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Biggest challenges and research gaps for organic plant breeding in the Global South

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Science Day: Technology Innovation Platform of IFOAM – Organics International (TIPI)

Biofach Messe Nürnberg, 16.2.2018

TIPI: Common Goals to be achieved

- Empower rural areas
- Provide eco-functional intensification that produces food, while harnessing and re-generating eco-system services as well as strengthening resilience to climate change
- Provide food for the health and well-being available to all

- **Plant breeding is key to achieve these goals** but it need to be developed together with improved soil and crop management adjusted to local conditions and demands
- Plant breeding and new technologies like robotics will allow more diverse farming systems optimizing ecosystem services and higher self regulating capacity
- Decentralized participatory breeding approaches strengthens autonomy and self estime of local farmers

How can Organic Plant Breeding contribute

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

Strategies for Organic Plant Breeding

Combining breeding & agronomic innovations for Organic

Breeding for increased diversity

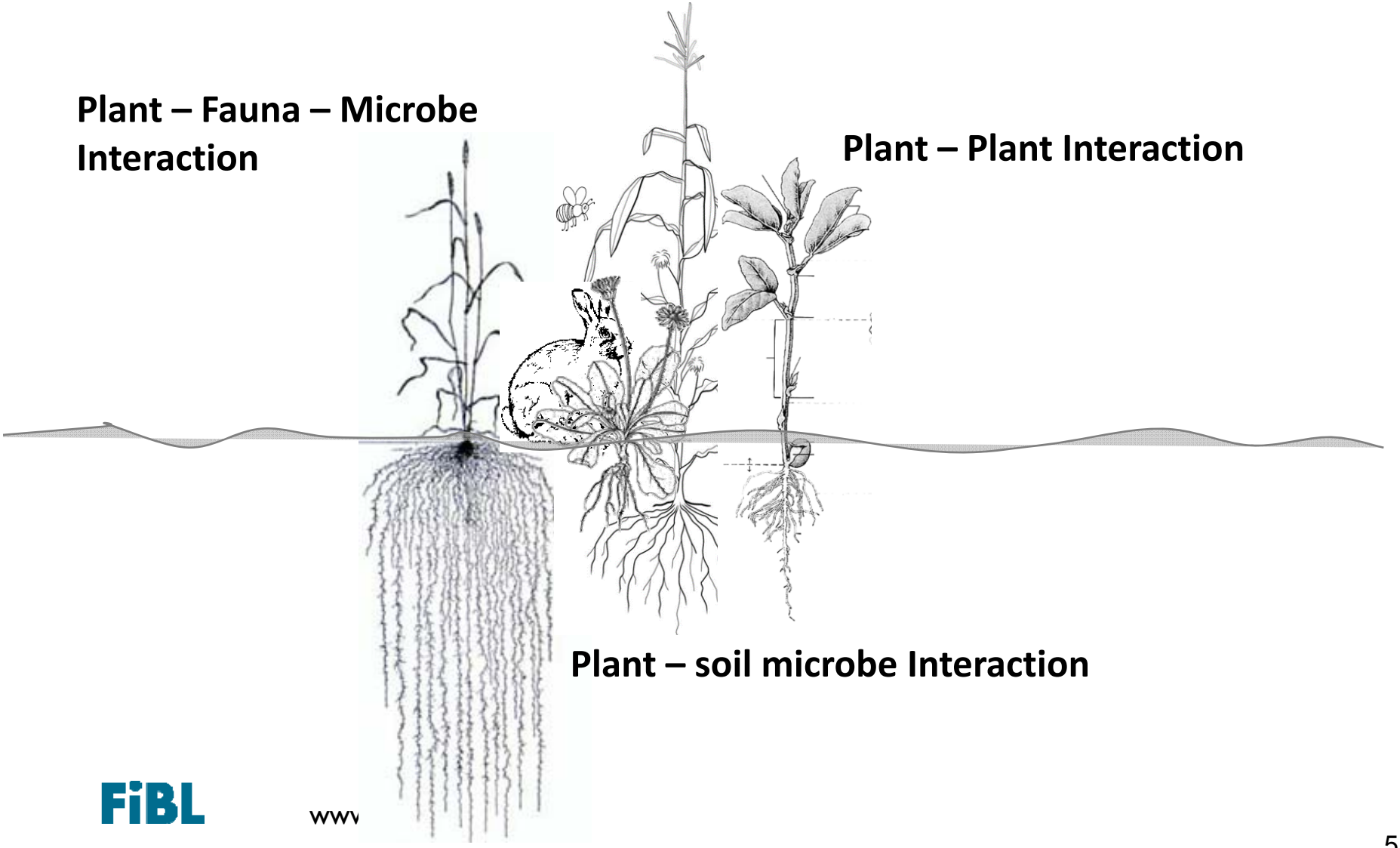
- Breeding for diversity within cultivars
- Breeding for mixed cropping systems
- Breeding for improve diversity of associated soil microbes
- Decentralized participatory breeding for local conditions

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 mixed cropping systems to improve resilience of the system towards climate change

