Seeds of the Future

Salvatore Ceccarelli

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Five global problems
…actually six

Water

Climate Change

Poverty

Obesity and Diabetes

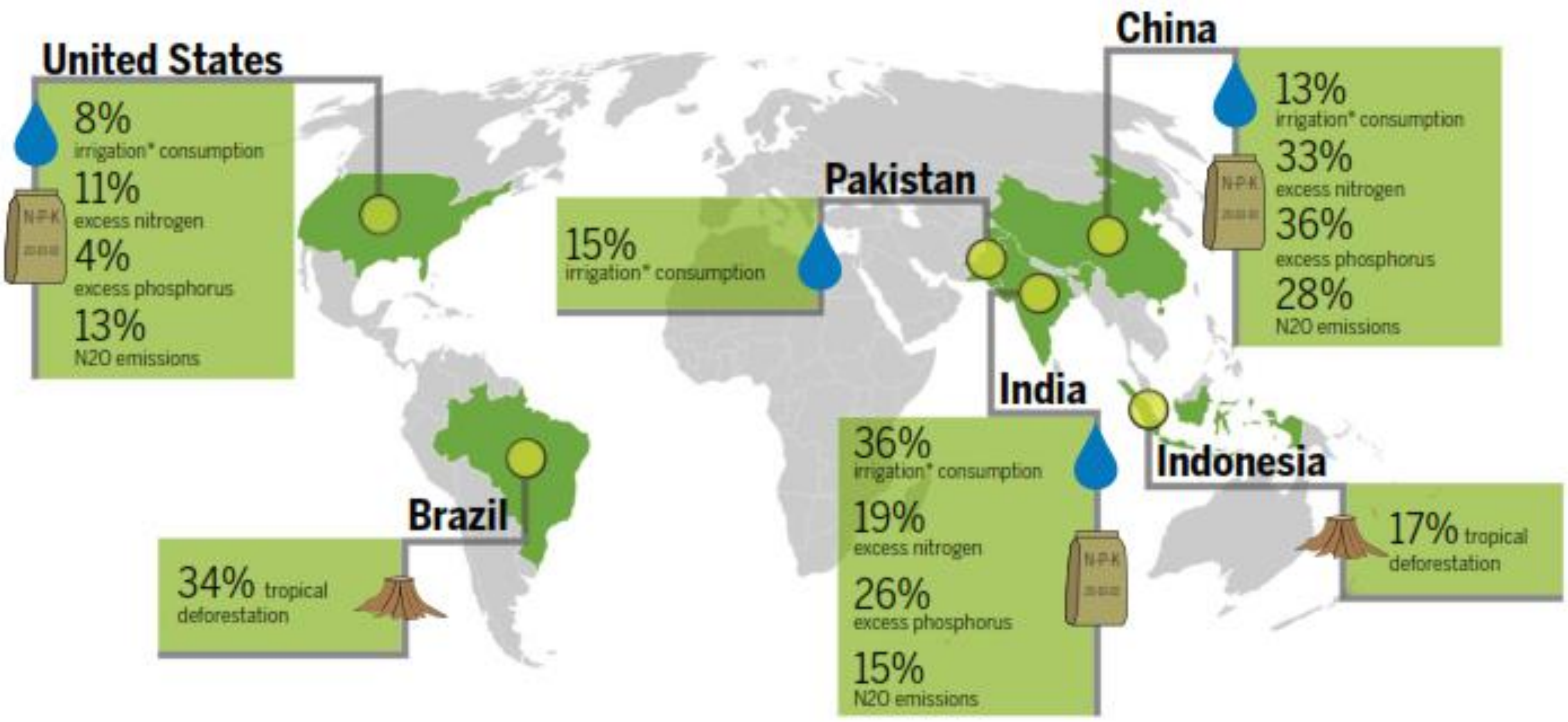
Hunger and Malnutrition

Biodiversity

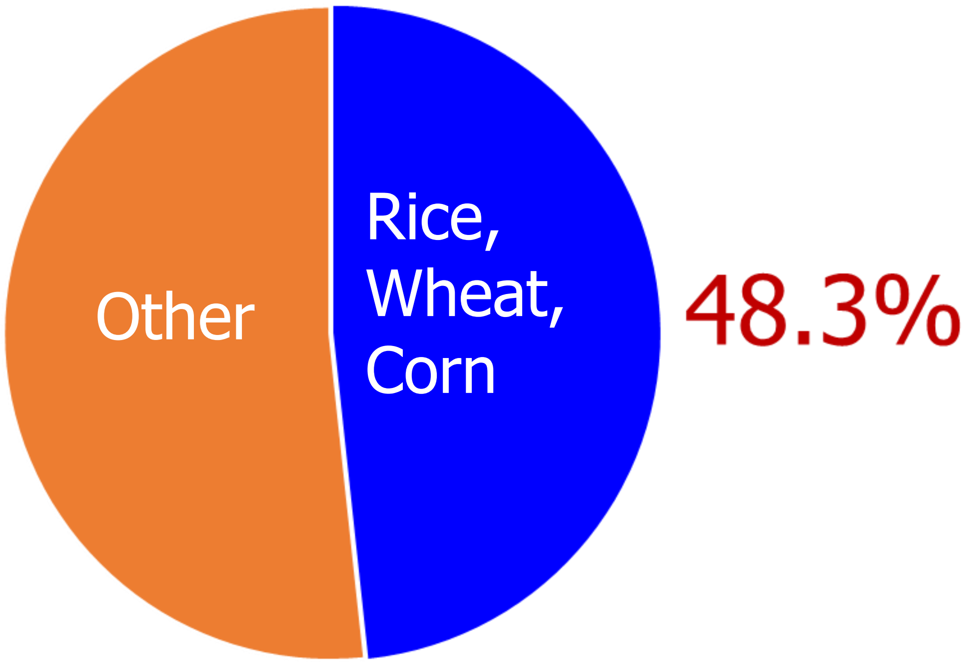
SEED → **FOOD** → **HEALTH**

Seed and Water

Irrigation accounts for about 70% of global water withdrawals



Seed and Water



Cotton and Sugarcane, occupy 3% of the area and use 20% of the total irrigation water

Poverty

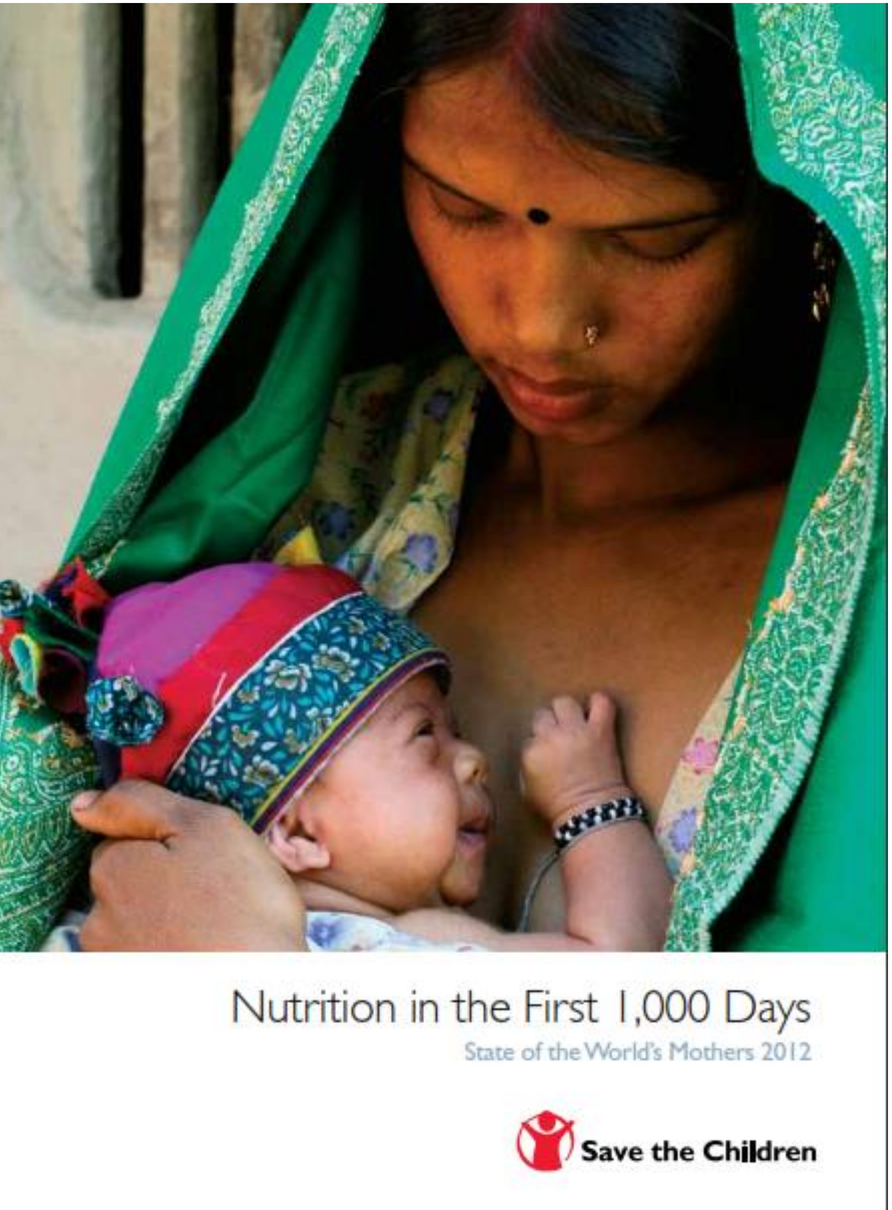
India grew at 8% in past 10 yrs, but most poor Indians didn't

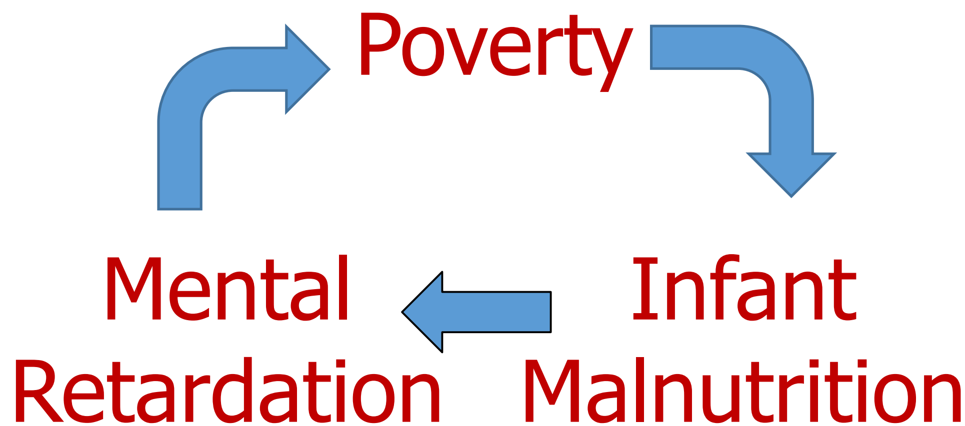
Subodh Varma | TNN

43.5L child labourers in India, UP has most

Over 20% of youth between 15 and 24 years of age were jo
seeking work acco
startling data rele
Tuesday by Census
absolute terms this
unemployed youth is
ingly huge – about 4.
which 2.6 crore are
2.1 crore are women.
These definitive
for 2011 reveal the
pervasive unemp
that has gripped Ind
the past decade eve
nomic growth was
along at over 8% pe
for most of this perio

Five global problems: poverty





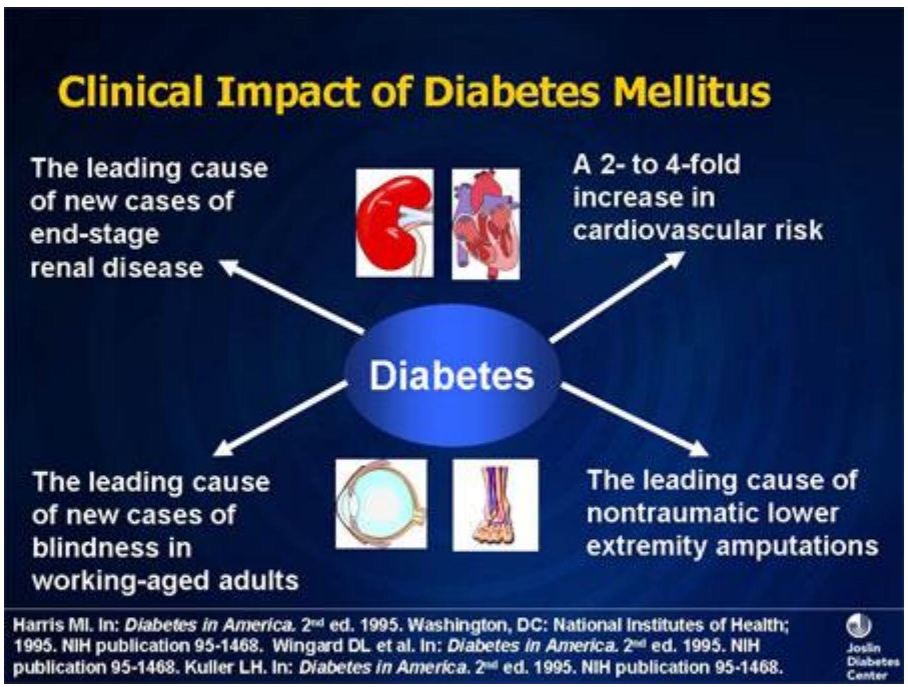
Too much and too little

Hunger and Malnutrition

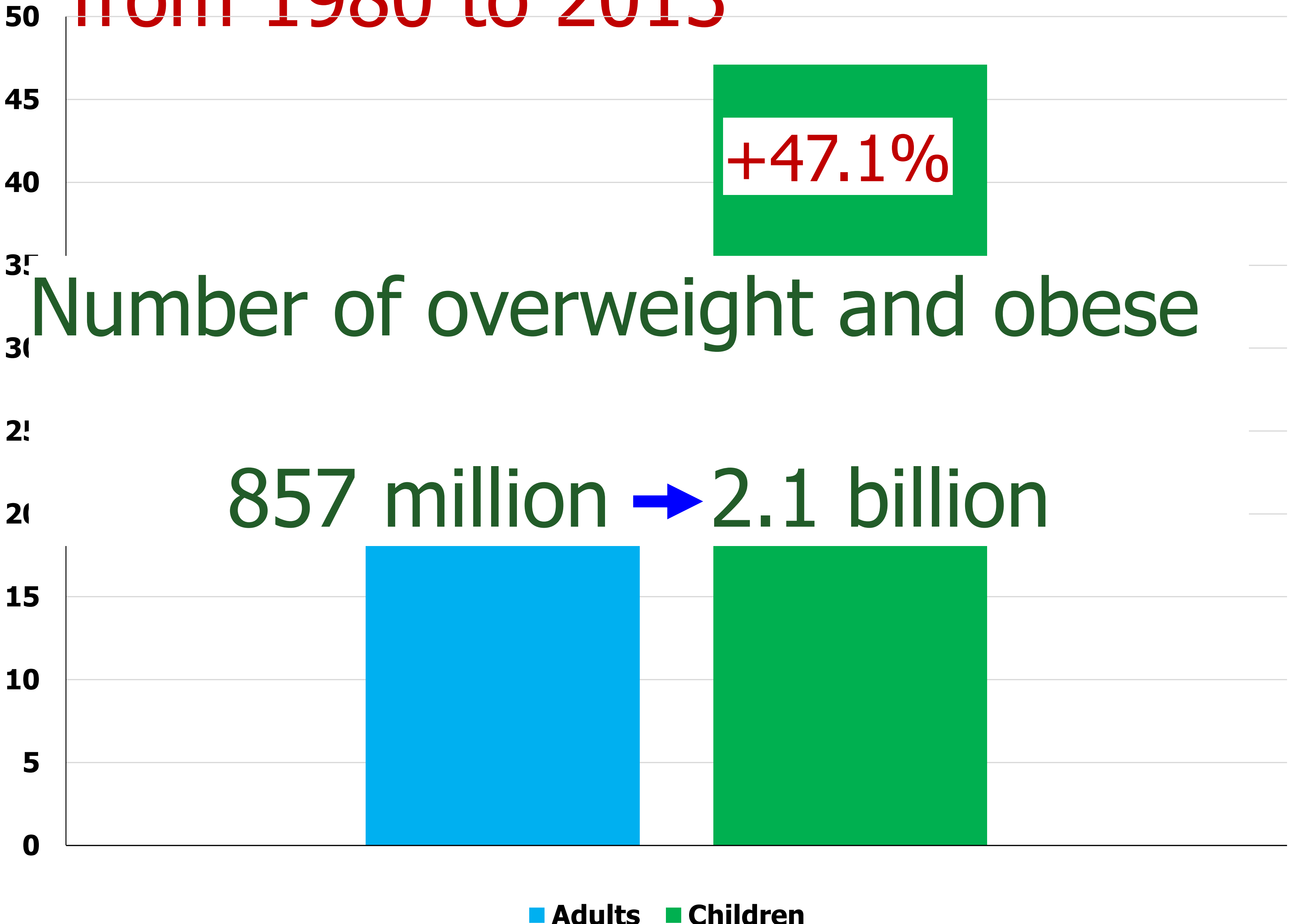
1.5 billion overweight, 500 million obese

842 million extremely undernourished, 165 million children stunted, 1.2 billion malnourished

Overweight, obesity, diabetes and Nonalcoholic Fatty Liver



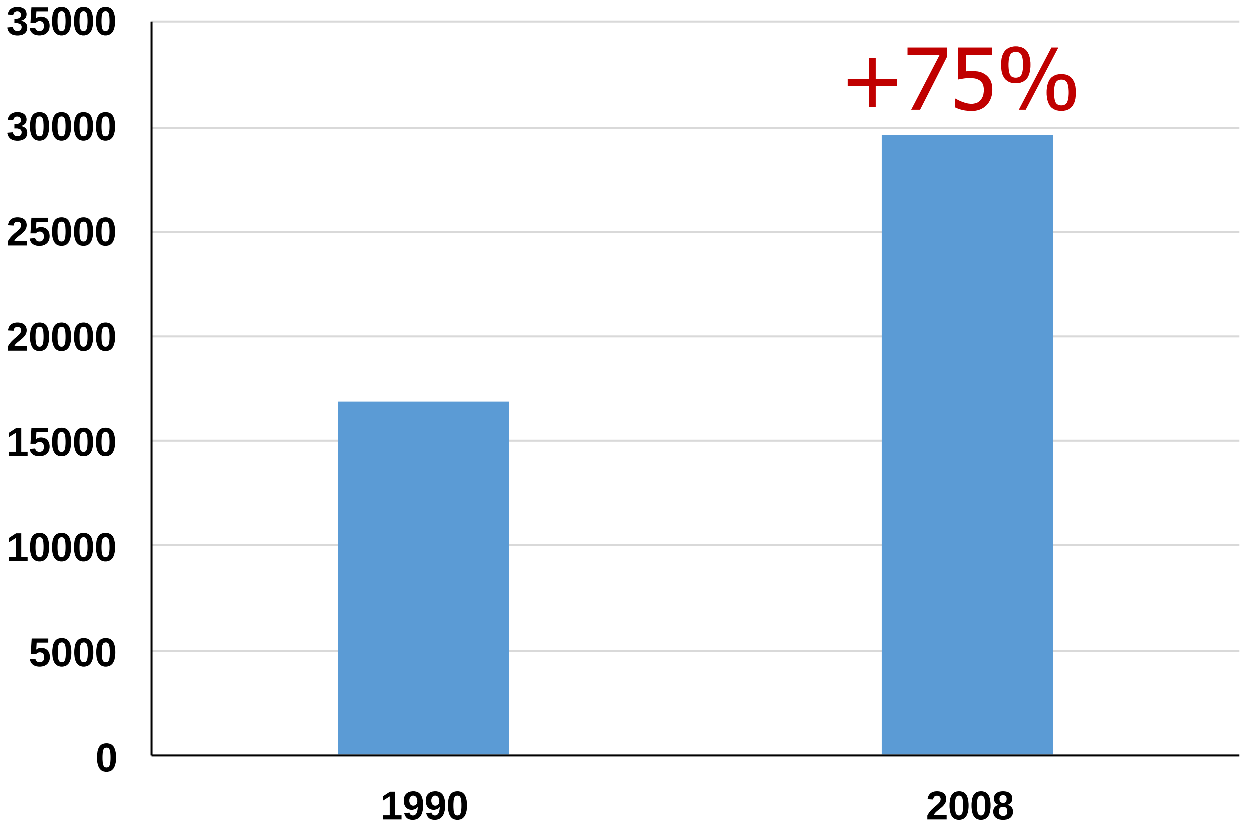
Increase in overweight and obesity from 1980 to 2013



Number of overweight and obese

857 million → 2.1 billion

Number of fitness center in the US



Health Club Industry in the US

(2007 data in USD)

Total Revenues	17.6 billion
Equipment Sales	4.7 billion
Total	22.3 billion

WORLD'S MOST POPULATED COUNTRIES

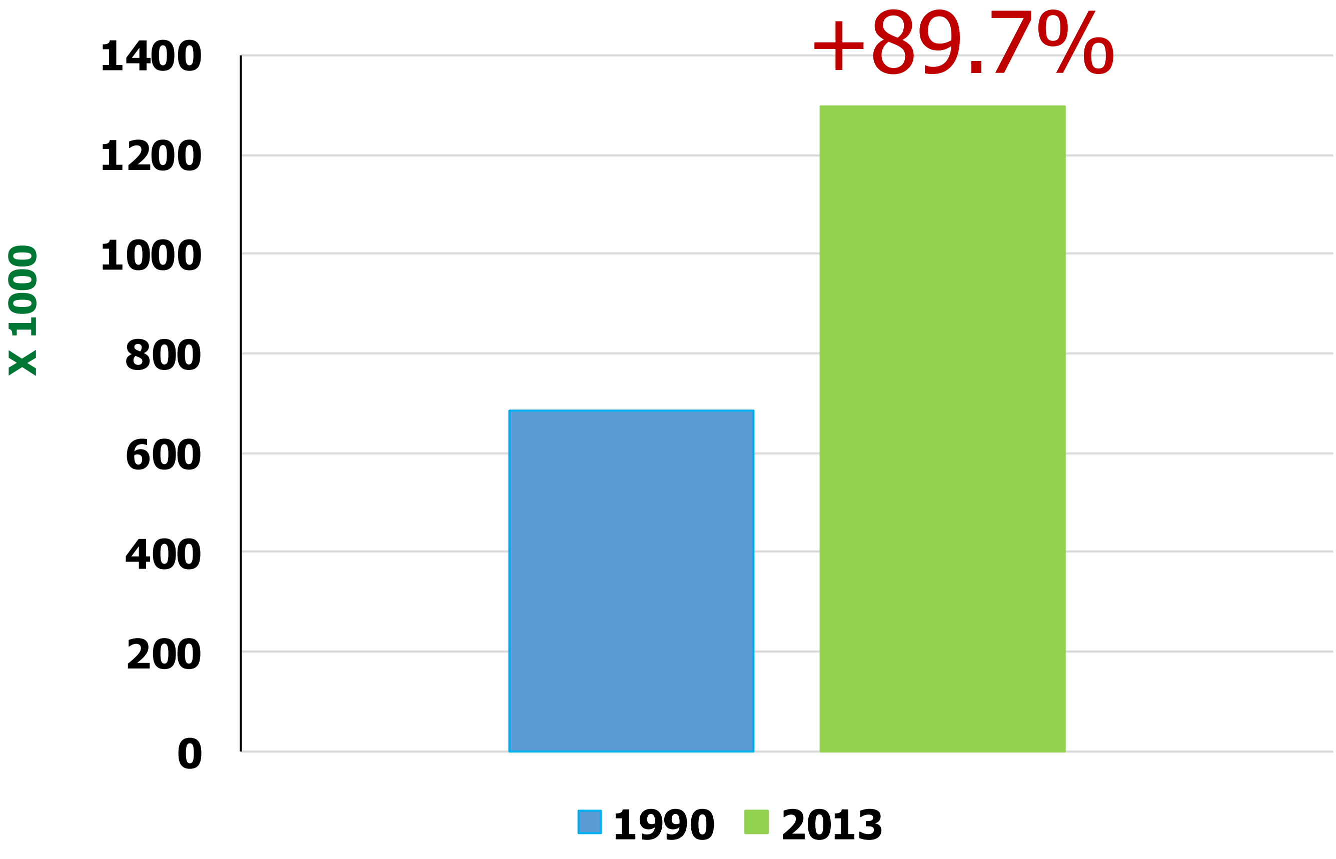
1. CHINA
2. INDIA
3. DIABETES
4. USA
5. BRAZIL

