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Organic Plant Breeding

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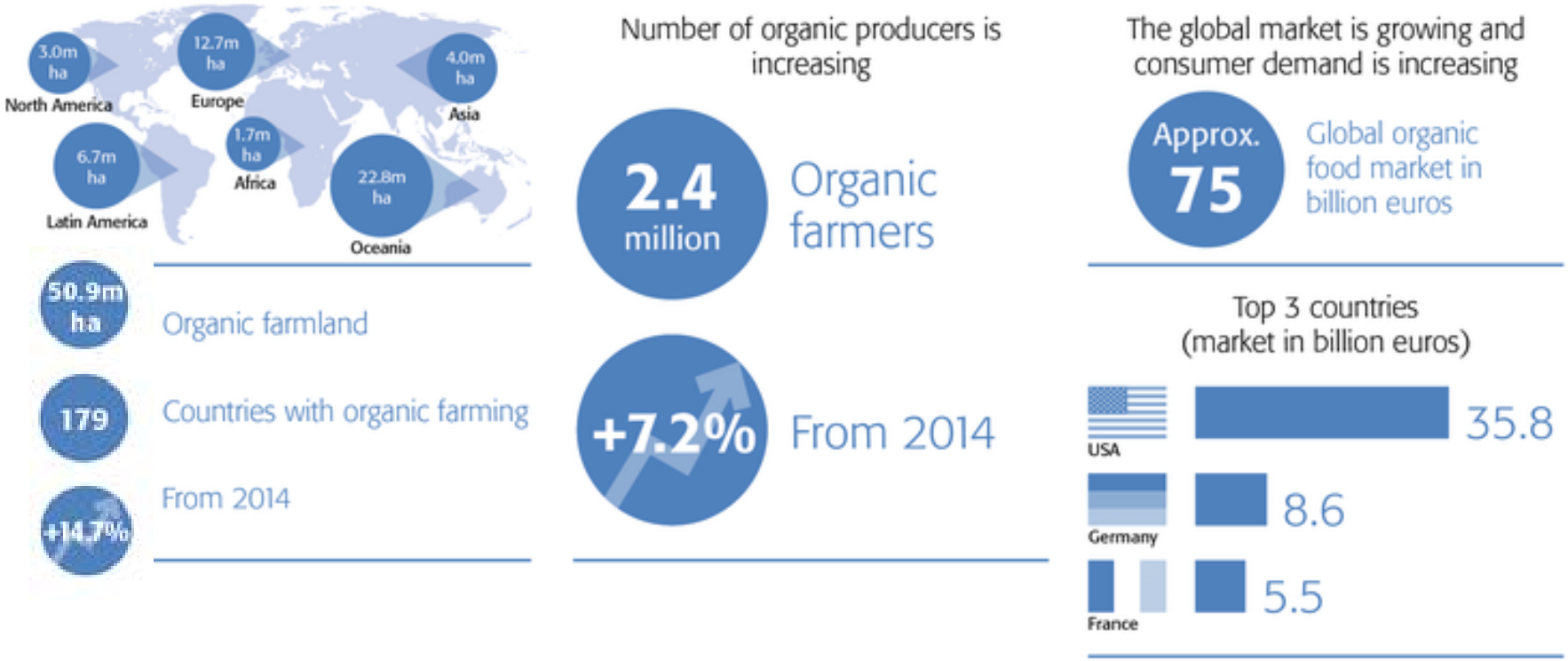
FFA Dinner Talk Brussels 29.05.2018

The World of Organic Agriculture 2015



FiBL Survey 2017 based on national sources
www.organic-world.net/yearbook/yearbook- 2017.html

Why we need Organic Plant Breeding

Ecological instensification of organic production through

- Focused breeding for target environments with limited external inputs
- Selection for specific traits, like seed- borne diseases, weed competition
- Meeting market demand and expectation of farmers and consumer
- Alternative breeding programs refraining from genetic engineering and certain breeding techniques

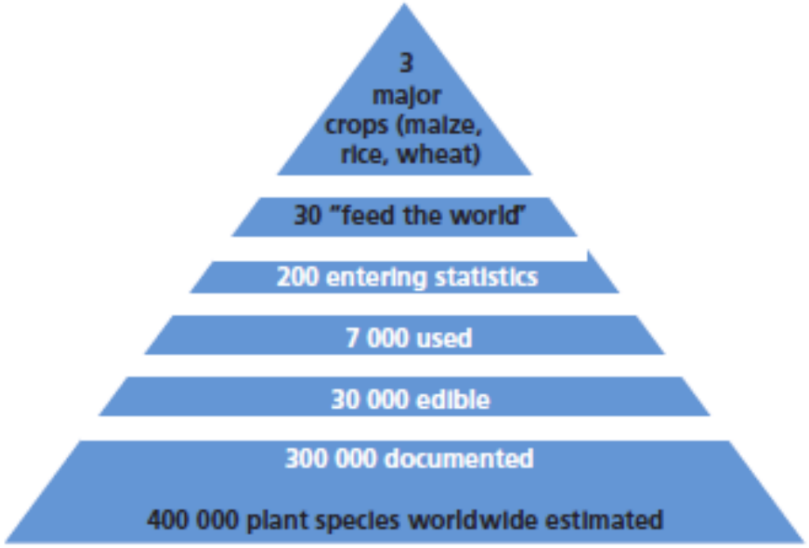
Enabling more sustainable food production systems through