Plant – Fauna – Microbe Interaction



Plant – Plant Interaction

Plant – soil microbe Interaction

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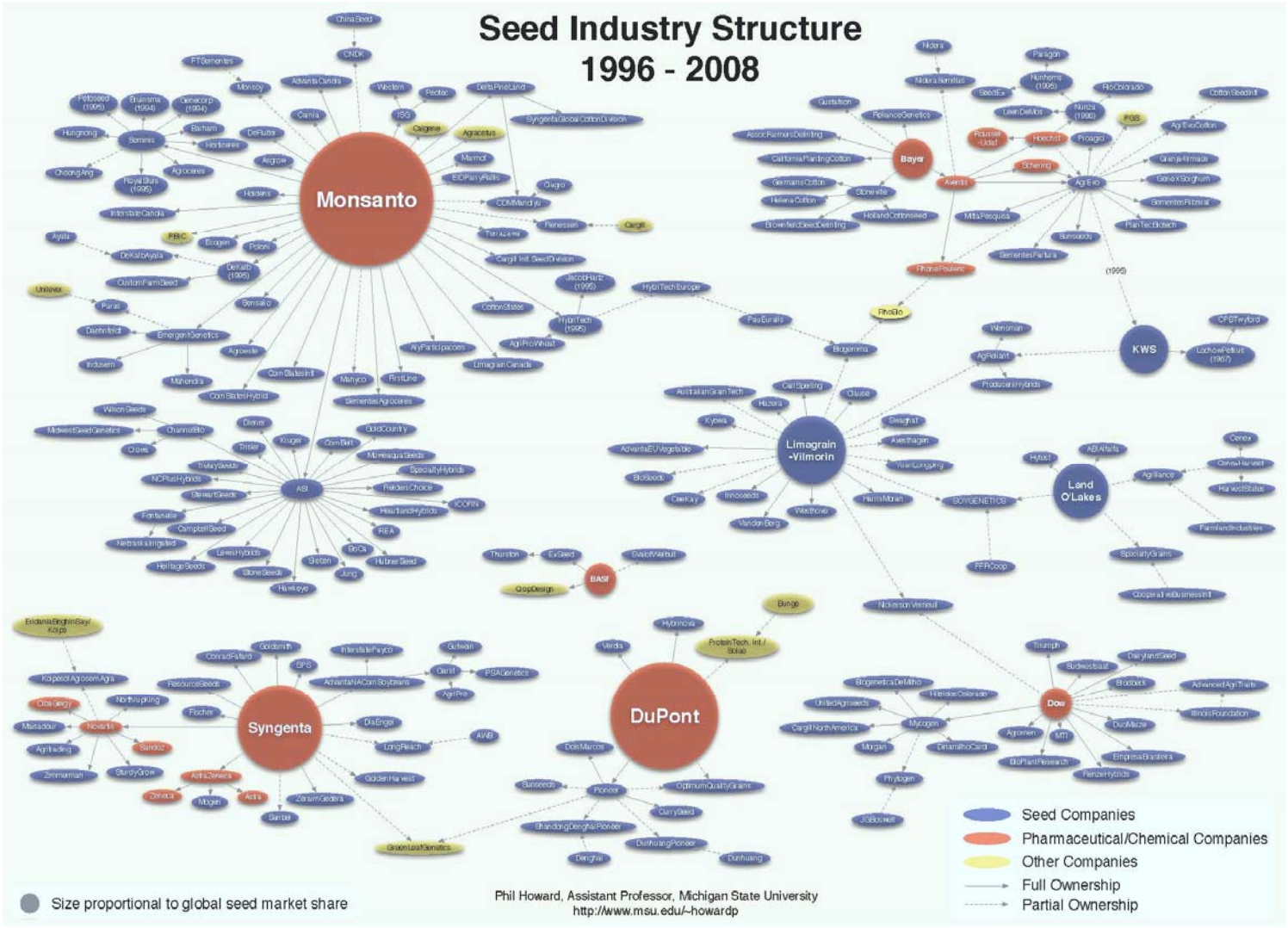
Main Challenges to obtain high quality seed of cultivars adapted to organic agriculture

- 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
- Organic breeding initiatives are not well connected with each others and conventional breeders
- Missing funding for oganic plant breeding and research as focus is on molecular breeding
- Participatory breeding approaches need to be installed involving the farmers, regional communities and value chain
- Capacity building and empowerment of female farmers
- Improve self estime of farmers to be proud to be the person who is feeding the society to prevent brain drain to cities

Main Challenges with respect to access to seeds

- **Concentration on the seed market**
  - Only 10 international companies control more than 60% of the commercial seed market
  - High influencial power on seed regulation, UPOV regulation
  - Breeding is done for main crops that give good return of investment
  - Cultivars bred for broad adaptation and mainstream agriculture (one key fits all)
  - Overdominance of F1 hybrids to prevent farm saved seeds

Concentration on global seed market



Howard, 2009, Visualizing Consolidation in the Global Seed Industry: 1996–2008 Sustainability

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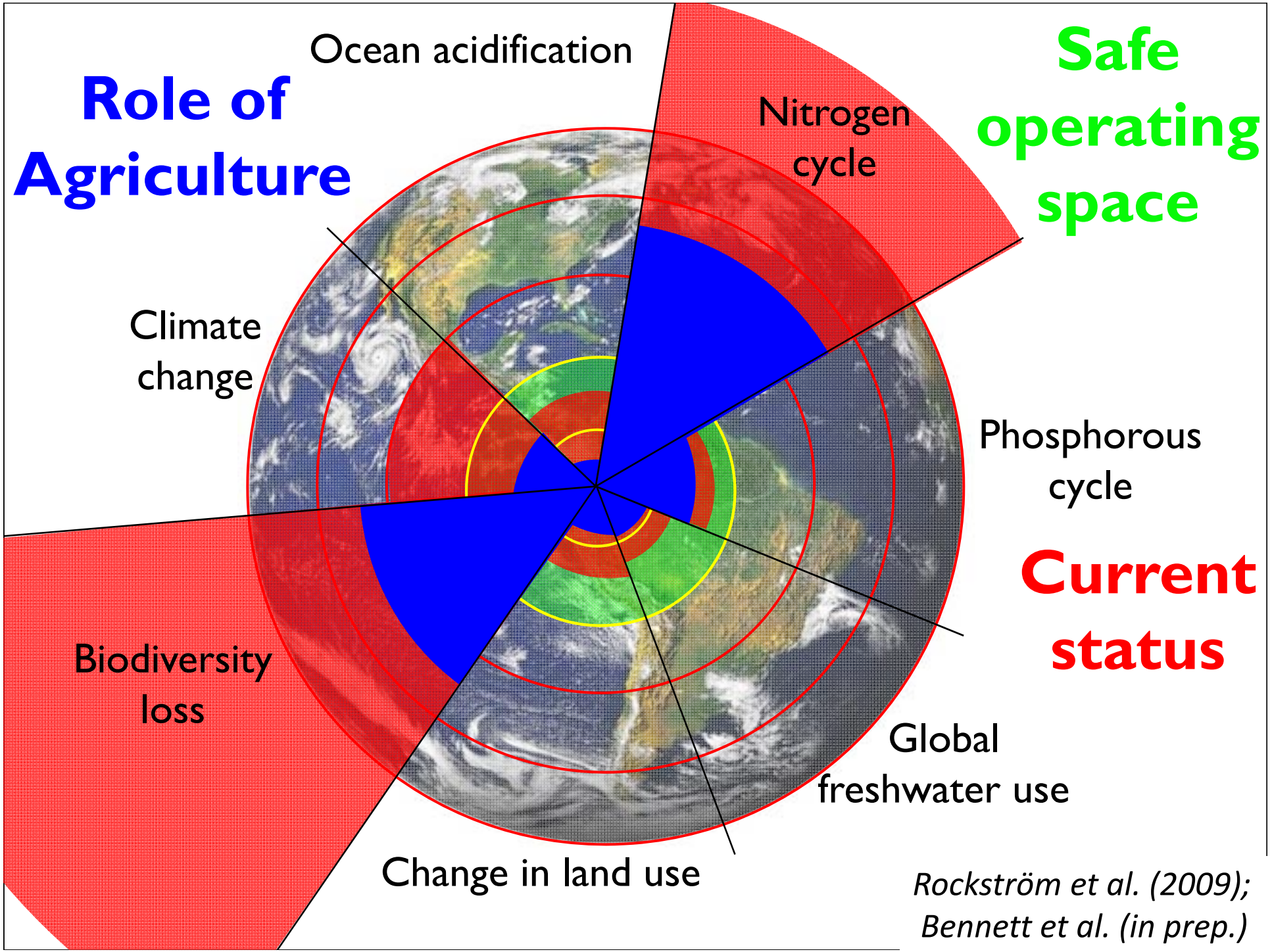