DIABETES:
PROTECT OUR FUTURE

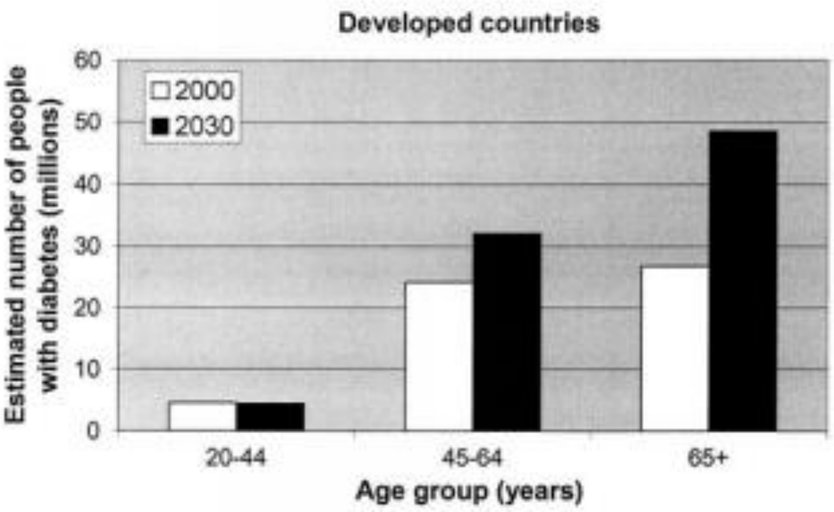
www.worlddiabetesday.org

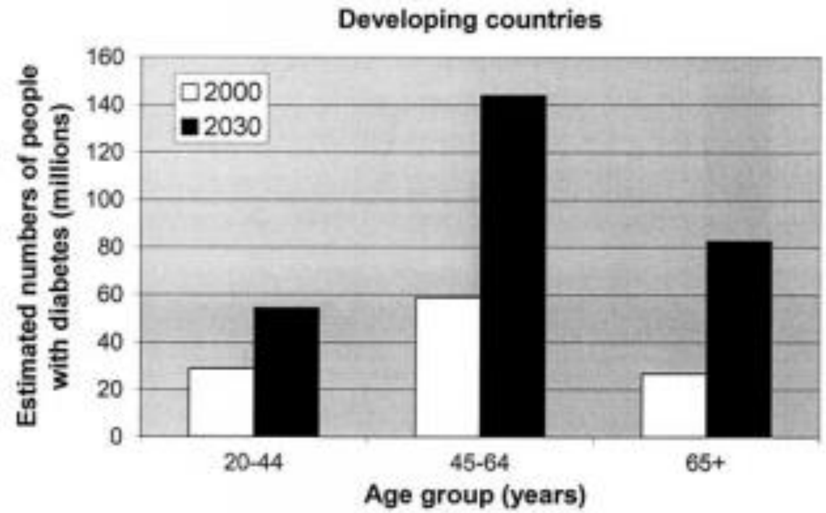
What do we die of?

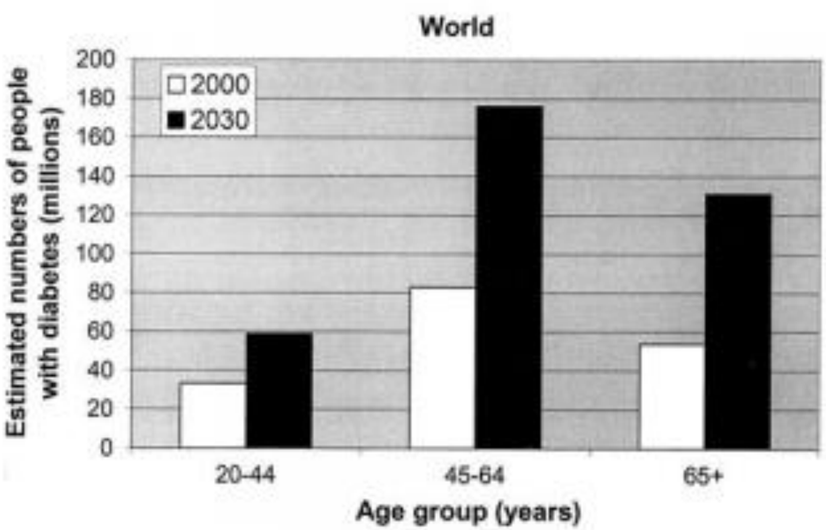
Diabetes



Diabetes by 2030







Estimated number of adults with diabetes by age-group in developed and developing countries and in the world

Sub-Sahran Africa

↓

Urbanization

↓

More processed food

↳ obesity, heart disease, cancer, and type 2 diabetes

Source: The Lancet Diabetes & Endocrinology, July 2015

Hunger and Malnutrition

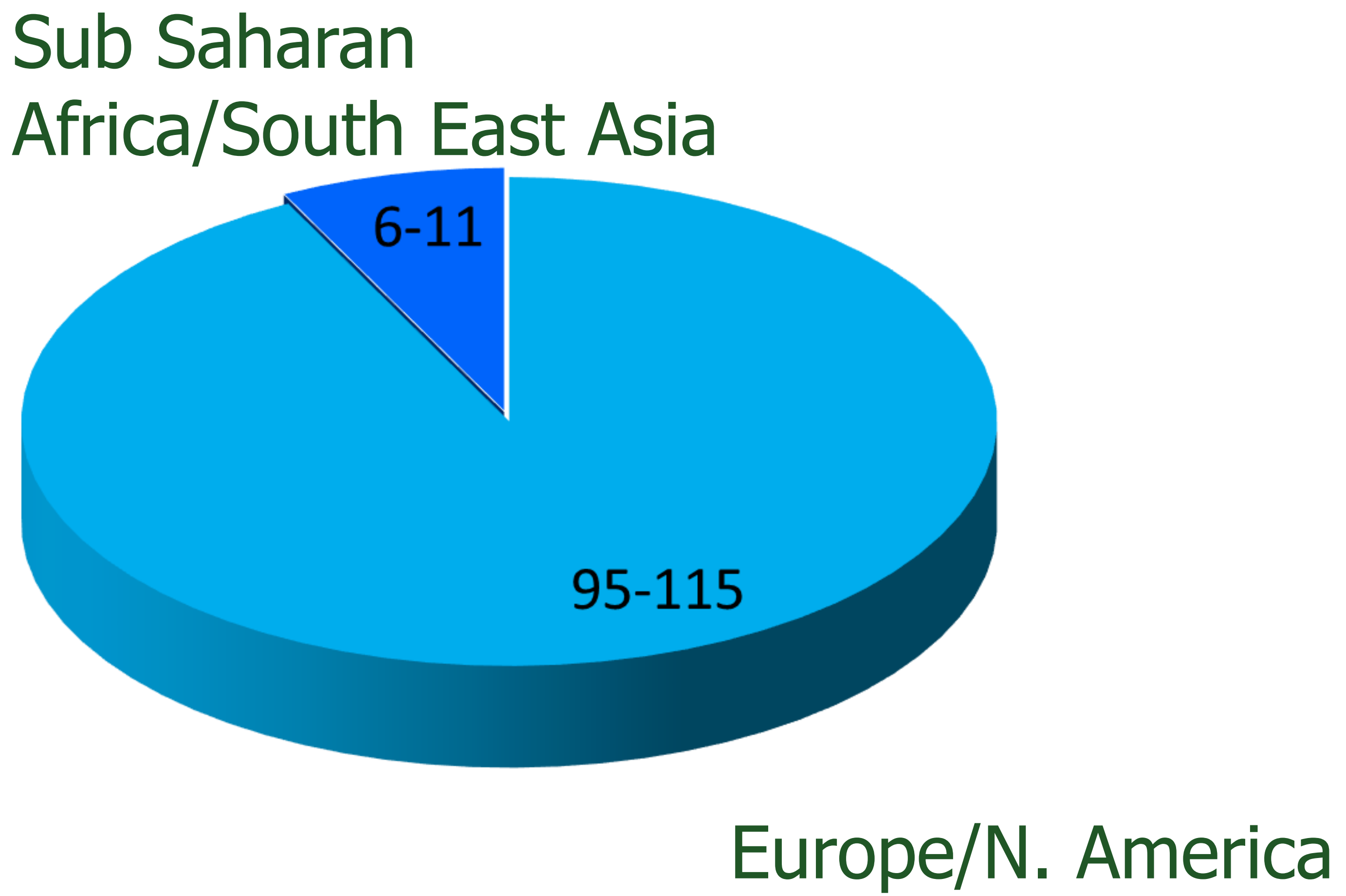
Increasing evidence that is not a problem of production but a problem of availability and/or accessibility

1.3 billion tons of food

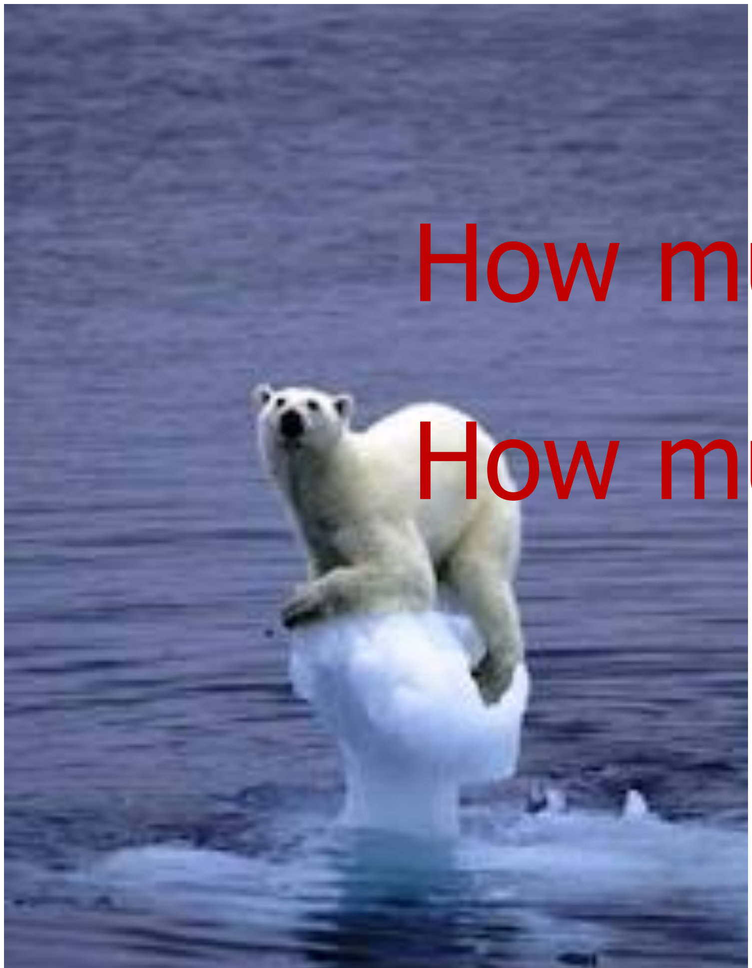
(≈30% of production)

Not all garbage bins are the same size

(kg of waste per person)



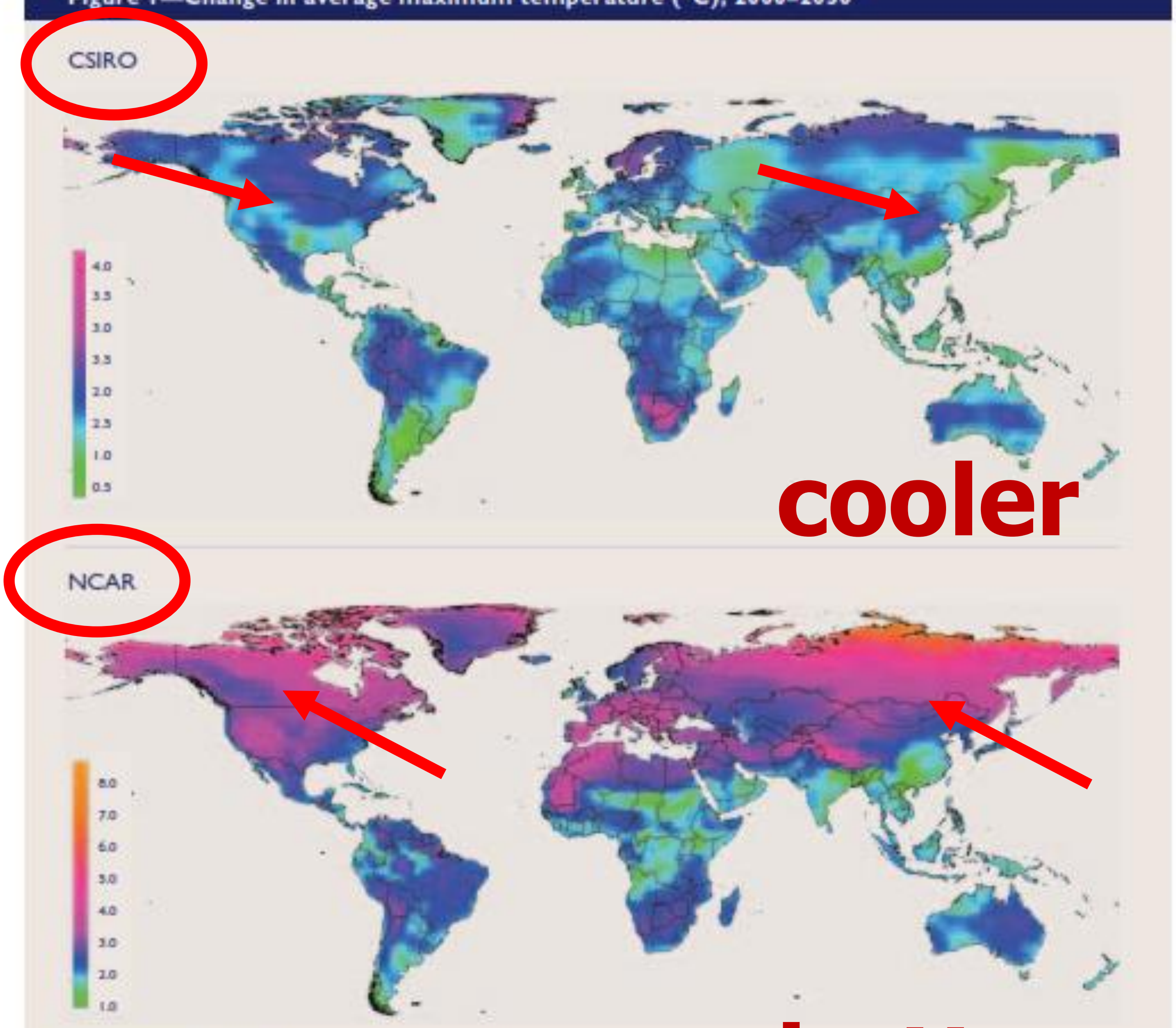
Climate Change



How much hotter?

How much drier?

Figure 1—Change in average maximum temperature (°C), 2000–2050



Source: Authors' calculations.

CLIMATE CHANGE

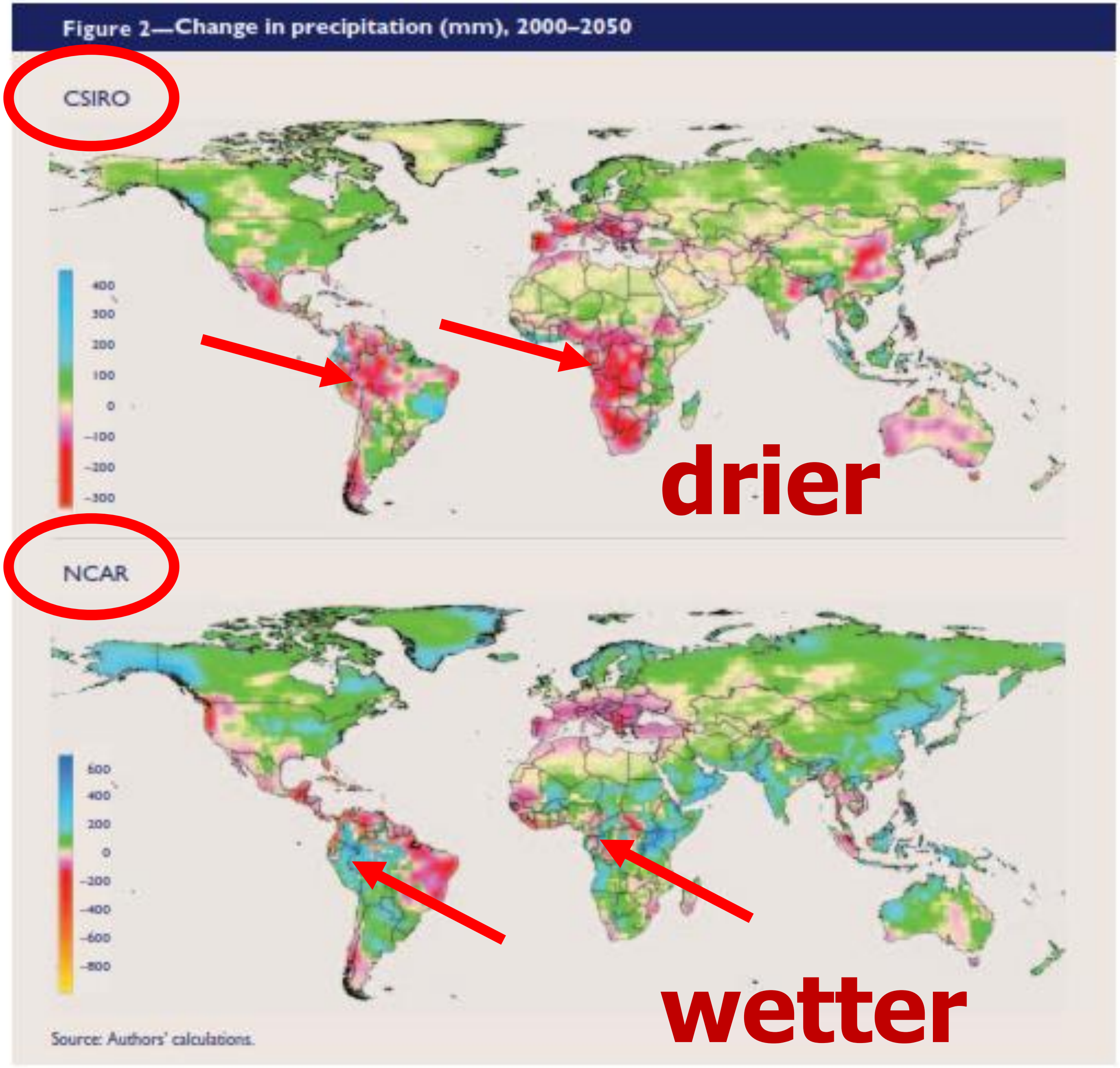
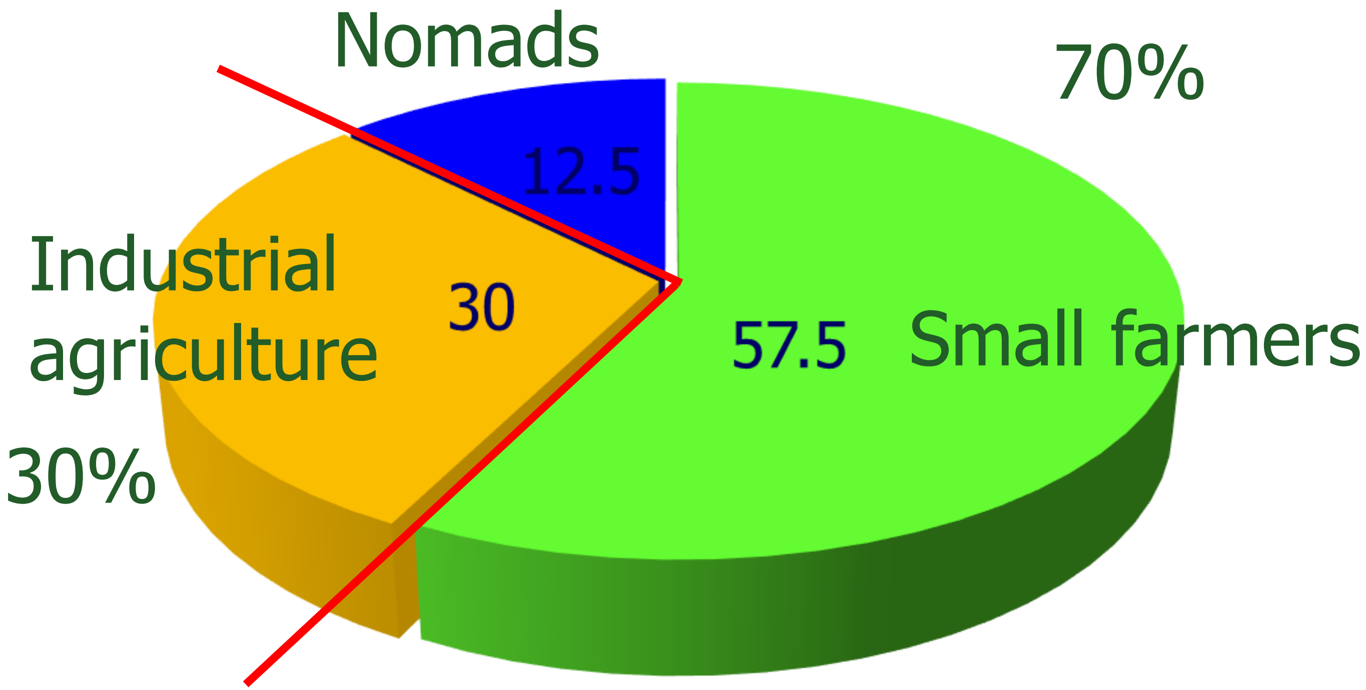


Figure 2—Change in precipitation (mm), 2000–2050
CSIRO
400
300
200
100
0
–100
–200
–300
drier
NCAR
600
400
200
0
–200
–400
–600
–800
wetter
Source: Authors' calculations.

Climate Change: a moving breeding target, and could be a different target in different locations


How much hotter?
How much drier?

Who is feeding the world?



