage and ultimately even to the use of illegal pesticides (food safety)
- ✓ **Rentability**
  - more yield with less **cost** and less **Risk**

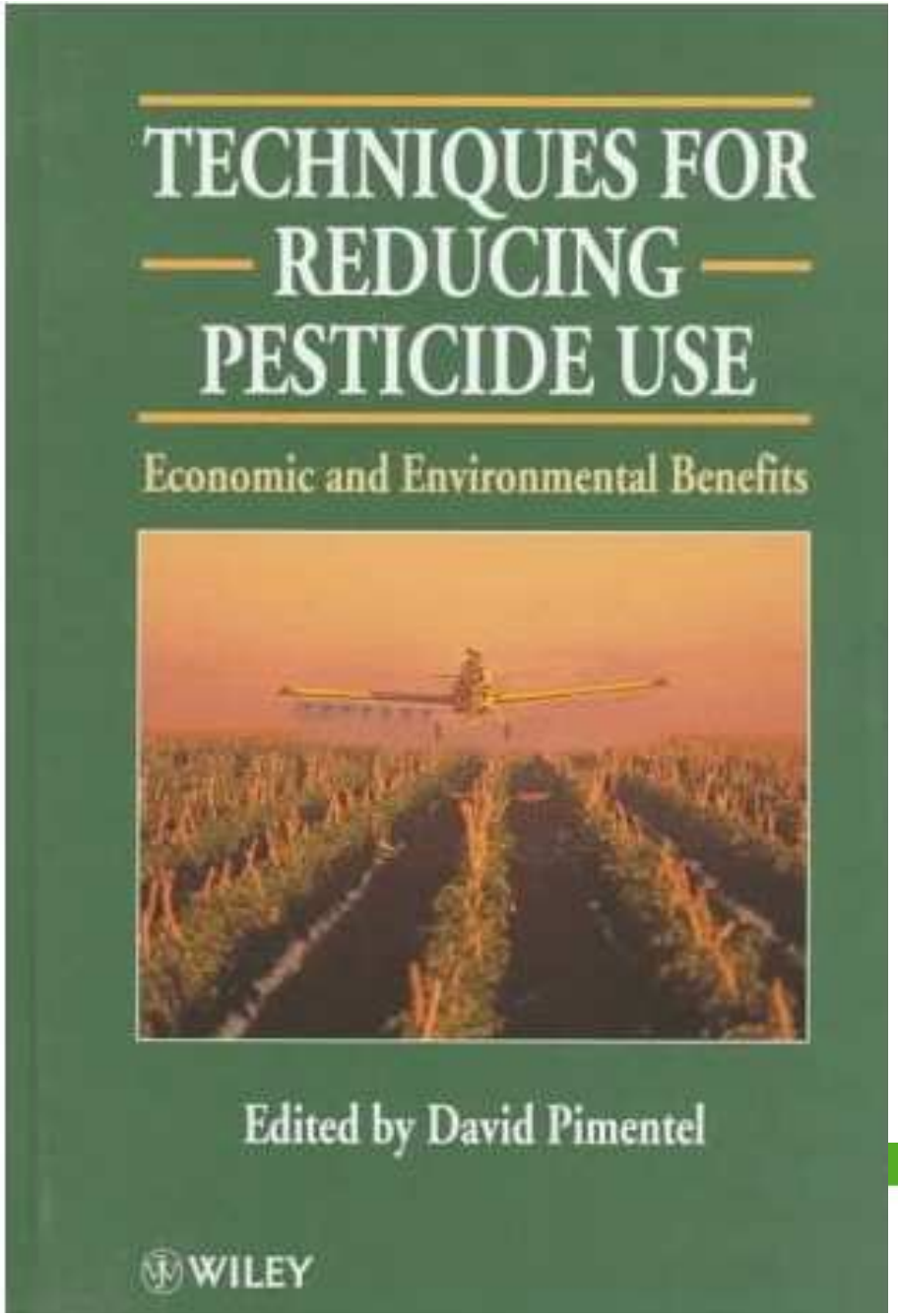
IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

Conclusions

- ✓ Chemical pesticides can and will no longer be the ***basis*** for crop protection.
- ✓ Integrated Pest and Disease Management has to be lifted to a higher level.
- ✓ Resilience against climate change and invasive alien pests and diseases

Thinking differently:
from **less negative impact**,
to a **positive impact** on the biodiversity and environment.