Role of Agriculture
Ocean acidification
Nitrogen cycle
Safe operating space
Climate change
Phosphorous cycle
Current status
Biodiversity loss
Global freshwater use
Change in land use
Rockström et al. (2009);
Bennett et al. (in prep.)

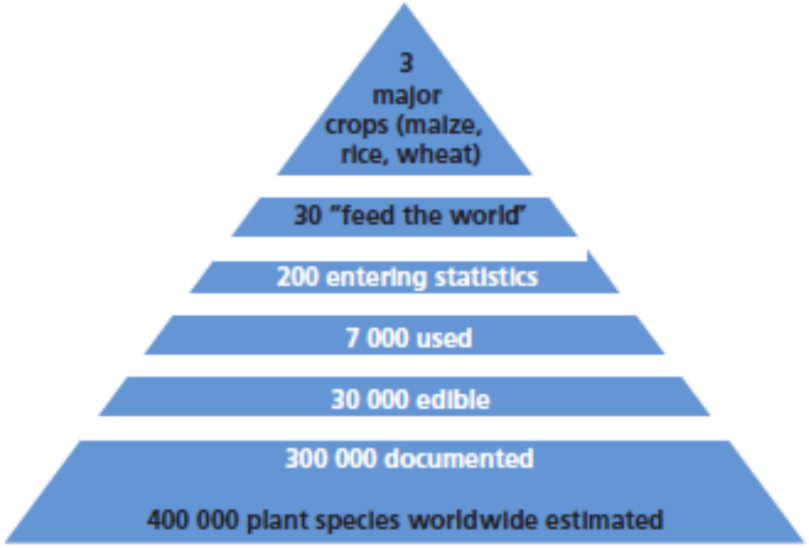
Main Challenges with respect to access to organic seed of adapted cultivars

- **Loss of genetic resources**
  - Many genetic resources get lost as landraces and farmers get replaced by modern F1 hybrids
  - Public institutes withdraw more and more from breeding, seed multiplication, and gene bank collections
  - No systematic collection of farmers landraces and populations with local adaptation
    - If collected farmers are hesitant to provide seed, as they are afraid that it might be patented or someone else is commercialize it without benefit sharing with farmers
  - Small number of accessions are maintained in seed banks for in situ maintenance
  - Lack of secure storage facilities to safe seed (risk to loose a seed during storms, post havest losses (animals, insects, disease) and damage by moisture, heat)

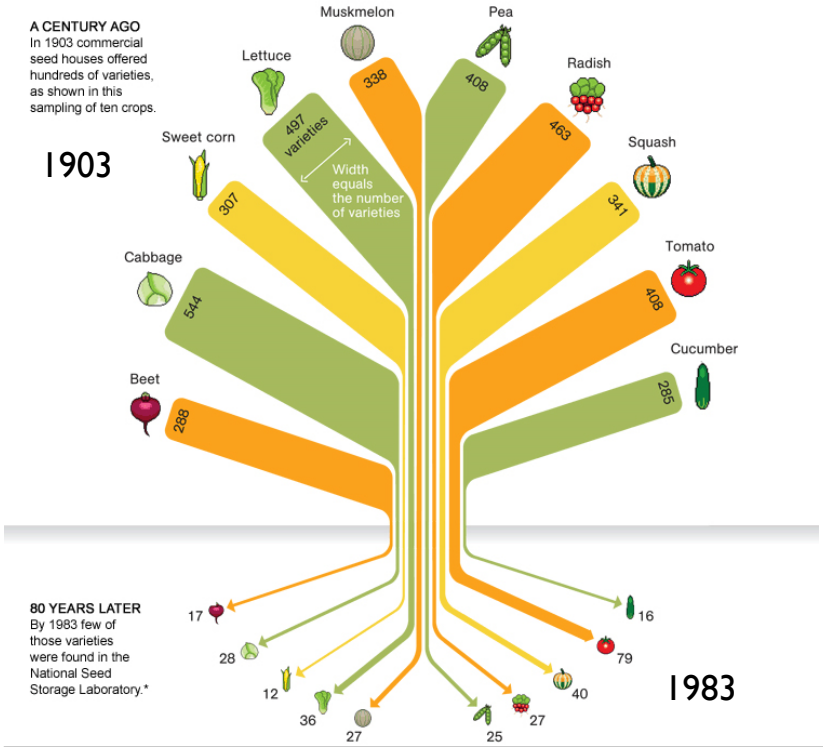
Reduced number of crops and cultivar per crops