Climate Change and Nutrition

Zinc and Iron Deficiency → Loss of 63 millions life-years annually

CO_2 ↑

Fe and Zn ↓

LETTER

doi:10.1038/nature13179

Increasing CO_2 threatens human nutrition

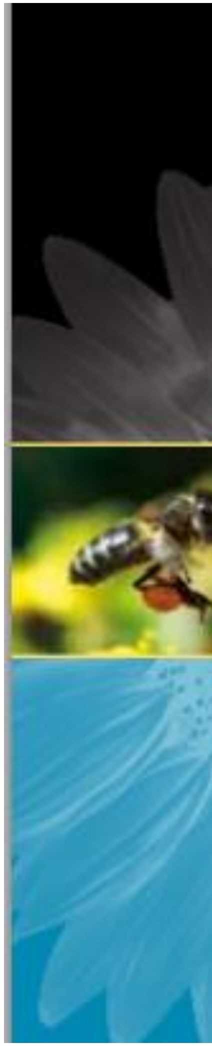
Samuel S. Myers[1,2], Antonella Zanobetti[1], Itai Kloog[3], Peter Huybers[4], Andrew D. B. Leakey[5], Arnold J. Bloom[6], Eli Carlisle[6], Lee H. Dietterich[7], Glenn Fitzgerald[8], Toshihiro Hasegawa[9], N. Michele Holbrook[10], Randall L. Nelson[11], Michael J. Ottman[12], Victor Raboy[13], Hidemitsu Sakai[9], Karla A. Sartor[14], Joel Schwartz[1], Saman Seneweera[15], Michael Tausz[16] & Yasuhiro Usui[9]

Dietary deficiencies of zinc and iron are a substantial global public health problem. An estimated two billion people suffer these deficiencies[1], causing a loss of 63 million life-years annually[2,3]. Most of these people depend on C_3 grains and legumes as their primary dietary source of zinc and iron. Here we report that C_3 grains and legumes have lower concentrations of zinc and iron when grown under field conditions at the elevated atmospheric CO_2 concentra-

experiments contribute more than tenfold more data regarding both the zinc and iron content of the edible portions of crops grown under FACE conditions than is currently available in the literature. Consistent with earlier meta-analyses of other aspects of plant function under FACE conditions[14,15], we considered the response comparisons observed from different species, cultivars and stress treatments and from different years to be independent. The natural logarithm of the mean response ratio

Late blight severity and control costs may be increased by climate change. (Late blight from Fry)

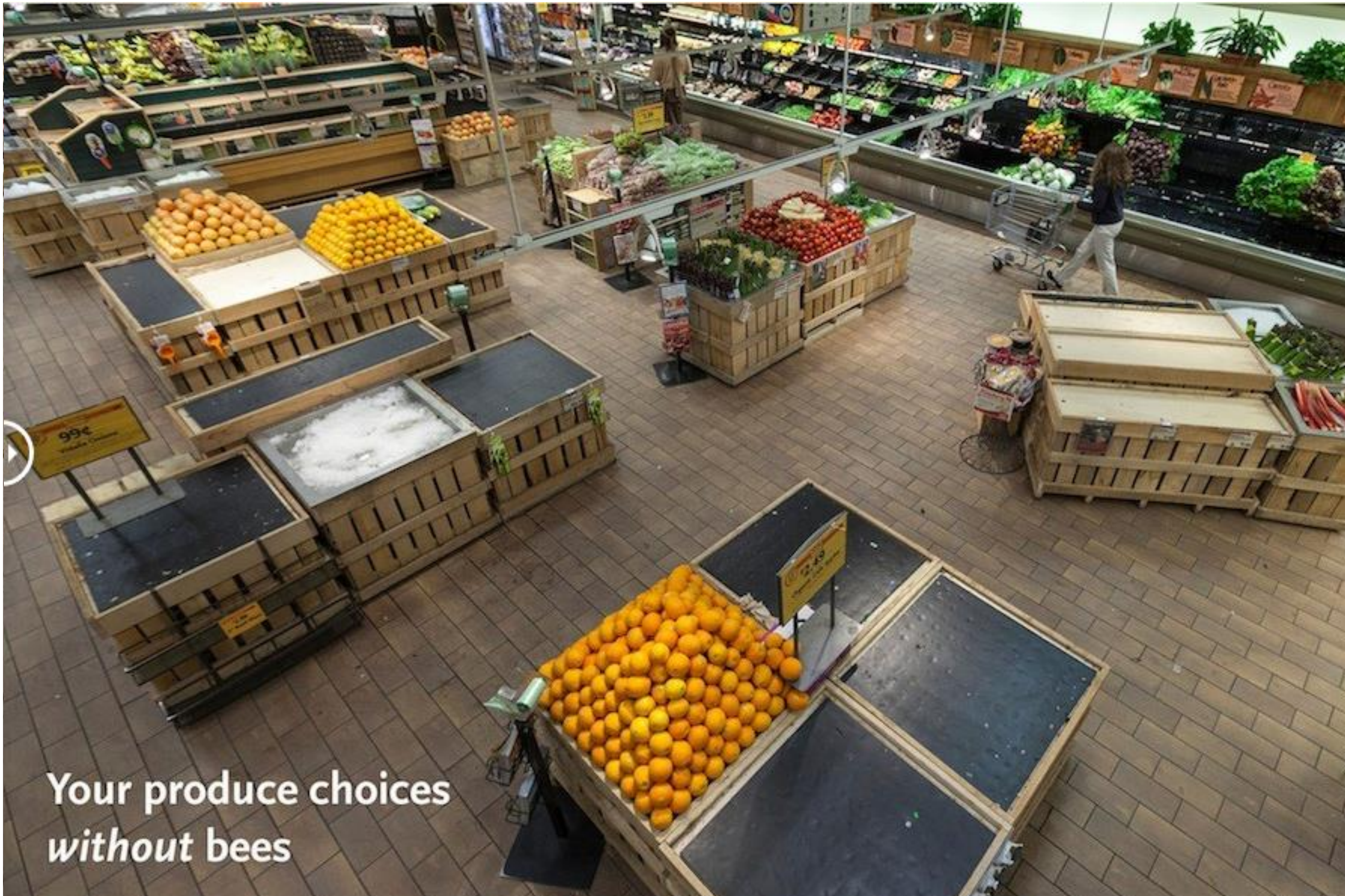
Stewart's wilt (transmitted by the corn flea beetle) frequency may be increased by climate change (flea beetle from Shelton - http://www.nysaes.cornell.edu/ent/factsheets/pests/cornfb.html; Stewart's wilt from Petzoldt)



The two-spotted bumblebee, found in eastern North America, is one of about 250 bumblebee species worldwide.

CLIMATE CHANGE

Bumblebees aren't keeping up with a warming planet


99¢
Your produce choices
without bees

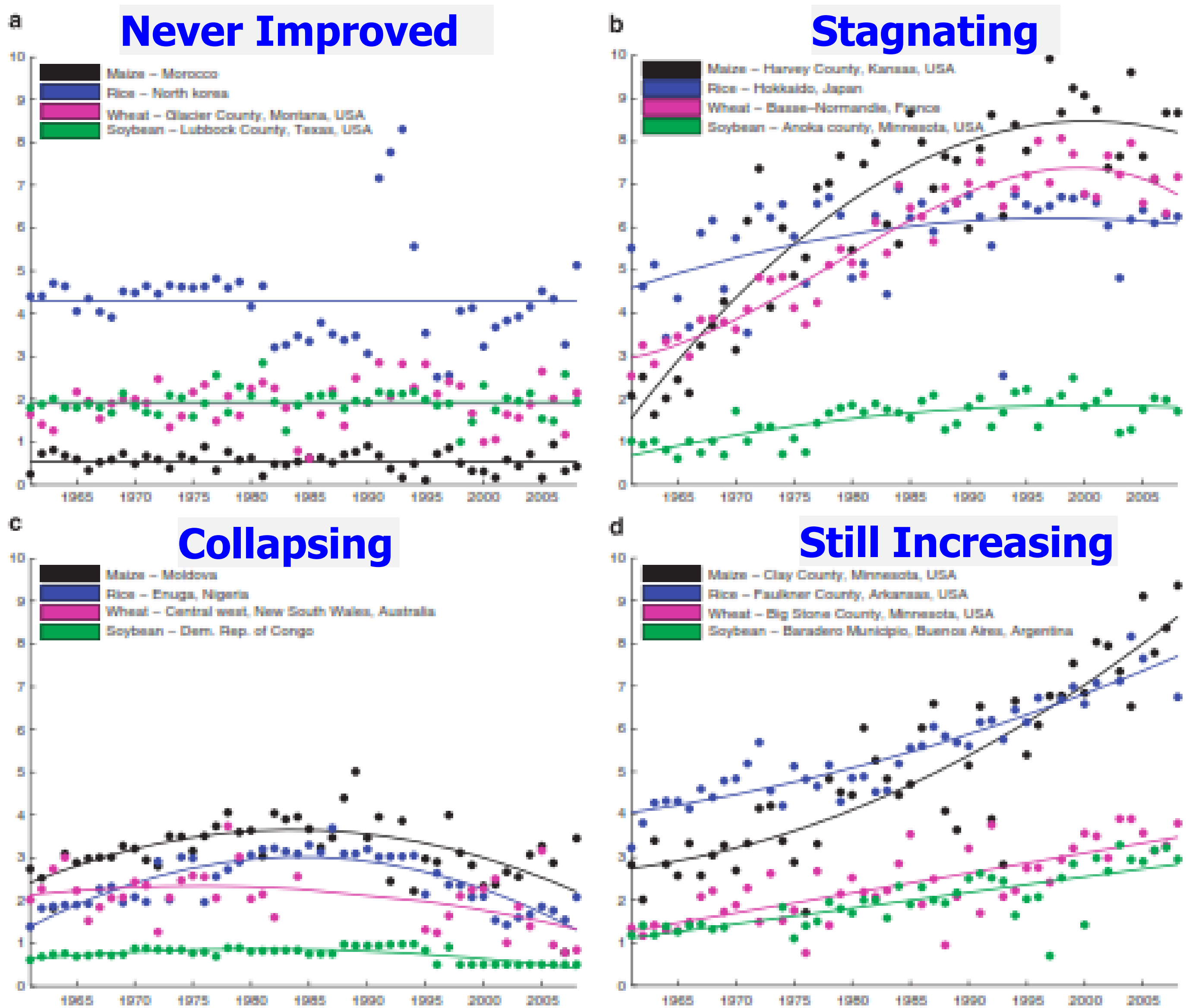


Figure 1 | Illustrative examples for each of the four types of global crop yield trends. The solid filled circles in each panel are the observed crop yields from various global locations to serve as illustrative examples. Colour codes indicate the crop. The solid curves are the statistical model fits to the data and similarly colour coded according to the crop type. (**a**) Yields never improved. (**b**) Yields stagnating. (**c**) Yields collapsed. (**d**) Yields still increasing.

Soybean

Never Improved	1.1%
Stagnating	23.0%
Collapsing	0.2%
Still Increasing	75.7%

Maize

Never Improved	0.6%
Stagnating	26.1%
Collapsing	3.2%
Still Increasing	70.1%

Rice

Never Improved	**1.0%**
Stagnating	**35.1%**
Collapsing	**1.4%**
Still Increasing	**62.5%**

Wheat

Never Improved	1.3%
Stagnating	36.8%
Collapsing	0.8%
Still Increasing	61.2%




Four crops ≈ 54% calories

In between 24 -39% of the area planted with those 4 crops, yields never improved, or are stagnating or are collapsing

Adaptation to Climate Change

Adaptation has emerged as a central area in climate change research

IPCC WGII AR5 Technical Summary, March 2014

The first vascular plant: Cooksonia

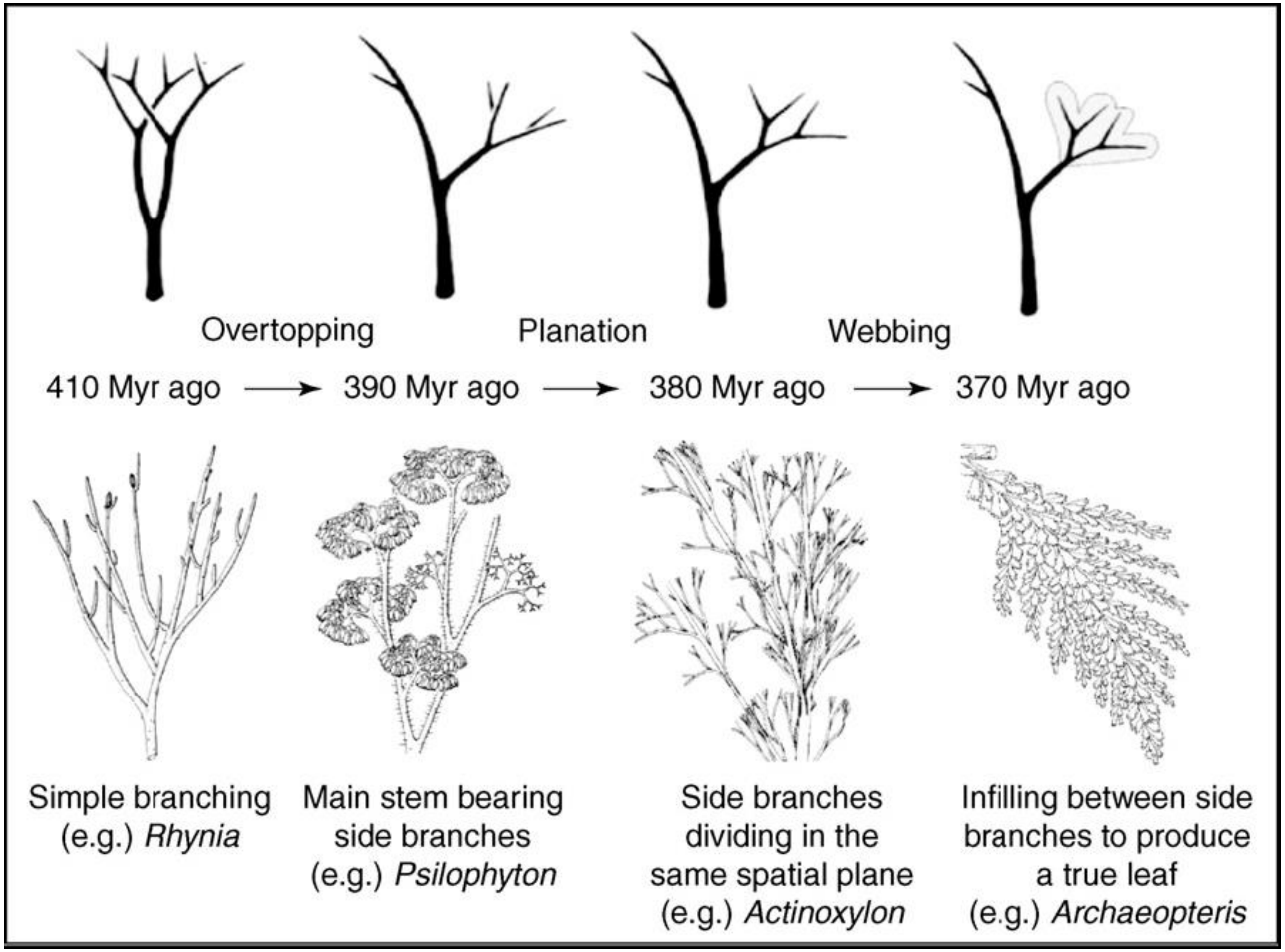
450 million years ago

No Leaves

Between 400 and 350 millions year ago the CO_2 content started to decrease to the level of today

W.H. Lang published the first species of Cooksonia in 1934. He gave the genus name Cooksonia in honor of the Australian paleo botanist Isabel Cookson

A superb example of adaptation: response to decrease CO_2 content



Decrease of stomata as a response to an increased CO_2 content

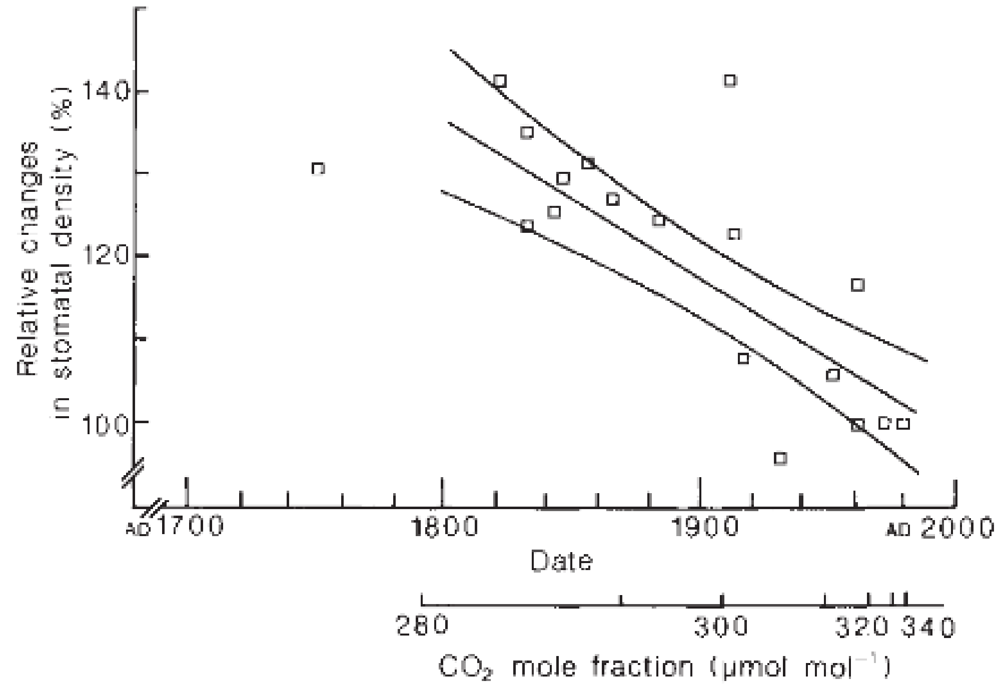


Fig. 1 Abaxial stomatal densities of herbarium stored leaves of *Acer pseudoplatanus*, *Carpinus betulus*, *Fagus sylvatica*, *Populus nigra*, *Quercus petraea*, *Q. robur*, *Rhamnus catharticus* and *Tilia cordata*. Leaves had been stored in the herbarium in the Department of Botany, University of Cambridge. Only leaves on reproductive shoots were sampled, with the assumption that these leaves had developed in full irradiance. Five leaves of each species were sampled from different dates, back to AD 1750, and from collections

Biodiversity


is
Ourlife
28/06/2010 19:10

Reduction of biodiversity

Biodiversity



It has been recognized that biodiversity is key to securing global food supply

Source: Thrupp LA (2000). Linking agricultural biodiversity and food security. The valuable role of agrobiodiversity for sustainable agriculture. Int. Affairs 76: 265-281

Source: International Union for Conservation of Nature (IUCN)

REVIEW

doi:10.1038/nature11148

Biodiversity loss and its impact on humanity

Bradley J. Cardinale[1], J. E… …ooper[4], Charles Perring…
Georgina M. Mace[6], Dav… …Gretchen C. Daily[9], Mi…
Anne Larigauderie[12], Dia…

whether there is any connection

ECOLOGY

Food and Bi…

H. Charles J. Godfray

Density-yield curves help evaluate whether land sharing or land sparing most benefits biodiversity.

LETTE…

doi:10.1038/nature11118

A global syn… …s as a major driver of ec…

David U. Hooper[1], E. Carol … …Kristin L. Matulich[6], Andrew Gonzalez[7], J. Emmett Duffy[8], Lars Gamfeldt[9] & Mary I. O'Connor[2,10]

Biodiversity

Uniformity

LETTER

doi:10.1038/nature10282

High plant diversity is needed to maintain ecosystem services

Forest Isbell[1], Vincent Calcagno[1], Andy Hector[2], John Connolly[3], W. Stanley Harpole[4], Peter B. Reich[5,6], Michael Scherer-Lorenzen[7], Bernhard Schmid[2], David Tilman[8], Jasper van Ruijven[9], Alexandra Weigelt[10], Brian J. Wilsey[4], Erika S. Zavaleta[11] & Michel Loreau[1]

EMBO *reports*

outlook

Natural immunity

Biodiversity loss and inflammatory diseases are two global megatrends that might be related

Leena von Hertzen, Ilkka Hanski & Tari Haahtela

PERSPECTIVES

SCIENCE AND SOCIETY

Protecting crop genetic diversity for food security: political, ethical and technical challenges

José Esquinas-Alcázar

Food security

PNAS

Biodiversity can support a greener revolution in Africa

Sieglinde S. Snapp[a,1], Malcolm J. Blackie[b], Robert A. Gilbert[c], Rachel Bezner-Kerr[d], and George Y. Kanyama-Phiri[e]

[a]The Kellogg Biological Station, Department of Crop and Soil Sciences, Michigan State University, Hickory Corners, MI 49060; [b]The Farmhouse, Cringleford, Norwich NR4 6TR, United Kingdom; [c]Everglades Research and Education Center, University of Florida, Belle Glade, FL 33430; [d]Department of Geography, University of Western Ontario, London, ON, Canada N6A 5C2; and [e]Department of Crop Sciences, Bunda College of Agriculture, University of Malawi, Lilongwe, Malawi

Edited by Robert W. Kates, Independent Scholar, Trenton, ME, and approved October 19, 2010 (received for review May 23, 2010)

Plant Breeding

EMBO reports

outloo

Natural immunity

Biodiversity loss and inflammatory diseases are two global megatrends that might be related

Leena von Hertzen, Ilkka Hanski & Tari Haahtela

We are witnessing two global and deeply worrying trends that, at first glance, seem unrelated. The first trend is the ongoing decline in biodiversity, which is caused by human actions. It could well become the sixth mass extinction of animal and plant species on Earth, comparable in magnitude with the fifth mass extinction at the end of the Cretaceous, 65 million years ago. The second trend is a rapid increase in chronic diseases that are associated with inflammation, especially in

microbiota? What is the relationship of the microbiota living on our skin, in our respiratory system and in our gut, with the environmental microbiota? What are the effects of any changes in human bacterial communities on human health?

