“Making agriculture more sustainable: a climate and energy perspective”

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November 11, 2024 Institute for Advanced Study (IAS)

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- Modern Agriculture
- Fertilizers: energy consumption and climate change
- Microbiome
- Climate change and pests
- Crop-protection

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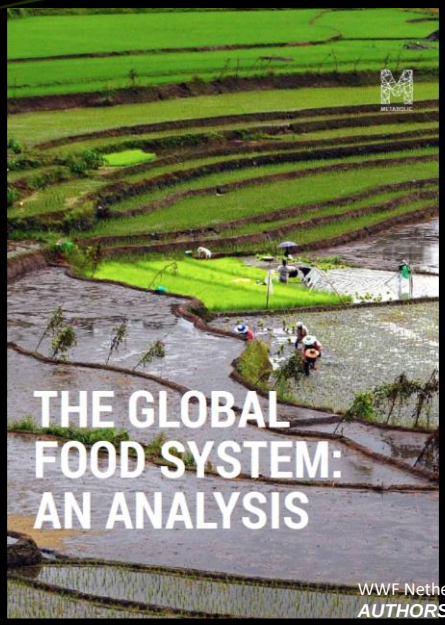

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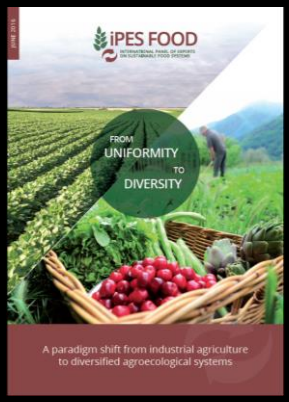

WWF Netherlands

AUTHORS: Eva Gladek, Matthew Fraser, Gerard Roemers, Oscar Sabag Munoz, Peter Hirsch, Erin Kennedy,

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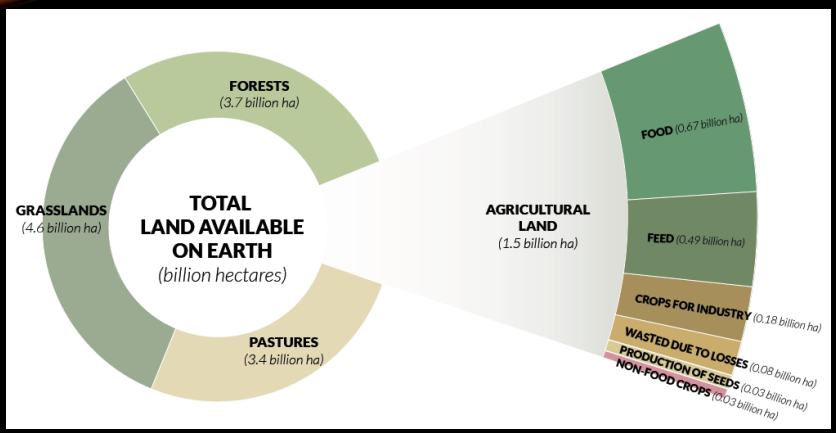
Earth:

Forest	3,7
Grassland	4,6
Meadows	3,4
Agriculture	1,5

Billion hectares



Agriculture

Food:	45 %
Feed:	33 %
Industrial:	16 %
Losses:	6 %

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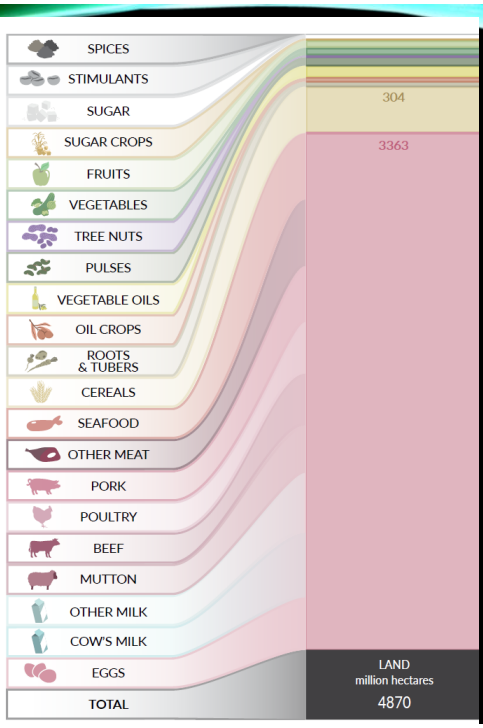
69% off all arable land is being used for the production of **meat, seafood, milk and eggs**



