

Globalisation and agriculture, the role of land and water use

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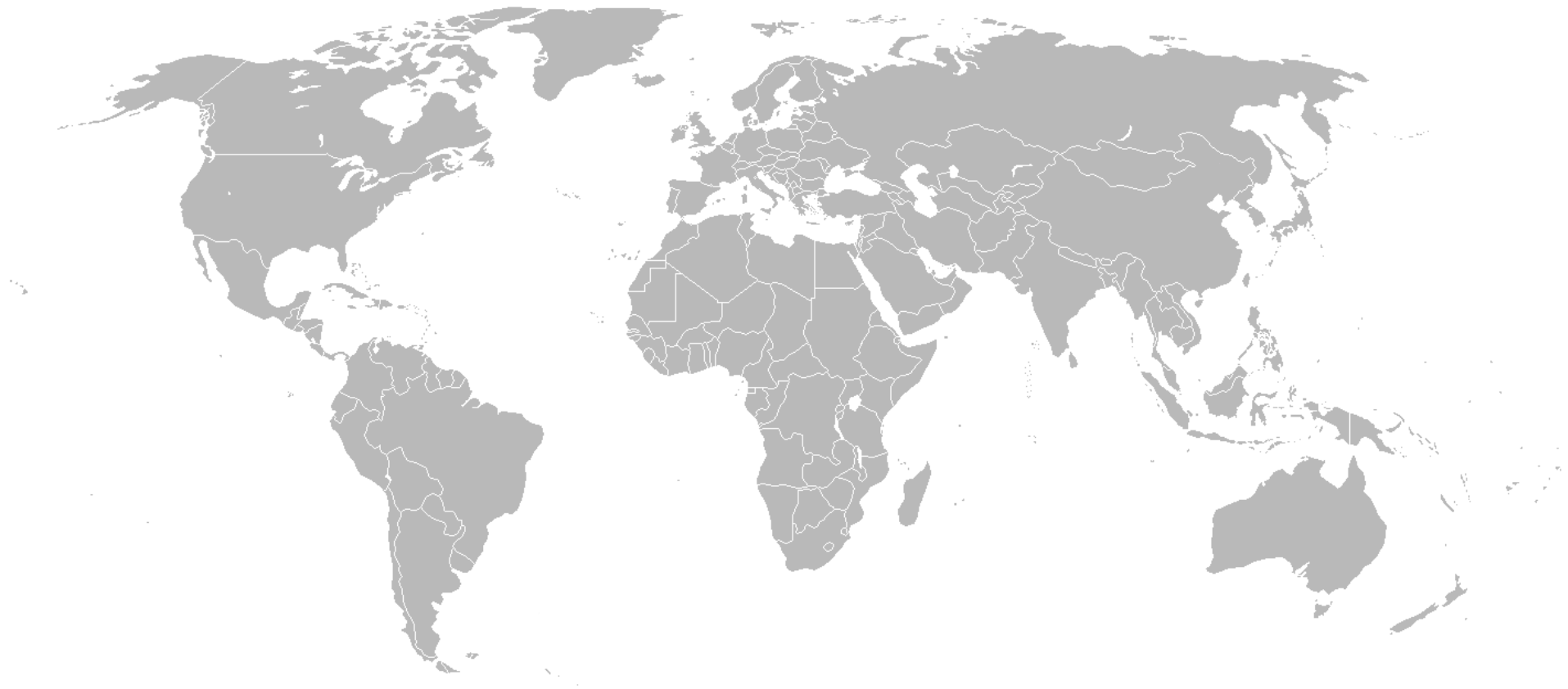
Land and Water Jubilee Conference, 18 May 2011

- With thanks to Martin van Ittersum and Prem Bindraban -



Contents

- Food security today
- Megatrends in agriculture
- Global challenges
- Utopia, Dystopia, Myopia
- A new green revolution, a rainbow evolution
- Land and water use
- Conclusions



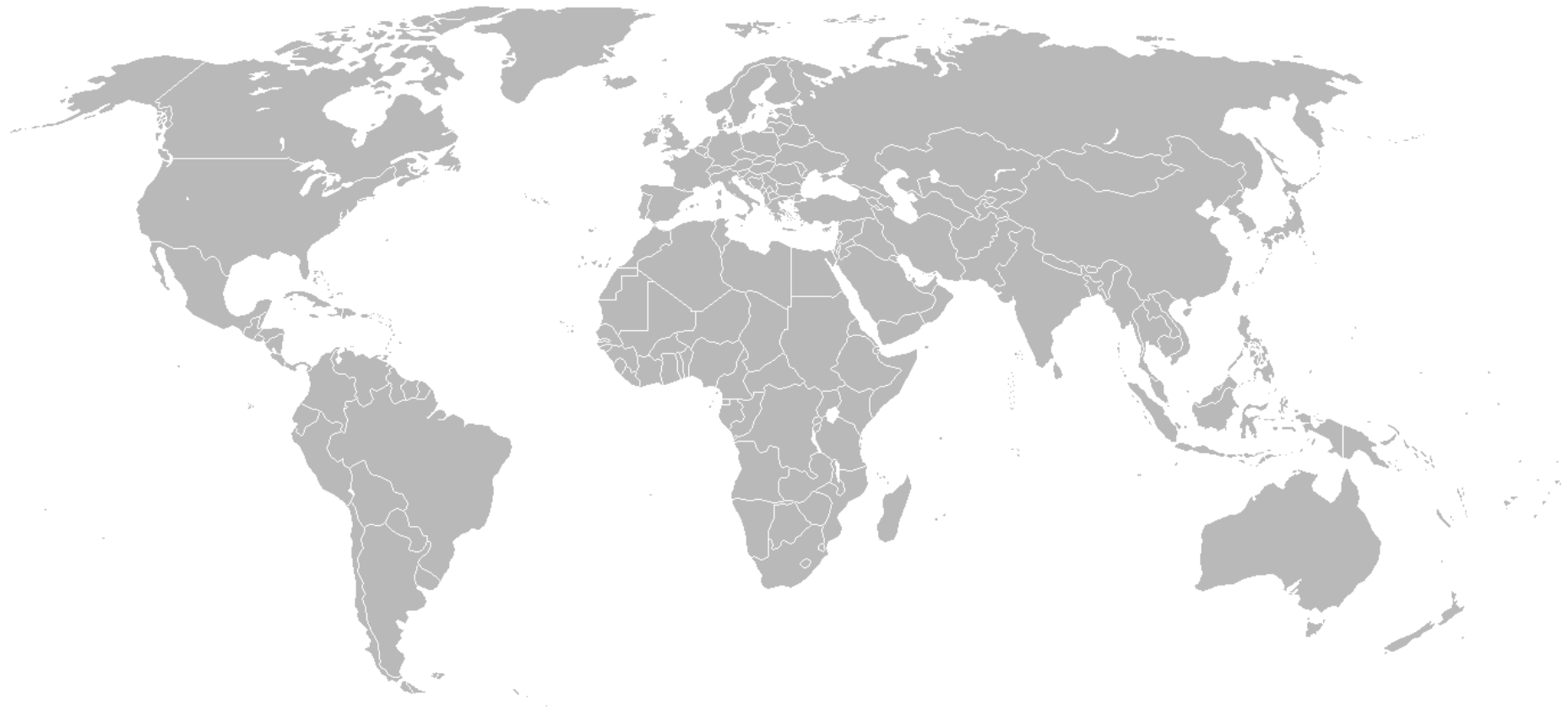
Food security today

Malthus



“The power of population is indefinitely greater than the power in the earth to produce subsistence for man”.

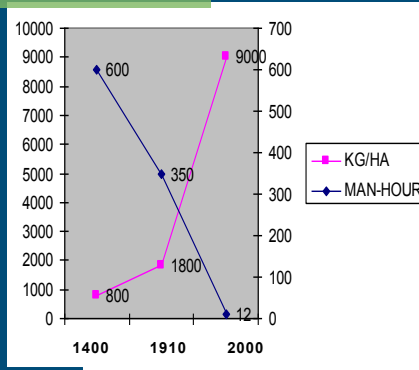
Malthus T.R. 1798. An essay on the principle of population.



