Plant Breeding as an integral part of Sustainable Agriculture

Dr. Dirk Zimmermann
Sustainable Agriculture Campaigner
Greenpeace Germany

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dirk.zimmermann@greenpeace.de

Picking Cotton

The choice between organic and genetically-engineered cotton for farmers in South India

Author: Reyes Tirado
Greenpeace Research Laboratories
University of Exeter, UK
GRL-TN 03/2010

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Campaigning for sustainable agriculture

Sustainability (in agriculture)

- Environment
- Economics
- social aspects

←→ GE crops (& food)

←→ pesticides

GE crops

Herbicide-tolerant or/ and

Insecticide-producing

Concerns about GMOs

…and their deliberate release into the environment:

- consequences of the introduced trait (e.g. herbicide tolerance) or type of genetic material (e.g. antibiotic resistance genes)
- unforeseen interactions between
  - the new or altered gene(s) and the plants own genes;
  - genomic irregularities (e.g. fragments and rearrangements) and/or
- alterations to plant biochemical pathways can give rise
- …to unintended and unpredictable effects in GM plants
- retrievability, health, hindering solutions, failure to yield

New „Breeding techniques“ = new GE

Gene scissors (nucleases), Oligonucleotides (ODM, directed mutagenesis), (Cisgenesis) … and more to come

GE or not?

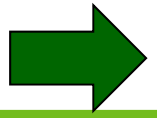
main criterion (for GE) is that an organism’s genetic material must have been altered using modern biotechnology to give rise to a novel composition,

i.e. a sequence of nucleotides that did not arise by mating, “does not occur naturally” rather than “could occur naturally”

→ If “new plant breeding technologies” result in a novel combination of DNA, they are GE

New GE - concerns

- “gene scissors” might cut DNA in another place, ODM might induce a similar mutation elsewhere
- many of these “gene editing” techniques are new, it is not yet possible to fully evaluate the potential for unintended changes
- may be more precise, but unintended changes to genetic material can still be expected
- can give rise to plants displaying unexpected and unpredictable effects – only assessed under GMO regulation!

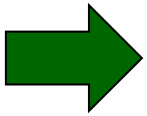


new GE (crops) need to be regulated as GMOs

(new) GE regulation

Classification as a GMO means (in the EU)