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION



IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

40 years after Apollo 11

What's our next step?

NASA via Reuters

Where no one had gone before: The footprint of an Apollo 11 astronaut marks the surface of the moon during America's historic mission in July 1969.

USA Today, July 17-19 2009

20 juli 1969

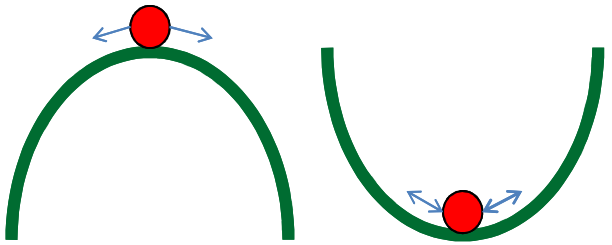
IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

From mainly curing, to mainly preventing

- ✓ From reductionism to holism
- ✓ Resilient production systems
  - *from risky balancing …*
  - *… to self-balancing systems*
- ✓ Biological control
- ✓ Slowing down pest and disease development
- ✓ Systems thinking at all system levels (*prevention*)
  - Resilient Plant
  - Resilient Soil/Substrate
  - Resilient Cropping Systems
  - Resilient Agro-ecosystems

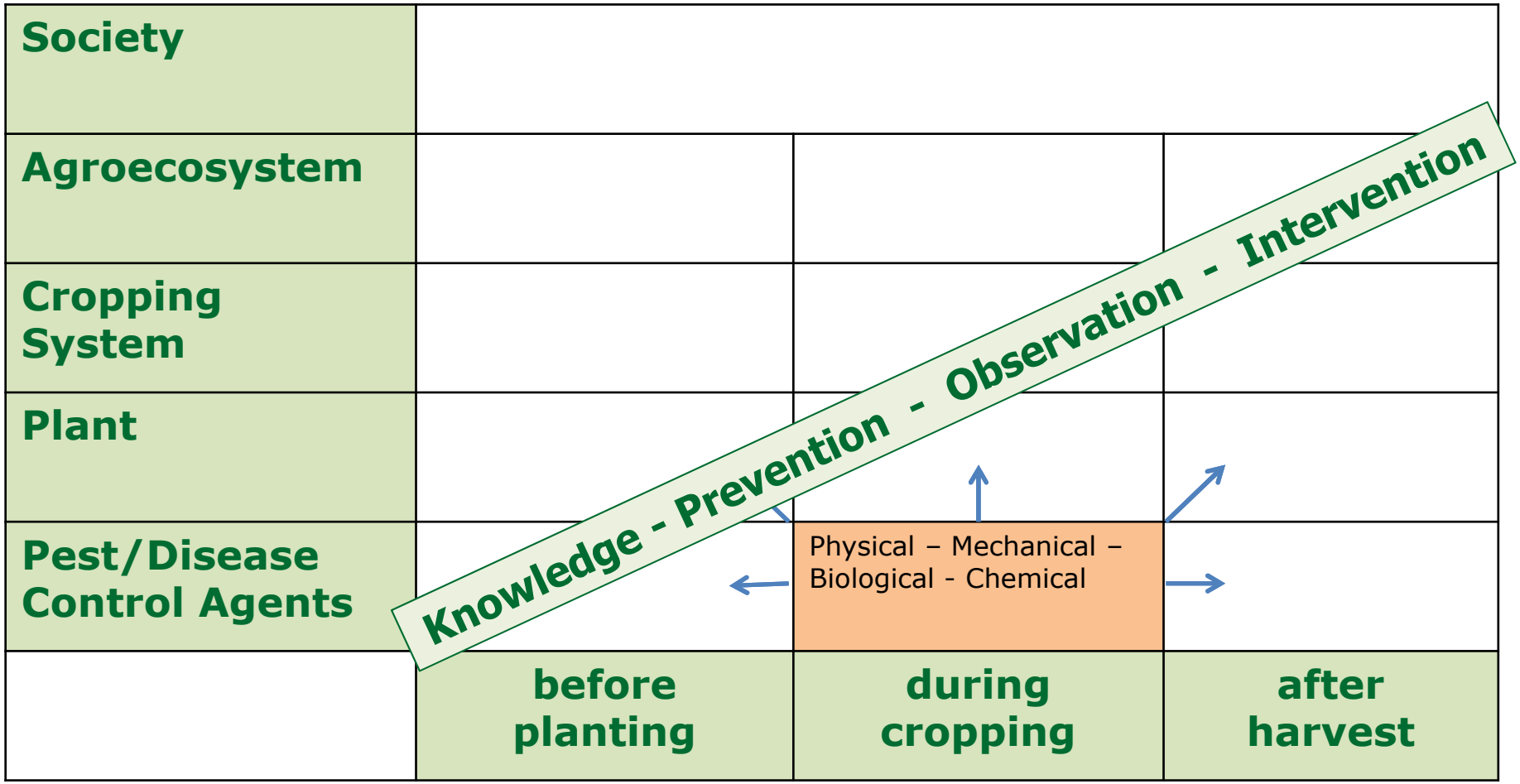
  } **efficiency**

  - Resilient Society → **sufficiency**



"the root cause"

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION



+ interactions between system levels

IPM = Systems Thinking

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

Biological Control

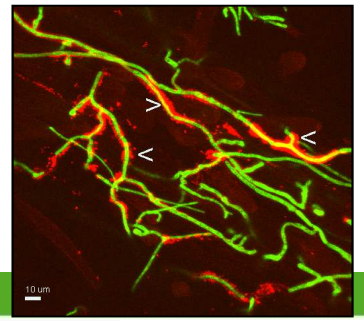
- ✓ **Classical Biological Control**
- ✓ **Conservation Biological Control**