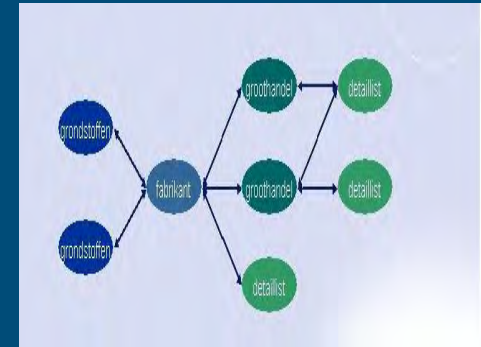
Megatrends in agriculture

Megatrends Agriculture

1: Productivity rise



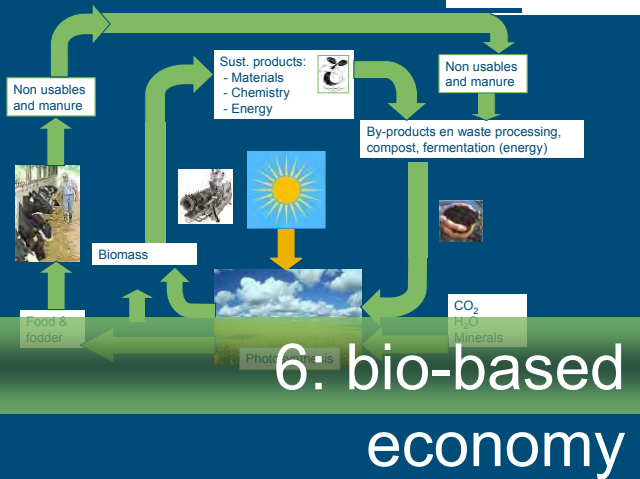
2: From craft to Industry



3: Chain approach

Megatrend

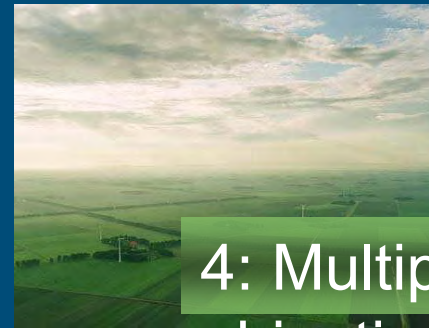
S



6: bio-based economy



5: food and health

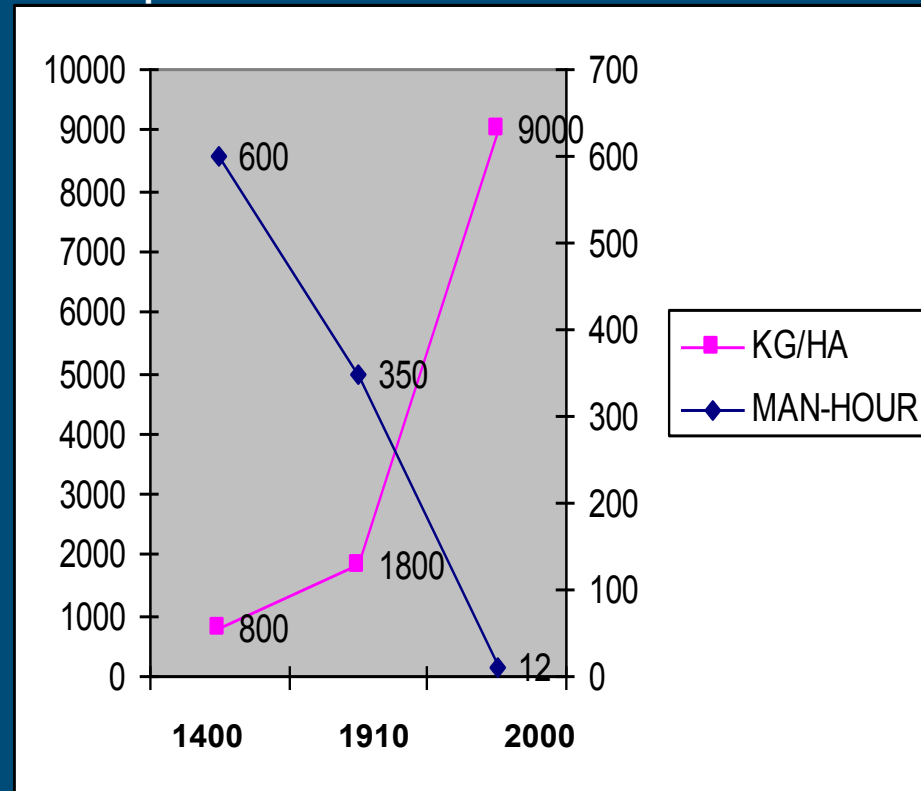


4: Multiple

Megatrend (1): Productivity rise last century

- Land productivity
x 5 - 6
- Labor productivity
x 200 - 300
- Energy and other inputs
x 2 - 4

Grain production in NL between 1400 and 2000



Megatrends (2): From craft to industry

- From adaptive (adapting to environment) to maximum control (fertilizer, pesticides, irrigation)
- Introduction of non-terrestrial agriculture



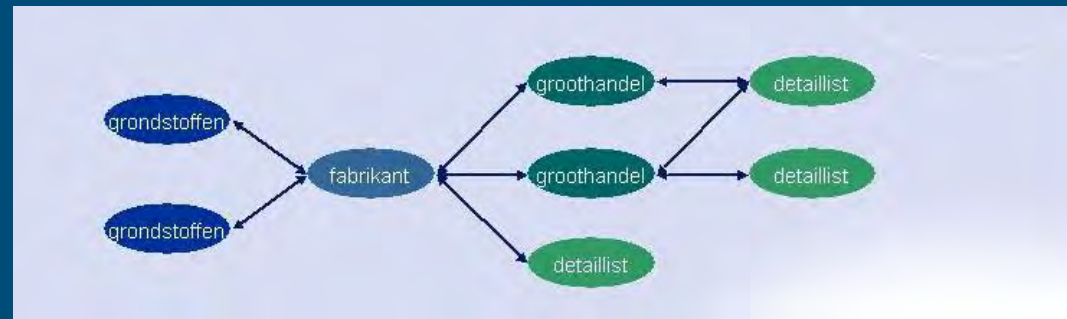
Greenhouse production
Substrate production



- High level of value-added !!

Megatrends (3): Chain management

- From spade to plate
- Reverse chain: consumer (or retail) driven
- Quality, food safety, convenience foods, etc.
- Logistic efficiency (on time delivery), unit cost of production
- Value-added on numerous stages of the chain
→ cumulative



Megatrends (4): Multiple objectives

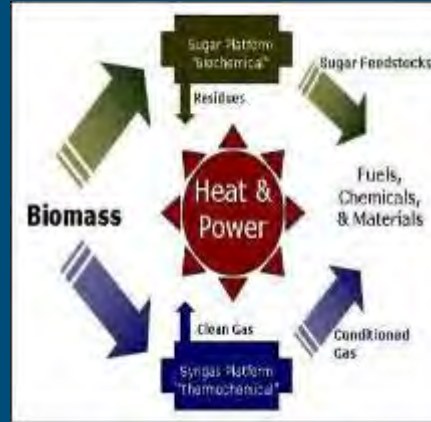
- Environmentally friendly
 - no pollution
 - no waste
- Animal friendly
- Landscape



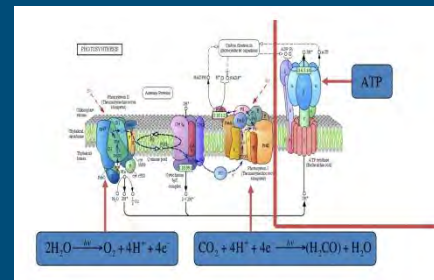
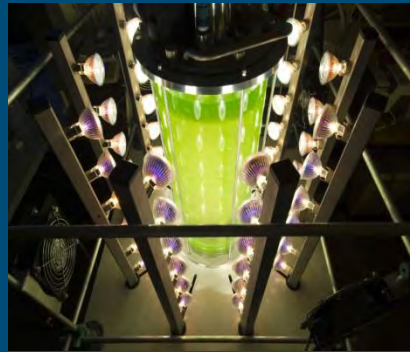
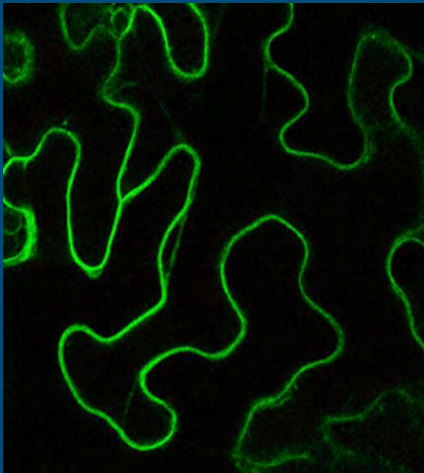
Megatrends (5): Food and health

- Vegetables, fruit and fish are good for health
- Aim to produce health inducing component through choices in inputs, farming systems and processing: multiple unsaturated fats
- Good Agricultural Practices: agricultural products free from residues (nitrate, pesticides)
- Food safety: tracking and tracing (BSE, dioxine)