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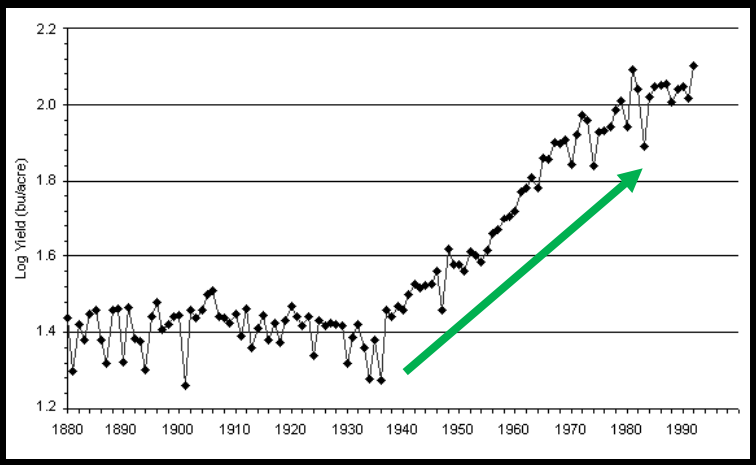
Green Revolution:

- Chemical fertilizer
- Crop protection
  - Herbicides
  - Pesticides
  - Fungicides
- Monocultures
- Mechanisation
- Plant Breeding

Yield Maize (USA) 1880-2000



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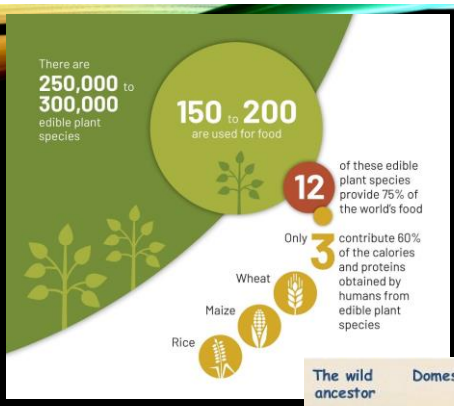
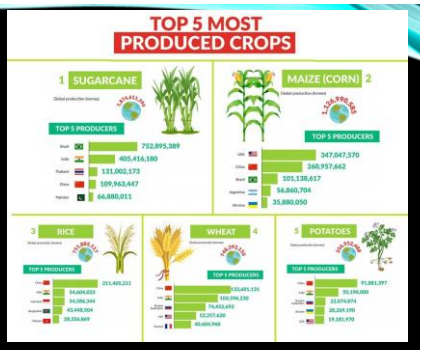
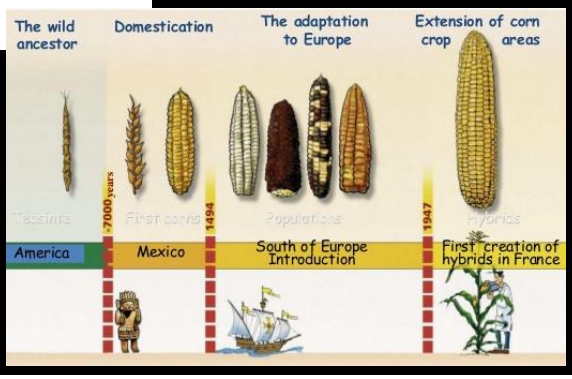
Green Revolution:

- Plant Breeding
- Domestication
- Adaptation
- **Commercial**







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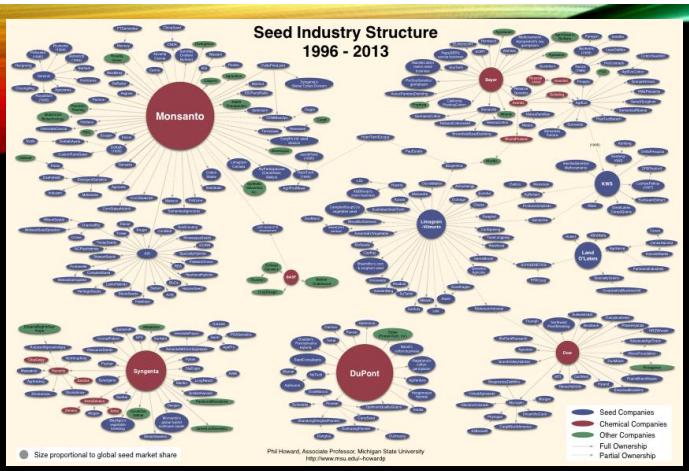