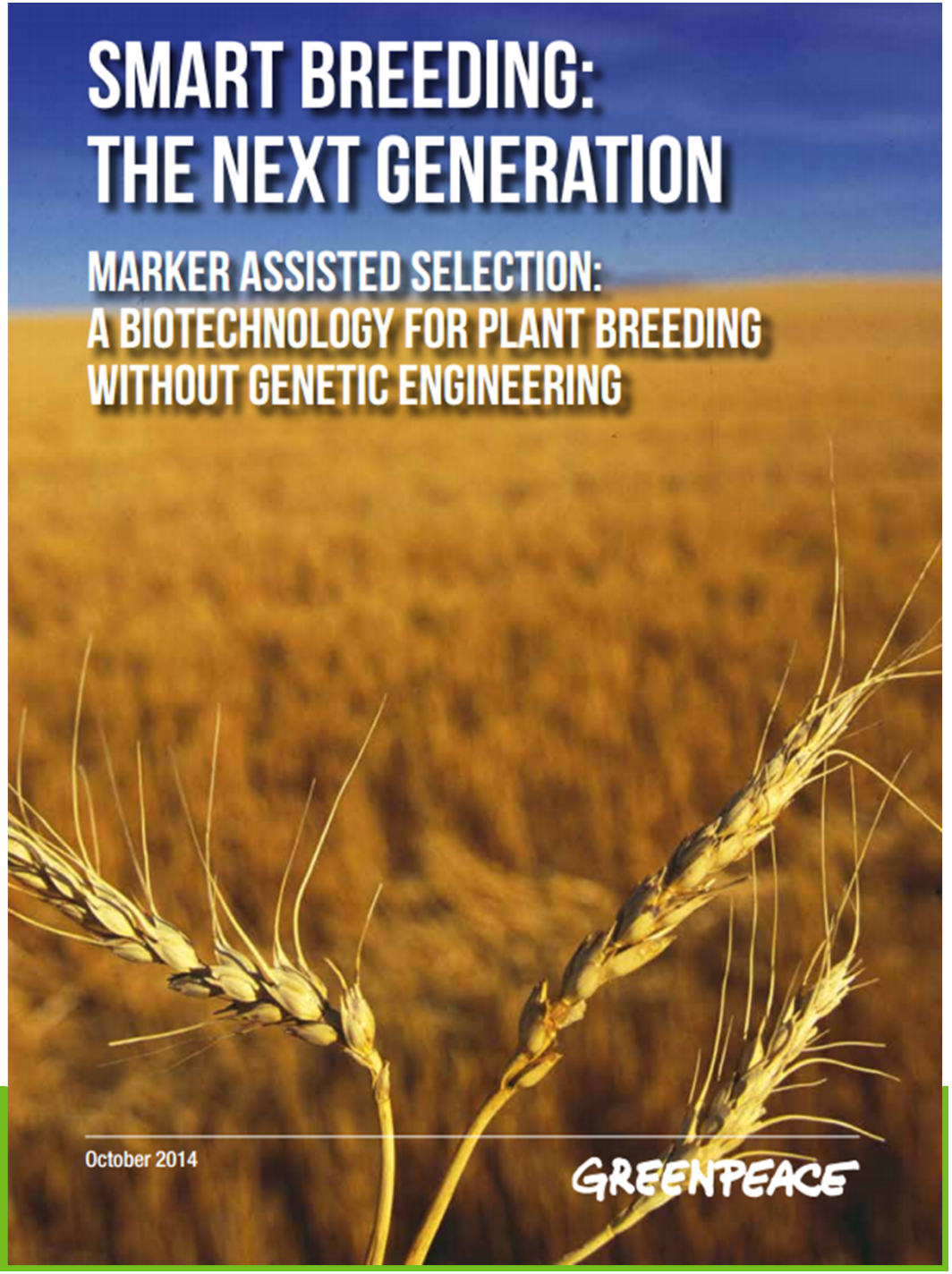
- Need for special authorization
- Risk assessment
- Monitoring
- Labeling (food/ feed/ seeds)
- Detection methods (?)
- Coexistence measures

 freedom of choice for consumers and farmers

Marker Assisted Selection (MAS)

"Safe" biotechnology

…that works.