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

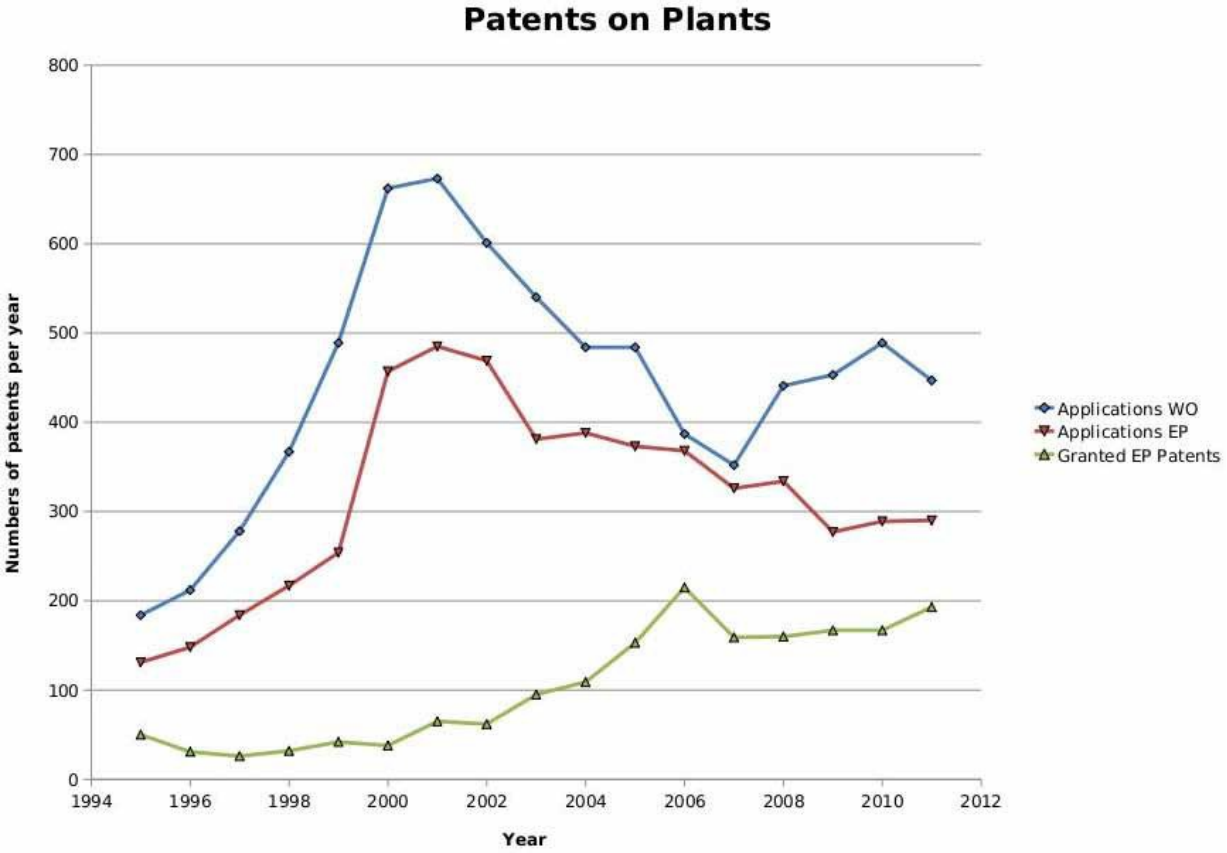
Main Challenges with respect to access to organic seed of adapted cultivars

- **Legal restrictions as seed buisness is highly regulated**
  - Nagoya protocol:
    - genetic resources belong to the state, they need to provide permission to collect genetic resources (prior informed permission)
  - International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA) and Standard material transfer agreement (SMTA)
    - Multilateral systems, genetic resources entered there are available to all who participate
    - 1.1% of sales of products need to be paid in FAO fonds

Main Challenges with respect to access to organic seed of adapted cultivars

- **Legal restrictions as seed buisness is highly regulated**
  - International Union for the Protection of New Varieties of Plants (UPOV)
    - UPOV 1978: breeders privilege and farmers rights for farm saved seed
    - Enforcement of UPOV 1991: breeder privilege, restricted farmers rights, only released varieties can be commercialized
  - Patents on plant species, cultivars, traits, genes, breeding procedures
    - National variety testing
    - New, distinct, uniform, stable (DUS test)
    - Value for cultivation and Use (VCU) tested under high input farming conditions
  - National seed law