- ✓ **Augementative Biological Control**

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

Biological Control Agents

- ✓ Develop and improve **beneficial insects and mites**
  - Screening of new BCA's
  - Selective breeding
  - Endosymbionts
  - Generalists
  - "Standing army" of predators
  - Semiochemicals

- ✓ **Sterile Insect Technique**
- ✓ Develop and improve **microbial antagonists of pests and diseases**
  - screening of new BCA's
  - formulation
  - ...



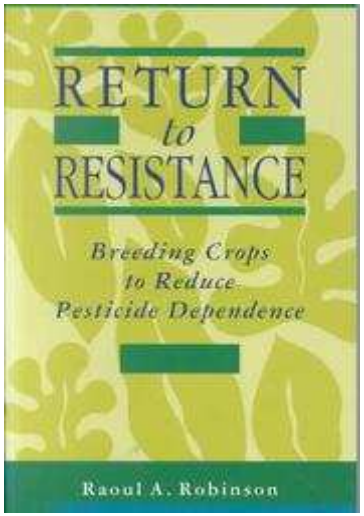
Pseudomonas chlororaphis op *Fusarium oxysporum* on tomato roots

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION


©Seraka


©WUR Glastuinbouw

Resilient Plants



- ✓ **Breeding for Resistance**
  - (partial) resistance, multi gene resistance
  - more adapted for beneficial insects and mites
- ✓ **Induced Systemic Resistance** (ISR)
  Systemic Acquired Resistance (SAR)
  - activators
  - micro-organisms : seed treatment
  - predatory bugs
- ✓ **Endophytes** : "systemic" micro-organisms
- ✓ **Resistance Inducing Substrates**
- ✓ **Low doses of pesticides** to slow down pest development
- ✓ **Preventive release of predators and parasites** ("standing army")
- ✓ **…**

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

Resilient Soils/Substrates

Resilient Soils/Substrates

a.k.a. "suppressive soils"