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Smart Breeding

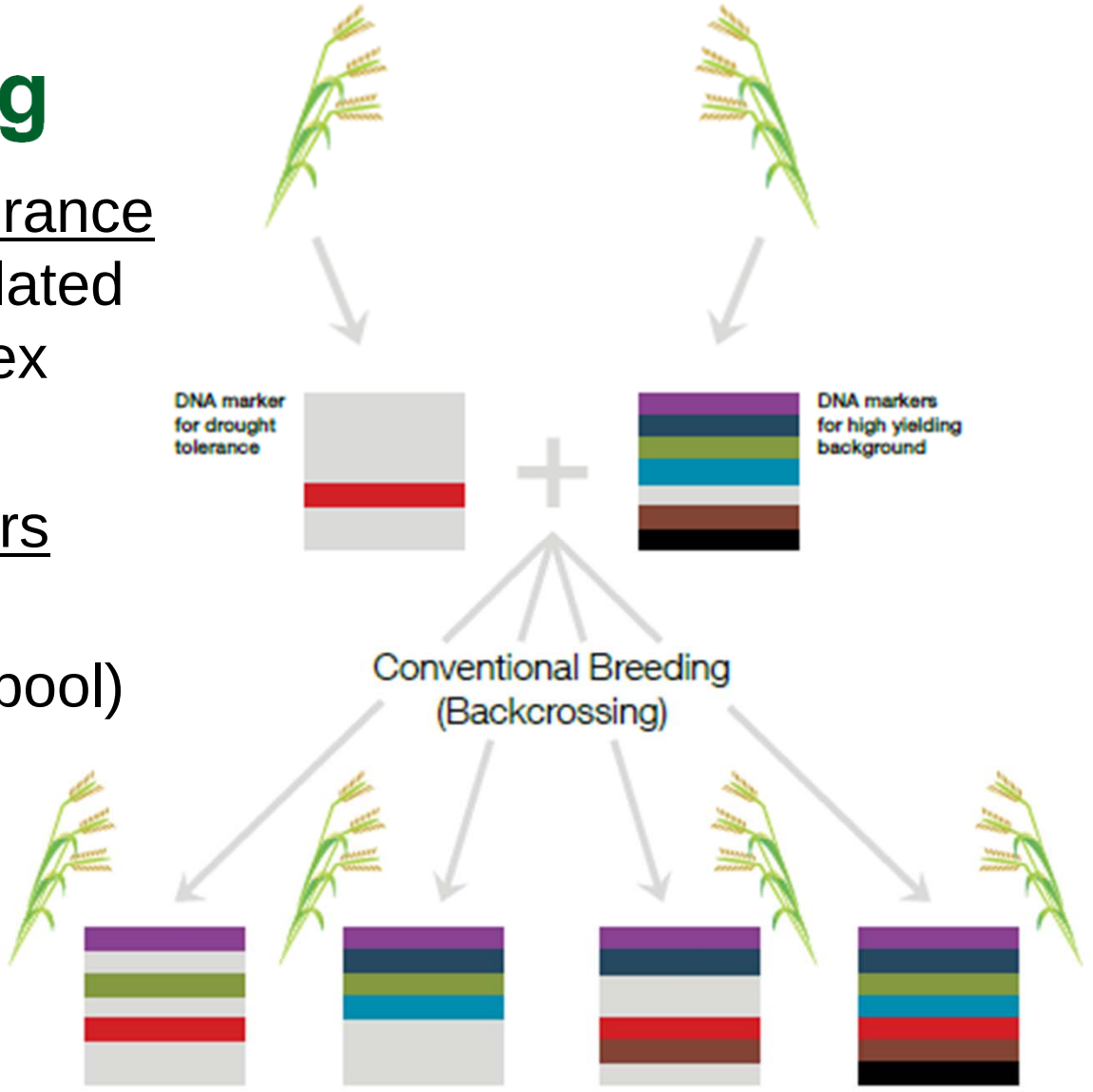
Can increase stress tolerance
(Drought tolerance regulated up to 60 genes + complex interactions)

Respects species barriers

(All genes incorporated present in natural gene pool)

Fewer safety concerns

(backcrossing and introgression
long history of safe use)



MAS successes - examples

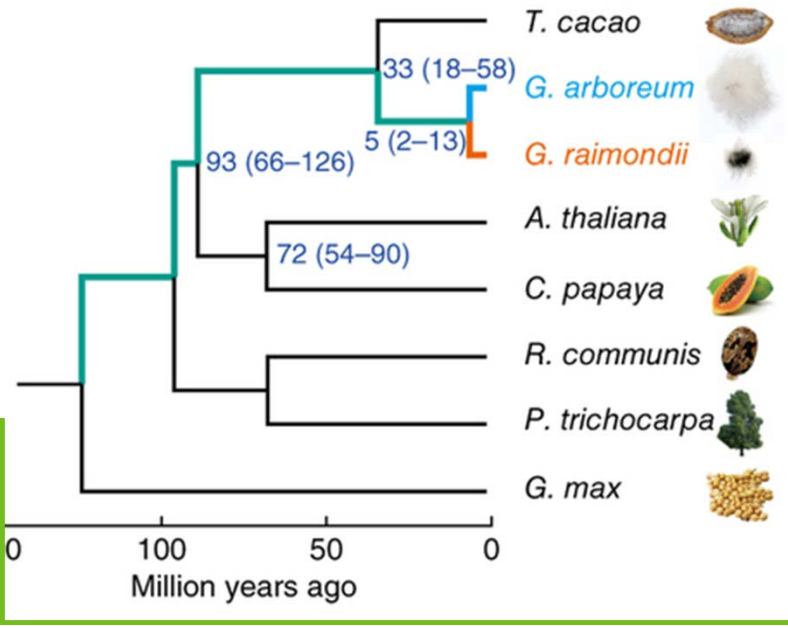
Trait		Crops
Biotic Stress Resistance		
	Insect resistance	maize, rice, wheat
	Fungal resistance	barley, bean, chili, lettuce, pearl millet, rice, soybean, tomato, wheat
	Bacteria Resistance	bean, lettuce, rice
	Virus resistance	barley, bean, cassava, tomato, wheat, lettuce
	Nematode resistance	barley, peanut, potato, soybean
	Parasite resistance	sorghum
Abiotic Stress Resistance		
	Acid soil tolerance	barley, rice
	Drought tolerance	maize, rice
	Salt + flood tolerance	rice
Quality	High protein grain	wheat
	High quality protein	maize
	Cooking quality	rice
	Malting quality	barley
Yield (!)	High yield	rice, sorghum, tomato