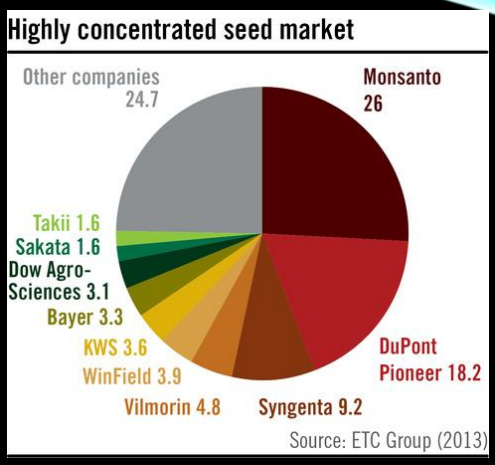

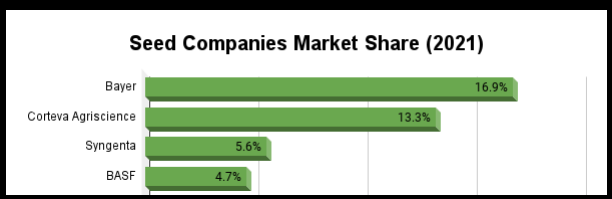

Chemical industry key player in seed market

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Effect of the Green Revolution:
Monocultures, mechanisation and large scale input of chemicals

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Green Revolution

Crop protection
(3,9 billion ton/yr)
27 % Orchards
27 % Cereals
9 % Vegetables
9 % Potatoes
9 % Rapeseed, Oilpalm
9 % Cotton
…..

Fertilizer
(200 billion ton/yr)
71% Cereals
15 % Feed
5 % Rapeseed, Oilpalm

Water-usage
69 % Agriculture

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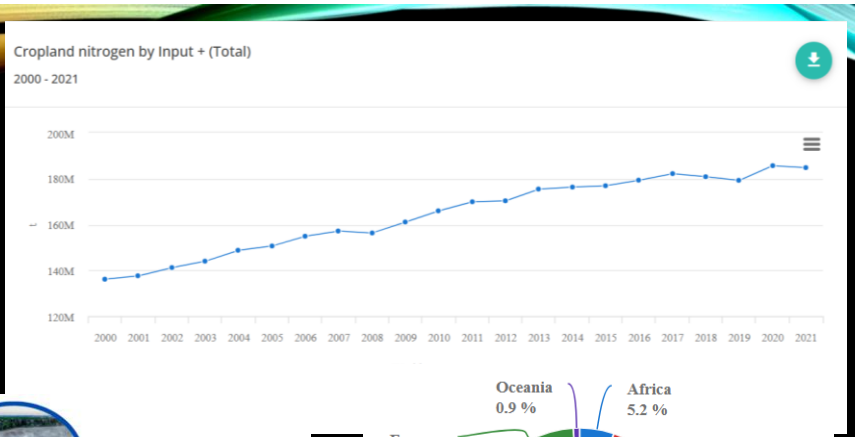
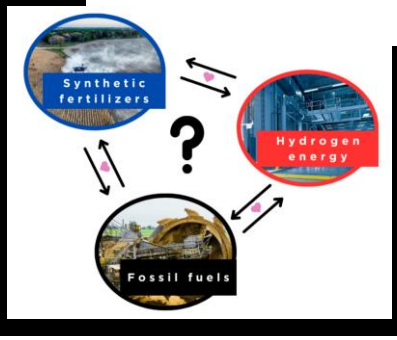
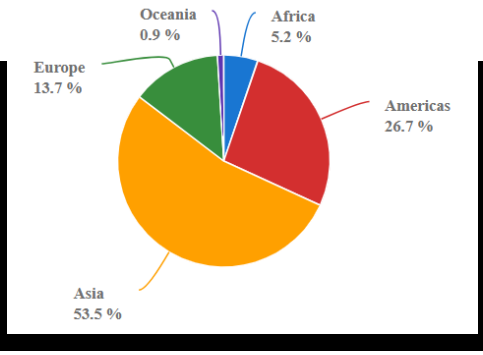
Chemical Fertilizer input increased by 28% over the past 20 years







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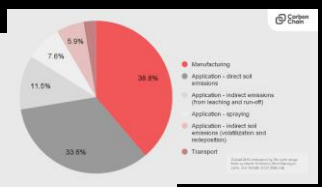
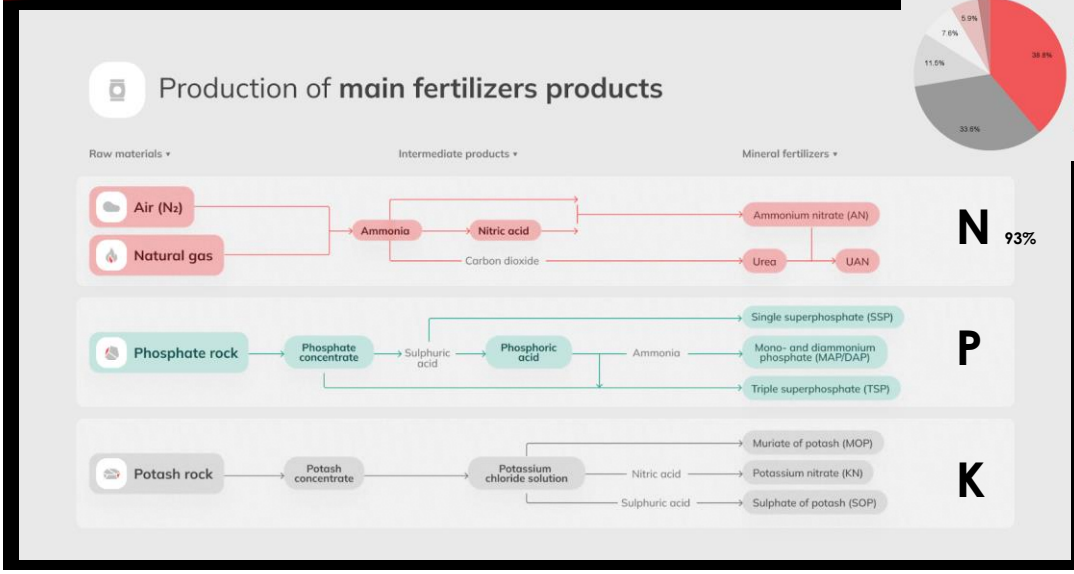
Fertilizer production consumes approximately **2% of the world's energy** and is responsible for approximately **1.8% of the total emission of the greenhouse gases** in the world