1. Respecting (microbial) soil life

- avoid harmful pesticides
- improve the physical/abiotic conditions in the soil

2. Increasing the quantity of (microbial) soil life

- soil organic material (SOM), compost, green manure, …
- biostimulants

3. Increasing the diversity of (microbial) soil life

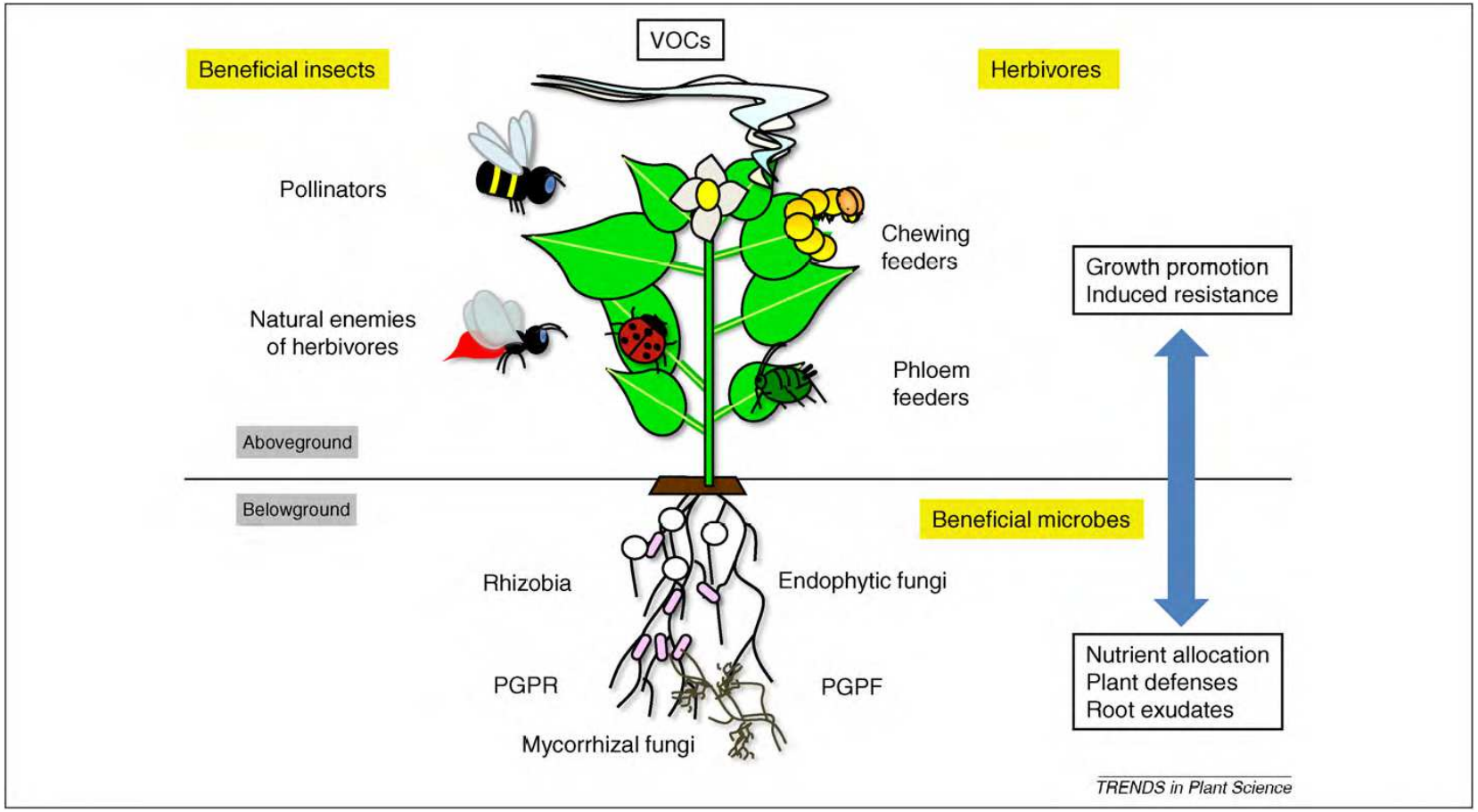
- soil organic material (SOM), compost, green manure, …

4. Adding specific antagonists

- Trichoderma spp., Bacillus spp., Pseudomonas spp., etc.

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

The root cause …



Pineda et al., 2010, **Helping plants to deal with insects: the role of beneficial soil-borne microbes**. Trends in Plant Science. Vol.15,Issue 9, p. 507-514

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

What can microbes do for us ?