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

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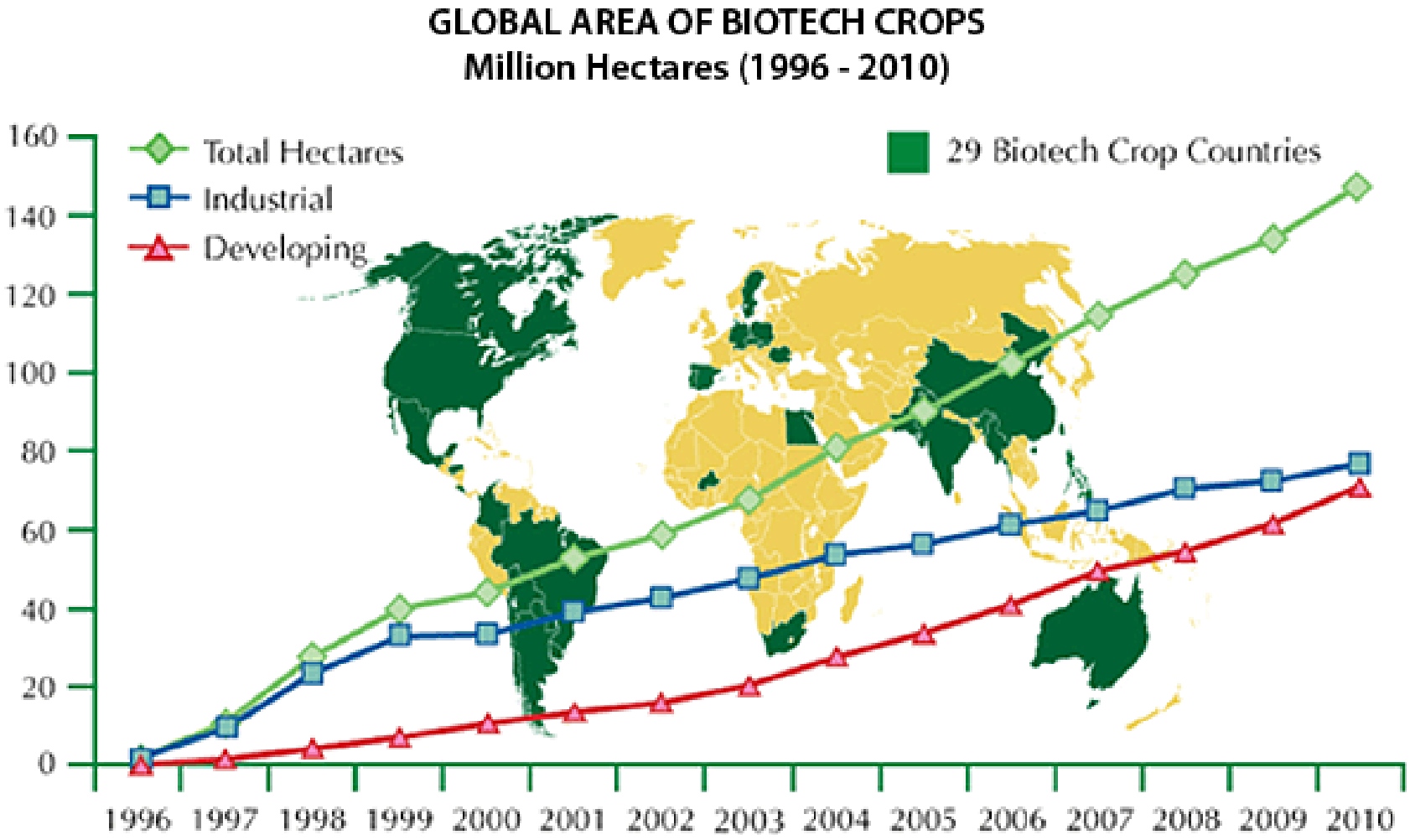
Who will control the *Green Economy?*
www.etcgroup.org

Increase of GM varieties



Source: James Clive 2011, ISAAA

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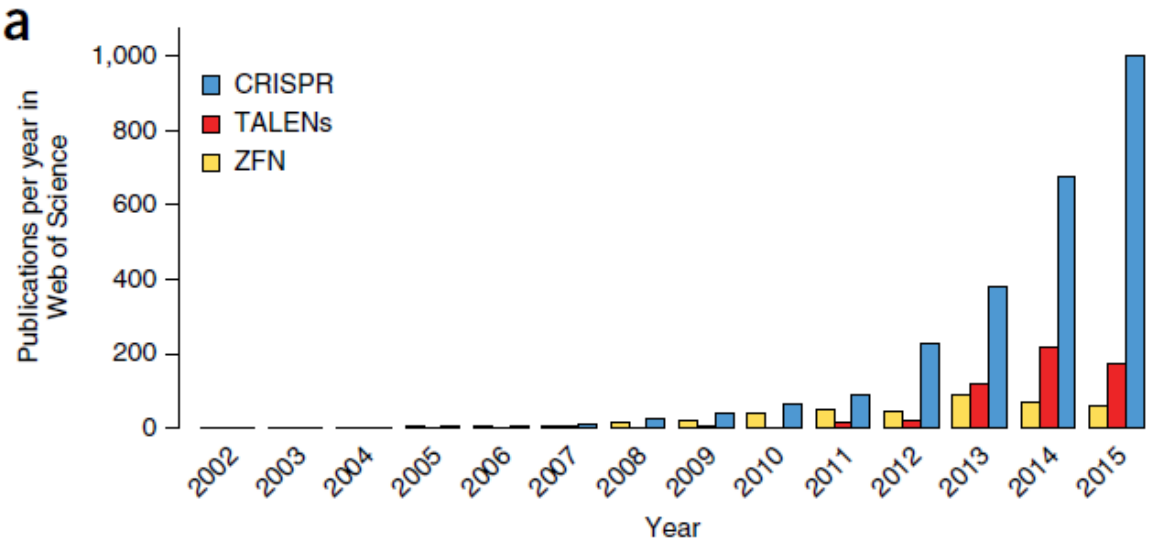
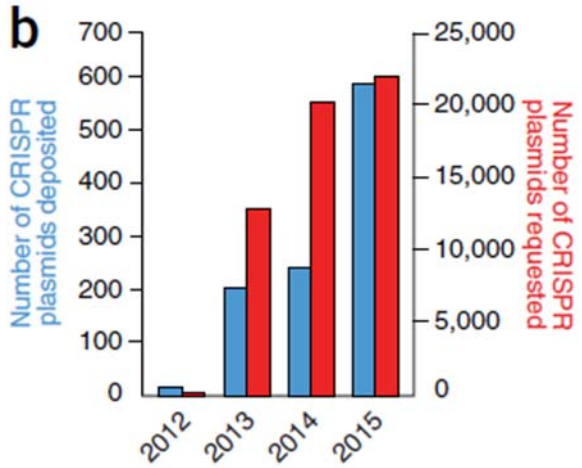
CRISPR-Cas9 Development