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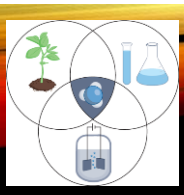
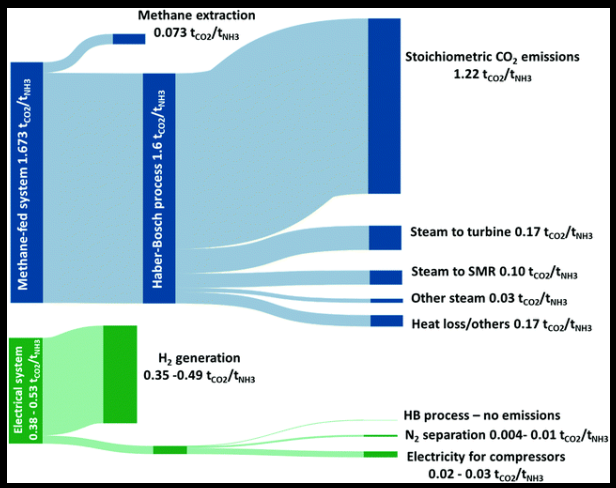
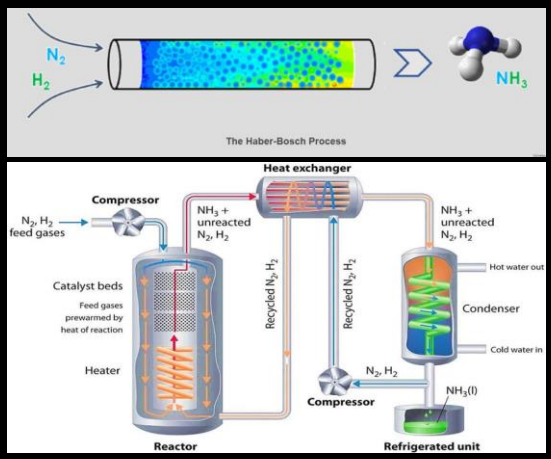


Fertilizer production:
Ammonia generated from N_2 and H_2 is **energy consuming**





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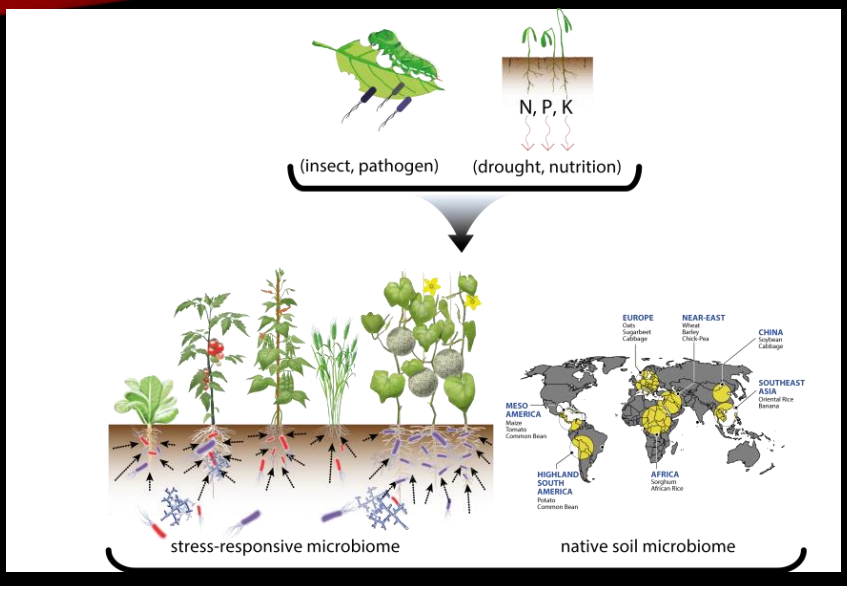
Soil microbiome:
Make nutrient acquisition by crops more efficient