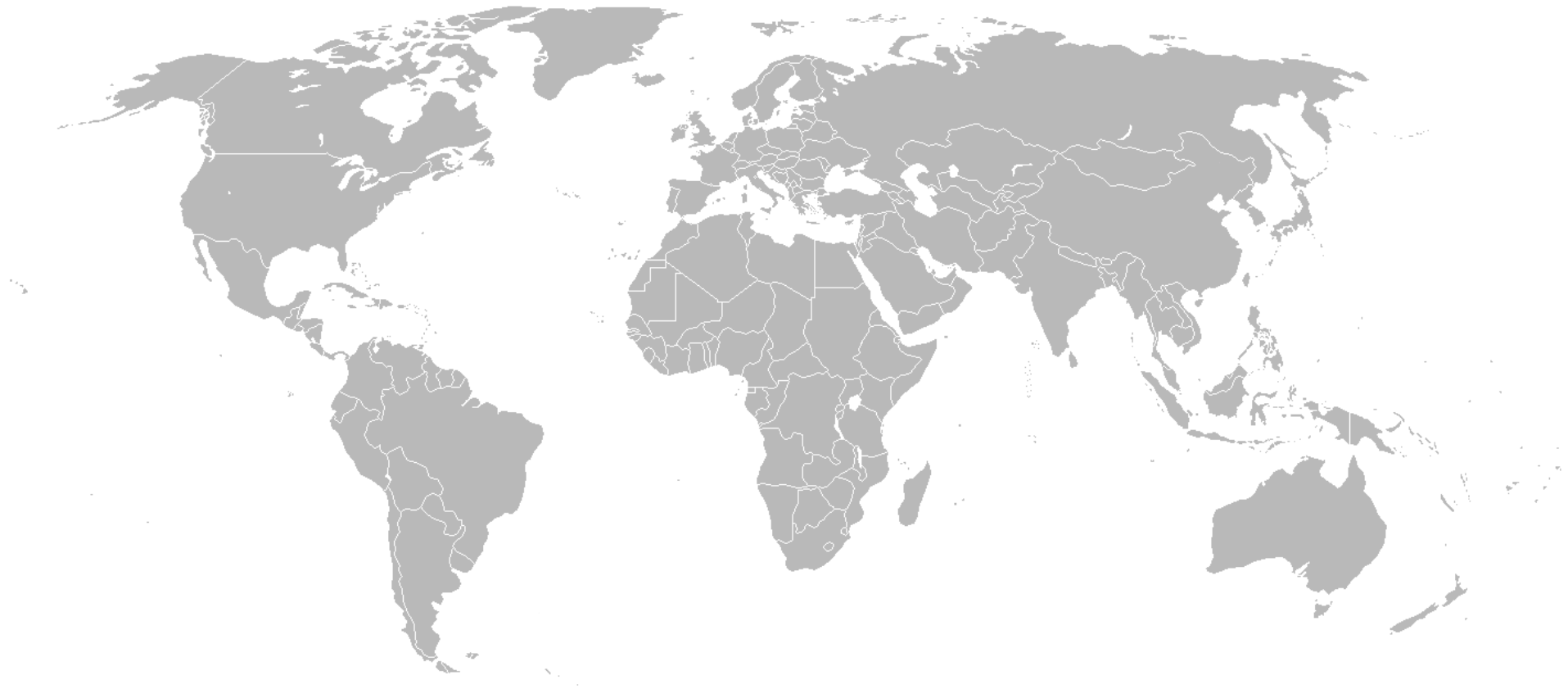
Megatrend (6): Biobased economy



Bio fuels
Bio materials
Bio refinery



Adapted crops
New systems



Global challenges

Global challenges

Food Security



Climate change



*Agricultural
Life
Sciences*



Stewardship

Food & Health



Biobased

Challenge: double plant production in 2050

World population increase

2000: 6 000 000 000

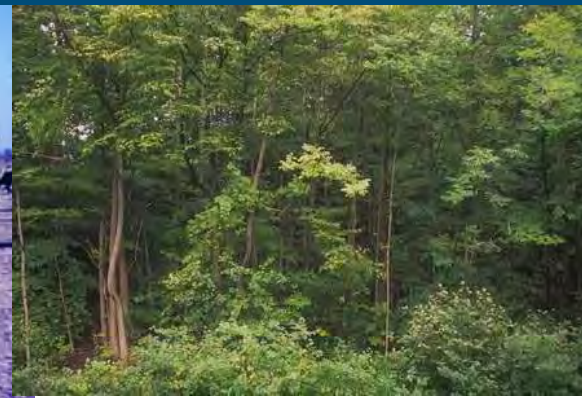
2050: 9 000 000 000



Increasing wealth → meat consumption increases

Limited possibilities for increased acreage

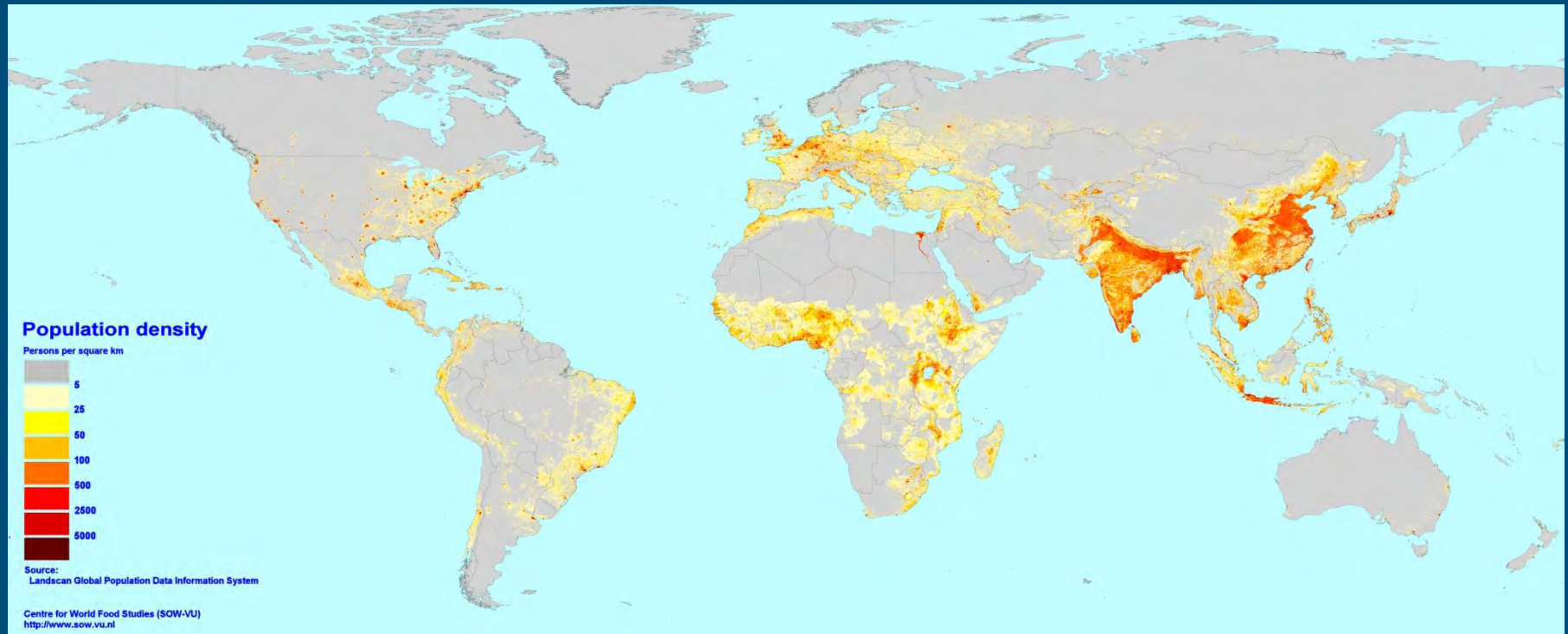
- Marginal soil = marginal yield
- Desertification
- Urbanisation
- Biodiversity
- Limited water availability



Challenge: a higher land productivity



Population density



Population density (persons per km²)
Centre for World Food Studies – Vrije Universiteit

Need for plant production in 2050

- A population of 9-10 billion
- Access to a rich calorie diet
- Access to a diet based on animal products

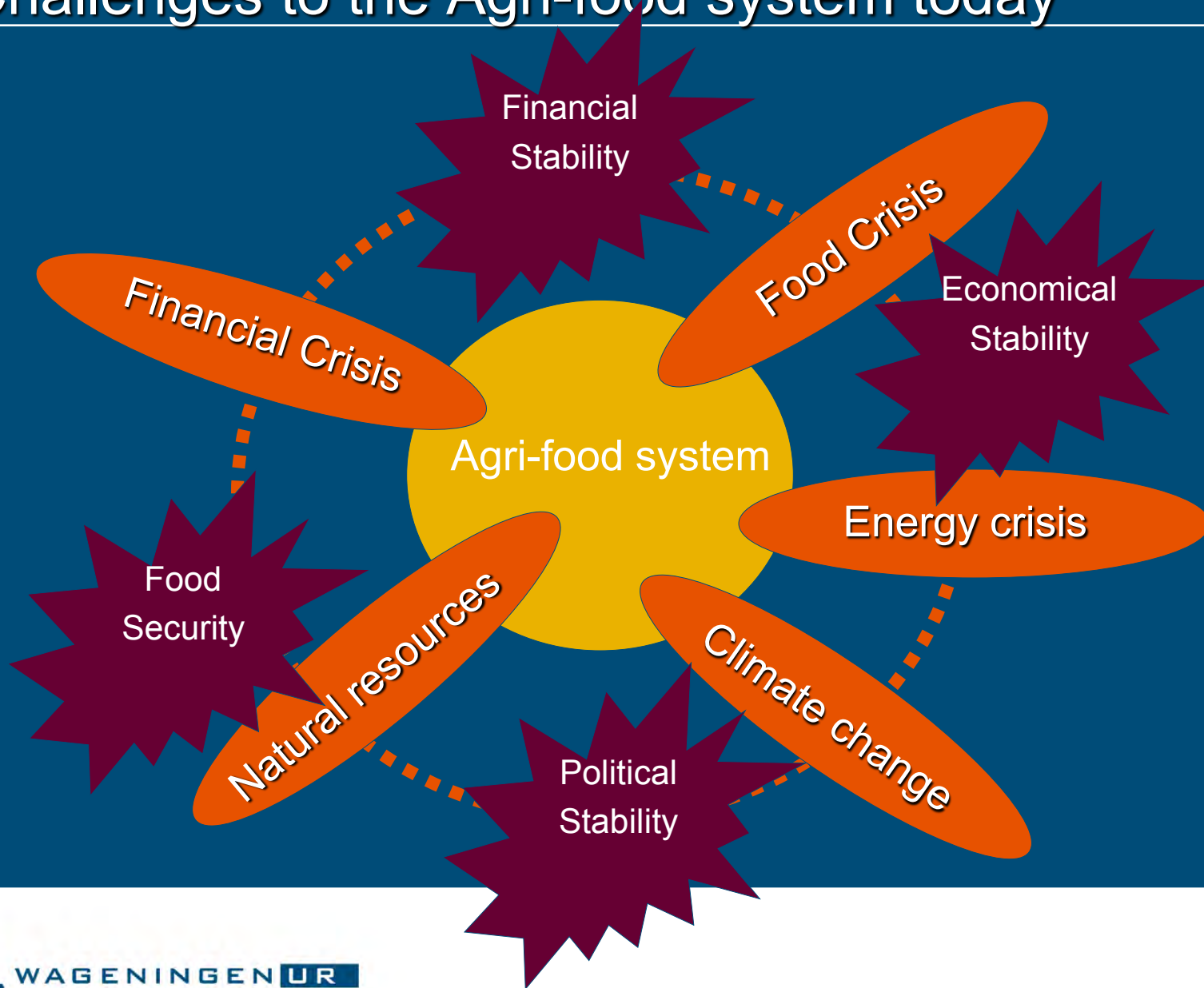
... A double quantity of primary products is needed in 2050 for food and livestock feed...