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

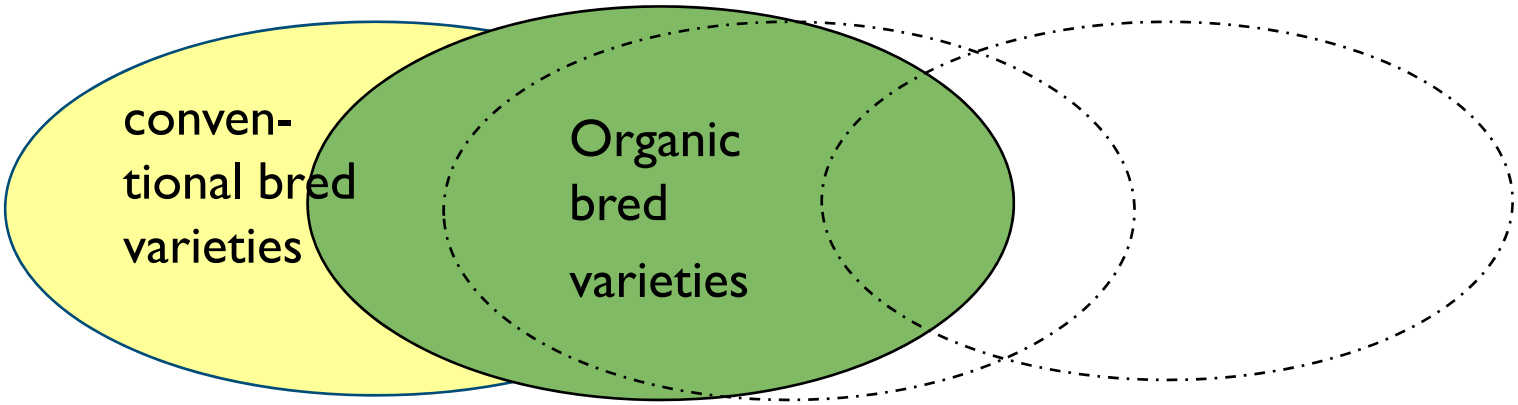
Main Challenges with respect to access to organic seed of adapted cultivars

- **Fast spread of cultivars derived from breeding technologies not accepted by IFOAM International**
  - Discussion about these techniques binds many resources
  - Common position on GMO and new genetic engineering techniques
    - But is this position also supported by the organic farmers in different regions, do they know about it? Who informs them?
    - Cell fusion are banned by IFOAM in 2008 but 10 years later only few label organisations in Europe have actually put this ban into force
  - GMO crops take over seed market (e.g. Bt-cotton, RR-soybean, Bt-maize, …), non GM crops disappear from the local markets
  - Contamination of seed
  - No strategy to main genetic germplasm GMO free

Drift between conventional and organic plant breeding

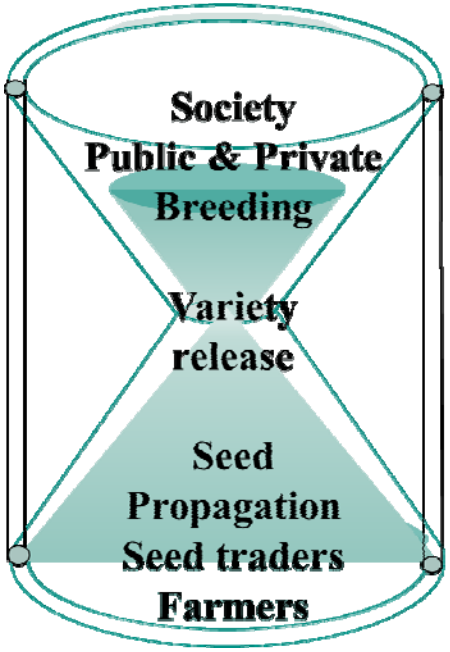
The degree of overlap between conventional and organic suited cultivars depends on:

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



Participatory Cultivar Evaluation and Participatory Breeding as a viable Alternative to Seed Monopoly