Our proposal would expand the 'hygiene hypothesis', which posits that environments rich in microbial diversity confer protection against allergic and autoimmune diseases (Rook, 2009). While the hygiene hypothesis mainly focuses on microbes in the

Overall, one-third of the 56,0 animal and plant species that are sufficiently well known to allow the evaluation of their status are threatened

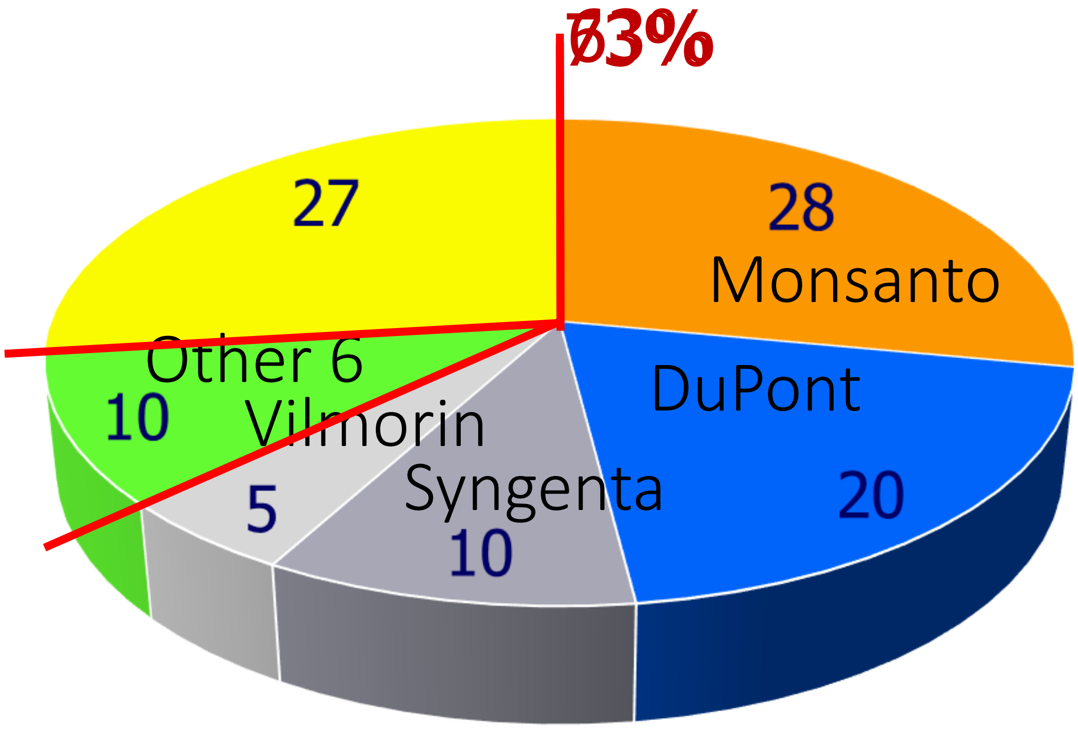
decline shows no signs of slowing down; various pressures on biodiversity continu increase (Butchart *et al*, 2010). On the b of figures from the Millennium Ecosys Assessment, the pre-human backgro

These 10 Corporations Control Almost Everything You Buy

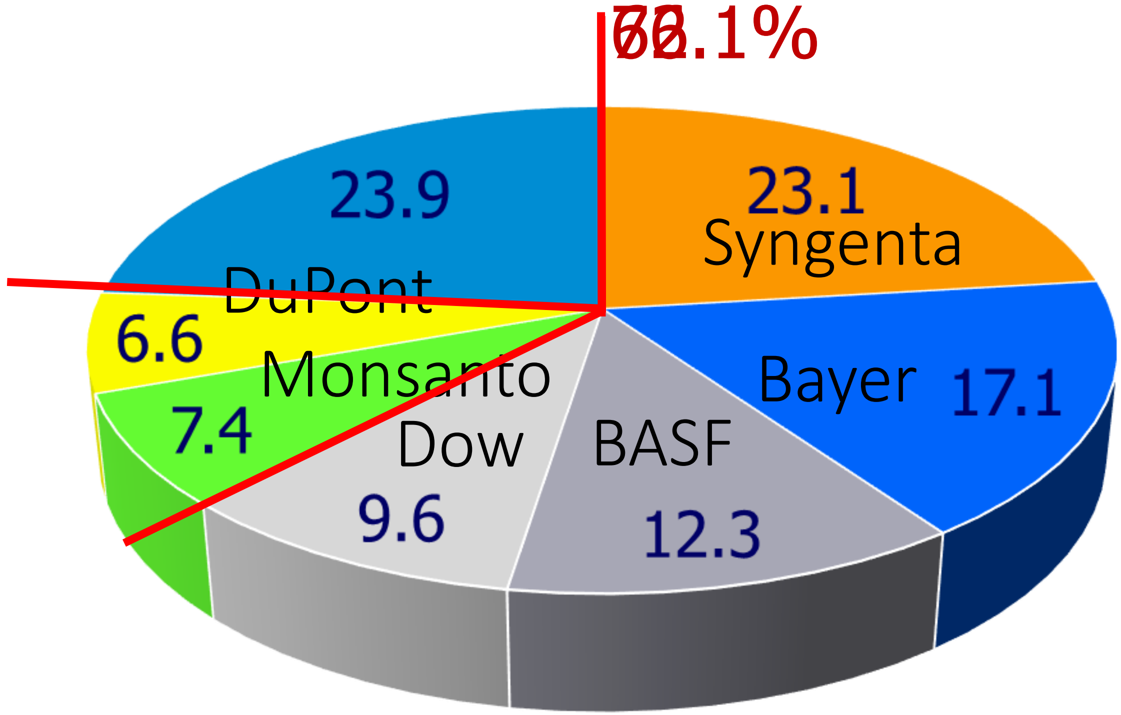
Who decides what you will have for dinner tonight?

A uniformity-dominated agriculture

The percent share of the global seed market



The percent share of the global pesticides market



Out of the 12 most dangerous chemicals in the world, 9 are pesticides

Growing Up With Pesticides

Long-term studies of the effects of pesticides and other environmental chemicals on the very young brain are coming up with worrisome results

SALINAS VALLEY, CALIFORNIA—It's a sunny July day, sweltering by midmorning. Fields with meticulously maintained rows of lettuce and bushy, berry-laden strawberry plants

ings I remember I would ask my husband, 'What's that smell?' " Aguilar recalls. But they became accustomed to it. "That was normal for us at that time," Aguilar says. Today

ences in certain brain regions during early childhood development.

A main culprit in the Columbia study, chlorpyrifos, was phased out in 2001 for most residential use, and urban exposure in the United States has dropped dramatically—but it's still widely used in agriculture. And a whole generation may already be suffering subtle but prolonged effects, says epidemiologist Virginia Rauh, deputy director of the Columbia Center for Children's Environ-

Are pesticides inevitable?

Approximately 99% of pests are controlled by natural enemy species and host plant resistance

Each insect pest has an average of 10-15 natural enemies that help control it

Source: Pimentel, D., Wilson, C., McCullum, C., Huang, R., Dwen, P., Flack, J., Tran, Q., Saltman, T., Cliff, B. Economic and Environmental Benefits of Biodiversity, 1997 BioScience 47: 747-757.

SEED → FOOD → HEALTH

Water

Obesity and Diabetes

WHAT SOLUTION?

Climate Change

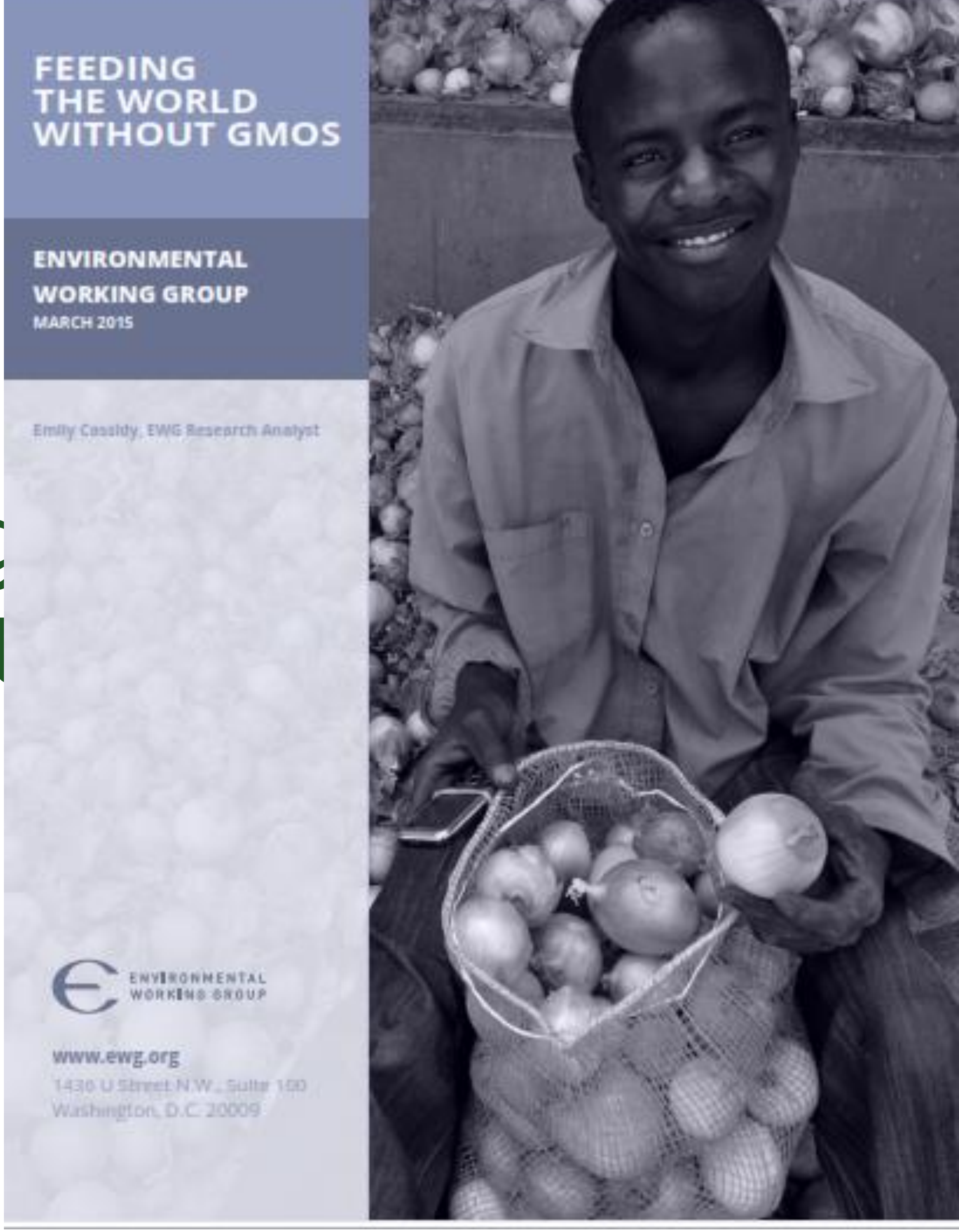
Poverty

Hunger and Malnutrition

Biodiversity

GM crops
can not be
the solution

Because they ig
Theorem of Nat



The fundamental theorem of natural selection (FTNS)

In simple terms it says that when the environment of a living organism changes, the organism evolves to adapt to a new environment

Predicts the speed of adaptation, a population's mean fitness as the ratio of its additive genetic variance in absolute fitness, $V_A(W)$, to its mean absolute fitness, $\overline{W}$

(Fisher, 1930)

In 2004 a farmer reported that few plants of the weed "pigweed" was resistant to Roundup

In 1997 GM cotton resistant to Roundup is introduced in USA

In 2012, 92% of farmers in

Geo… e

GM…

Source: Crop Science Society of America News

In the best of the hypothesis GMOs can only be a temporary solution which creates another problem

OPEN ACCESS Freely available online — PLoS on

Field-Evolved Resistance to Bt Maize by Western Corn Rootworm

Aaron J. Gassmann*, Jennifer L. Petzold-Maxwell, Ryan S. Keweshan, M

Department of Entomology, Iowa State University, Ames, Iowa, United States of America

Adaptation and Invasiveness of Western Corn Rootworm: ...g Research ...ening Pest*

...Thomas W. Sappington,[2] ... Joachim Moeser,[3]

Critical Reviews in Plant Sciences, 32:458–482, 2013
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ISSN: 0735-2689 print / 1549-7836 online
DOI: 10.1080/07352689...

Resistance Mechanisms Against Arthropod Herbivores in Cotton and Their Interactions ...

S. Hagenbucher,[1] D. M. Olson,[2] J. R. Ruberso...

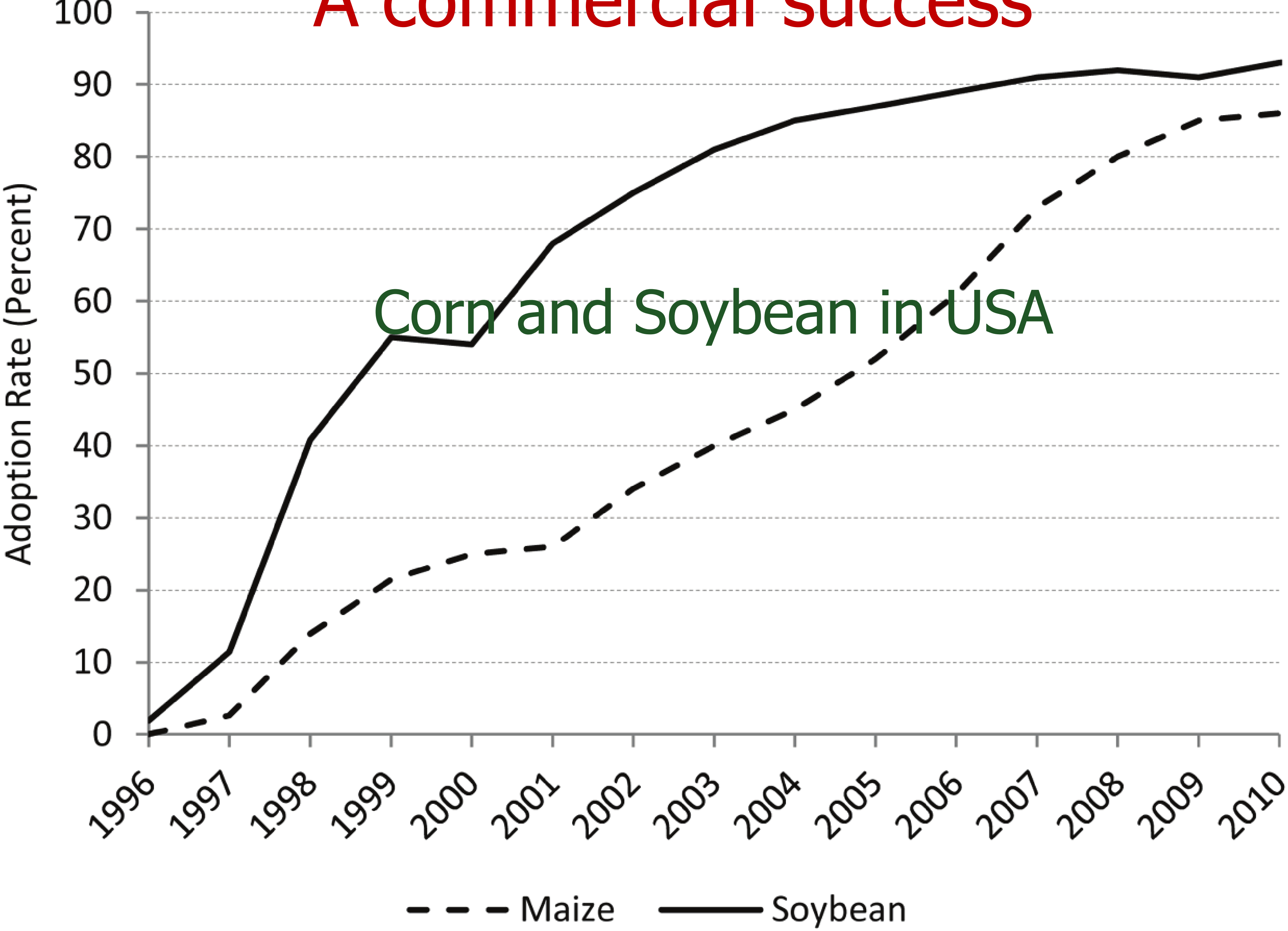
Pest trade-offs in technology: reduced damage by caterpillars in Bt cotton benefits aphids

...Wäckers[2], Felix E. Wettstein[1], Dawn M. Olson[3], ...omeis[1]

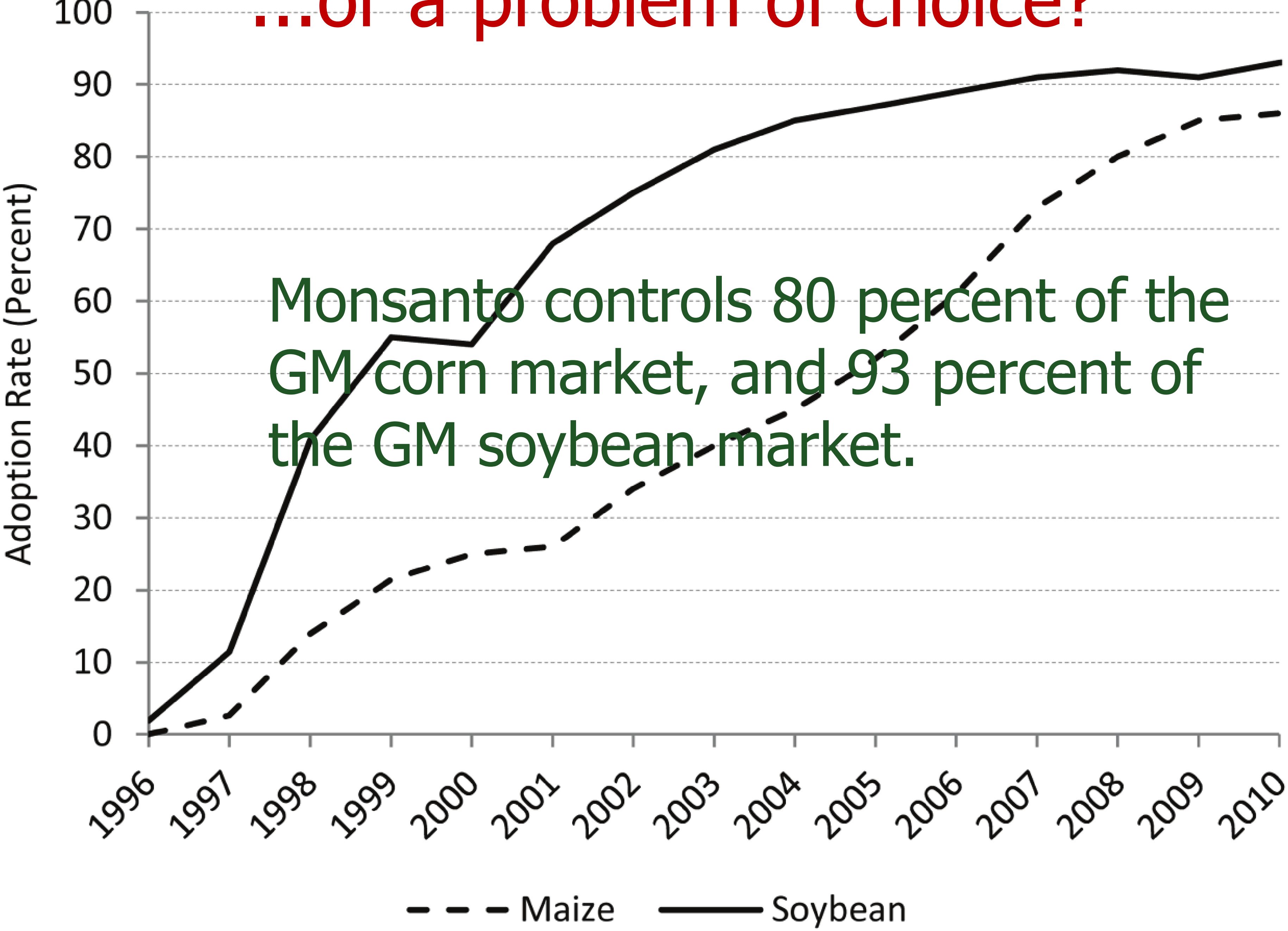
Mirid Bug Outbreaks in Multiple Crops Correlated with Wide-Scale Adoption of Bt Cotton in China

Yanhui Lu,[1] Kongming Wu,[1]* Yuying Jiang,[2] Bing Xia,[2] Ping Li,[2] Hongqiang Feng,[1] Kris A. G. Wyckhuys,[1]† Yuyuan Guo[1]

A commercial success



...or a problem of choice?



Monsanto controls 80 percent of the GM corn market, and 93 percent of the GM soybean market.

Use of Pesticides

Table 1 Projected rates of change in herbicide use since the most recent USDA survey, relative to recent annual percent changes in rates

	2010-2011	2005-2010	Per Year 2005-2010
Corn			
Total Herbicides	2%	10.2%	2.0%
Glyphosate	2.5%	[illegible]	2.5%
Soybeans	**2007-2011**	**2000-2006**	**Per Year 2000-2006**
Total Herbicides	3.2%	35.2%	5.9%
Glyphosate	3.3%	53.4%	8.9%
Cotton	**2010-2011**	**2007-2010**	**Per Year 2007-2010**
Total Herbicides	2.2%	3.1%	1.0%
Glyphosate	-1%	-10.3%	-3.4%

Substantial increases in the number and volume of herbicides applied

Organic Agriculture: the problem

Organic Agriculture: can be the solution

- minimizes soil erosion
- reduces water loss
- uses organic fertilizers and green manures
- uses crop rotations to minimize buildup of weeds, diseases and insect populations
- promotes evenness among natural enemies and this avoids the selection of new, often more aggressive strains of fungi, insects or weeds

Yields under organic conditions are lower than under conventional

Is a case of specific adaptation

How did we go from here to…………

…….to here?

The Evolution of Plant Breeding

For millennia plant breeding has been done by farmers

Many different farmers in very many places

Selected for specific adaptation

Diversity within and between landraces

Landraces

Resilience at farmer and at global level

The Evolution of Plant Breeding

With the beginning of Genetics plant breeding was taken away from farmers and started being done by very few people in very few places

Selection for wide adaptation

↓

Displacement of landraces

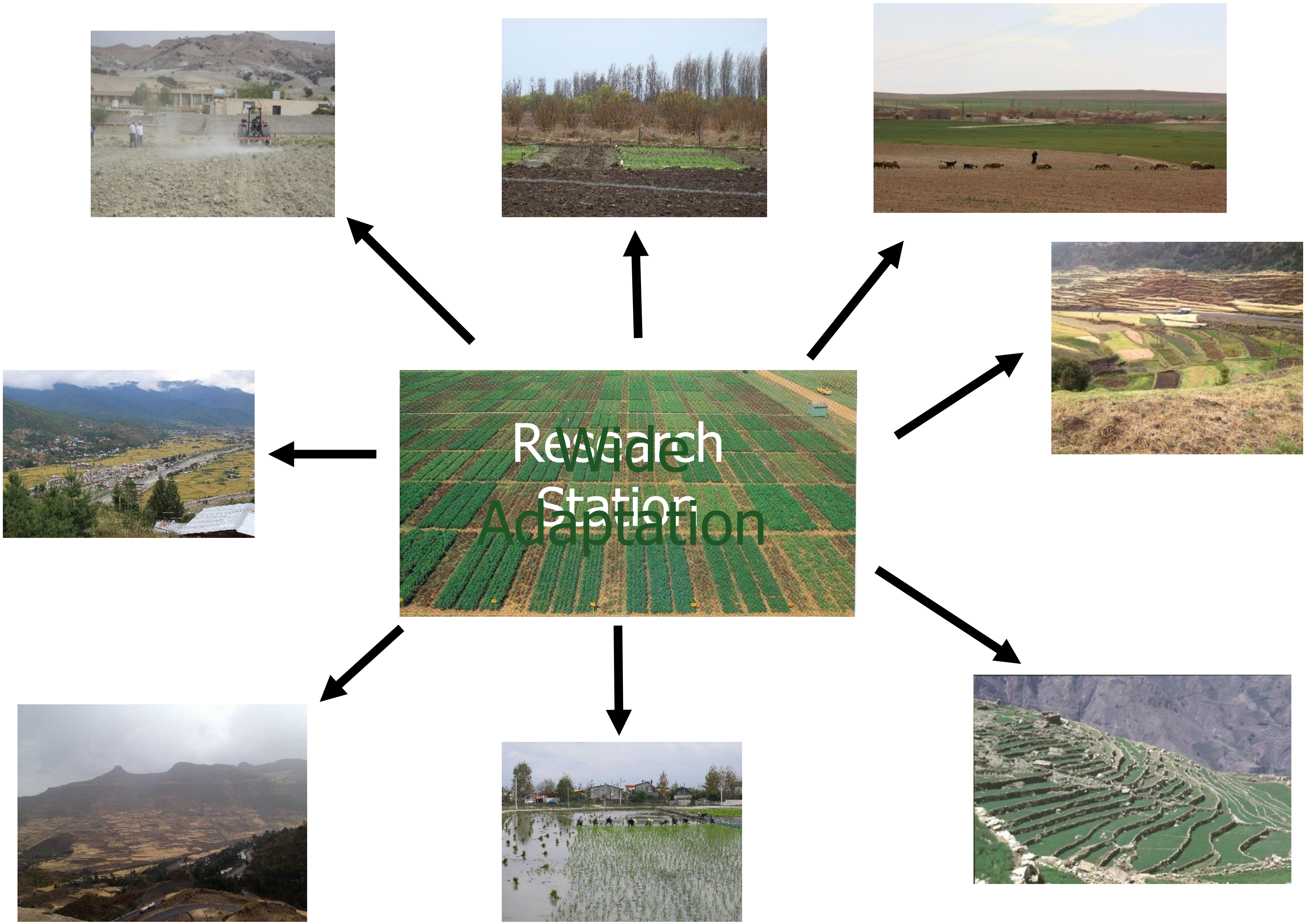
Plant Breeding and Wide Adaptation

The Green Revolution

A definition used for the first time by William Gaud, the then Director of USAID to indicate a movement to increase agricultural production based on:

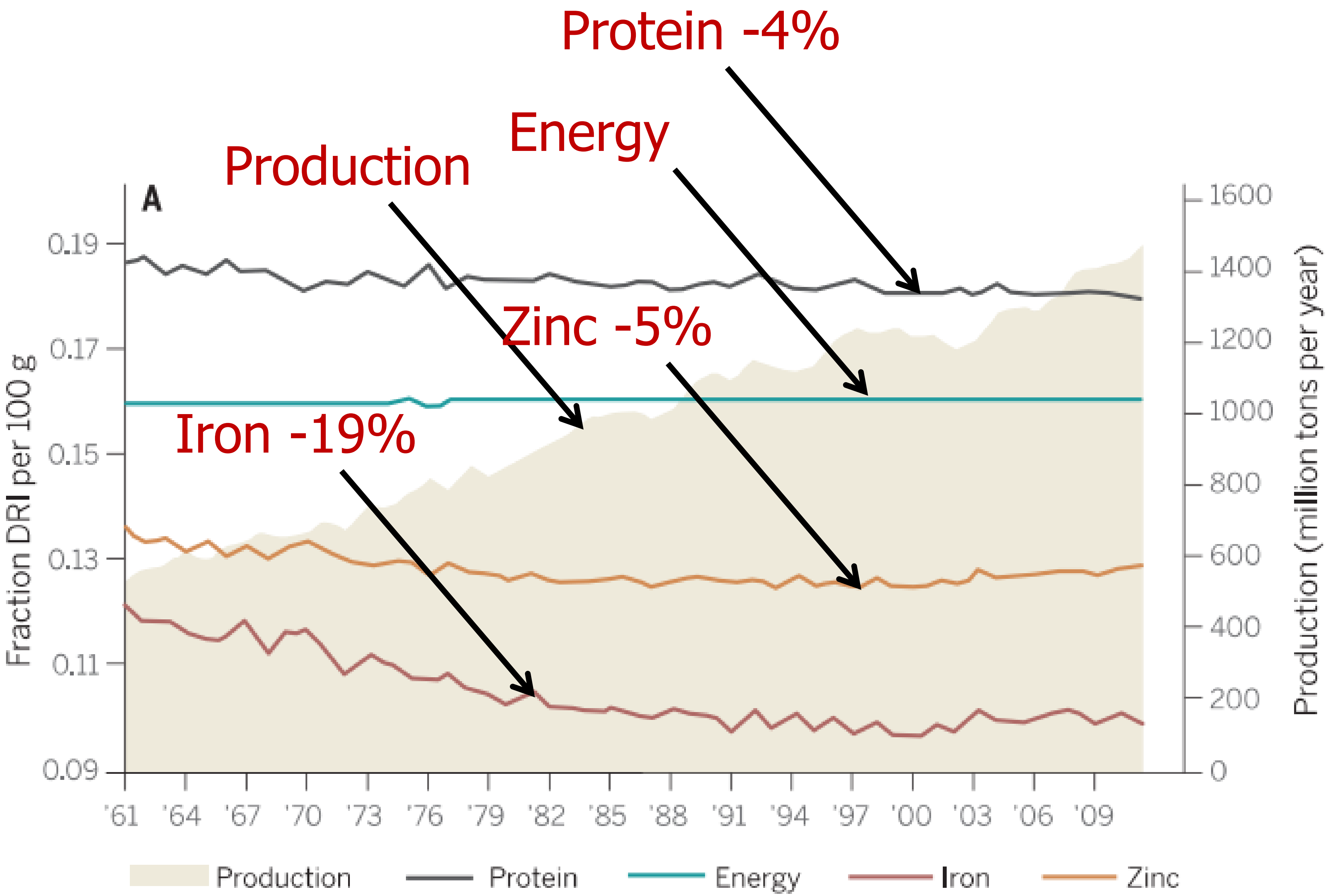
- New varieties
- Irrigation
- Fertilizers
- Pesticides
- Mechanization

Conventional Breeding



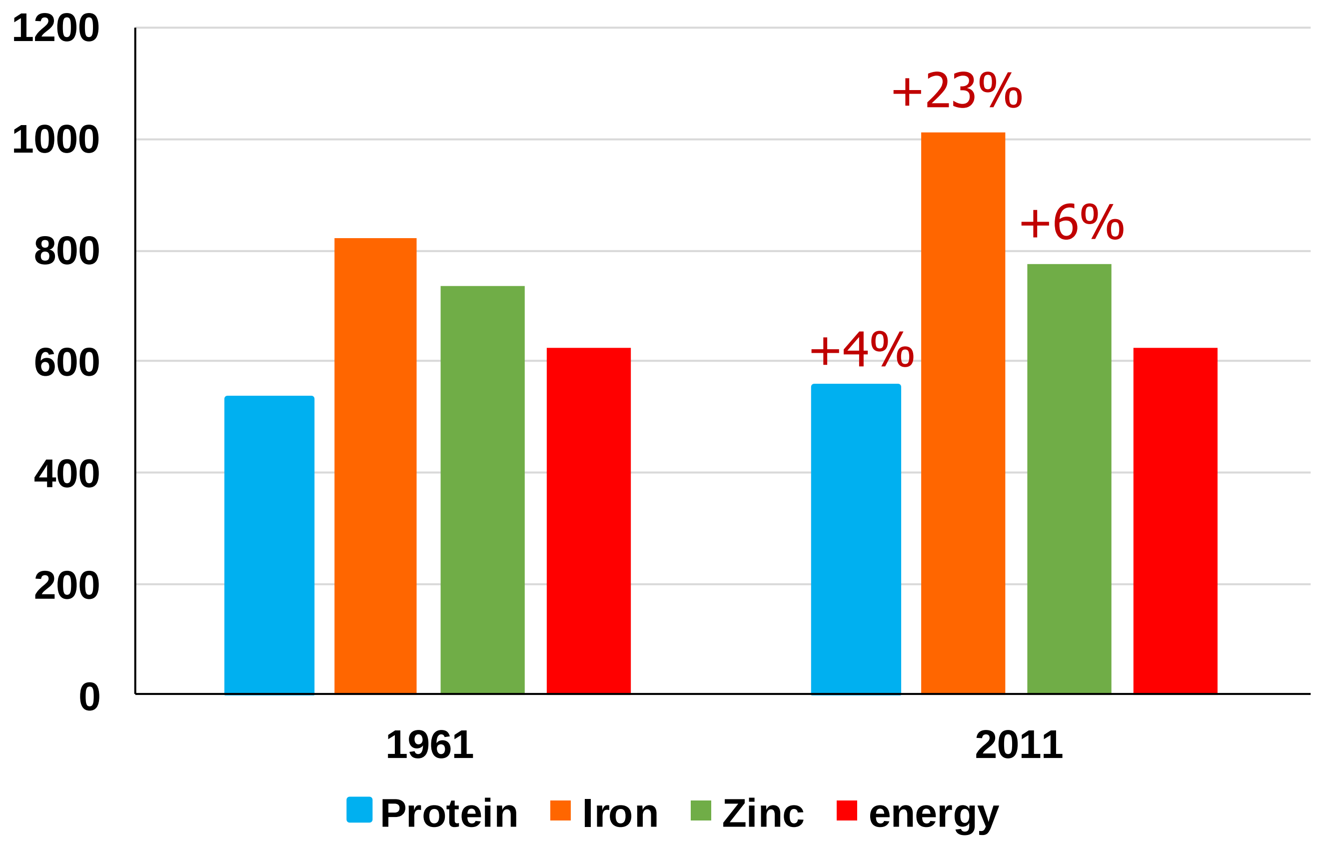
The Green Revolution

Food Security > Food Safety



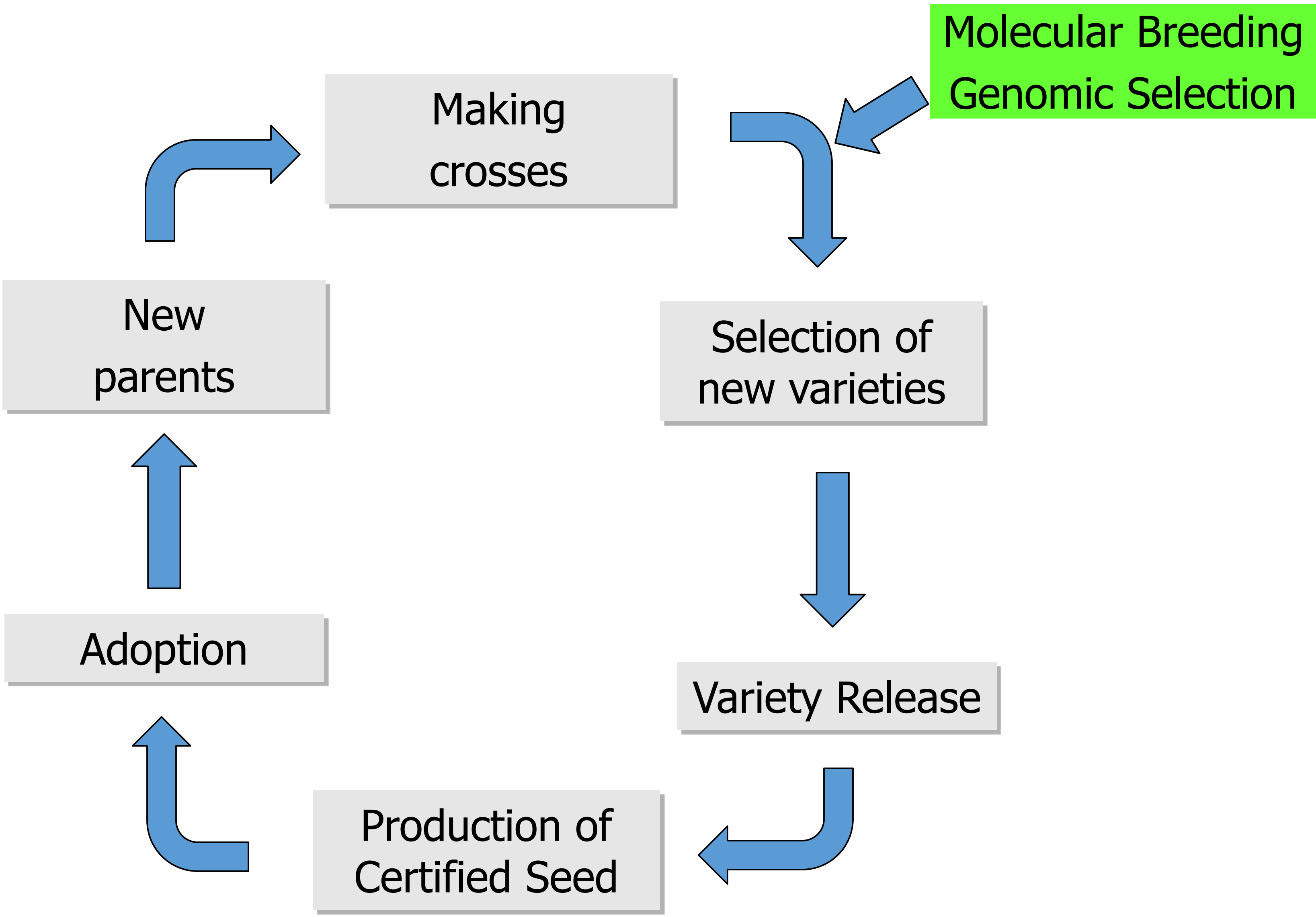
Protein -4%
Energy
Production
Zinc -5%
Iron -19%
A
0.19
0.17
0.15
0.13
0.11
0.09
Fraction DRI per 100 g
1600
1400
1200
1000
800
600
400
200
0
Production (million tons per year)
'61
'64
'67
'70
'73
'76
'79
'82
'85
'88
'91
'94
'97
'00
'03
'06
'09
Production
Protein
Energy
Iron
Zinc

Amount (g) of cereal needed to fulfil the requirement of Protein, Iron and Zinc



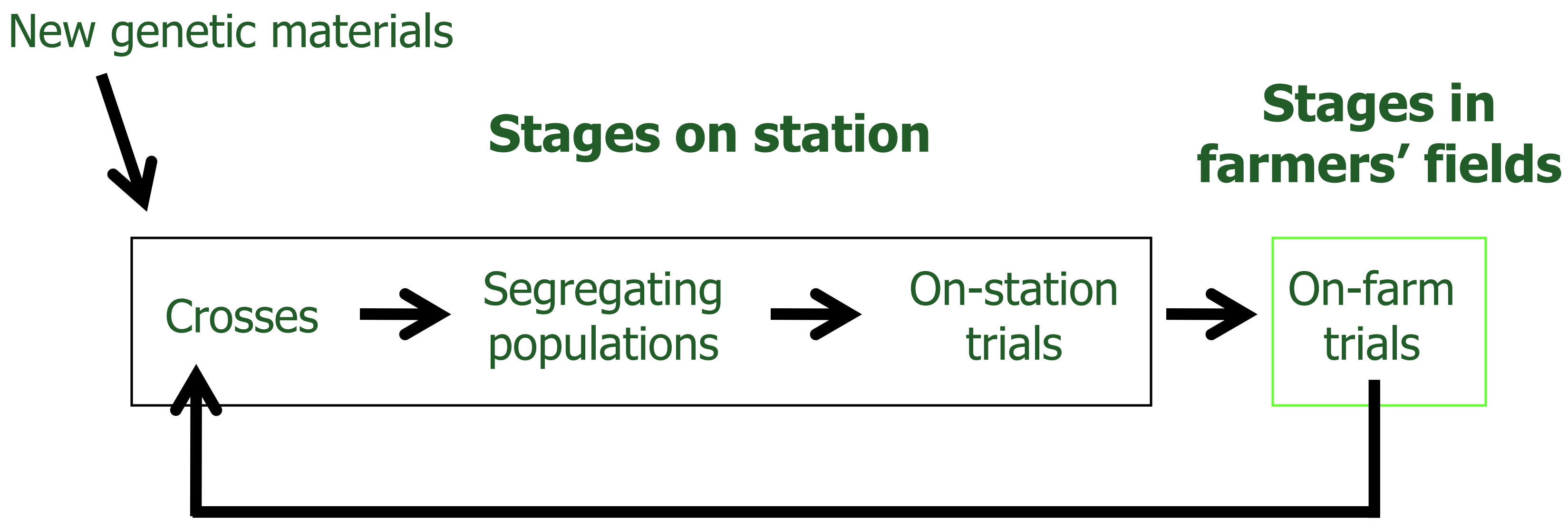
Seeds of Future

A Plant Breeding Program



Return to Diversity through Participatory Plant Breeding

A Plant Breeding Program

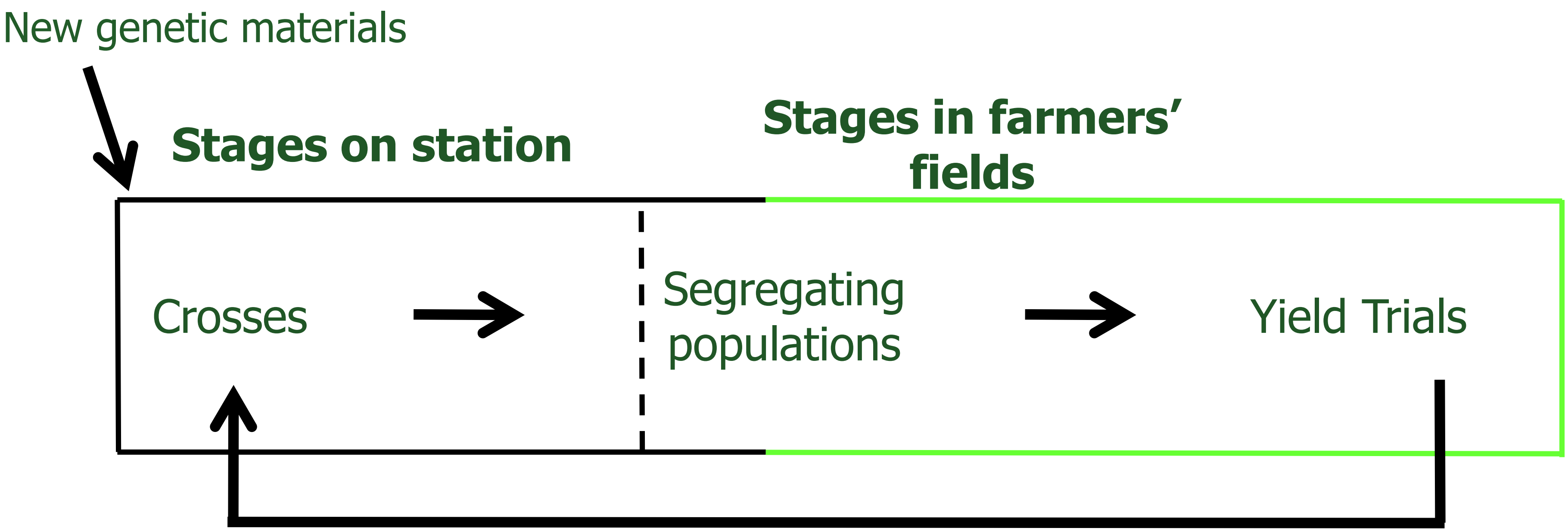


All the decisions are taken by the breeder's team

Is always partly decentralized

Participatory Variety Selection

Participatory Plant Breeding

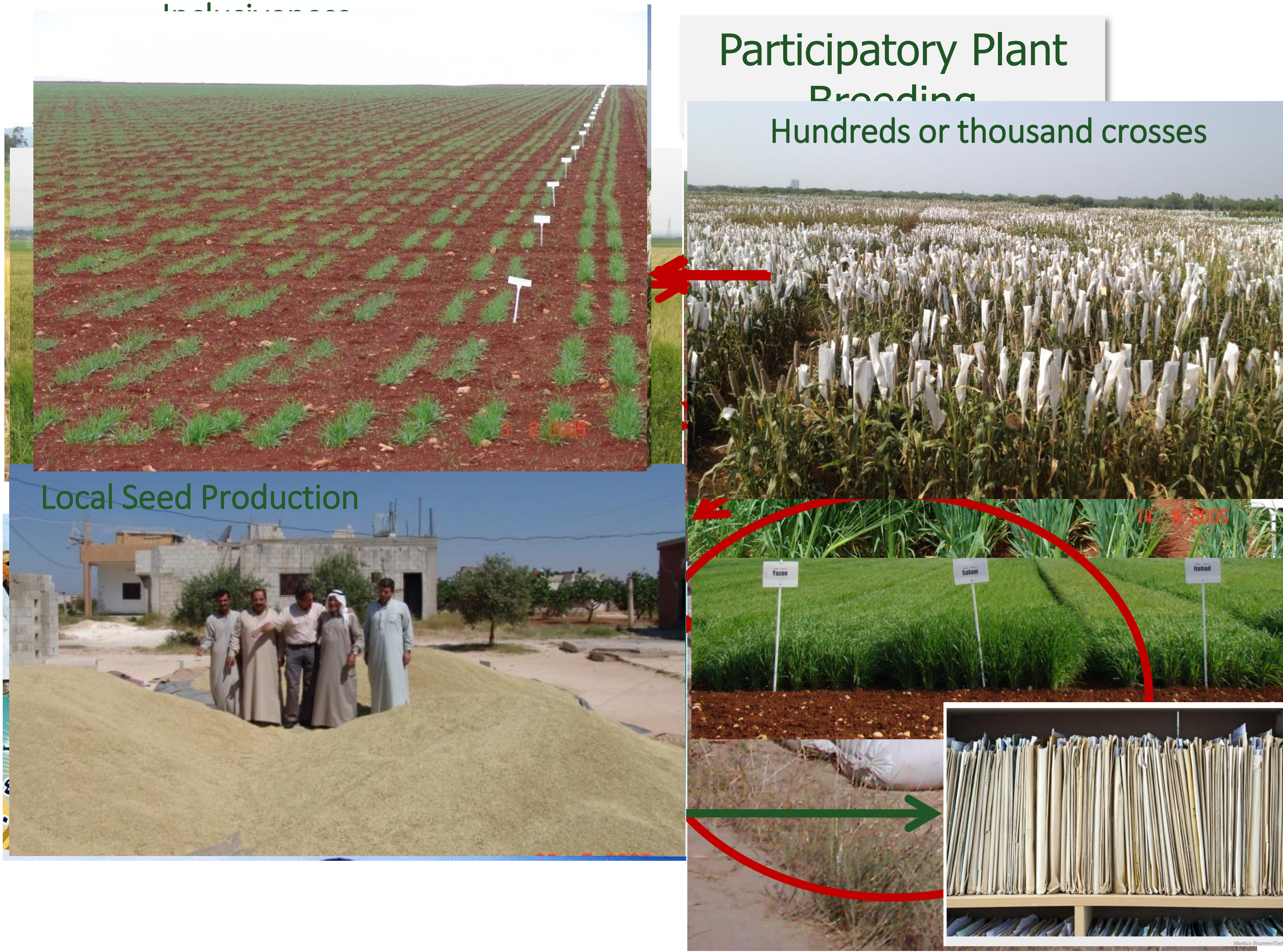


All the decisions are taken jointly by the breeder' and the farmers' community

All the decisions are taken jointly by the breeder' and the farmers' community

Decentralized

There are much less choices to be made



Participatory Plant
Hundreds or thousand crosses
Local Seed Production
Yazan
Salam
Itehad

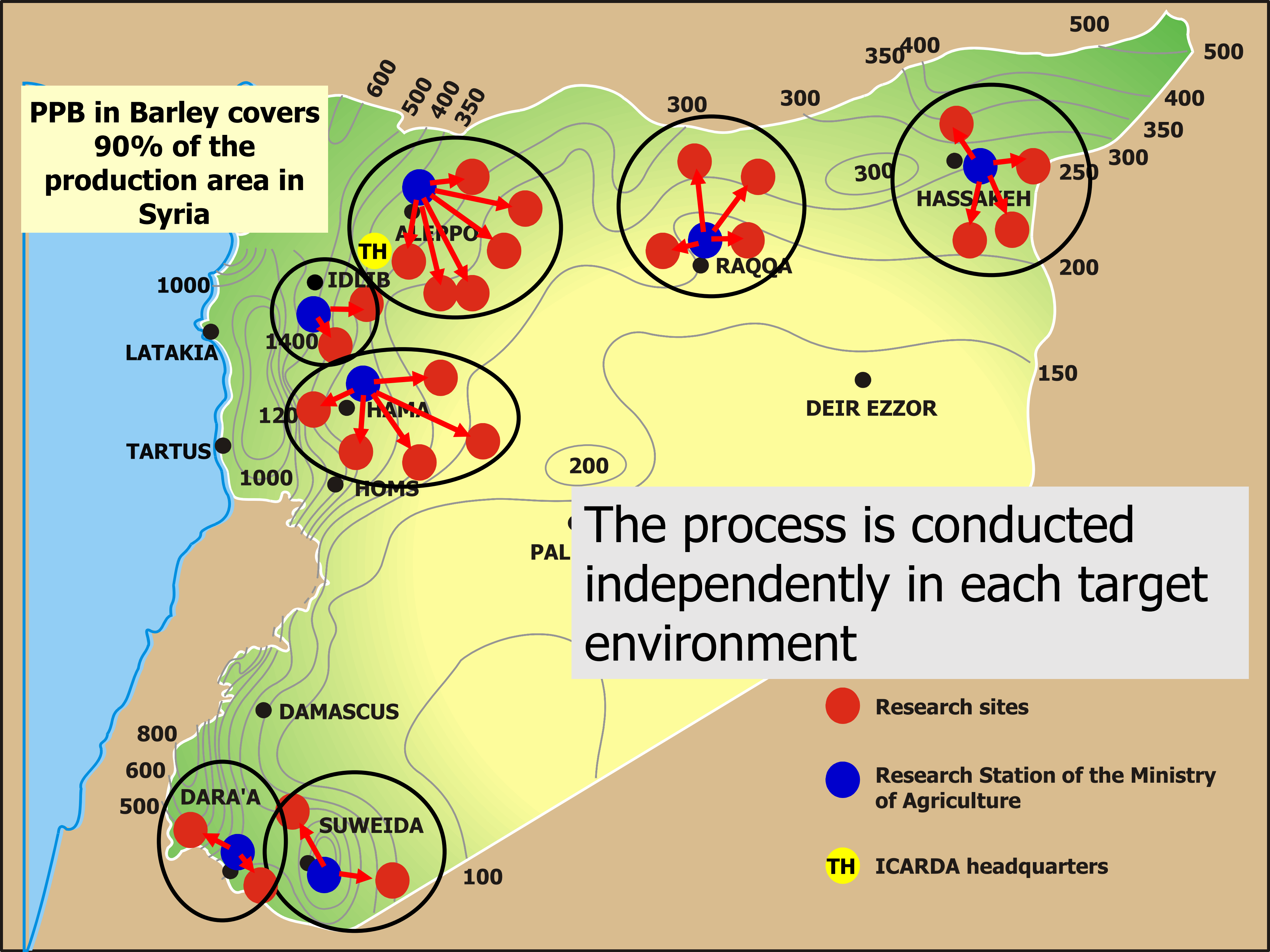
PPB changes the temporal relationship between release and adoption