A double plant production

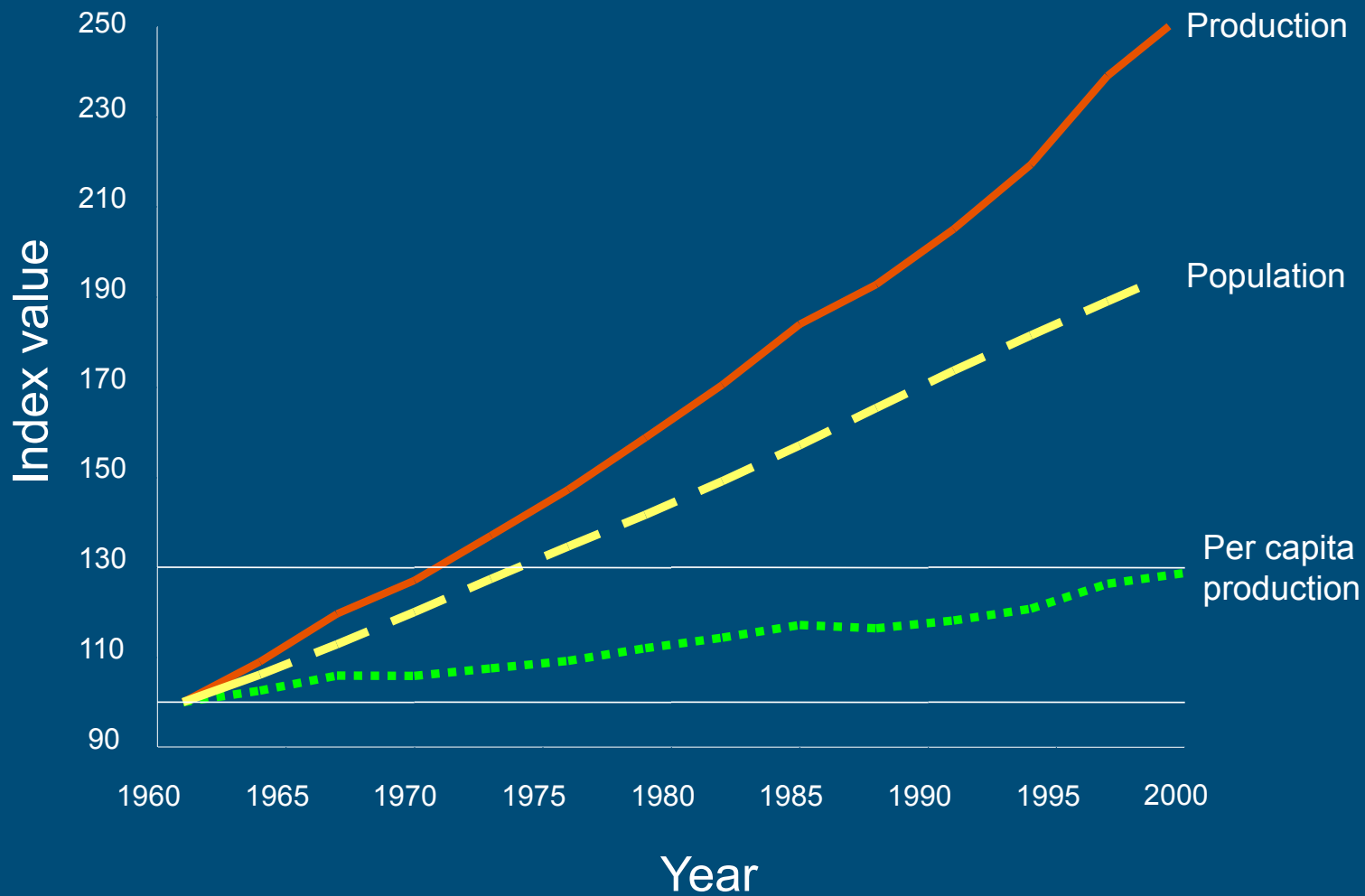
- Extending farmlands
- Increasing production per ha



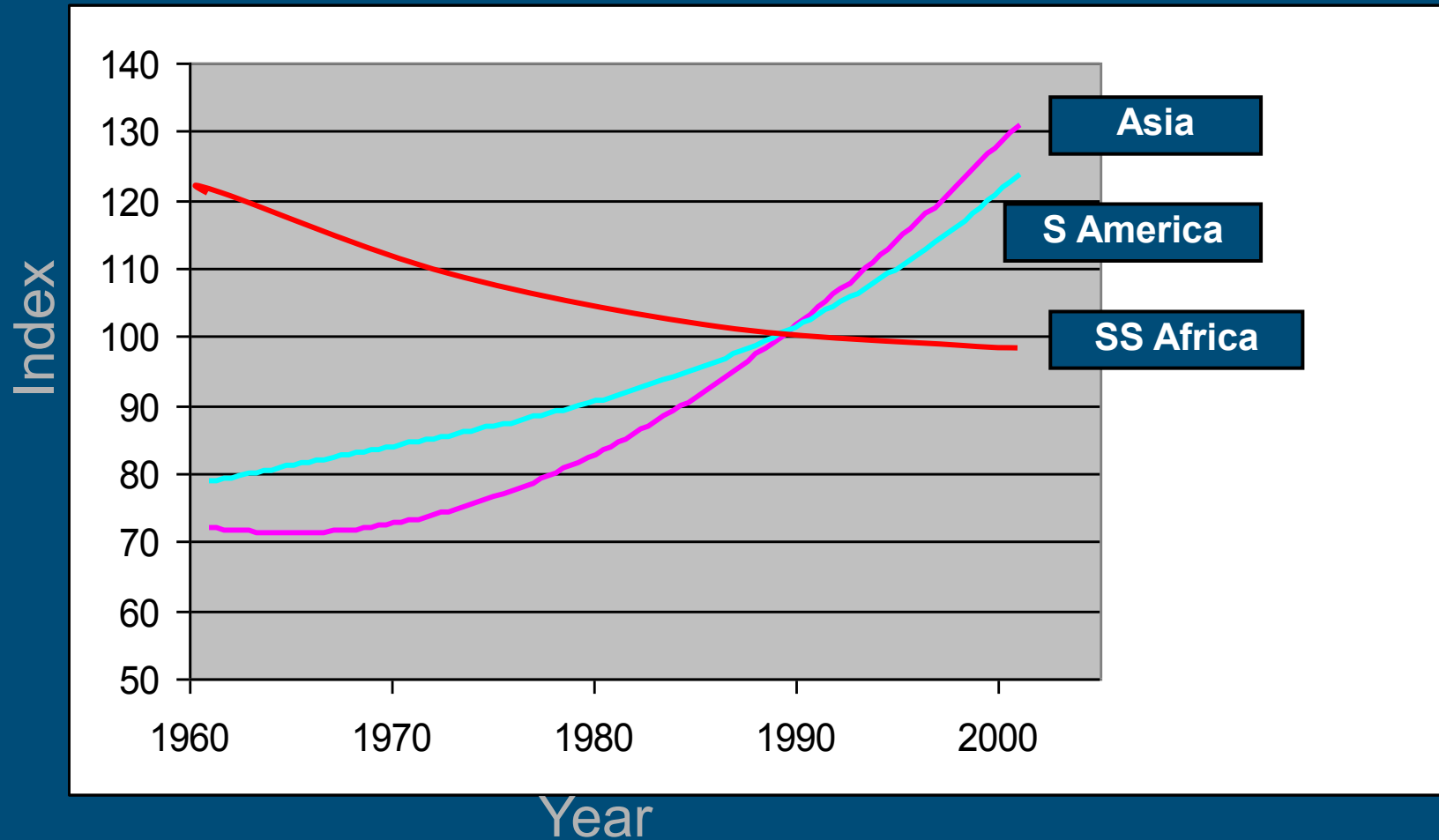
Challenges to the Agri-food system today



Global food production – 1960 - 2000

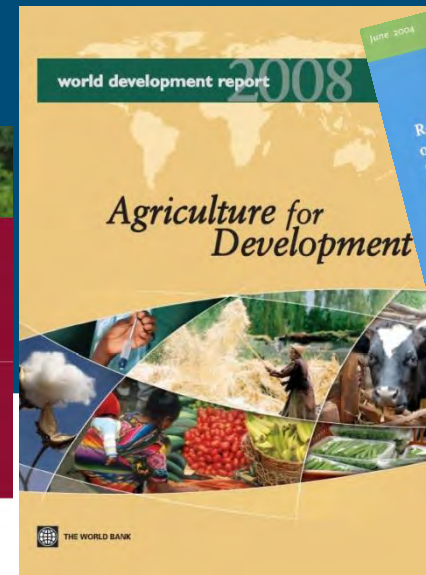
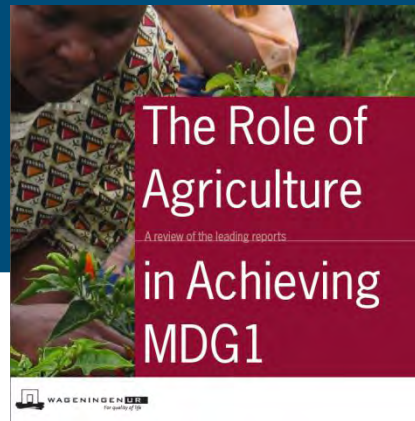