Genome Sequencing

Crops with published genome sequences

2002	Rice (indica and japonica)
…	
2006	black cottonwood
2007	grape
2008	papaya
2009	maize, cucumber, sorghum
2010	apple, castor bean, jatropha, soybean
2011	barbados nut, cacao, chinese cabbage, chinese plum, clementine mandarin, date palm, hemp, pigeon pea, potato, …
2012	banana, barley, cassava, flax, foxtail millet, melon, neem, tomato, watermelon, wheat
2013	chickpea, lupin, sweet orange, peach, pear, kiwifruit, norway spruce, rubber tree
2014	i.e. **cotton**

(Li et al., 2014)



Breeding for sustainable agriculture

- Non GE (neither „classic“ nor „new“)
- Classic, „safe“ breeding methods (considered „natural“ or „history of safe use“)
- non-invasive biotechnology: MAS
- Open source – no patents on life
- Participatory: in cooperation with farmers for local needs
- For „sustainability“ traits/
  organic (ecological) agriculture

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ONE

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Sustainable solutions

→ Agroecology

UN-report 2011

United Nations A/HRC/16/49

General Assembly

Distr.: General
20 December 2010

Original: English

Human Rights Council
Sixteenth session
Agenda item 3
Promotion and protection of all human rights, civil, political, economic, social and cultural rights, including the right to development

Report submitted by the Special Rapporteur on the right to food, Olivier De Schutter

Summary

The reinvestment in agriculture, triggered by the 2008 food price crisis, is essential

NEWS RELEASE

Eco-Farming Can Double Food Production in 10 Years, says new UN report

GENEVA – Small-scale farmers can double food production within 10 years in critical regions by using ecological methods, a new UN report* shows. Based on an extensive review of the recent scientific literature, the study calls for a fundamental shift towards agroecology as a way to boost food production and improve the situation of the poorest.