Participatory Plant Breeding

Scientifically Conventional and Participatory Plant Breeding are identical processes with three organizational differences:

Trials moved from Research Station to Farmers’ Fields

Decisions shared between breeder and farmers


PPB in Barley covers 90% of the production area in Syria
The process is conducted independently in each target environment
ALEPPO
TH
IDLIB
LATAKIA
HAMA
TARTUS
HOMS
PAL
DAMASCUS
DARA'A
SUWEIDA
RAQQA
HASSAKEH
DEIR EZZOR
600
500
400
350
300
250
200
150
100
1000
1400
1200
800
Research sites
Research Station of the Ministry of Agriculture
ICARDA headquarters

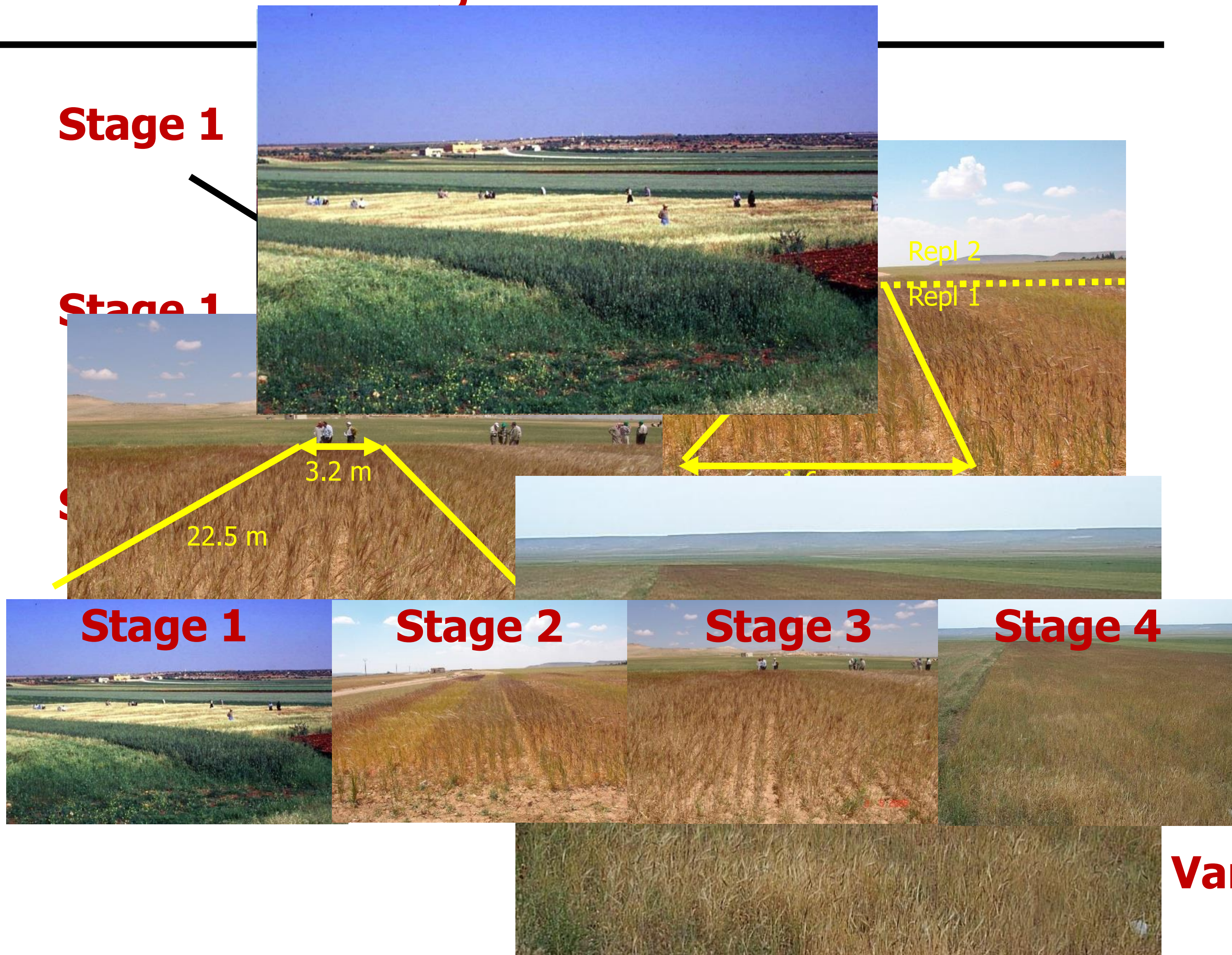
One Type of Participatory Plant Breeding Program

Year 1 **Stage 1**

Year 2 **Stage 1**

Year 3

Year 4



Variety

A Simplified Type of Participatory Plant Breeding Program

Year 1 **Stage 1**

Year 2 **Stage 2**

Year 3 **Stage 3**

Year 4 **Stage 4**

Year 5 **Stage 1** **Variety**

In each stage and in addition to the usual data collected in a breeding program a group of farmers score all the plots



At the end of the analysis the final selection for the following stage is done in a joint meeting with farmers


Terraces in Yemen

Mountains in Tigray

Organic tomato in Italy

High plateau in Ethiopia

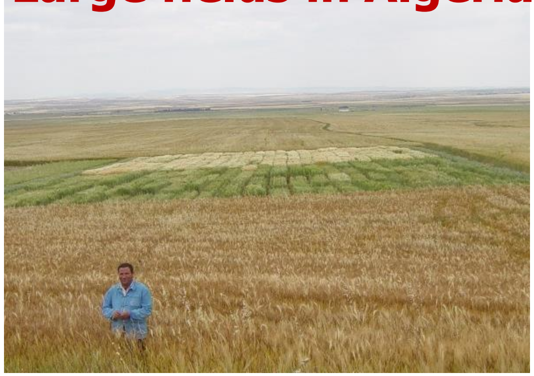
Dry Areas in Syria

Small fields in Eritrea

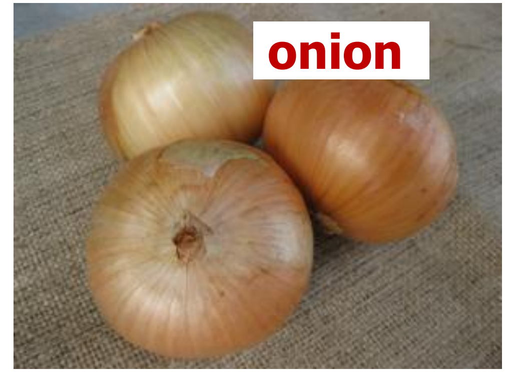
A village in East Uganda

Under irrigation in Iran

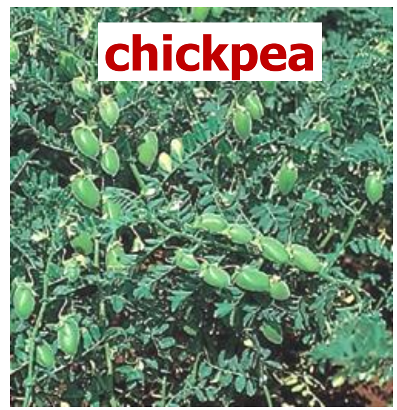
Large fields in Algeria




barley

tomato

onion

wheat

faba bean

chickpea

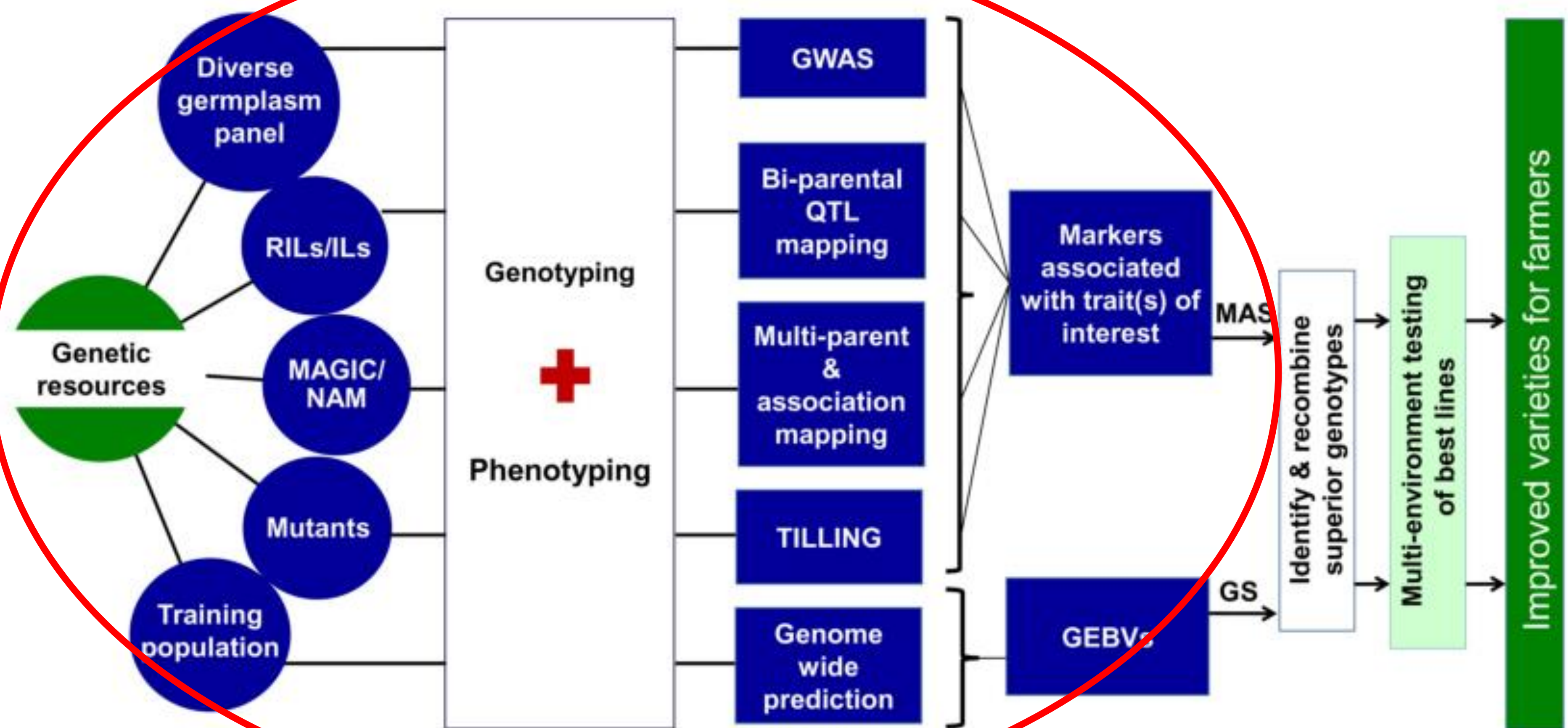
sorghum

cowpea

lentil

Genomics Assisted Breeding

Varshney, R.K., Terauchi, R., McCouch, S.R., 2014. Harvesting the Promising Fruits of Genomics: Applying Genome Sequencing Technologies to Crop Breeding. PLoS Biol 12(6): e1001883. doi:10.1371/journal.pbio.1001883



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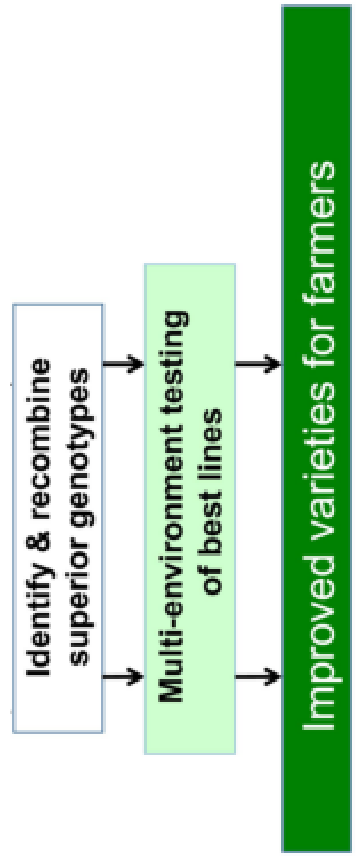

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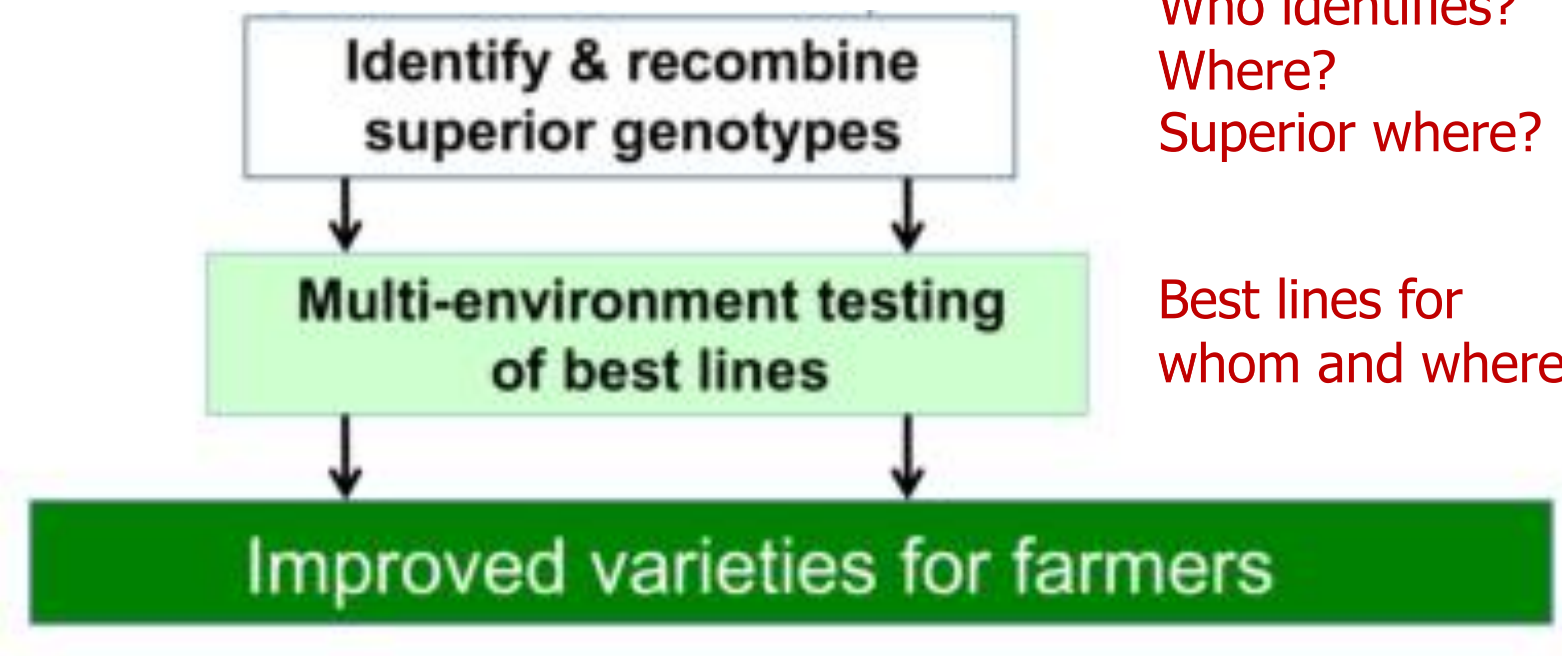
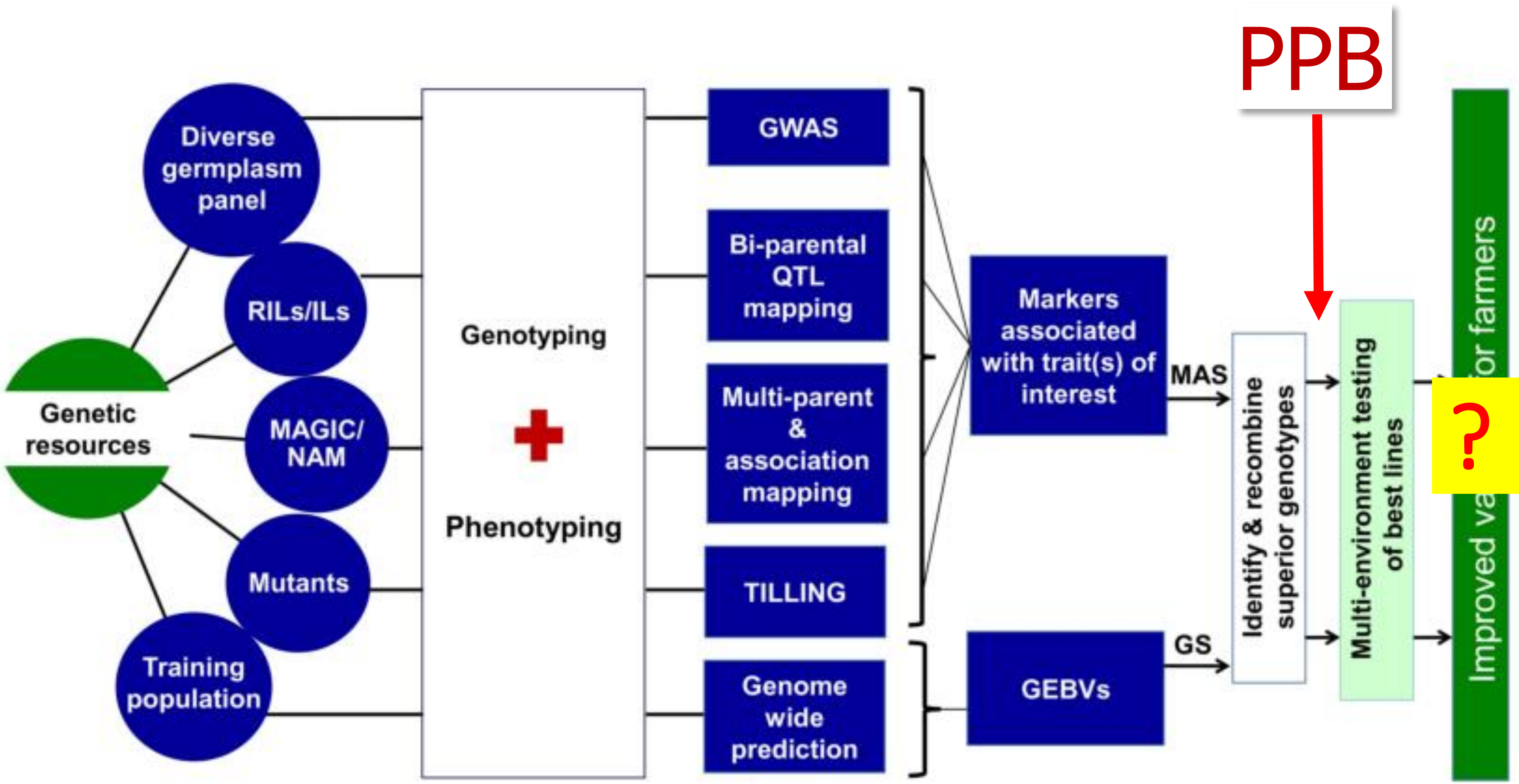


Who identifies?
Where?
Superior where? For what?

Best lines for
whom and where?