MICROP
Harnessing the second genome of plants



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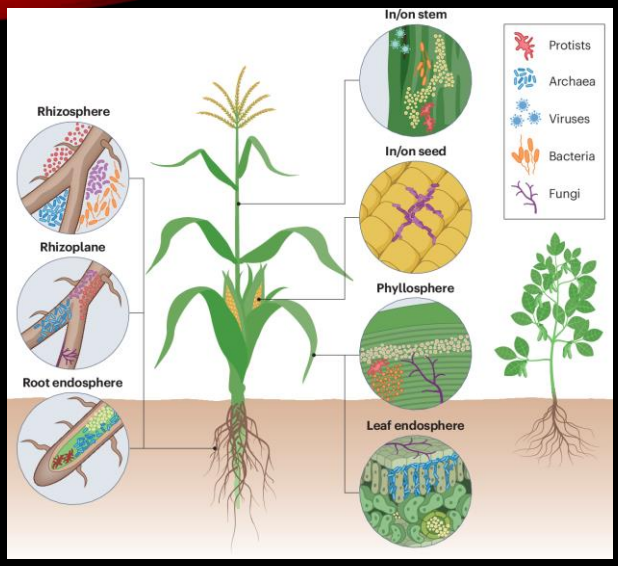


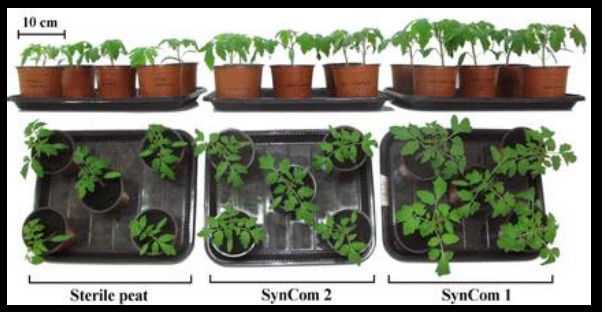
nature reviews microbiology

https://doi.org/10.1038/s41579-024-01079-1

Review article

Check for updates

Harnessing the plant microbiome for sustainable crop production



Microbial communities improve plant performance without extra fertilizers

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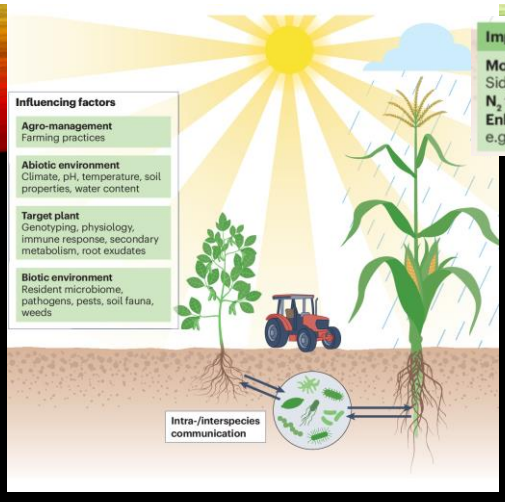
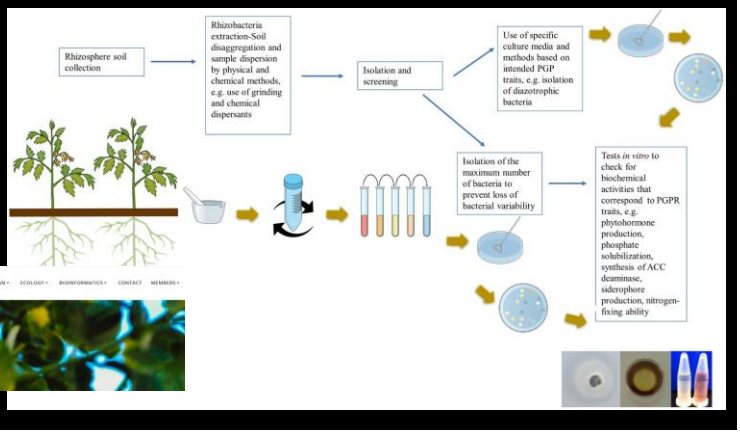
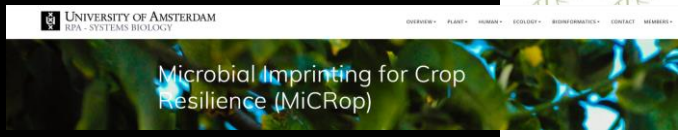


Improving plant nutrition

Mobilization
Siderophores, enzymatic activities, P, K, Fe, micronutrients
N_2 fixation
Enhanced uptake
e.g. through activation of plant transporters