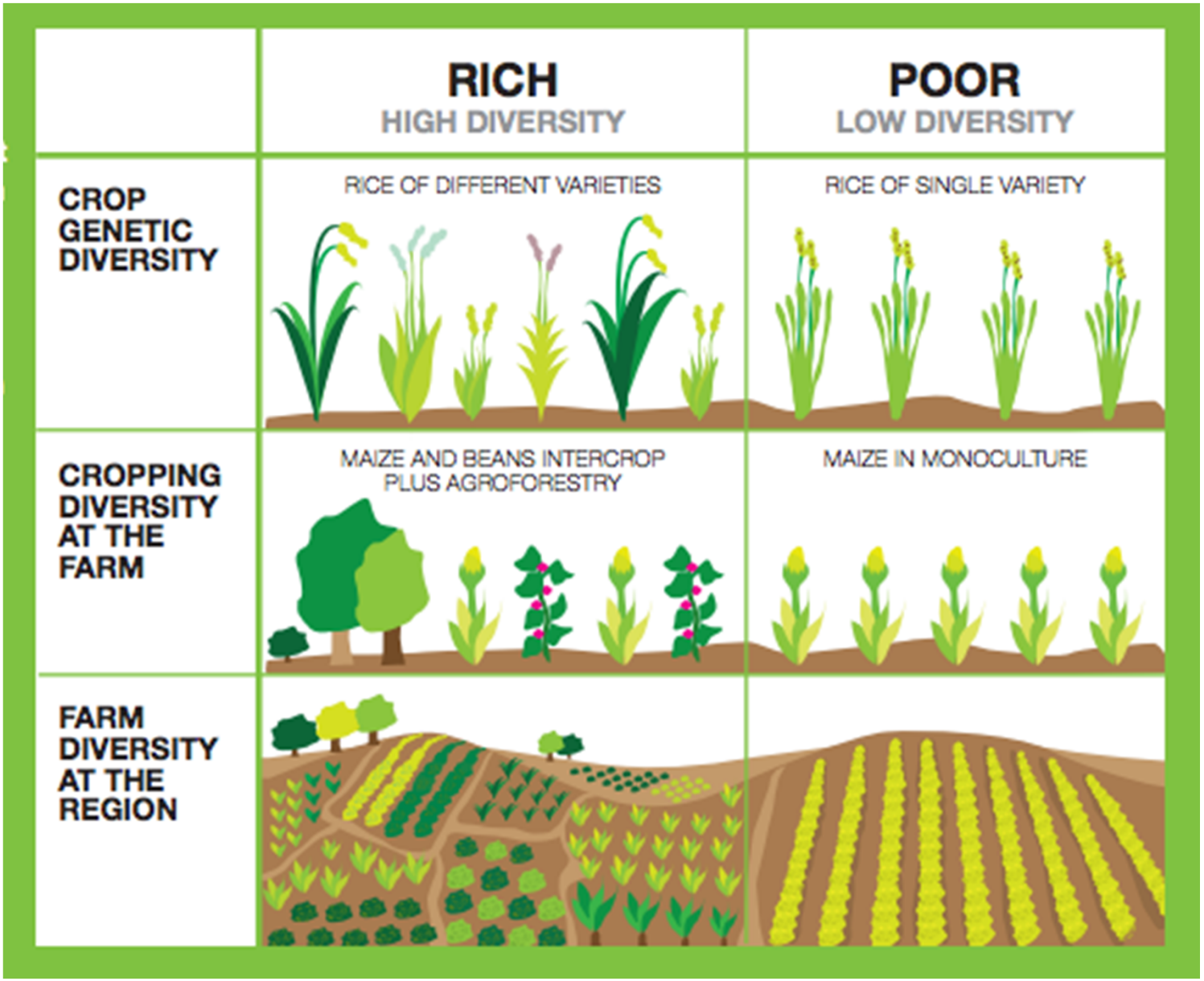
"To feed 9 billion people in 2050, we urgently need to adopt the most efficient farming

Ecological, „diversity“ farming

Shift from high inputs of Agrochemicals to knowledge-based agriculture, using agroecological principles (including free „ecosystem services“)

… and „diversity farming“

- Increases resilience to erratic weather changes
- Reduces pests and diseases by diluting their hosts
- Prevents soil erosion + increases soil organic matter + improves water use efficiency
- Increases productivity + maximises yield over years, decreasing crop failure in bad years