- **Nutrient Uptake enhancement** and **Plant Growth Promotion**

  - increase root surface, production of bio-active compounds for plant uptake : Plant Growth Promoting Micro-organisms (PGPR's), mycorrhiza, biostimulants

- **Nutrient bio-availability enhancement**

  - increase availability of nutrients : fertiliser solubilization (e.g. phosphate), mobilization (e.g. potash), decomposition of organic material

- **Nitrogen fixing**

  - Nitrogen fixing bacteria (Rhizobium spp. and free-living bacteria), Inoculants

- **Improve soil aggregation**

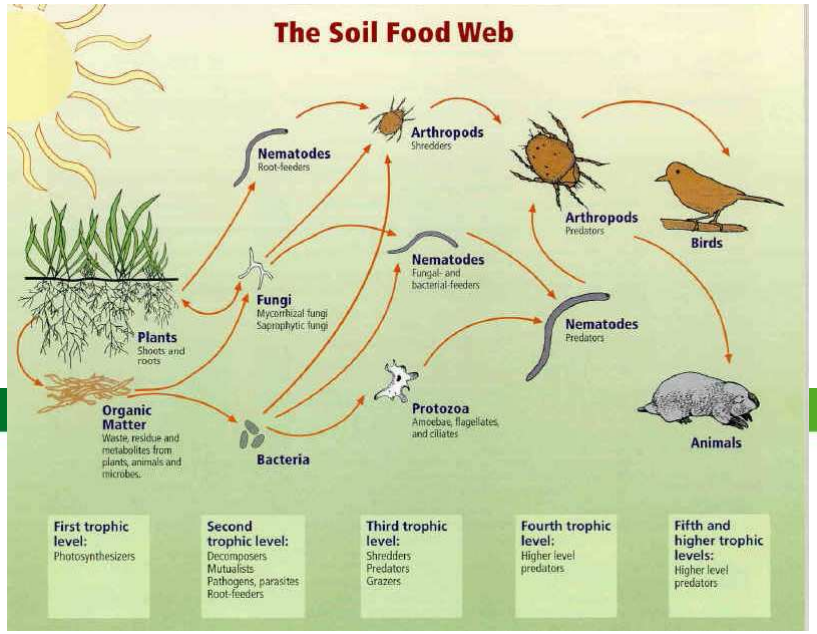
  - Mechanisms : production of polysaccharides to improve soil aggregation

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

What can microbes do for us ?

- **Tolerance to salinity**
  osmotic protectants : enable crop production in salinated soils
- **Tolerance to drought stress**
  enable crops to better tolerate periods of drought.

Soil Food Web !



IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

Crop Protection & Productivity

- ✓ Increased production when intensive use of chemical pesticides is stopped.
- ✓ Plant growth promoting (PGP) effect of antagonistic micro-organisms ("biofertilizers").
- ✓ Reduction of use of chemical fertilizers by applying micro-organisms ("biofertilizers").
- ✓ Protection against salt stress and drought stress by using micro-organisms.
- ✓ Convergence of *Integrated Pest & Disease Management* (IPM) and *Integrated Soil & Nutrient Management* (INM).

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

Plant Protection Policy Paradox

Succesful European policy aimed at reducing the number of chemical PPP's and the use of chemical PPP's.

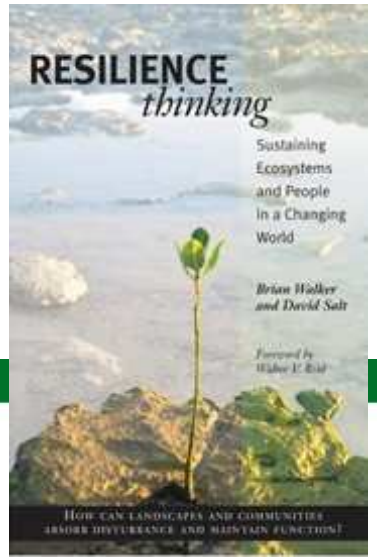
Policy is not sufficiently aimed at enabling the development and availability of alternatives:

1. Registration requirements for microbials.
2. Very long registration proces for microbial biological control agents due to insufficient expertise of the examiners.
3. Declining support of research into non-chemical alternatives. Tunnelvision with regards to genetics only.
4. Regulation of biostimulants and biofertilisers.
   Are now considered as PPP's under 1107/2009.