Food availability per caput

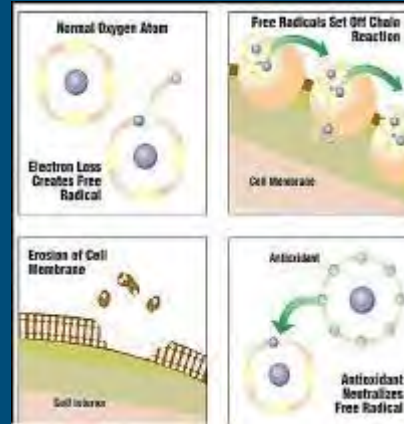


Hunger today: a matter of access

- The world produces sufficient food
- The problem is *access* to food
- The challenge is economic development ...
- ...starting with agriculture



Global challenge: Food and health



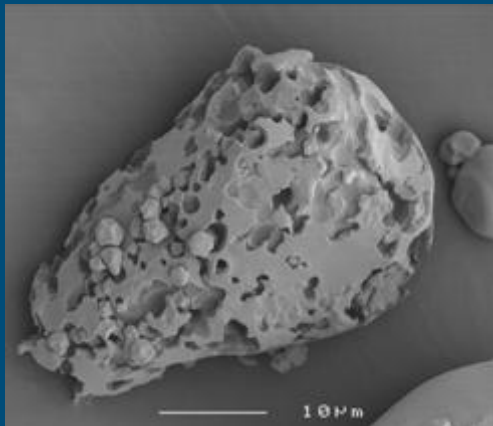
Obesitas

Allergy

Anti oxidants

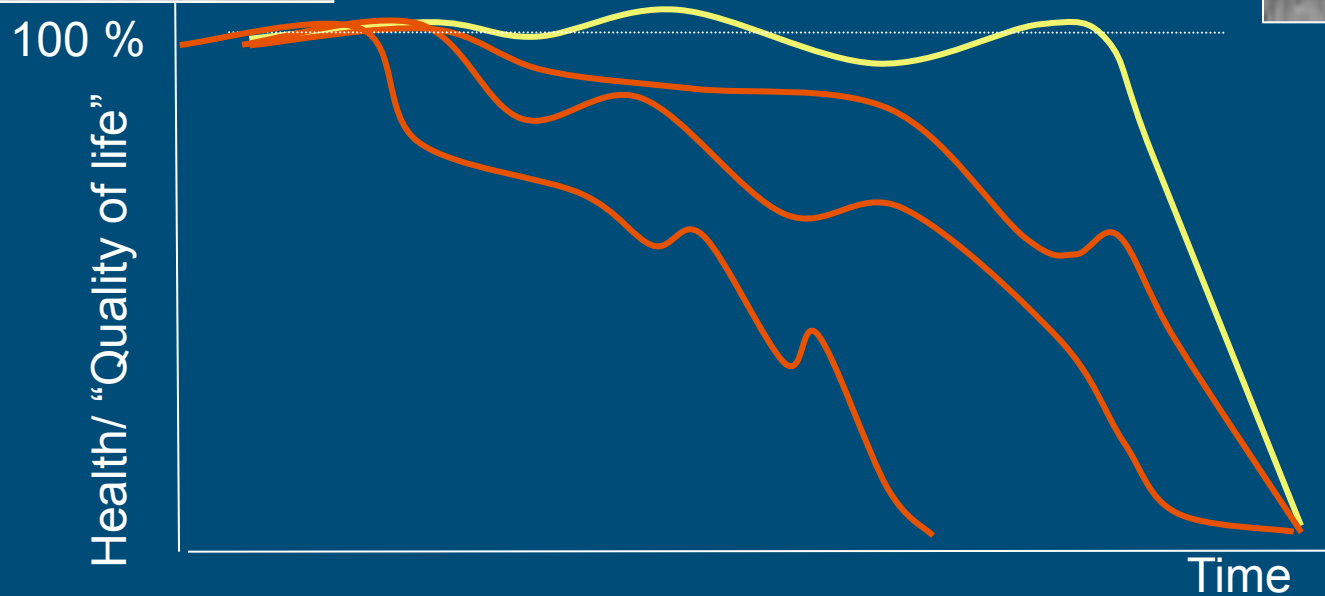
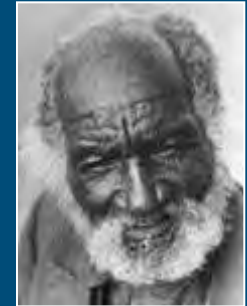


Healthy food products



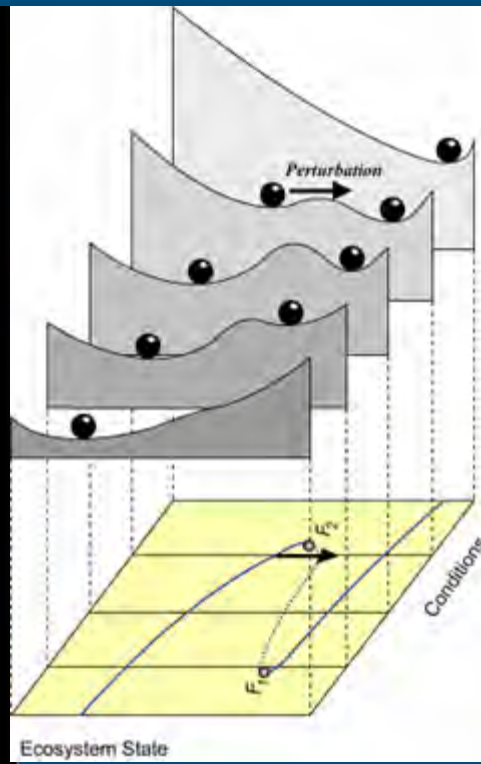
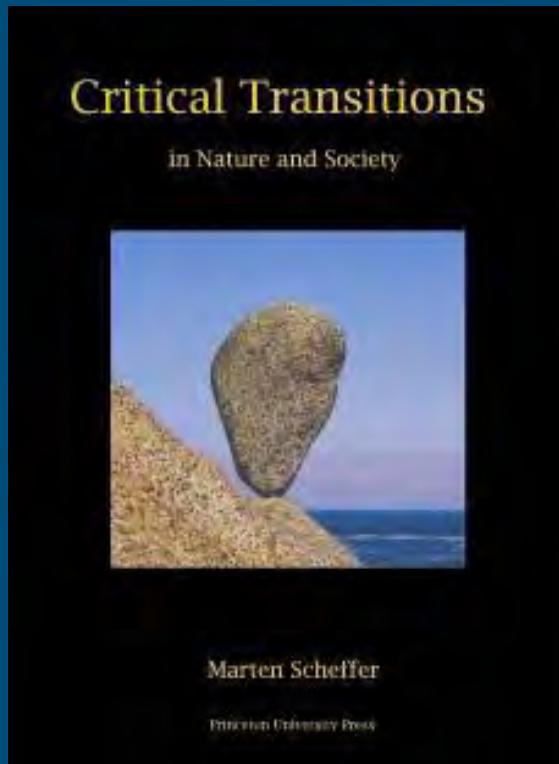
Global challenge: Food and health