- Large portfolio of crops on farm level to mitigate risks of crop failure
- Functional biodiversity on field level to reach high level of self regulation and closed nutrient cycle
- Safeguarding and evolving genetic resources for future generations

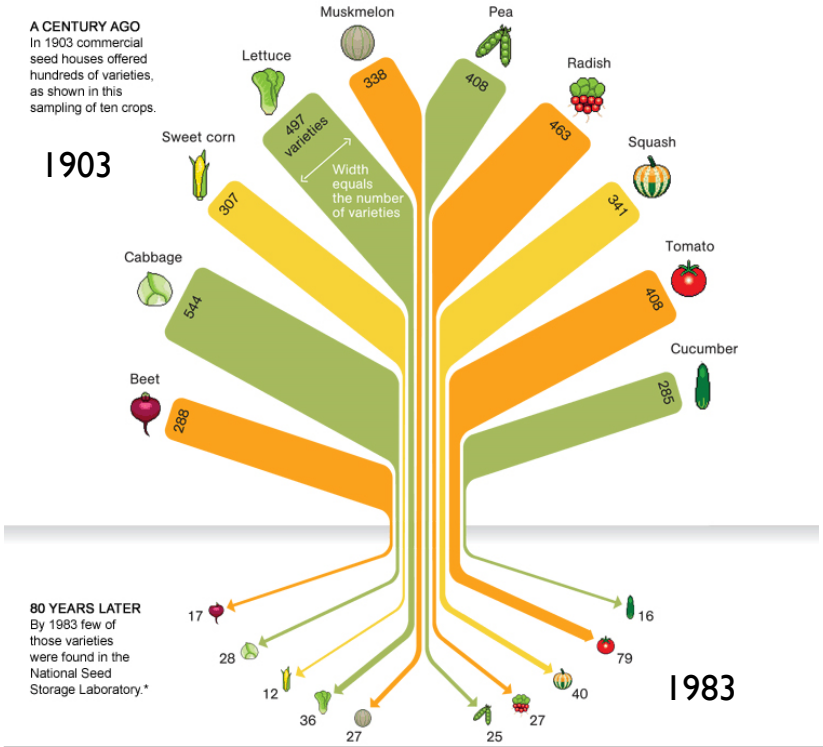
Reduced number of crops and cultivar per crops

FIGURE 5.1

Use of crop species diversity in agriculture

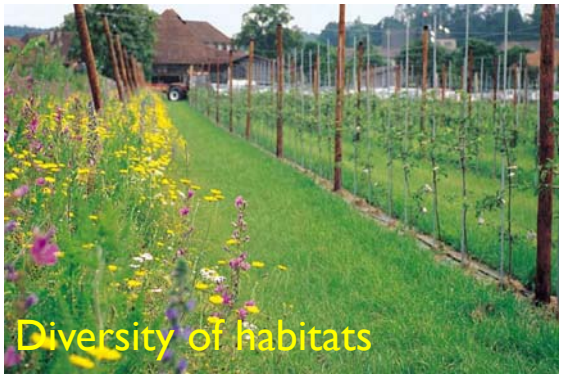


Source: FAO, 1996



John Tomanio, NGM Staff Food Icons, Quickhoney, Source Rural Advancement Foundation International