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

Resilient Cropping Systems and Agroecosytems

- ✓ **Diversity** in **time**: crop rotation
- ✓ **Diversiy** in **space**:
  - at the **field** level: mixed cropping of varieties with different resistance genes , different crops, agroforestry, …
  - at the **landscape** level: functional agrobiodiversity, ecological focus areas, …
- ✓ **Diversity** and **Redundancy** of crop protection practices



Agronomic research

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

"We are now on the threshold of a third phase in the development of IPM systems that recognizes pests not as enemies, but as indicators of problems in the design and management of systems"

Hill (1985)

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

Thank you !

kbolckmans@koppert.nl

IBMA
INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION

Research Needs

1. Screening of new BCA's* + development of efficient and effective screening methods for BCA's
2. Pro-active research on Invasive Alien Pests
3. Effect of biological control on crop yield
4. Effect of BCA's on resistance against biotic (pests, diseases) and abiotic stresses (salinity, drought, heat)
5. Environmental Risk Assesment, development of ERA methods
6. Human Risk Assesment (toxicology, pathogenicity, etc.), development of HRA methods
7. Production technology for microbial and invertebrate BCA's (cost, reliability, quality, scale)
8. Formulation technology for BCA's

Research Needs

9. Long term storage of BCA's
10. Quality Control methods
11. Techniques for enhancing efficacy and consistency of BCA's (e.g. endosymbionts, selective breeding, synergists, plant breeding, conservation biocontrol, etc.)
12. Application technology for BCA's
13. Integration in IPM Systems, Total Systems Approach
14. Agroecology, Systems Thinking, Resilience Thinking, Complexity theory, …
15. Farmer training and technical support (advisory services), Simplification
16. Cost-Benefit Analysis of biontrol-based IPM
17. IPM Indicators

Predators

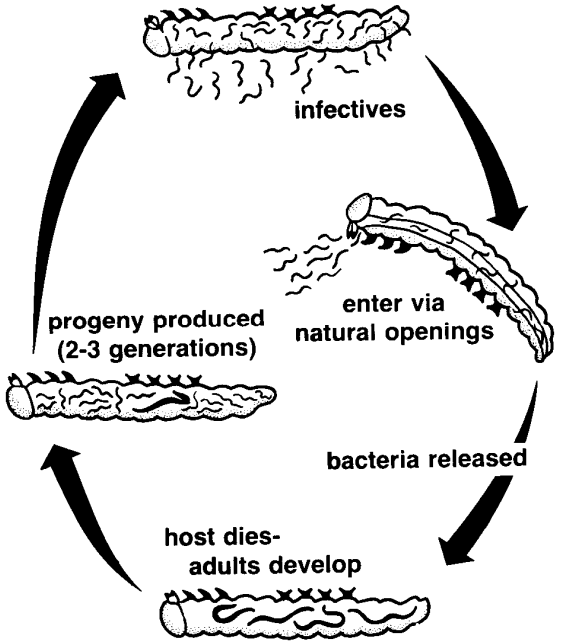
Predators

Parasites

Sterile Male Technique

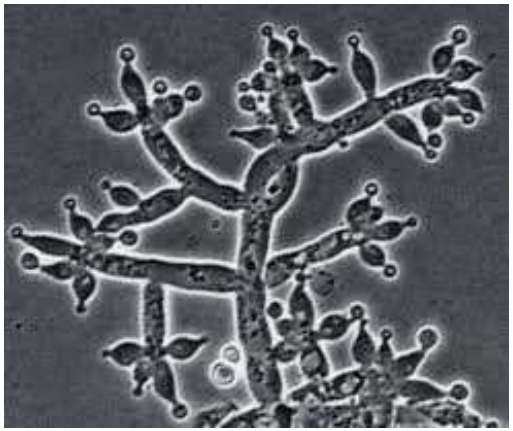
Insect Pathogens

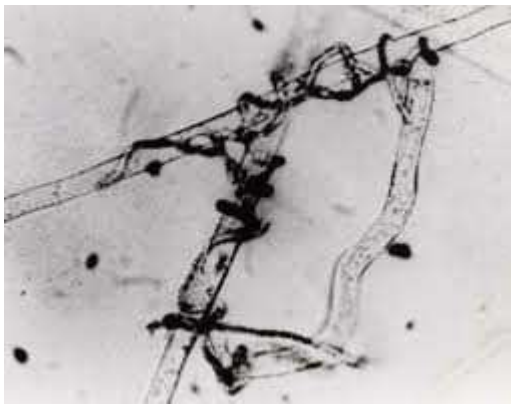
Insect Pathogenic Nematodes



Biological Control of Diseases

- Foliar diseases and root diseases
  => Control microbes with microbes
- Mode of action
  1. Antibiosis
  2. Competition
  3. Parasitism
  4. Compensatory root growth
  5. Activating plant defense system





Pheromones