Nutritious diets & safer food



Global challenge: Climate change

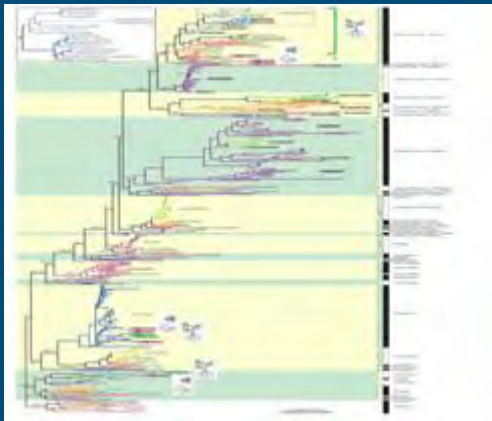
Resilient natural resource systems



Global challenge: Environmental stewardship



Nature
Biodiversity
GHG

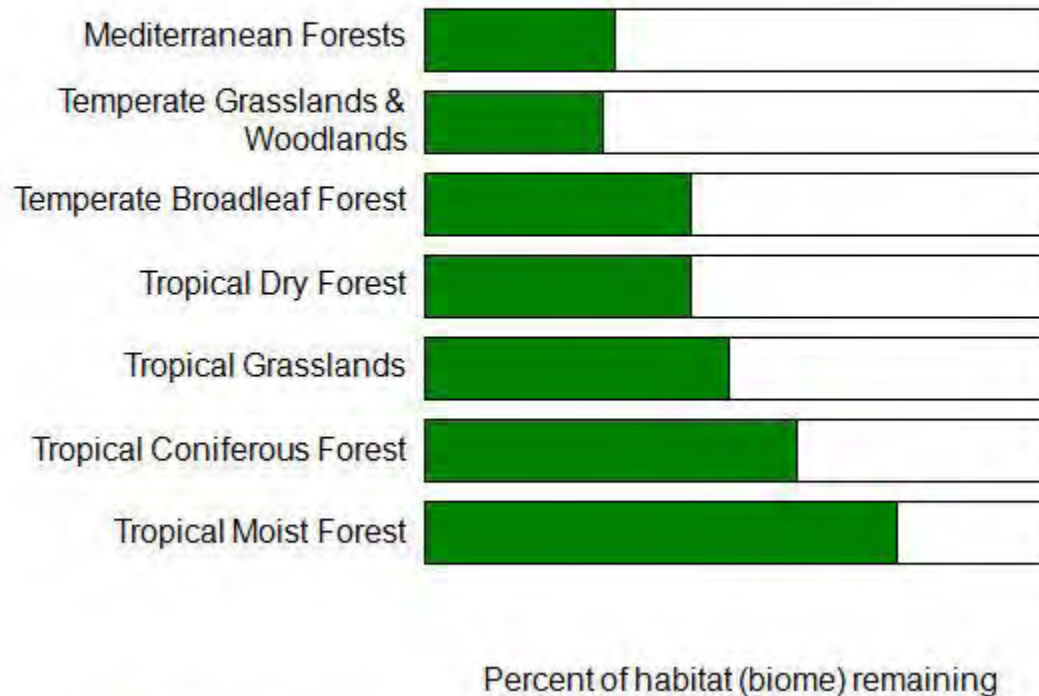


Monitoring
Preservation
Ecosystem services

Global challenge: Environmental stewardship

Biodiversity

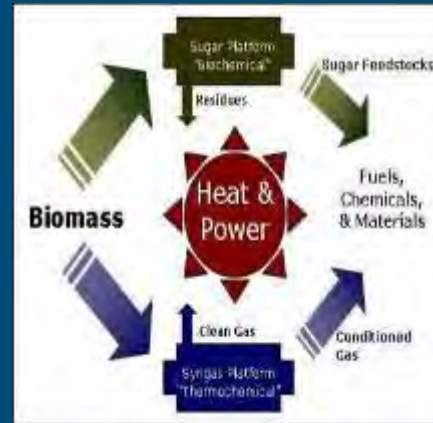
Habitat Loss to 1990



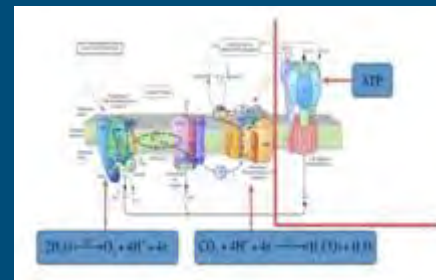
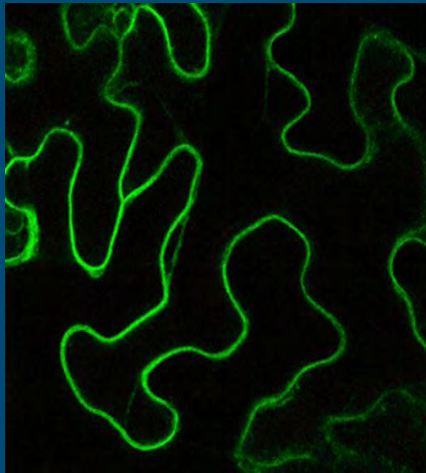
Source: Millennium Ecosystem Assessment



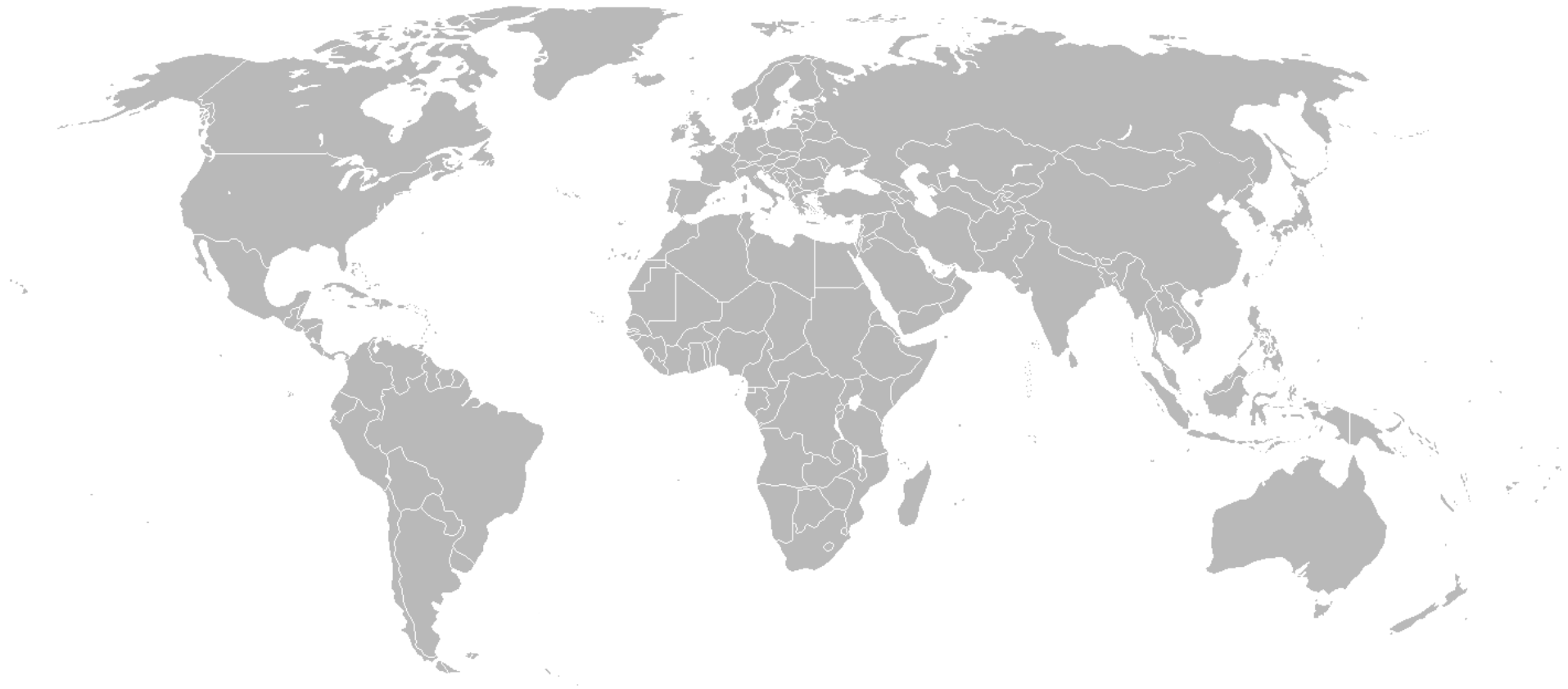
Global challenge: Biobased economy



biofuels
bio materials
bio refinery



Adapted crops
New systems



Utopia, Dystopia, Myopia

Water use

- Drinking - 2 liter/day
- Basic household needs – 100 liter/day
- Food – 2600 (vegetarian) – 5400 (meat) liter/day
- Agriculture is by far the largest user of water
- Water saving to be sought in this sector
- Plant requirements: 1000 liter water for 1 kg grain

From food to fashion

- Pharmaceuticals
- Fragrances
- Functional molecules

Health

- Flavours
- Flowers

Fashion

- Fruits
- Fresh vegetables

Food

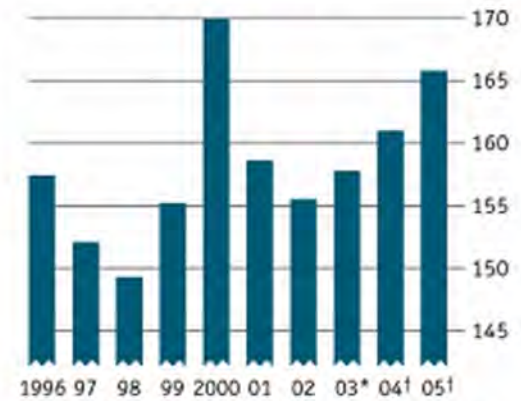
- Food crops
- Fodder
- Fermentation products

- Fibers
- Fuel

Warmth & safety

1 A sensitive flower...

Global luxury-goods market, \$bn



Source: Euromonitor

*Estimate †Forecast

2 ...of enduring appeal

Merrill Lynch Luxury-Goods Large Index
Log scale, April 1977-100



Source: Merrill Lynch

An aerial photograph of a massive, dense crowd of people, likely at a festival or concert. The crowd is composed of individuals of various ages and ethnicities, many wearing colorful clothing and holding up phones or cameras. The overall scene is vibrant and energetic. Two green semi-transparent text boxes are overlaid on the image. The first box, located in the upper center, contains the text "Future harvest". The second box, located in the lower center, contains the text "Global and long-term perspective".