Formal plant breeding and seed supply



One Way Information:
Scientist

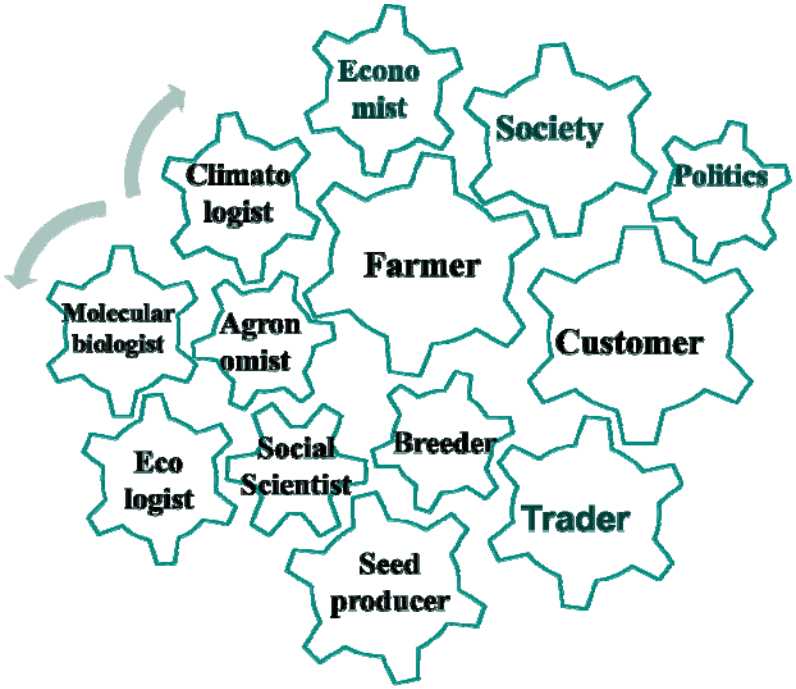
↓

Extension Service

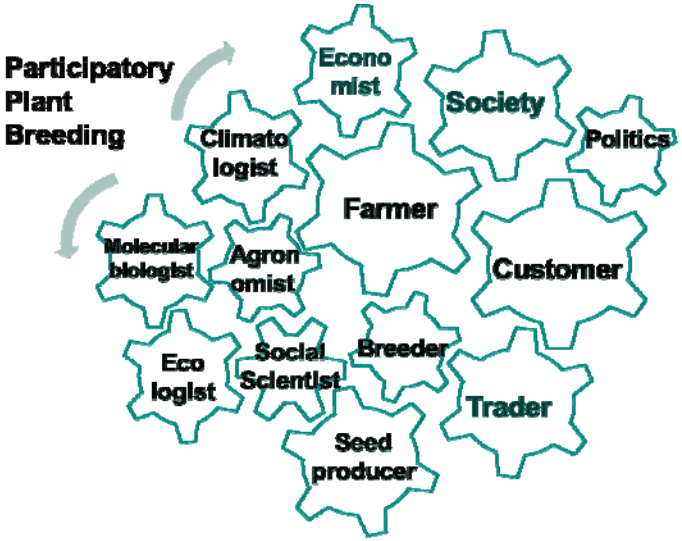
↓

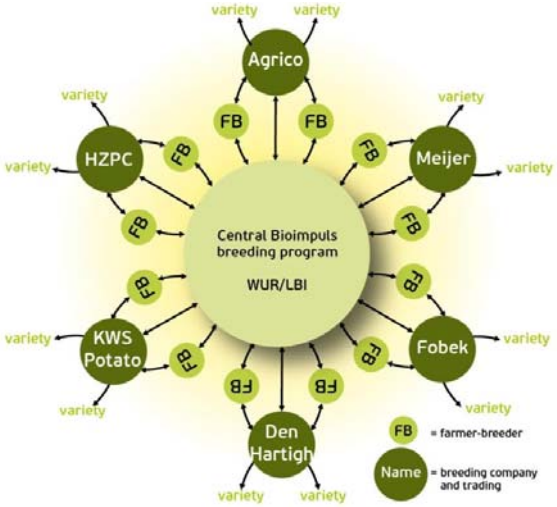
Farmer

Participatory plant breeding and seed multiplication



Decentralized Participatory Plant Breeding





Needs strong facilitator to steer collaboration process, identify common goals and conflict of interest, translate between different actors, keeping collaboration and exchange moving

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*

Capacity buiding

Networking to achieve higher impact and visibility

European Consortium for Organic Plant Breeding ECO-PB

Bioverita: labal for valorization of organic plant breeding organized organic breeding exhibition: Organic right from the start

Organic Farmers Seed Alliance in US

Bharat Beej Swaraj Manch in India

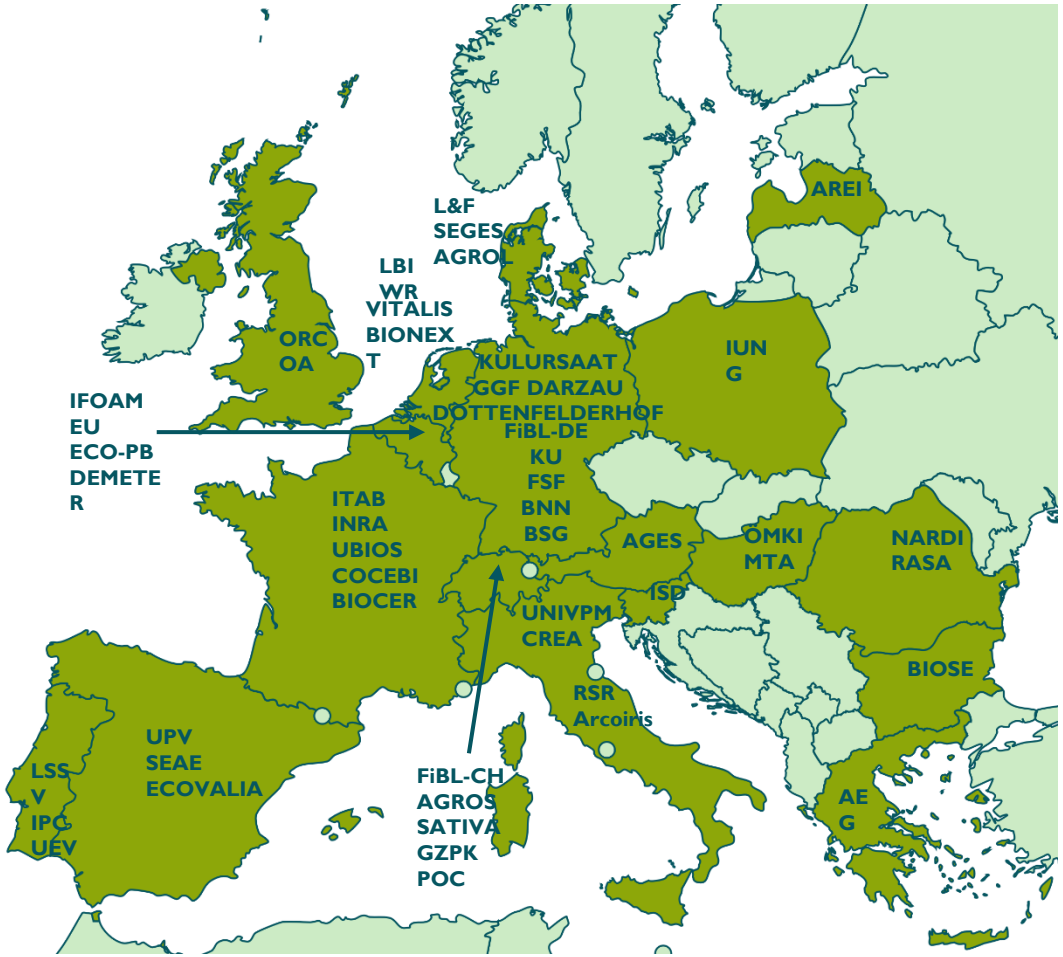
…

founded as a result of last Pre-conference on Organic Seed in Istanbul in 2014 to move forward on the issue of seed and plant breeding in Organic Agriculture

- Support IFOAM World Board on all topics related to seed and plant breeding
- Connecting different seed and breeding initiatives
- Start global discussion on relevant topics
- Join forces for lobbying
- Integrate seed topics in IFOAM World Conferences
- Membership open for organisations (individuals) on all continents for good representation of the organic seed and plant breeding issues

IFOAM Seeds Platform <info@seeds.ifoam.bio>
https://www.ifoam.bio/pt/sector-platforms/ifoam-seeds-platform

Coordinated research for organic seed and plant breeding



LIVESEED

35 partners
14 linked parties
18 countries

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

FLIVESEEDrg

This project received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727230.