Genomics Assisted Breeding



Moving from conventional to participatory plant breeding

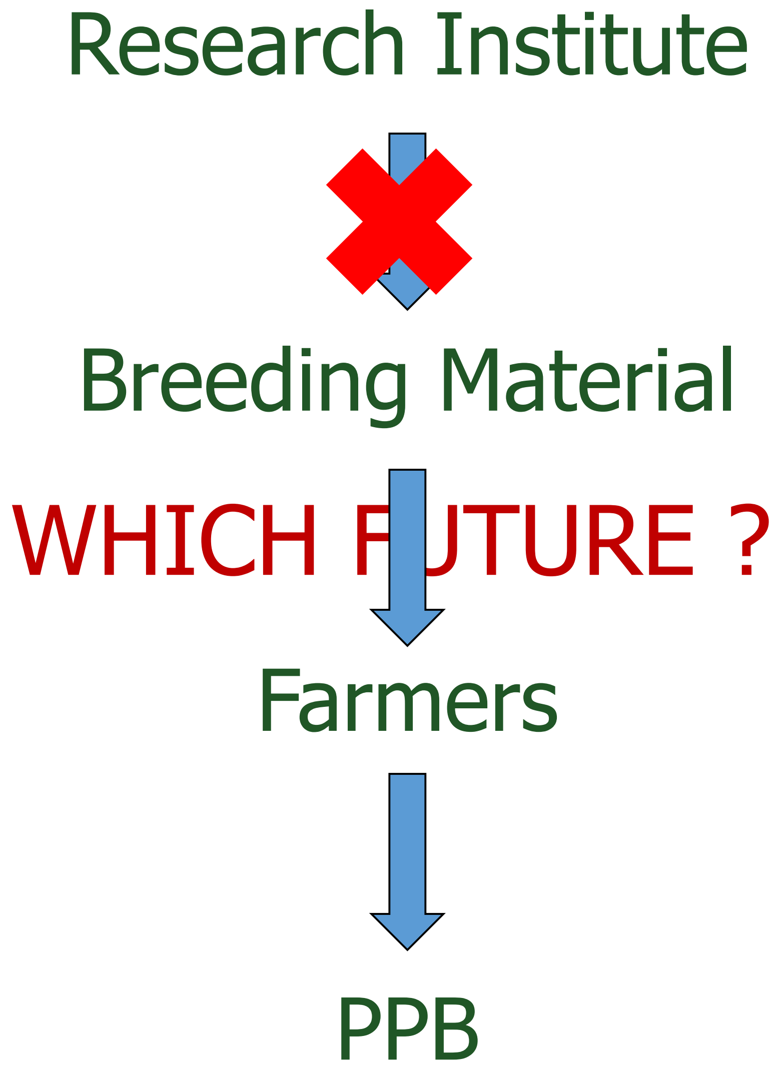
Participatory Plant Breeding: the weakness of the model

Farmers depends on external sources (usually the breeder) for the continuous flow of germplasm

The attitude of Institutions and

wards


0 95 190 380 570 760
Kilometers



Research Institute
Breeding Material
WHICH FUTURE ?
Farmers
PPB

Combining Participation and Evolution

Coit Suneson: 1940's – 1960's

Suneson (1956) – An evolutionary plant breeding method

Agronomy Journal 48:188–191

Populations obtained from thousand of crosses or from mixing new and old varieties left evolving in the target environments

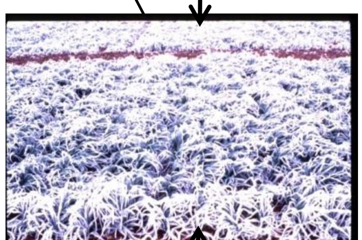
Evolutionary-Participatory Plant Breeding

Original Population

.... With evolutionary populations we exploits the Fundamental Theorem of Natural Selection to our advantage

Organic

PPB program



Cold

PPB program

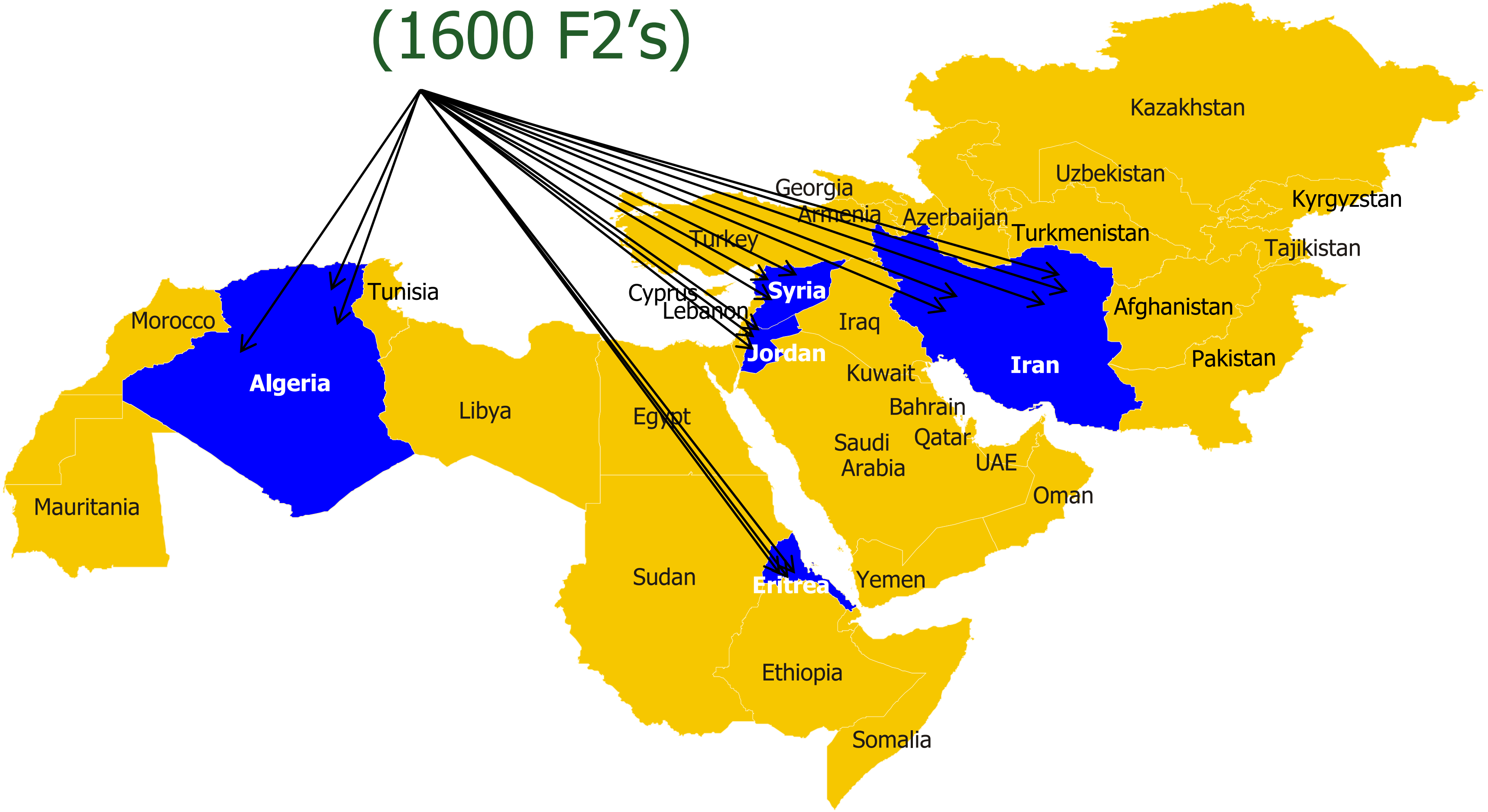
Pest and Diseases

PPB program

PPB program

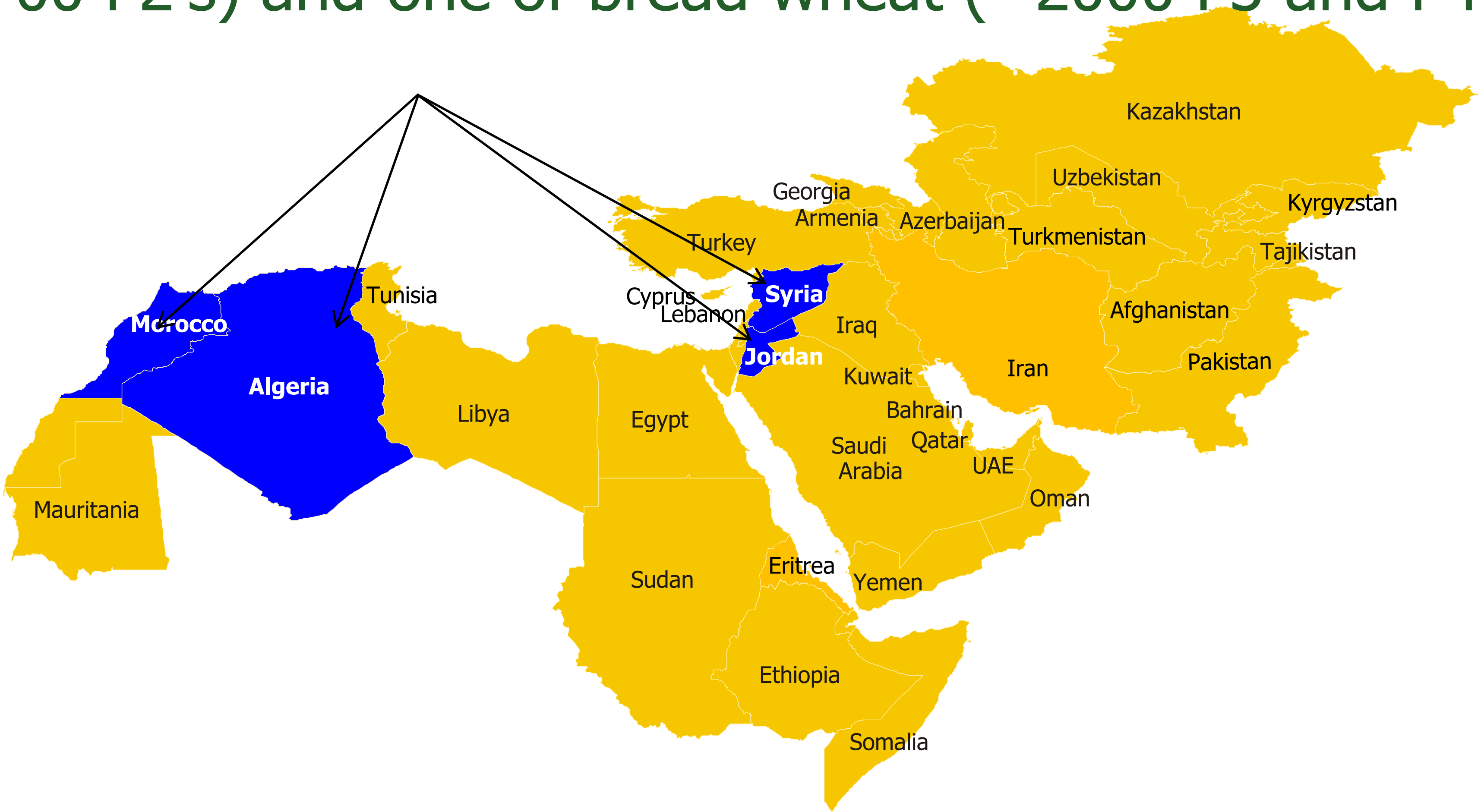
Evolutionary Plant Breeding

One evolutionary population of barley (1600 F2's)



Evolutionary Plant Breeding

One evolutionary population of durum wheat (700 F2's) and one of bread wheat (~2000 F3 and F4)



PPB. Participatory plant breeding is a methodology in which scientists and farmers collaborate during all the phases of the process that produces new varieties.

Wheat Barley

EPB. Evolutionary Plant Breeding is a methodology in which populations with a large amount of diversity are left to the effects of natural selection to slowly become better adapted to the conditions in which they evolve including changes in climate.
Natural selection can be integrated by artificial selection (e.g selections made by the farmers)

Landraces. Old varieties, in some cases still cultivated, in other cases replaced by modern varieties. When landraces disappear they may still be available in gene banks.

Mixtures. Mixtures are populations made by different varieties of the same r different crops. They are made because in general mixtures give more stable yields over different seasons than uniform crops. Also, mixtures are generally more resistant to disease than uniform crops.

Triticale. Is a hybrid of wheat (Triticum) and rye (Secale) first bred in laboratories¬ during the late 19th century. The grain was originally bred in Scotland and Sweden.

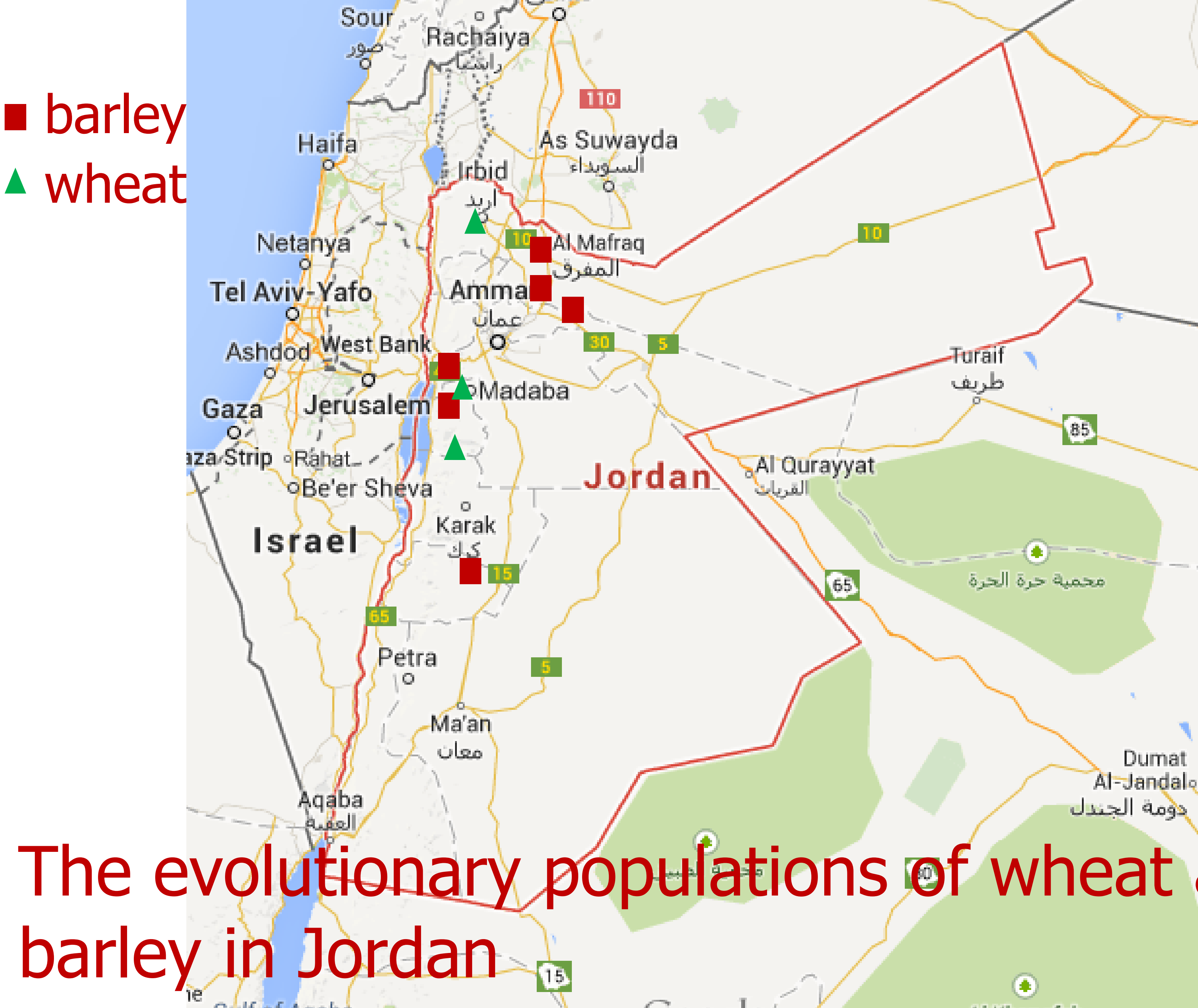
Rice. Restoring native rice seeds.

Participatory Plant Breeding (PPB) in Iran (2006-2012)

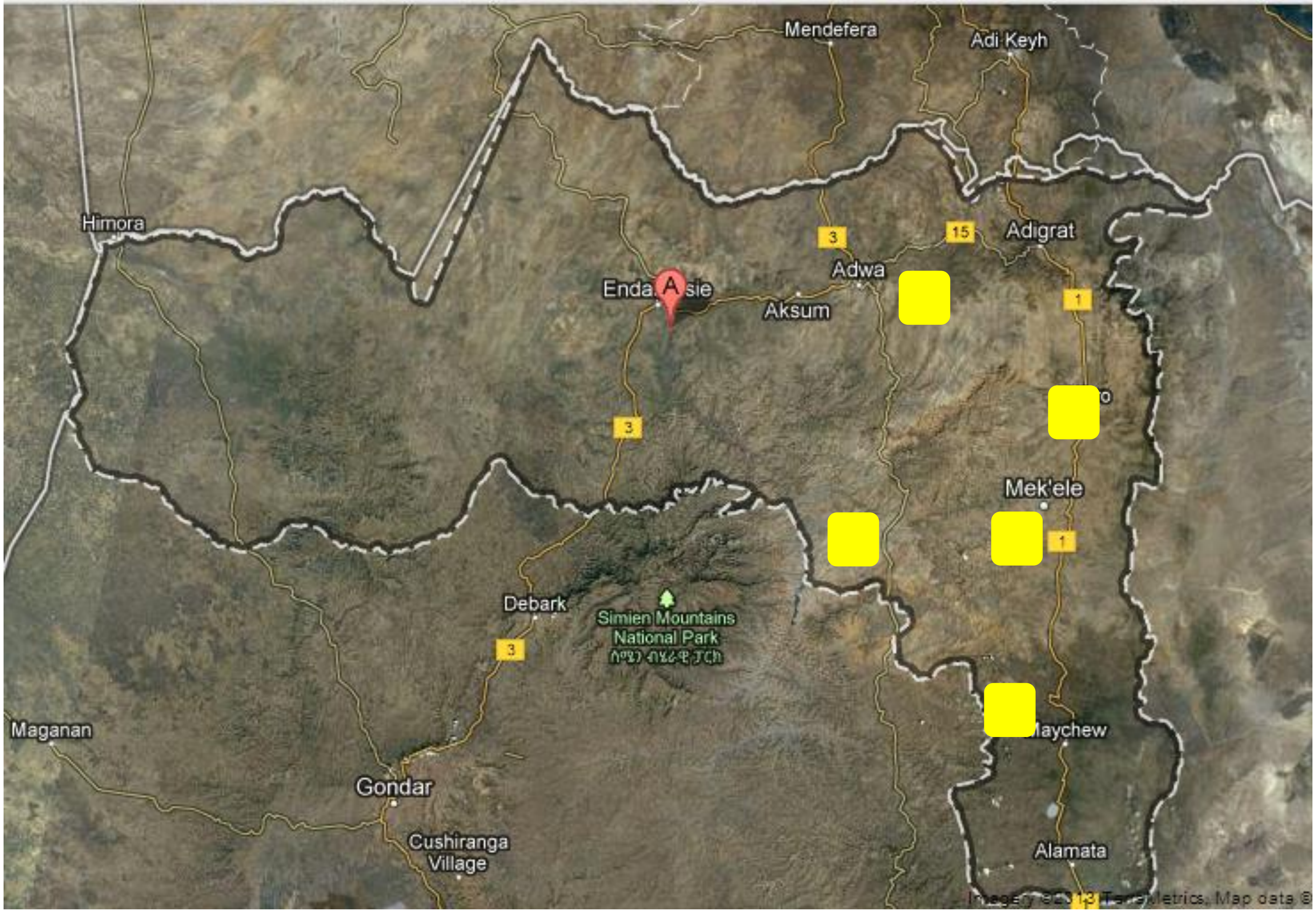
An evolutionary barley population in the Fars province (Iran) under rainfed organic conditions


An evolutionary population of barley
in Garmsar, Iran


An evolutionary population of bread
wheat in Kermanshah, Iran



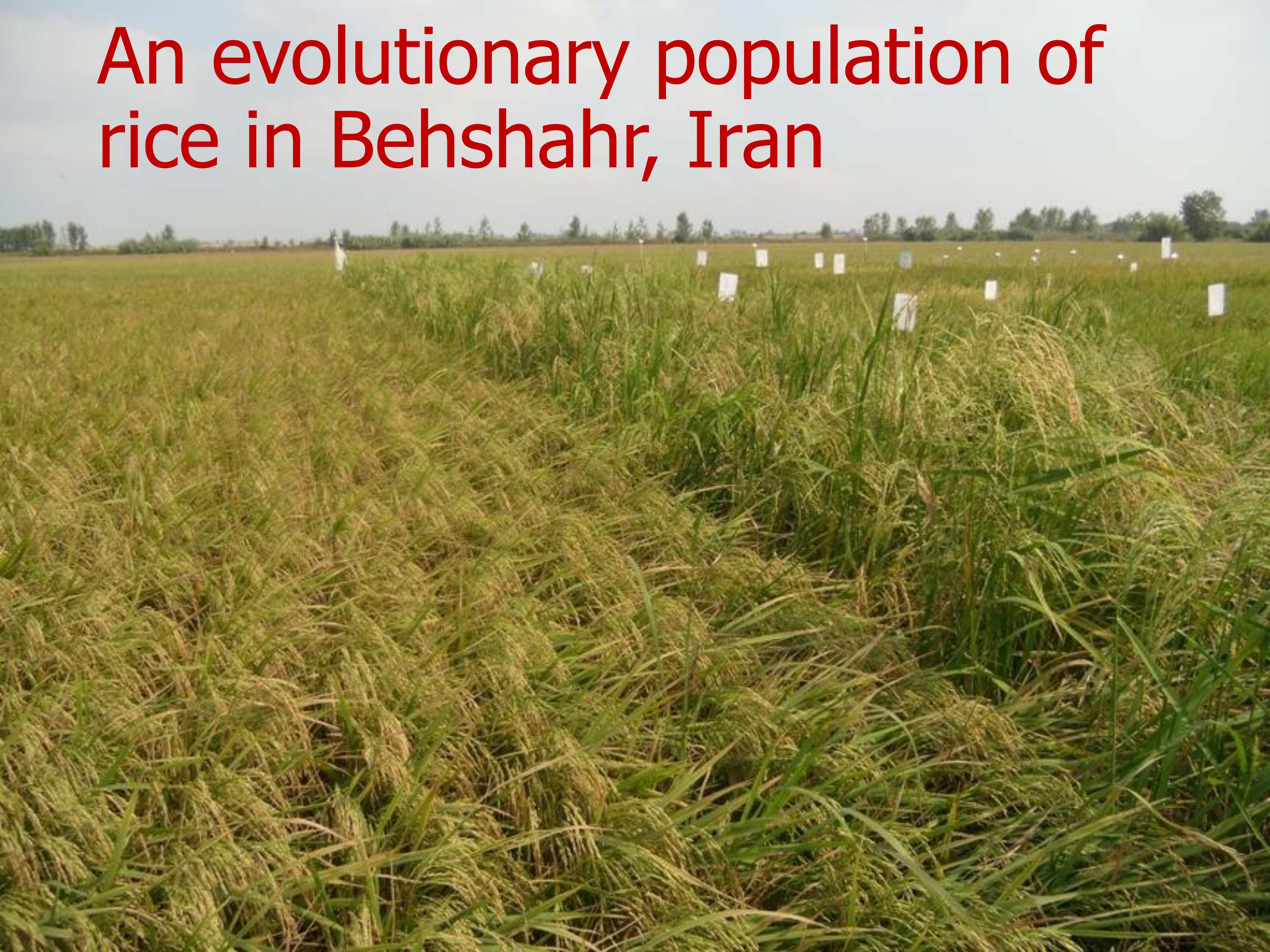
The evolutionary populations of wheat and barley in Jordan