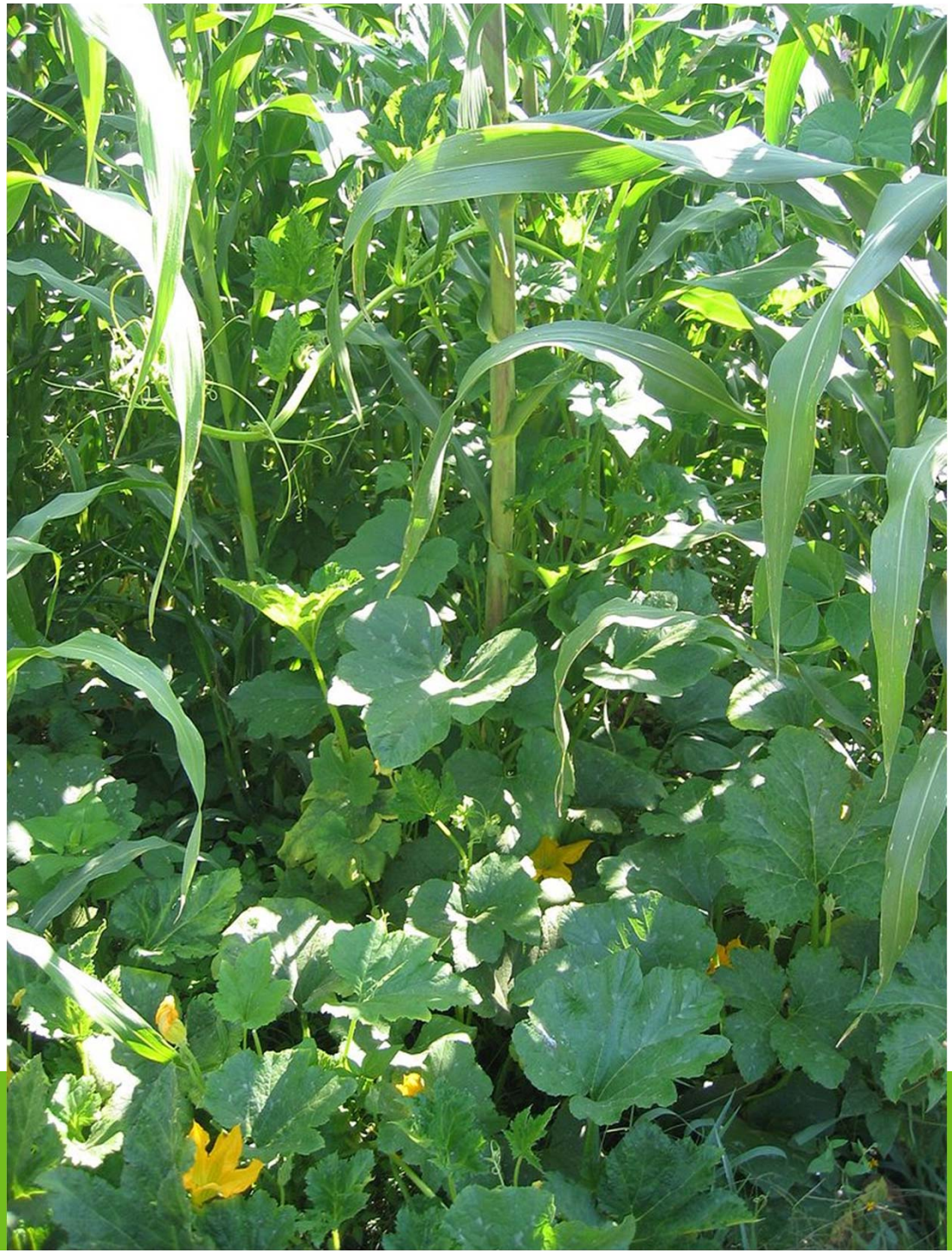

RICH
HIGH DIVERSITY
POOR
LOW DIVERSITY
CROP GENETIC DIVERSITY
RICE OF DIFFERENT VARIETIES
RICE OF SINGLE VARIETY
CROPPING DIVERSITY AT THE FARM
MAIZE AND BEANS INTERCROP PLUS AGROFORESTRY
MAIZE IN MONOCULTURE
FARM DIVERSITY AT THE REGION