Impact of Climate Change on Plant Genetic resources

Shift the distribution of land suitable for crop production.

Substantial falls in the yields of key crops in a number of food-insecure regions.

Impact on ability of many wild relatives of crops to survive in their current locations.

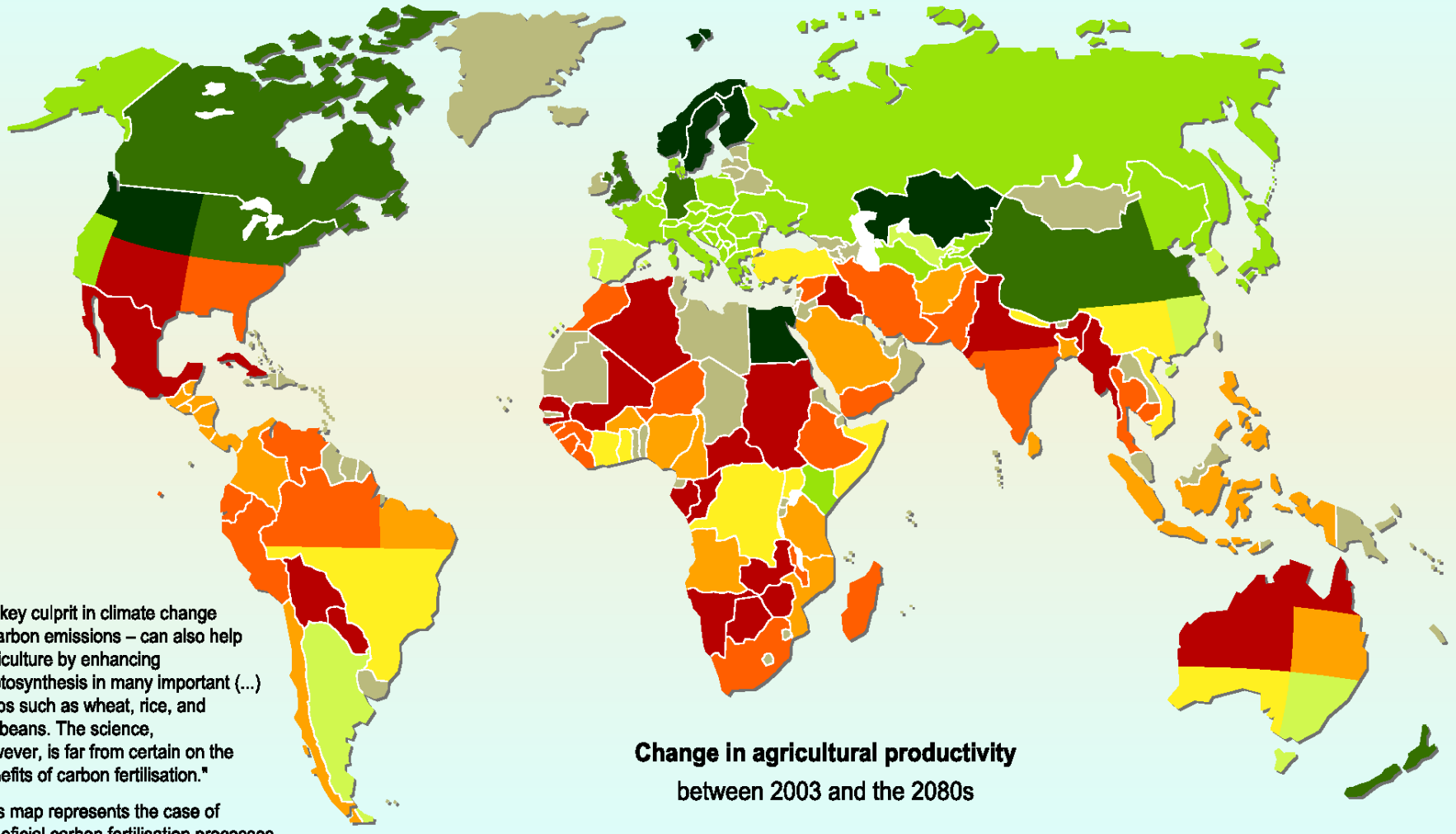
Shifts to new crops species may become necessary.

Plant diseases and pests are influenced by climate change.

Relevant eco-systems services will be affected: pollination, biological control, nutrient cycling.

Magnitude and speed of climate change may surpass the capacity of tree populations to adapt.

Projected impact of climate change on agricultural yields



" A key culprit in climate change – carbon emissions – can also help agriculture by enhancing photosynthesis in many important (...) crops such as wheat, rice, and soybeans. The science, however, is far from certain on the benefits of carbon fertilisation."

This map represents the case of beneficial carbon fertilisation processes.

Source: Cline W., 2007, *Global Warming and Agriculture*.

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Urgent need to improve legal and political framework

New regulations needed that allow formal and informal seed sector to coexist

Establishment of new criteria for variety evaluation

Easier access to plant genetic resources

- Farmers acknowledged as breeders
- Momorandum of Understanding between partners, national and international institutions needed (access & benefit sharing)

Ownership of varieties derived from PPB

- Develop concept of „open source“ genetic resources

Political awareness for importance of access to seed and planting material

Institutionalisation and upscaling of PPB

→ improves agrobiodiversity & local adaptation

Roadmap for organic seed of locally adapted cultivars

- Mobilise resources and finances!!!!
- Political lobbying for organic farming and the need for special cultivars
- Political awareness for improvement of legal regulations to improve access to seed and planting material
- Local capacity building and international networking
- Define priotities of crops and breeding goals for given region
- Identify local farmers and stakeholders to set up a seed and breeding network
- Identify enthusiatic facilitator !!

Thanks a lot for your attention

Come and visit us at the special exhibition on organic plant and animal breeding

ORGANIC RIGHT FROM THE START!

And meet several breeding initiatives and presentations on breeding

Messe Entrance: Mitte Foyer