Microbial processes to improve plant performance





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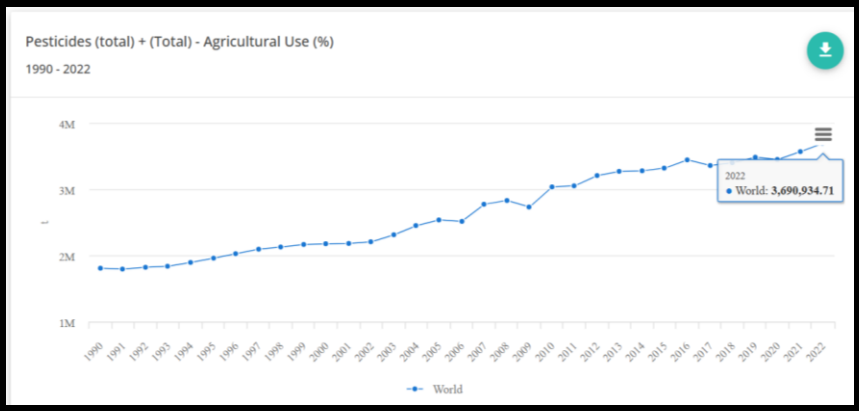
1990 till 2022
Increase use **pesticides**



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The effect of genetically modified soybean:
Roundup Ready

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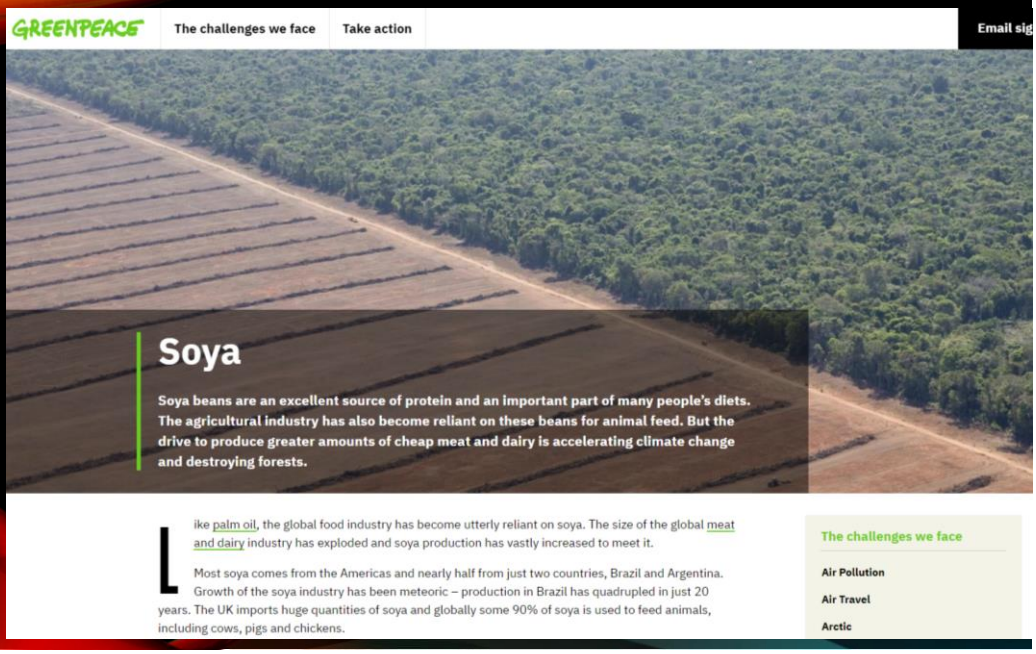
Industrial soybean cultivation in the Amazon area:

Climate change



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Tree cover loss 2001 - 2012

Tree cover loss 2001 - 2012

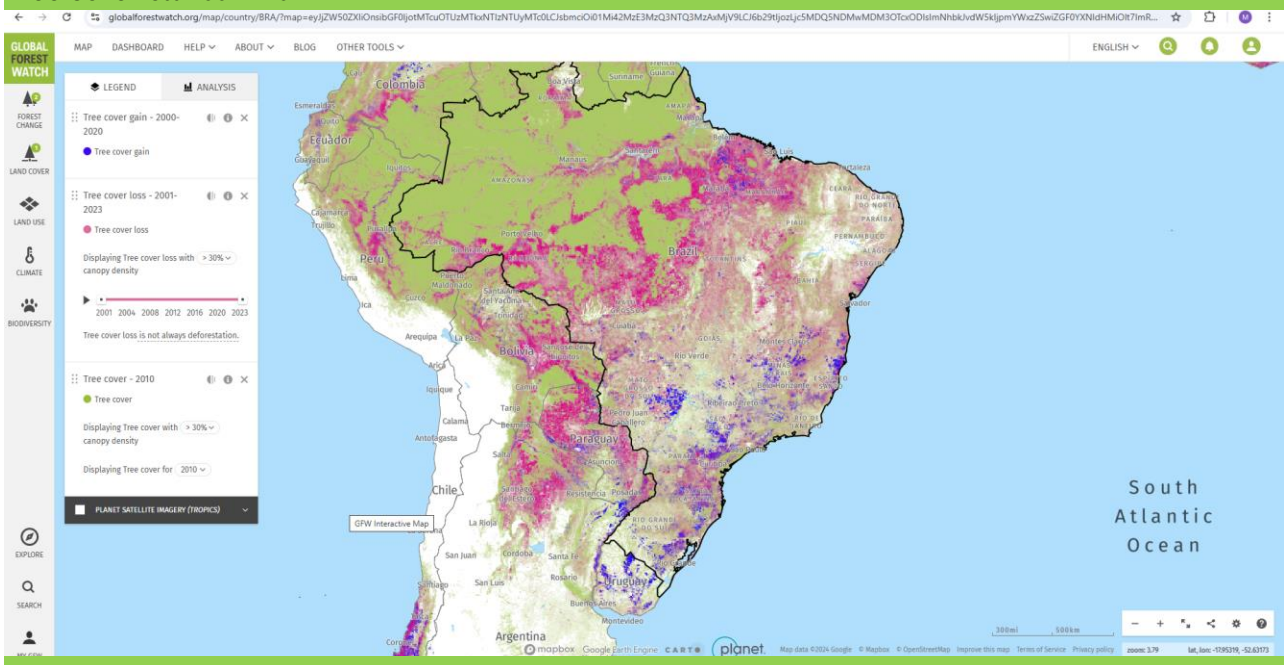
20

Tree cover loss 2012 - 2024

Tree cover loss 2012 - 2024

21

Tree cover loss 2001 - 2024



Tree cover loss 2001 - 2024

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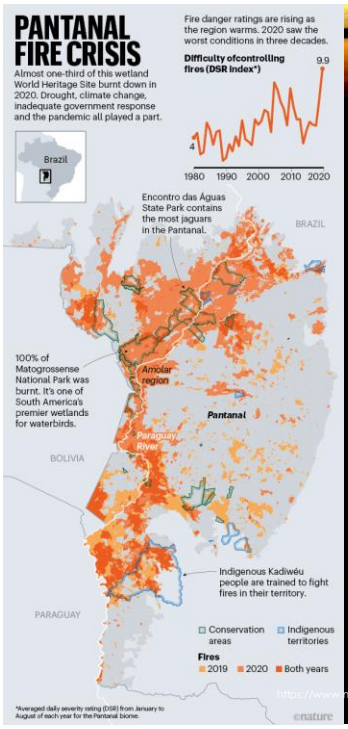

- Industrial soybean cultivation in the Amazon area:

Climate change

https://www.nature.com/articles/d41586-020-03464-1

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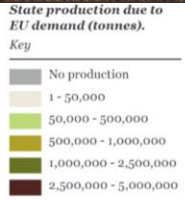
https://www.wnf.nl/custom/LPR_2016_fullreport/



Dramatic effect of Gentech Soy: deforestation and monocultures for animal industry of EU

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Climate change allows pest to colonize new niches in agriculture, forestry and ecosystems

Spodoptera frugiperda, fall armyworm (Lepidoptera: Noctuidae)
(a) Maize ear damaged by larvae; (b) larva and damage in whorl-stage maize.

Source: EPPO (2020b); courtesy B.R. Wiseman, USDA/ARS, Tifton (United States of America)

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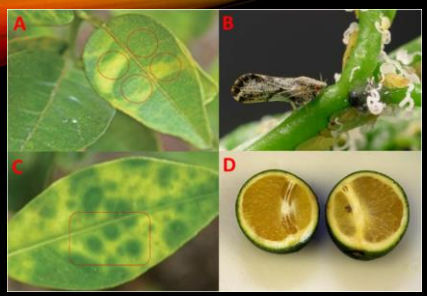
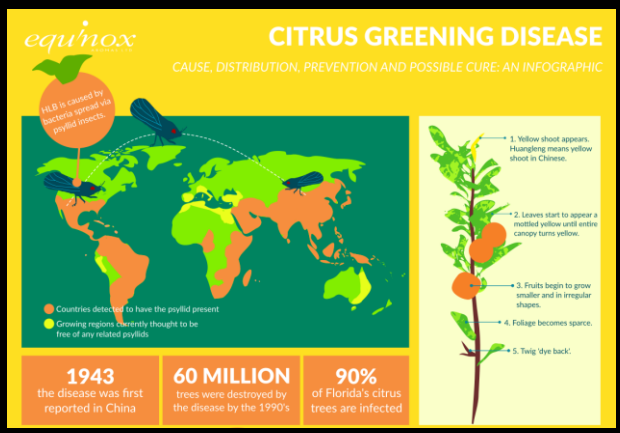
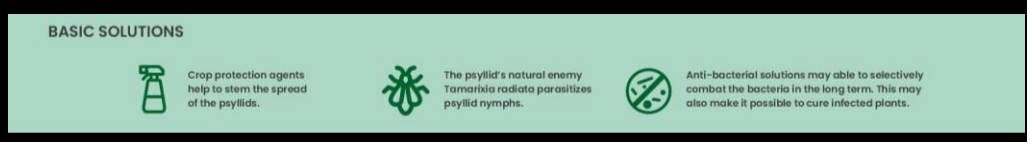




Climate change allows pest to migrate and survive in other ecosystems.