Breeding for functional biodiversity



Fotos: FiBL

Strategies for Organic Plant Breeding

Combining breeding & agronomic innovations for Organic

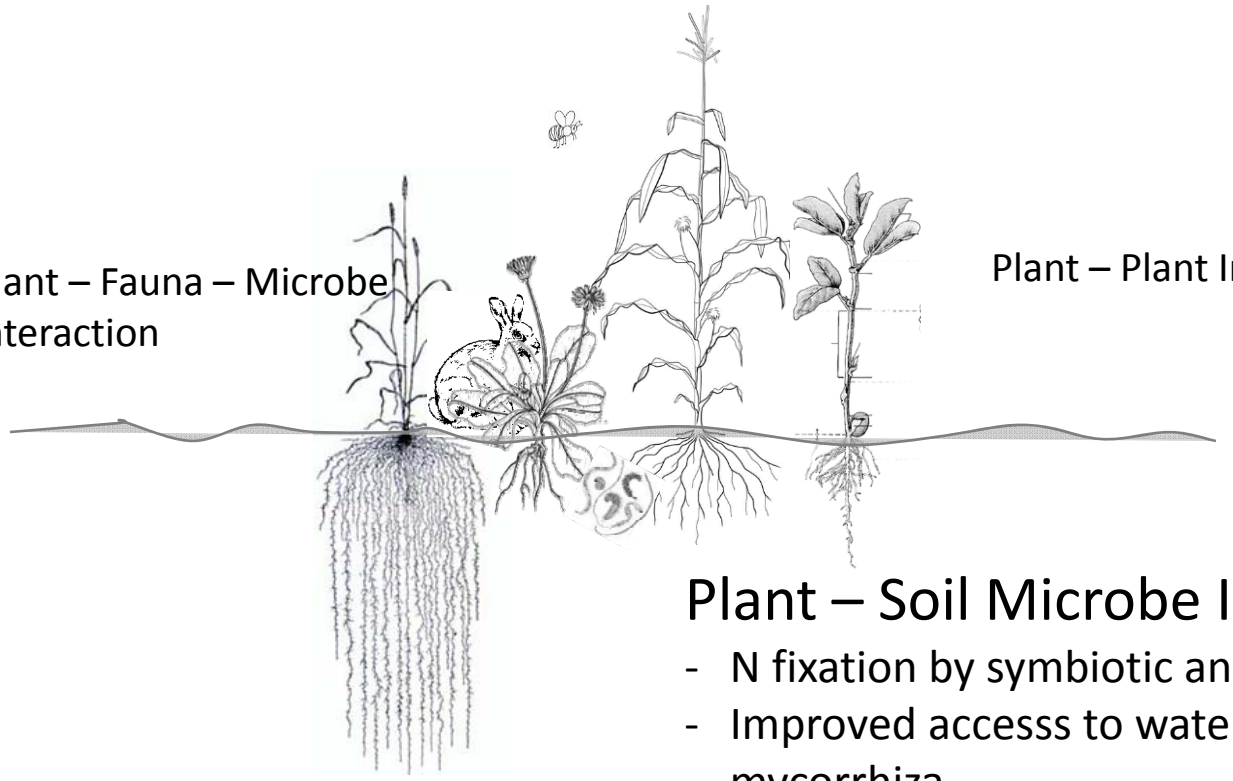
Breeding for increased diversity

- Breeding for diversity within cultivars
- Breeding for mixed cropping systems
- Breeding for improve diversity of associated soil microbes
- Decentralized participatory breeding for local conditions

Embedding diversity into markets

- Involving all stakeholders (farmer, value chain and community driven breeding)
- New concepts for the ownership of cultivars and their financing
- Changing regulatory framework to foster greater agrobiodiversity (official variety testing, seed regulation)
- Valorization of organic plant breeding along the value chain (www.bioverita.org)

Breeding for improved symbiosis



Plant – Fauna – Microbe Interaction

Plant – Plant Interaction

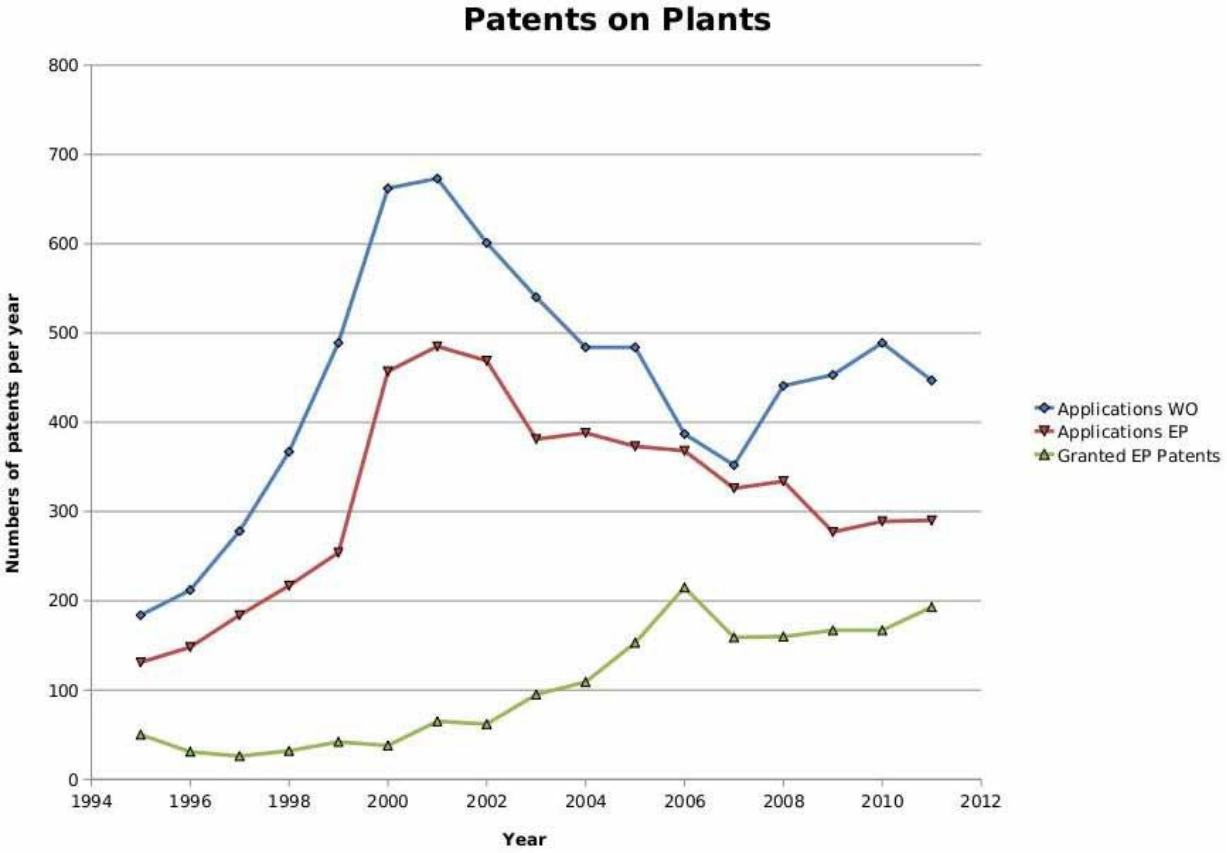
Plant – Soil Microbe Interaction

- N fixation by symbiotic and free living bacteria
- Improved accesss to water and nutrients by mycorrhiza
- Mineralisiation of organic fertilizer
- Root exudation
- Plant growth promoting rhizobacteria (PGPR)
- Pathogenes & counterparts