Agroforestry

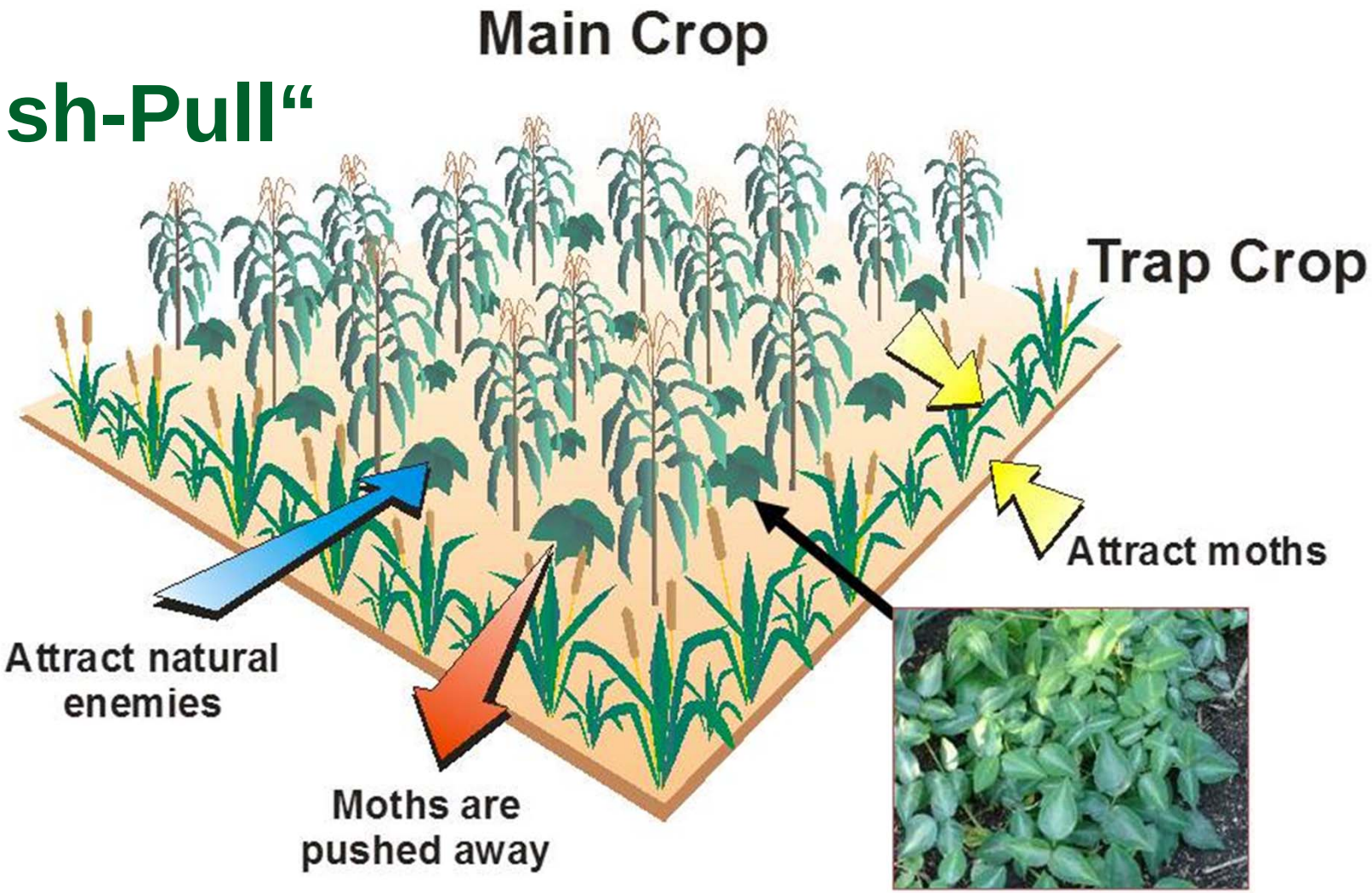
Malawi:
Maize
+ *Faidherbia albida;*
Maize-yields +280%