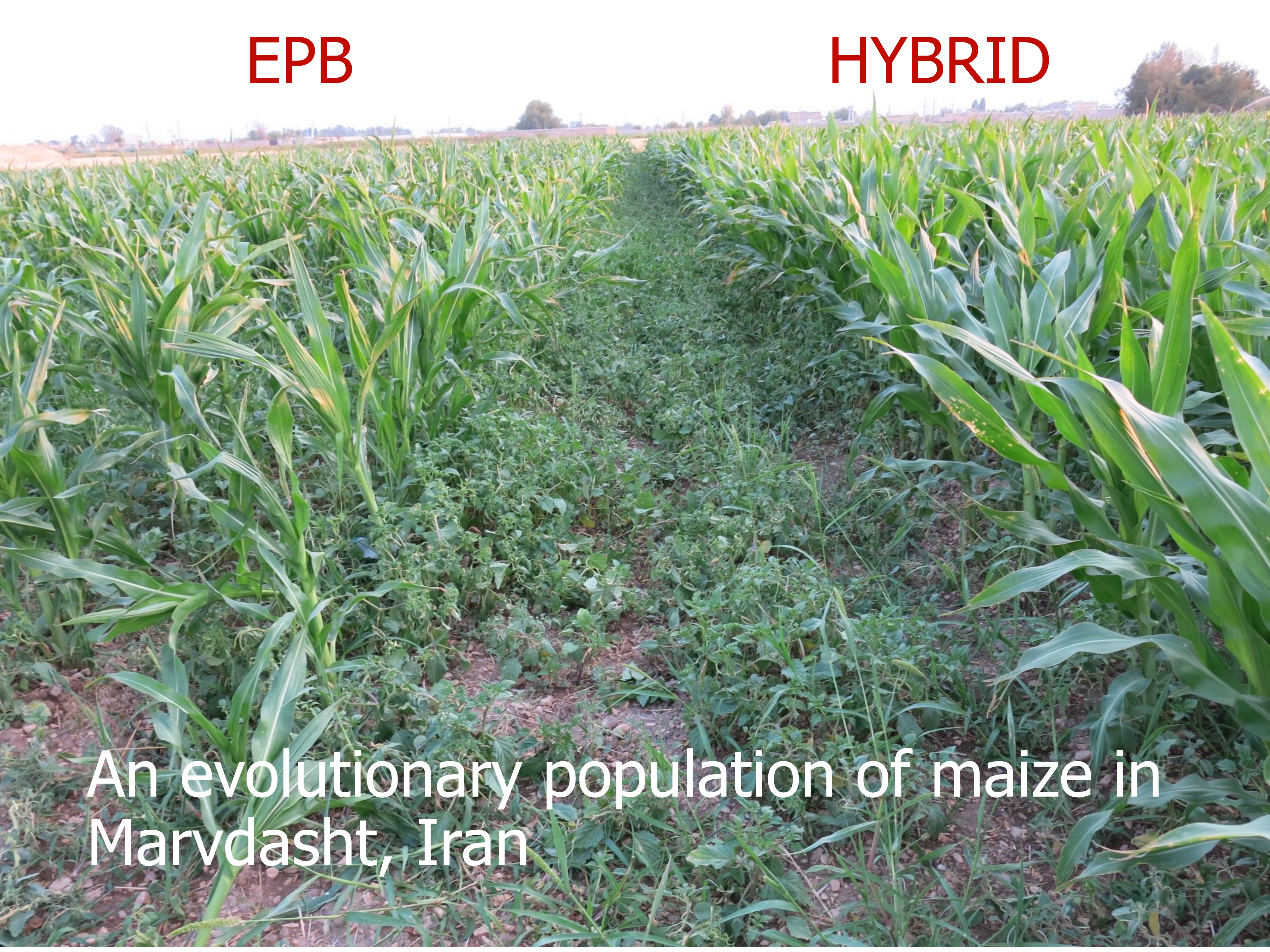


A barley evolutionary population in Tigray, Ethiopia


A barley evolutionary population at
2400 m elevation in Tigray, Ethiopia

An evolutionary population of rice in Behshahr, Iran




EPB
HYBRID
An evolutionary population of maize in Marvdasht, Iran

An evolutionary population of rice in Dehradun, India

A winter wheat evolutionary population at Washington State, USA

Barley and Wheat

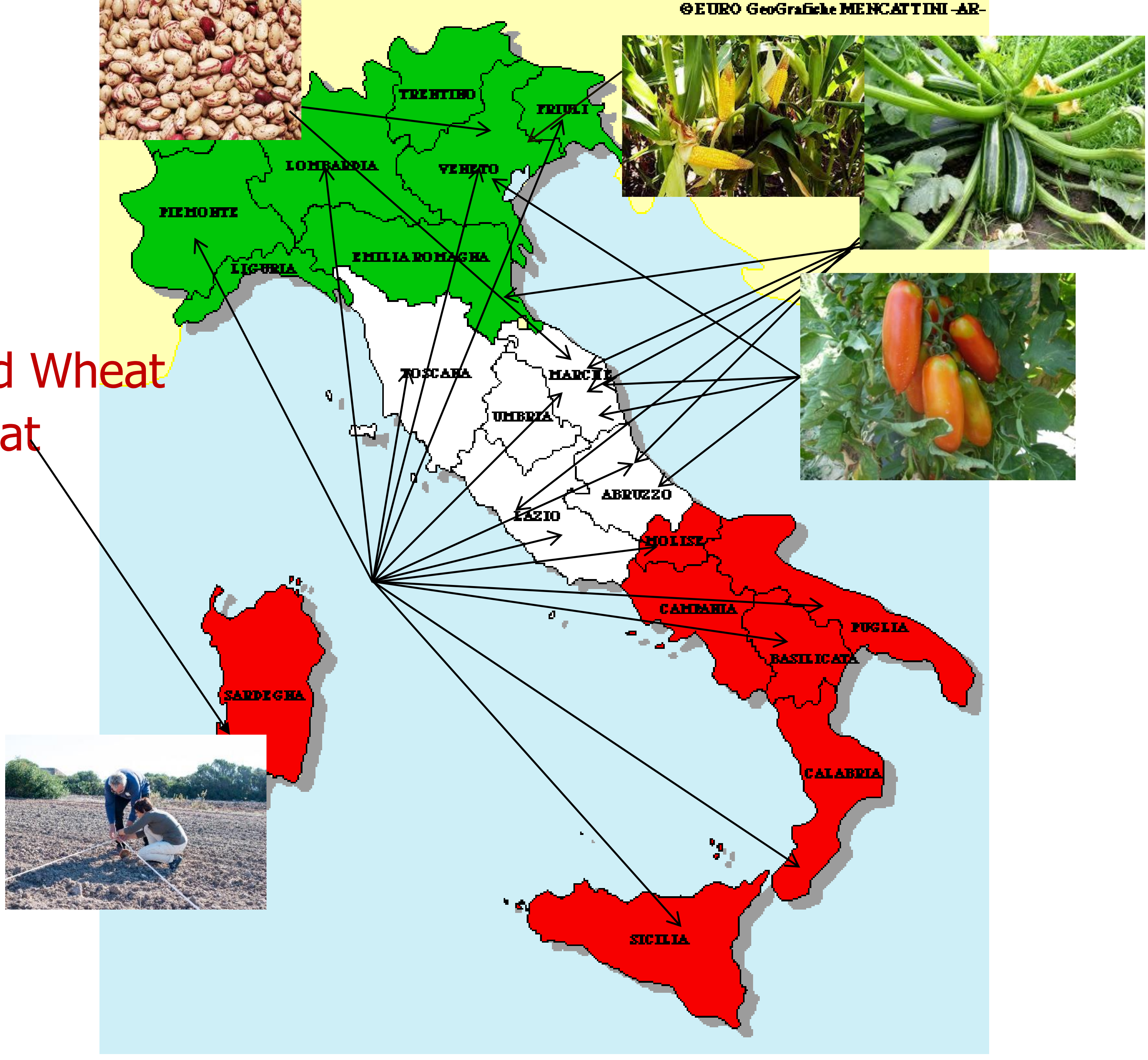
Local wheat

Zucchini

Tomato

Corn

Beans




A barley evolutionary population
in Molise, Italy


The evolutionary population of bread
wheat in Sicily, Italy


A new evolutionary population of durum wheat (locally made) in Sicily, Italy

The evolutionary population of bread wheat in Toscana, Italy

…………….where a farmer helped by a student is selecting heads

Year 0 | Base Population

To different farmers

Year 1 | Population Year 1

Year 2 | Population Year 2

Year 3 | Population Year 3

Year 4 | Population Year 4

Spike or plant

Year n | Population Year n → Spike or plant selection → New variety

Evolutionary Populations

Research Institute

Breeding Material

WHICH FUTURE ?

Farmers

PPB

Evolutionary Populations

Breeding Material

Farmers

PPB

Crop

The case of Iran

A Bread Wheat Evolutionary Population in Iran (> 100 varieties mixed together)

Evolutionary Populations

Crop

The case of Iran

Cultivating diversity can be economically profitable

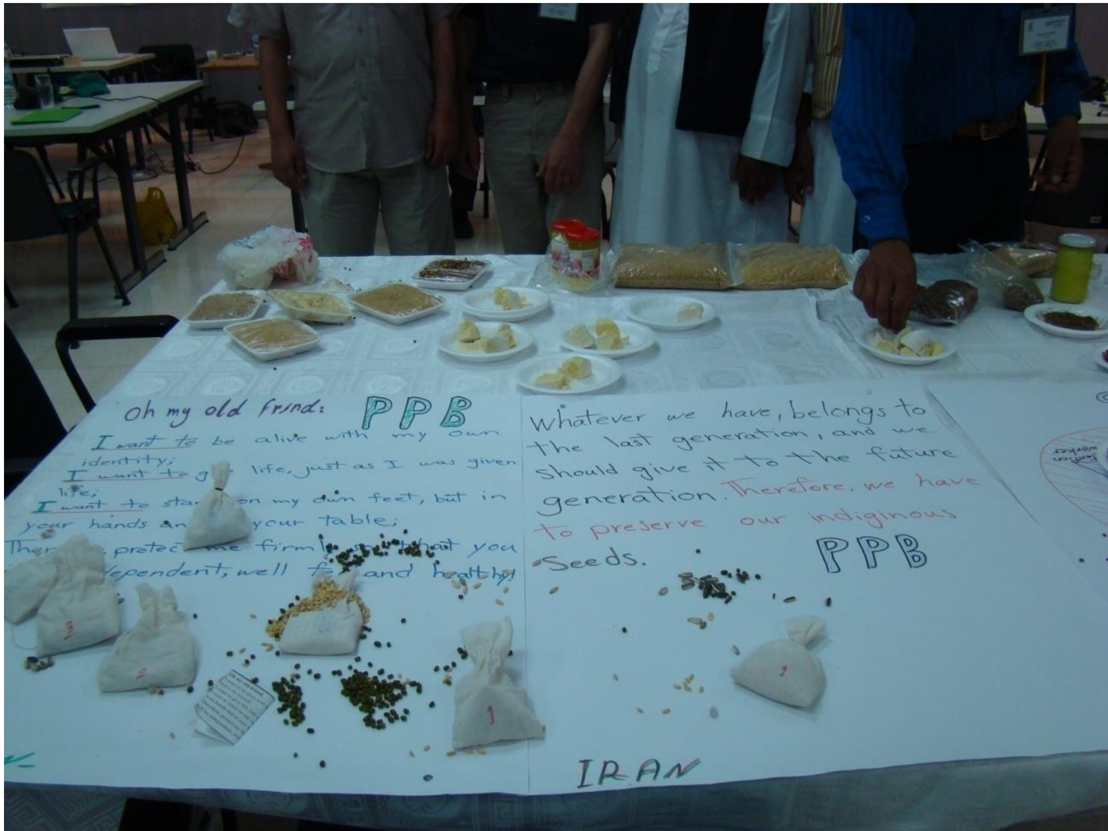
- Higher yields
- Better weed control
- Better control of pests and diseases

Take home messages

Conclusions

Institutions could do plant breeding in a way that addresses some of the major global issues such as:

Hunger
Biodiversity
Climatic changes
Water
Poverty



Conclusions: Hunger

Is now recognized that there is enough food but the problem is its availability and accessibility

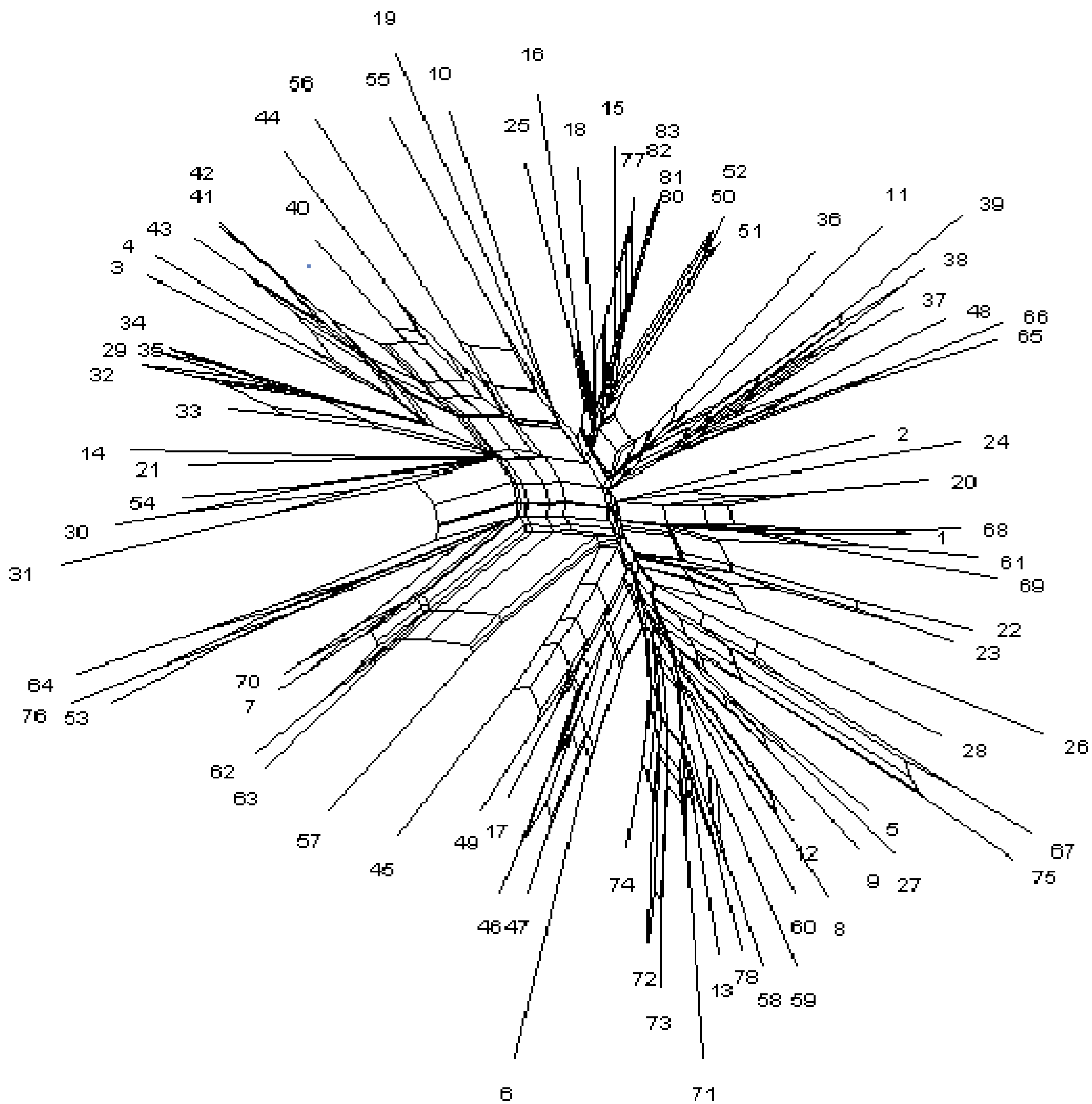
Participatory plant breeding increases crop production directly in the hands of the farmers

Conclusions: Biodiversity

Being a highly decentralized process participatory plant breeding produces varieties which are:

- Different from country to country
- Different from village to village within a country
- Different within the same village

Split tree obtained with the SSR data for 83 PPB varieties



Conclusions: Organic Agriculture

Fits crops to the environment rather than modifying the environment, and therefore is ideal for organic conditions

Conclusions: Organic Agriculture

Combining the strength of organic agriculture and evolutionary plant breeding

Organic Agriculture

Evolutionary breeding

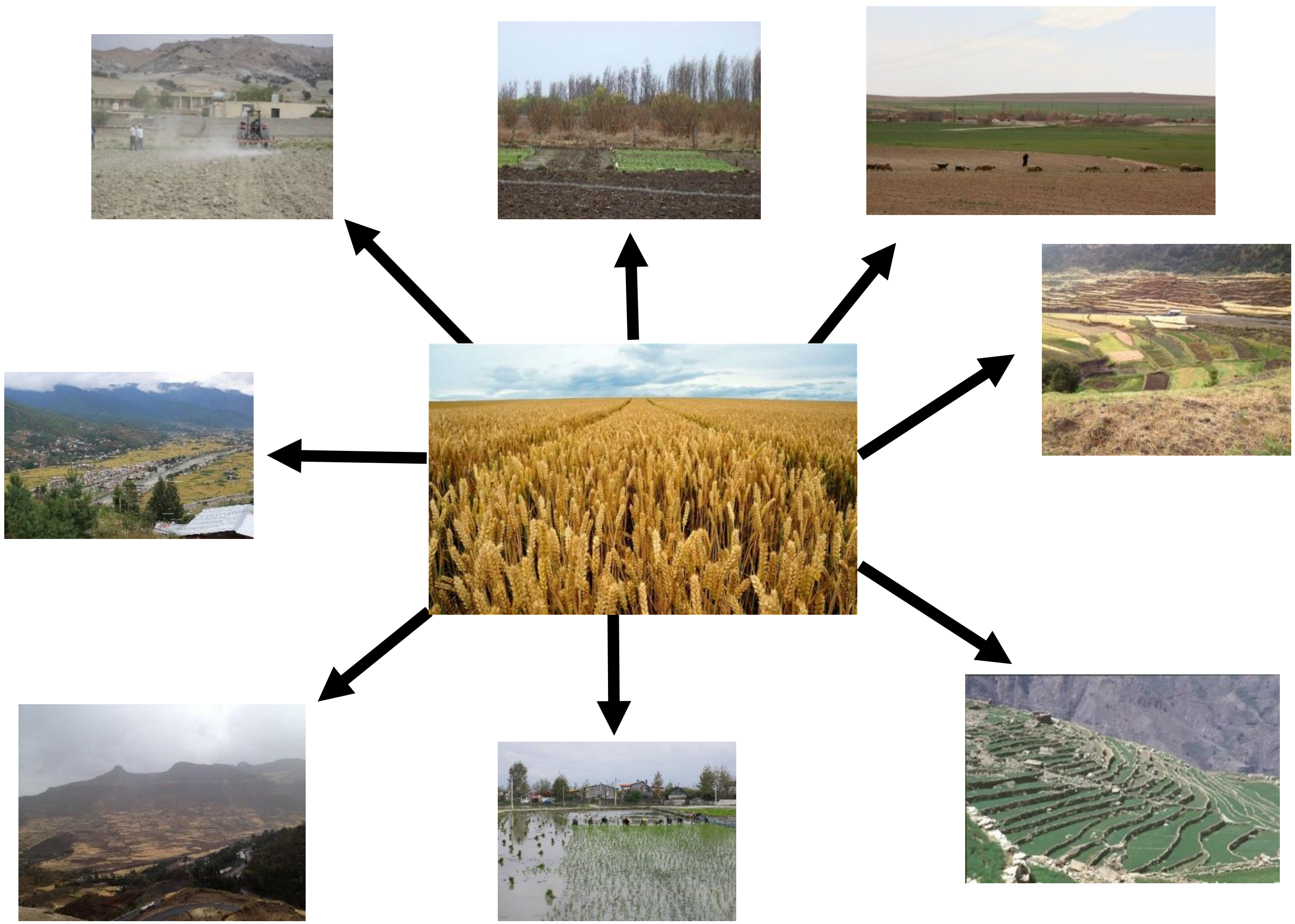
Mitigation

Adaptation

Climate Change

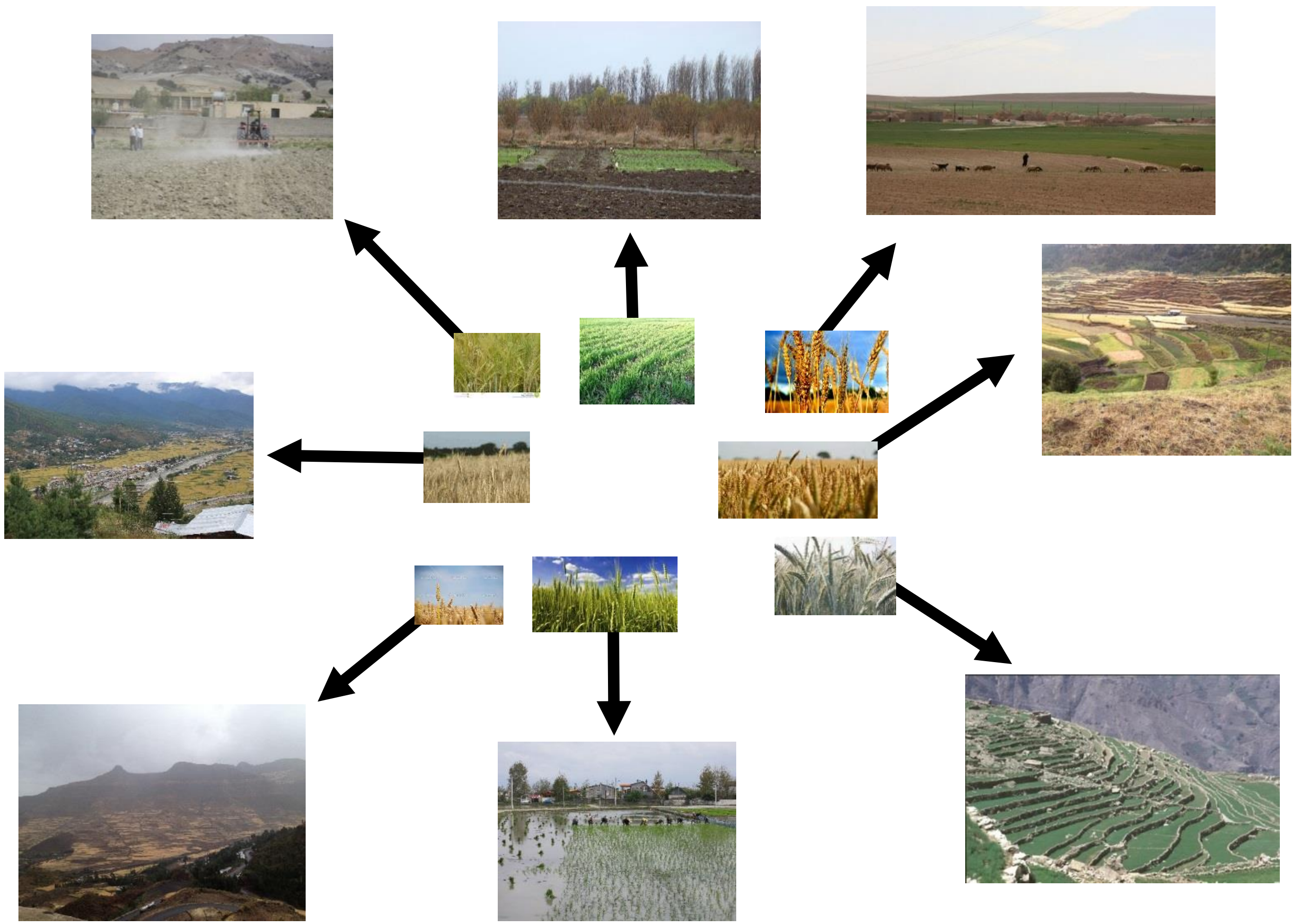
From Global to Local

Global Solutions to Global Problems



From Global to Local

Locally-Shared Solutions to Global Problems



Conclusions

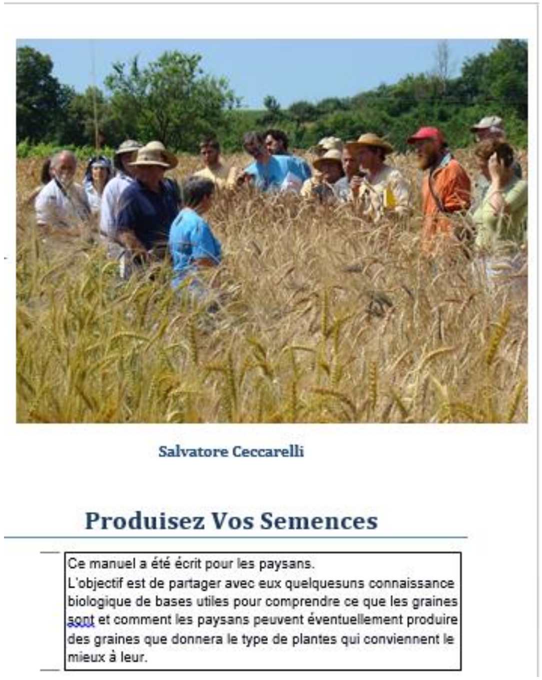
Evolutionary Plant Breeding

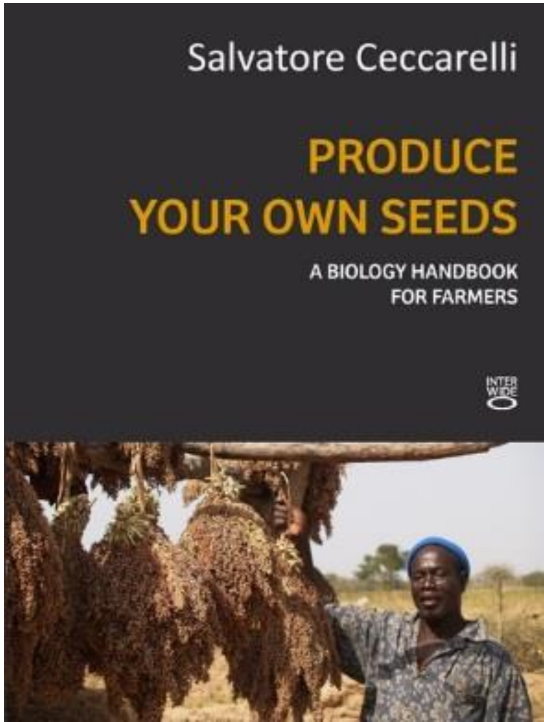
Brings back in farmers' hands the control of seed

Decreases crop vulnerability by cultivating and generating new diversity

Inexpensive and dynamic way of adapting crops to climate change

Evolutionary populations cannot be patented





Thank you