Main Challenges to obtain high quality seed of cultivars adapted to organic agriculture

- Very limited breeding initiatives to develop improved cultivars that are adapted to organic farming conditions with slow release nutrient supply
- Breeding is dominated by commercial sector while public breeding programs get reduced personel and financial resources
- Concentration on few main crops negleting grain legume and minor crops
- Organic breeding initiatives are not well connected with each others and to conventional breeders
- Missing funding for oganic plant breeding and research as focus is on molecular breeding
- Official Variety Registration is optimized for F1 hybrids (DUS) and testing for Value of cultivation and use (VCU) is conducted mainly under conventional farming

Restriction of exchange of genetic material by IP rights

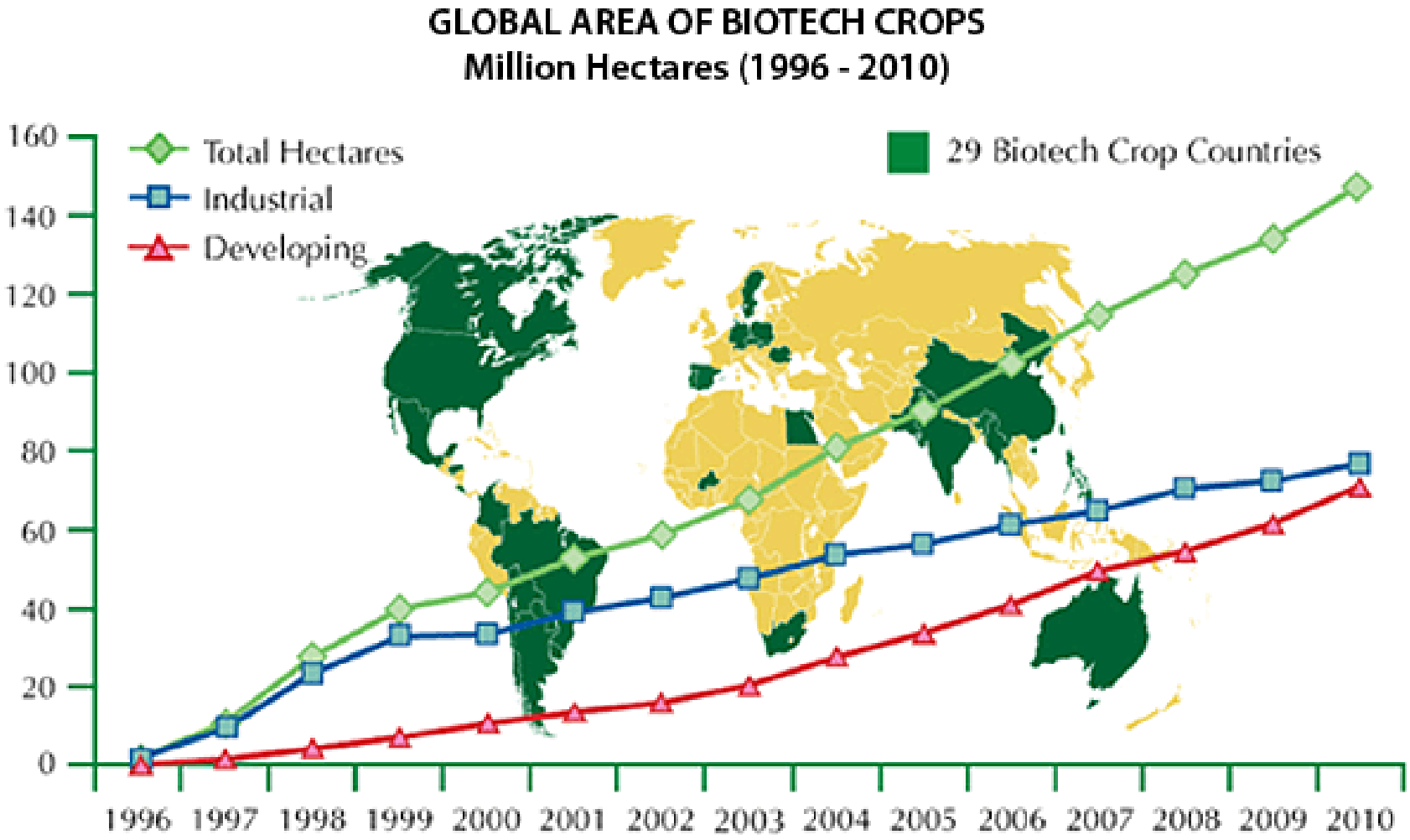


Overview of patent applications on plants under PCT/WIPO (WO) and at the EPO as well as of patents granted by the EPO. Research according to official classifications (IPC A01H or C12N001582). Christoph Then & Ruth Tippe March 2012
www.no-patents-on-seeds.org