„Milpa“

Maize + beans + pumpkins



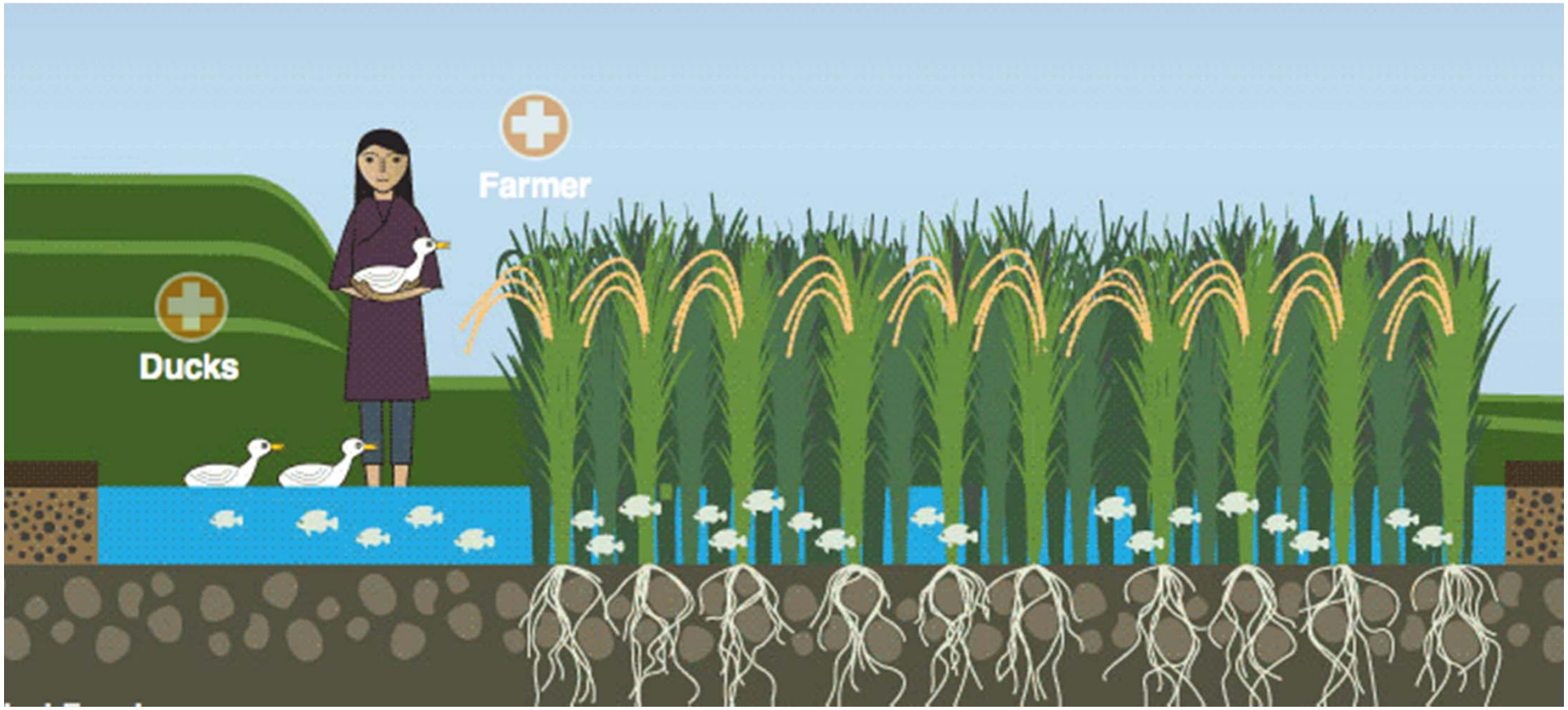
„Push-Pull“



Khan et al. (2010) *J. Exp. Bot.* 61: 4185

Integrating livestock in farming

i.e. Rice-Duck/-Fish-Systems



Conclusions

- Non-GE-breeding is (just) one element of sustainable agriculture
- Diversity and agroecology are key to sustainable farming systems

Literature new GE and MAS

http://www.greenpeace.org/eu-unit/Global/eu-unit/reports-briefings/2016/Joint%20position_New%20techniques%20of%20genetic%20engineering_March%202016-1.pdf

http://www.greenpeace.to/greenpeace/wp-content/uploads/2015/11/Application-of-GMO-definitions-to-plants-developed-by-cisgenesis-and-gene-editing-techniques.pdf

http://www.greenpeace.org/international/en/publications/Campaign-reports/Agriculture/Smart-Breeding/