Example of citrus greening disease



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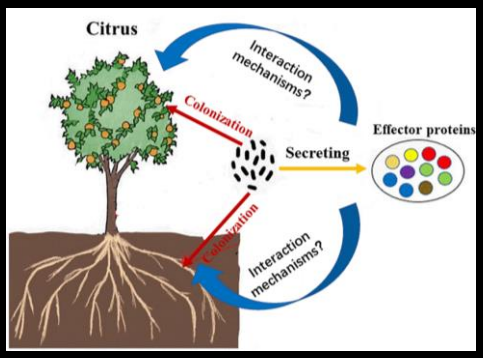

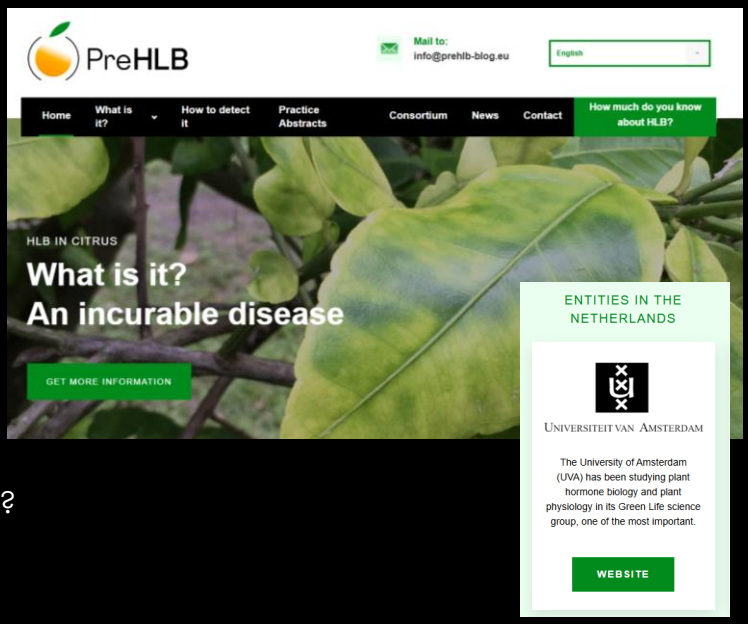

How to mitigate risks of new pests?

- Resistant cultivars
- Protective microbiome

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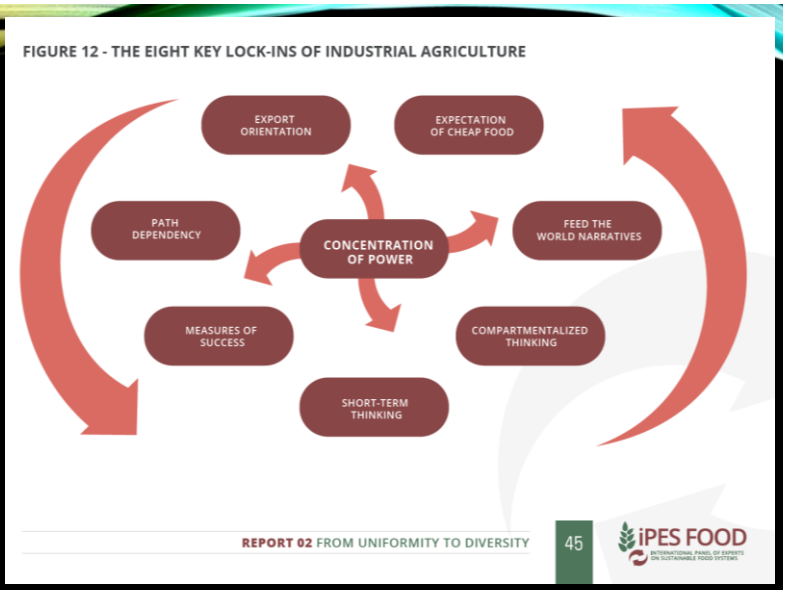
System "lock-ins"

- Concentration Power
- Short term policies
- Cheap food
- Export oriented
- Measures of success
- No integration
- "Fake Science"



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University of Amsterdam
Swammerdam Institute for Life Sciences

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