FiBL www.fibl.org

Who will control the *Green Economy?*
www.etcgroup.org

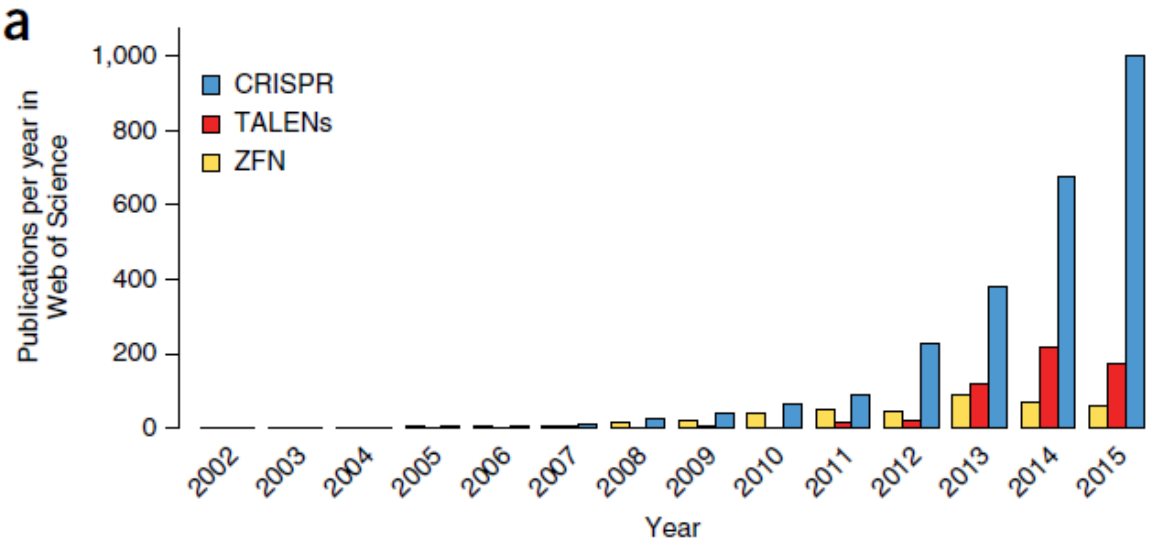
Increase of GM varieties



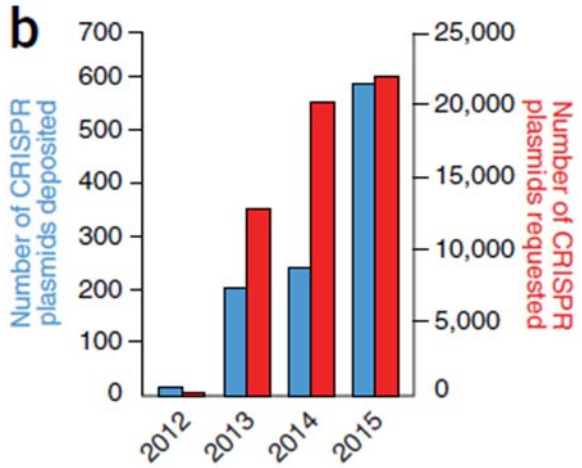
Source: James Clive 2011, ISAAA

FiBL www.fibl.org

CRISPR-Cas9 Development



No. of Publications



No. of available CRISPR Plasmids

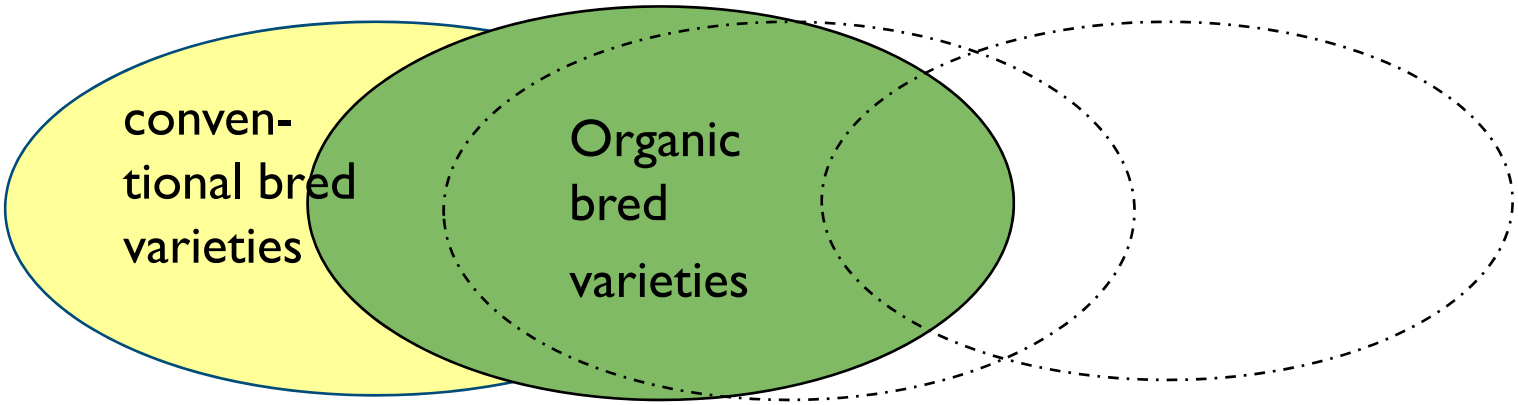
No. of ordered CRISPR Plasmids

Barrangou R., Doudna J.A. (2016) Applications of CRISPR technologies in research and beyond. Nature Biotechnology 34:933