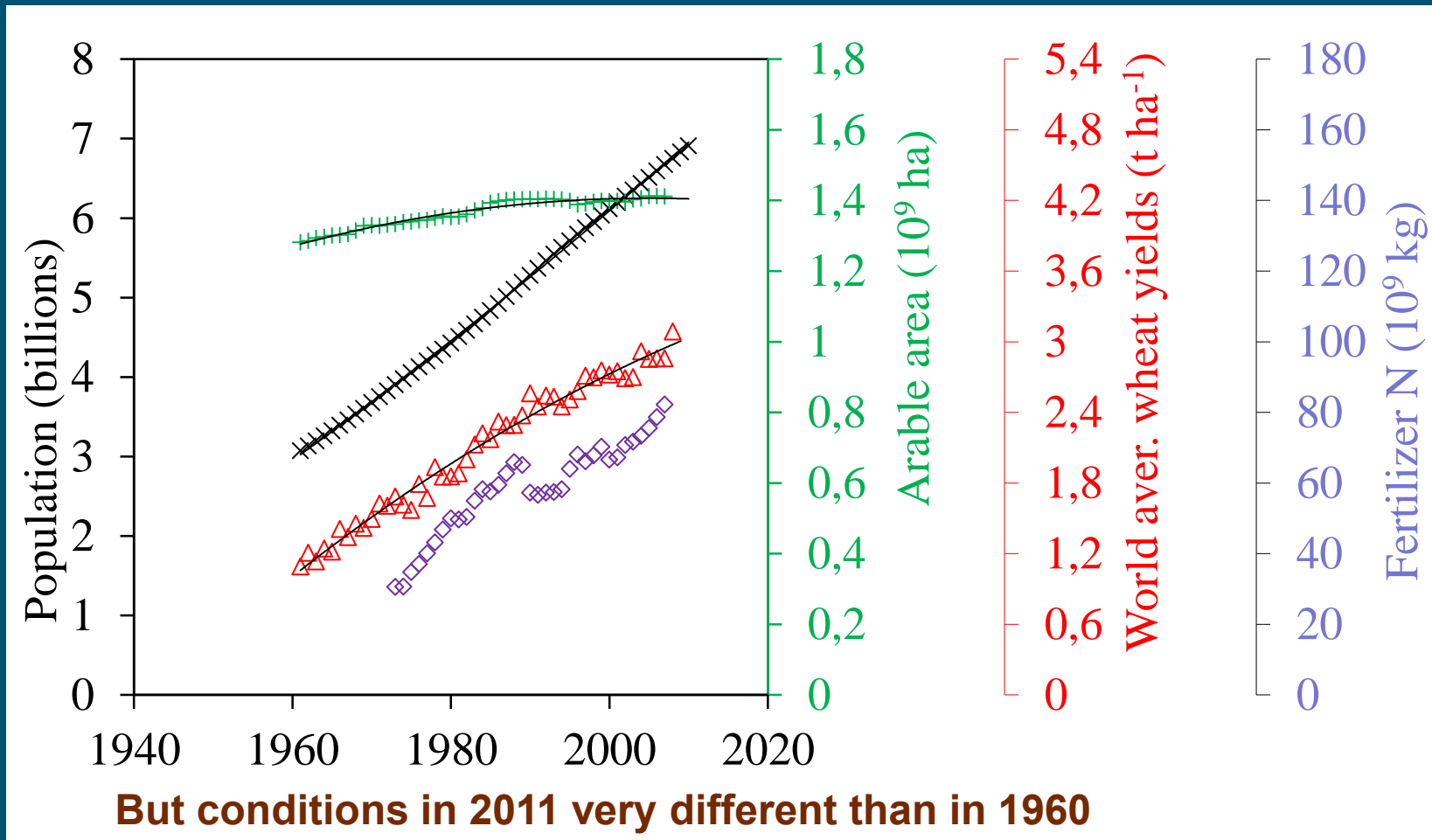
Future harvest

Global and long-term perspective

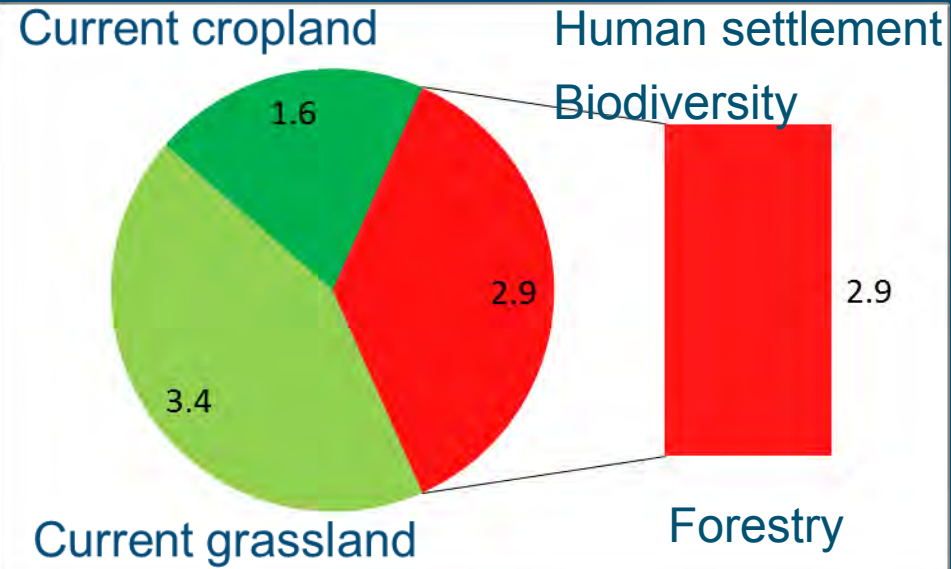
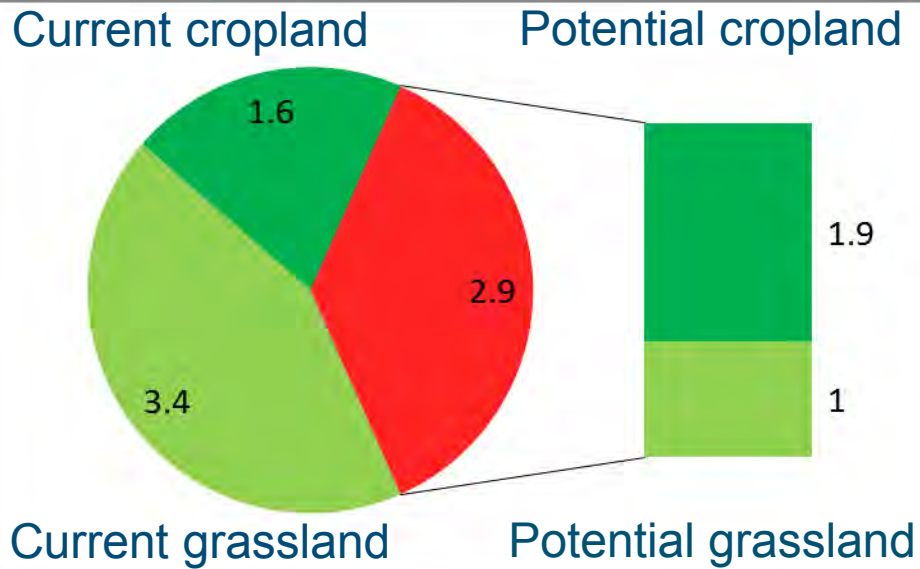
Hunger

- Before 1875 hunger was a problem of poverty and scarcity
- After 1875 hunger became a problem of poverty amidst plenty
- 21st century: will it remain so, or will rising food prices add to the hunger of the poor?

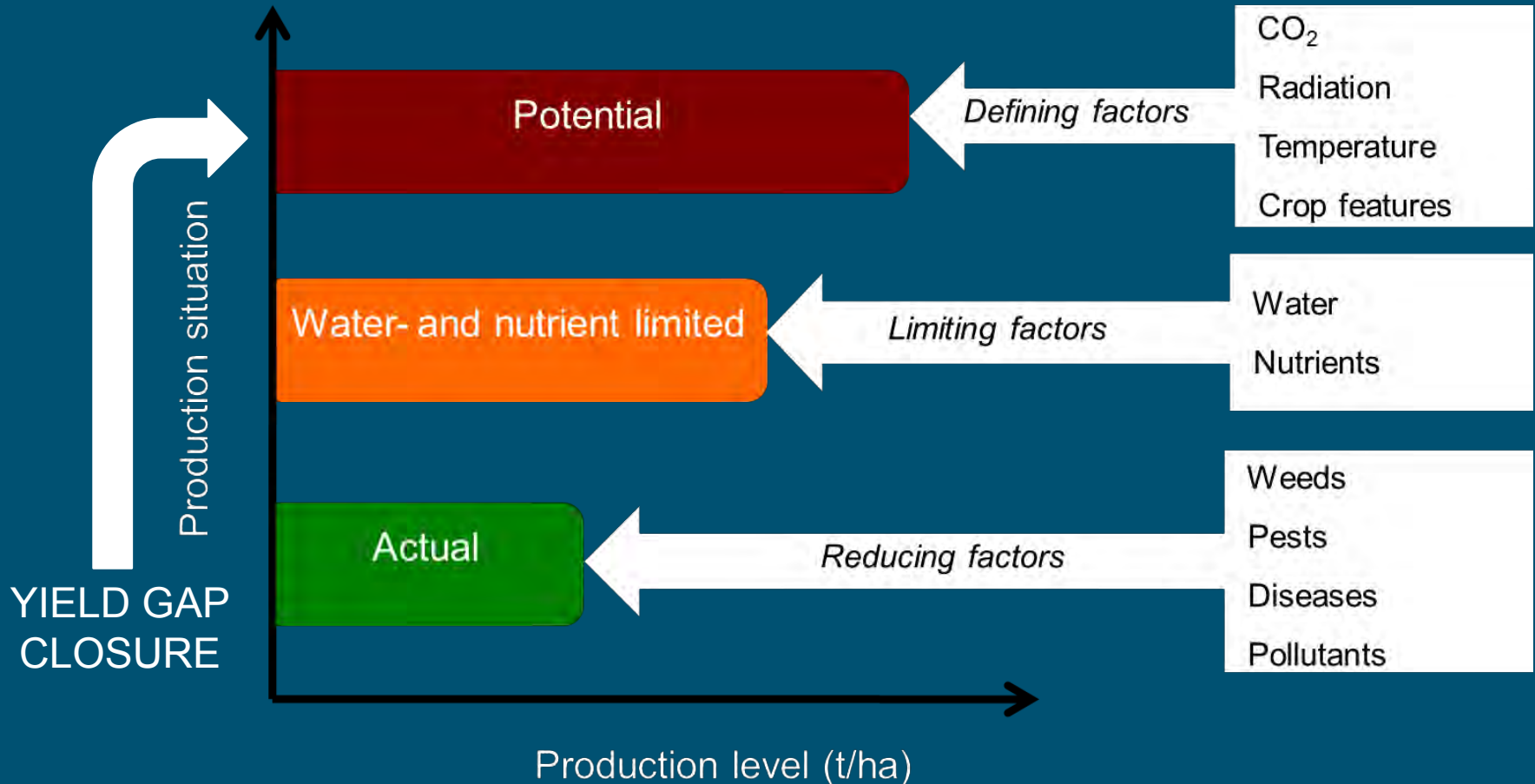
Required growth for food and feed is nothing new