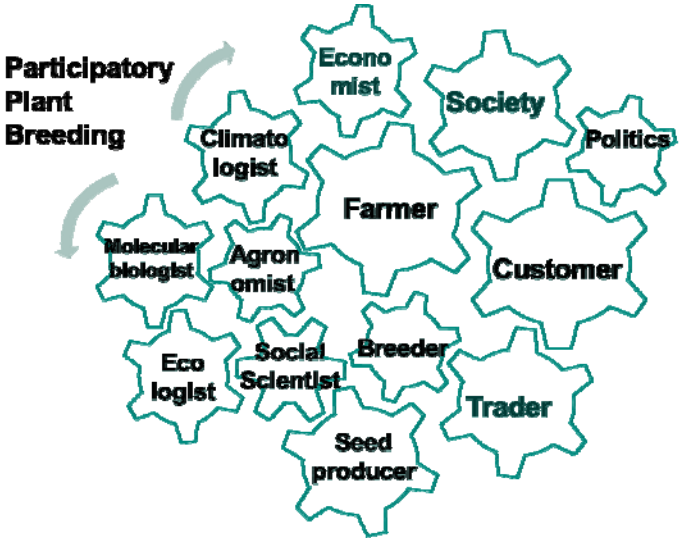
Drift between conventional and organic plant breeding

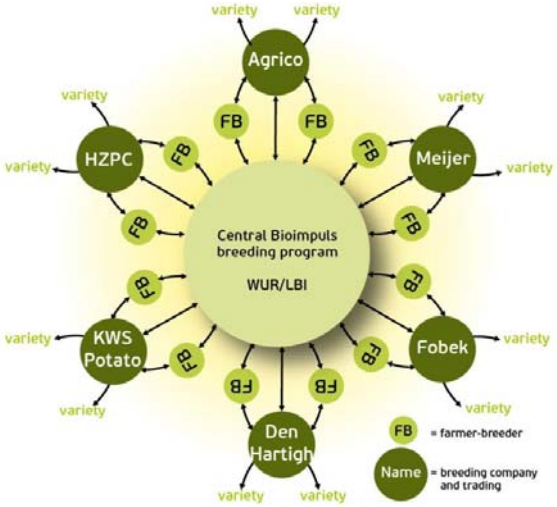
The degree of overlap between conventional and organic suited cultivars depends on:

- Breeding goals & philosophy, Selection environment
- applied breeding techniques



Decentralized Participatory Plant Breeding





Involvement of whole value chain to support organic plant breeding

Green Cotton Project (2013-2021): Participatory cotton breeding in India
www.greencotton.org

Bioimpuls Programme 2009-2013: Perspectives on Phytophthora-resistant potato varieties, *Lammerts van Bueren et. al. 2013 Broshure*

Criteria for Organic Plant Breeding

Ethical issues

Genom is respected as indivisible entity, no technical/physical intervention (e.g. isolated DNA)

Cell is respected as indivisible functional entity, no technical/physical intervention (e.g. cell fusion)

Maintain reproducibility in species specific manner

No legal or technical barriers to restrict breeders' right

Natural crossing barriers are respected

Promotion of open pollinated varieties as alternative to F1 hybrids to enable farm saved seed

Transparency

Position of the Organic Sector on the complience of New Breeding Techniques (NBT)

Position Paper of ECO-PB on Organic Plant Breeding 2013:

- Organic plant breeders in Europe will refrain from any breeding technique that technically interfers below the cell level
- www.eco-pb.org/fileadmin/ecopb/documents/ecopb_PostitionPaperOrganicPlantBreeding.pdf

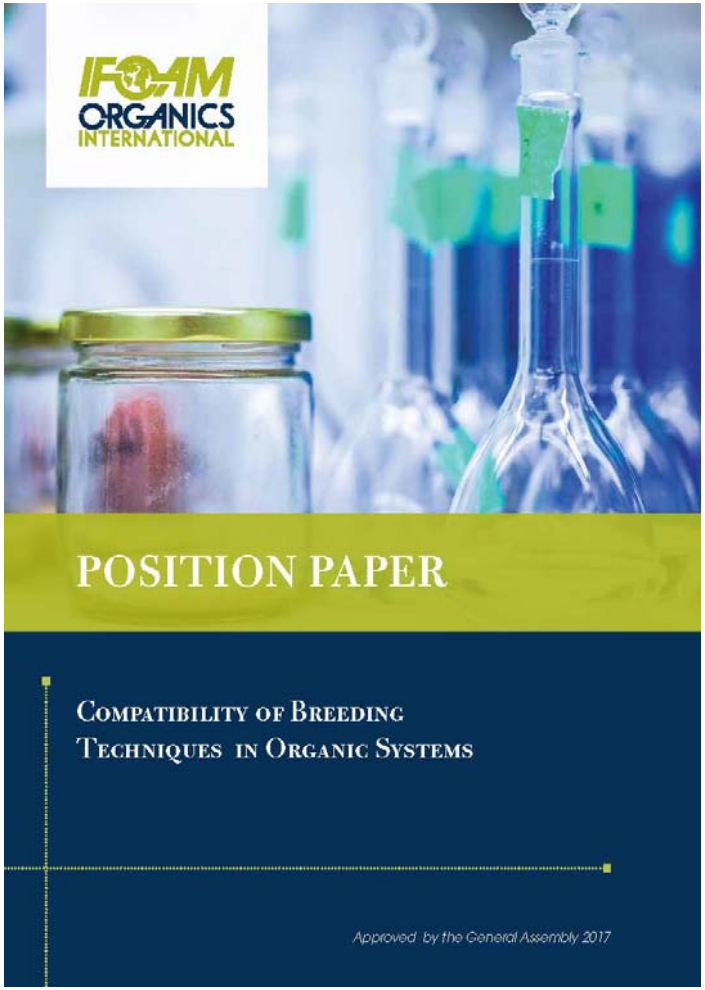
IFOAM EU Position Paper on New Plant Breeding Techniques 2015:

- NBT are not compatible with organic farming
- Should be declared as GMO according to EU regulation and labelled accordingly
- http://www.ifoam-eu.org/fr/file/position-paper-new-plant-breeding-techniques

IFOAM International: Position Paper on New Breeding Techniques 2017

- Draft February 2017, consultation and final approval on General Assembly of IFOAM in November 2017
- Transparency & traceability to allow freedom of choice for farmers & consumers

Outcome: Compatibility of Breeding Techniques in Organic Systems



Clarity & Transparency on the Criteria Used to determine what breeding techniques are compatible with Organic Farming Systems

Recommendations

- Clarity on new genetic engineering technologies
- GMO regulations need to protect organic integrity
- Genetic resources need to be protected, preserved, and maintained
- Breeding techniques need to be transparent
- Varieties and breeds acceptable to organic need to be identified

Recommendations (cont'd)

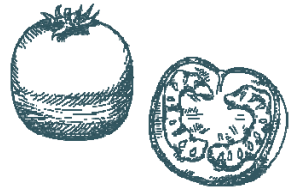
- Greater public resources are needed for research & development of breeding techniques acceptable for organic production
- Intellectual property rights need to be fair to all
  - No patents should be granted for genetic resources
  - Participatory breeding should involve and reward all stakeholders
- Polluter Pays Principle for GMO contamination of seed
- Responsibility for Diversity and Rural Livelihood

European Projects to promote new Breeding Concepts

- FP7 Solibam: Strategies for Organic and Low-input Integrated Breeding and Management www.solibam.eu 2010-2014
- Core organic COBRA: Coordinating organic plant breeding activities for diversity www.cobra-div.eu 2013-2016
- Horizon 2020 DIVERSIFOOD: Embedding crop diversity and networking for local high quality food systems, www.diversifood.eu 2015-2019
- Horizon 2020 LIVESEED : Improve performance of organic agriculture by boosting organic seed and plant breeding efforts across Europe 2017-2021
- Horizon 2020 ReMIX: Redesigning European cropping systems based on species MIXtures 2017-2021
- New Horizon 2020 BRESOV organic vegetable breeding 2018-2022
- New Horizon 2020 ECOBREED organic cereal breeding 2018-2022
- New Horizon 2020 call Innovation in Variety Testing

LIVESEED

Boosting organic seed and plant breeding across Europe
2017 - 2021



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LIVESEED in a nutshell

- Budget: 7.4 M EUR EU funding & 1.5 M EUR Swiss funding
- Duration: 4 years
- Coordinator: IFOAM EU
- Scientific coordinator: FiBL (Switzerland)
- Goal: **Boosting organic seed and plant breeding in order to improve the performance, sustainability and competititveness of the organic sector**
- Approach:
  - Inter- and transdisciplinary
  - Policy – economy – science interface
  - Multi-actor & stakeholder involvement
  - Wide geographic representation

LIVESEED

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Working together

49 partners
18 countries

23 breeding & research institutes
7 breeding companies
8 seed companies
11 organic associations

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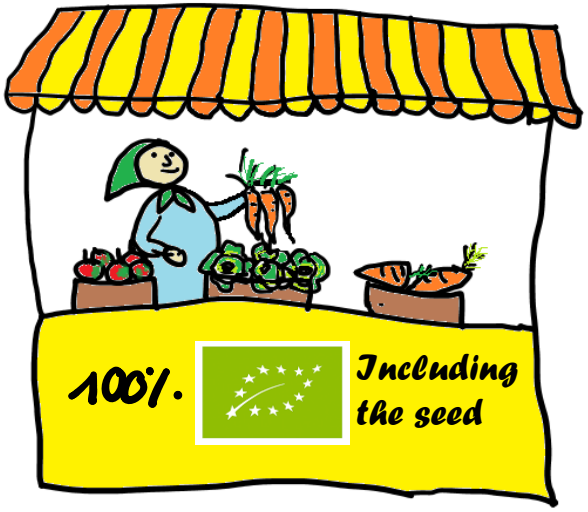
Aim: 100% organic seed of adapted cultivars



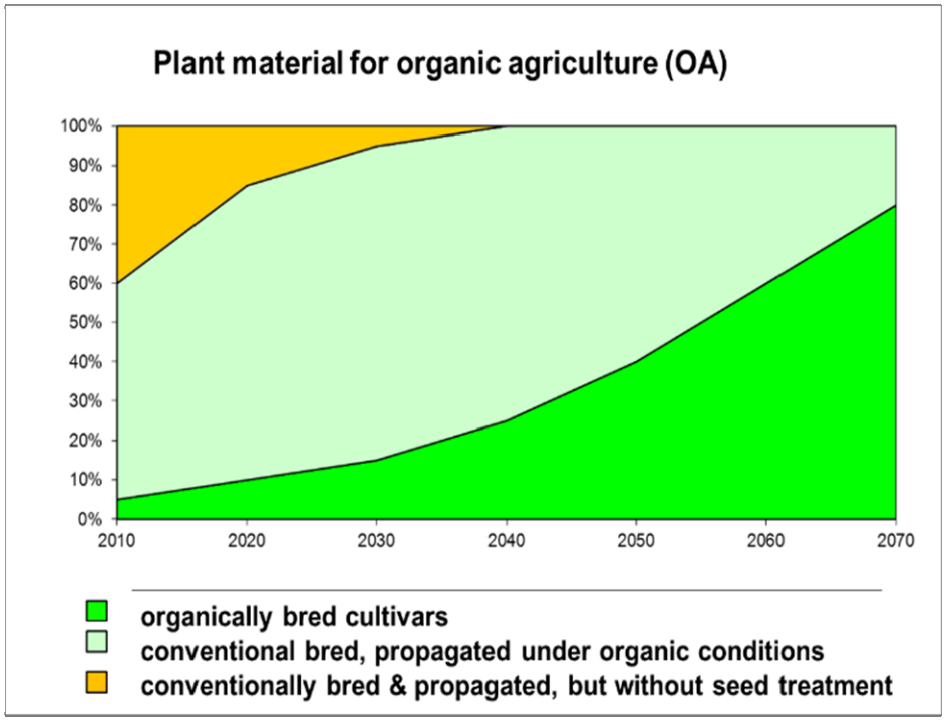


Figure 1 : Schematic time line to reach the goal of 100% organically propagated seed of suitable cultivars (light green) in short term and to foster cultivars specifically bred for organic farming systems (bright green) in the long term

LIVESEED

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Main objectives

Policy & regulation

Provide a level playing field for the use of organic seed and variety registration across Europe

Research & development

Develope innovative approaches in organic plant breeding and improve quality of organic seeds

Socio-economics

Increase access to organic seed and promote use of adapted cultivars

Economy & market

Improve the competitiveness of the organic seed supply chain

Communication & network

Enhance knowledge exchange & rise awareness on the benefits of organic seed and plant breeding

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Crop categories

Research activities of LIVESEED will cover five main crop categories:

- Legumes (lupin, pea)
- Vegetables (carrot, tomato, broccoli, cauliflower)
- Fruit trees (apple)
- Cereals (wheat, barley, maize)
- Fodder crops (lucerne, grasses)

→ considering different farming systems (mixed cropping, agroforestry) pedoclimatic zones across Europe

LIVESEED

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What LIVESEED will do:

- Foster **harmonised implementation of the EU organic regulation** on organic seed. Strengthen organic seed databases in the whole EU.
- **Widen the choice of organic cultivars** meeting the demand of farmers, processors, retailers and consumers
- Develop **innovative breeding and seed health strategies**
- Investigate socio-economic aspects related to **production and use of organic seed**
- Improve availability and quality of organic seed. Develop **guidelines for organic cultivar testing and registration**

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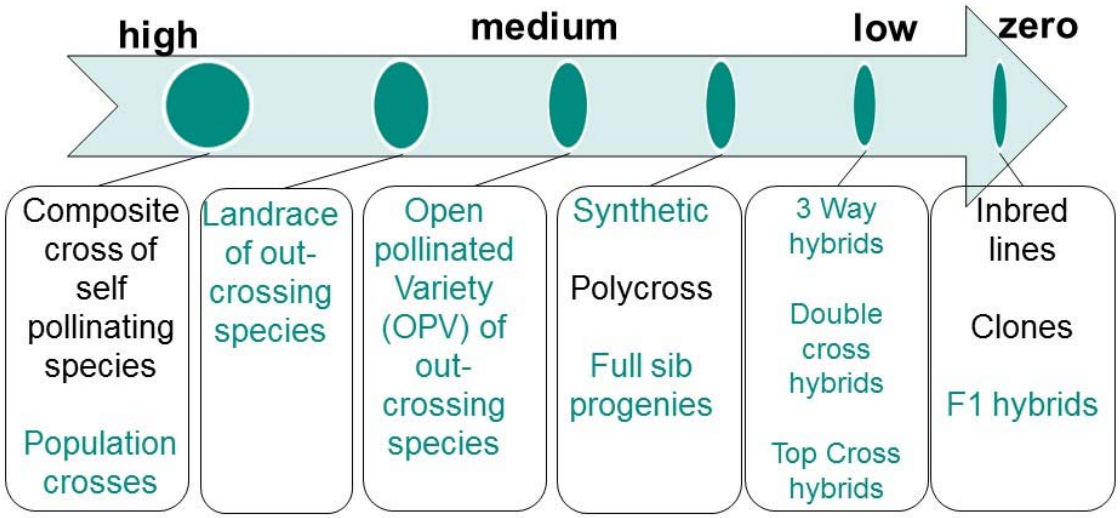
Heterogeneous material

It is important for the organic sector to have a wide range of species & cultivar types that are adapted to different growing conditions and match the demand of different market chains:

- Homogeneous inbred lines
- Homogeneous F1 hybrids
- Open pollinated populations (e.g. population varieties of outcrossing species)
- Heterogeneous material (e.g. composite cross populations of inbreeding species)

Genetic diversity within cultivar for different cultivar types



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Thanks a lot for your attention