Agricultural area



Production ecological principles



Global production potential

Assumptions

- Current land area
- Multiple cropping per year
- 80 % yield gap closure
- Climate change: 0% effect

Potential:

ca. 36 10⁹ tons GE

Irrigated land: max +50%:

ca. 27 10⁹ tons GE

„Scenarios“	Biomass (10 ⁹ tons GE)
Current	7
2050: food and feed	12
2050: + 10% of global energy supply	17
2050: + all citizens a European diet	23

1. Yield gap closure

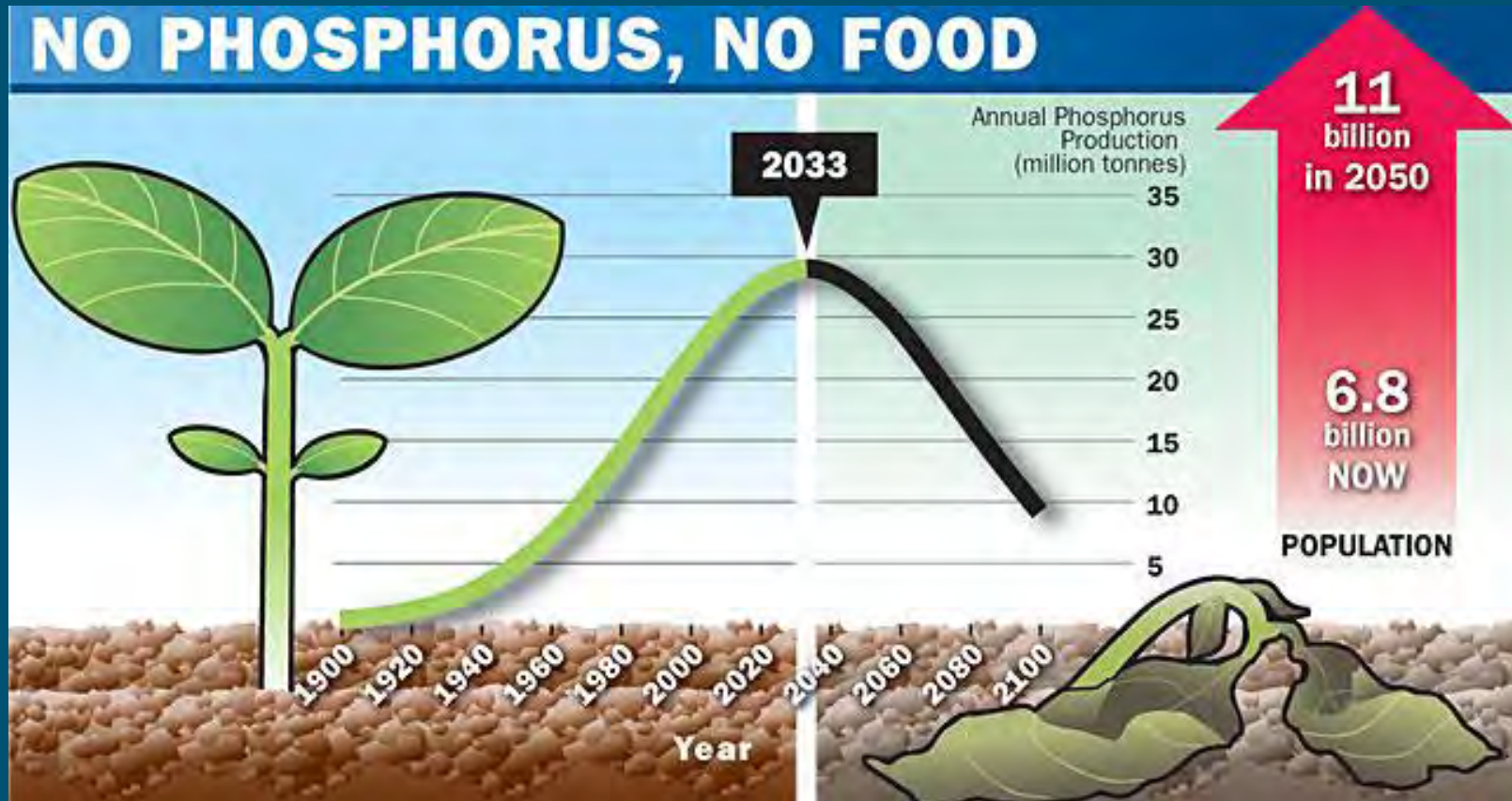
Location	Crop(s)	Yield gap closure (%)
Mostly Asia (<i>Lobell et al., 2009</i>)	Various	16-95
Kenya (<i>Tittonell et al., 2008</i>)	Maize	17-33
SE Asia (<i>Laborte et al., in review</i>)	Rice	44-71
The Netherlands (<i>Wolf et al.,</i>	Various	75-87

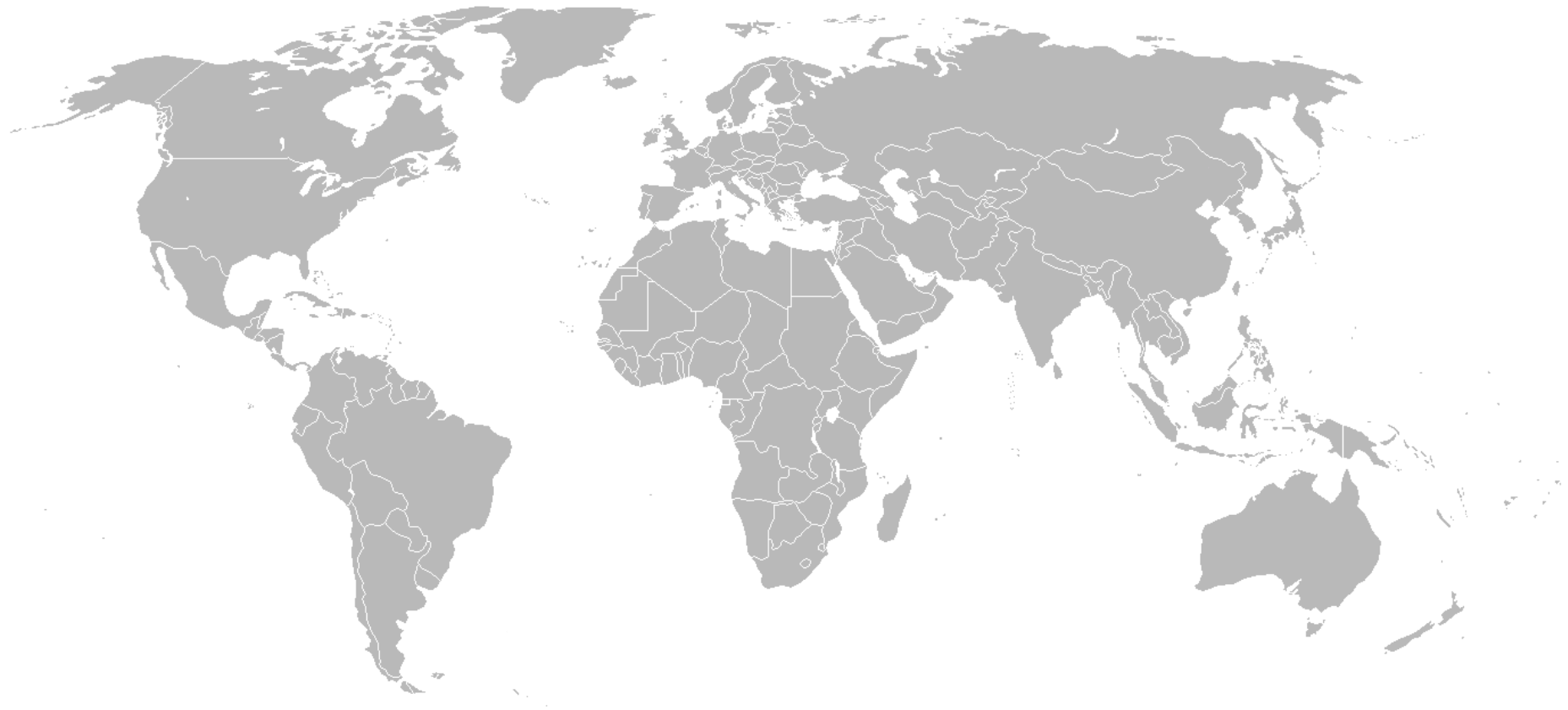
unpu



Photo:
Ken Giller

2. Resource availability and resource use efficiency





A new green revolution

Needs for new discontinuities, rainbow evolutions

- Demographic reasons
- Changes in diet (more animal proteins)
- Shortage of good agricultural land
- Safeguard biodiversity
- Environmental reasons

Rainbow evolutions

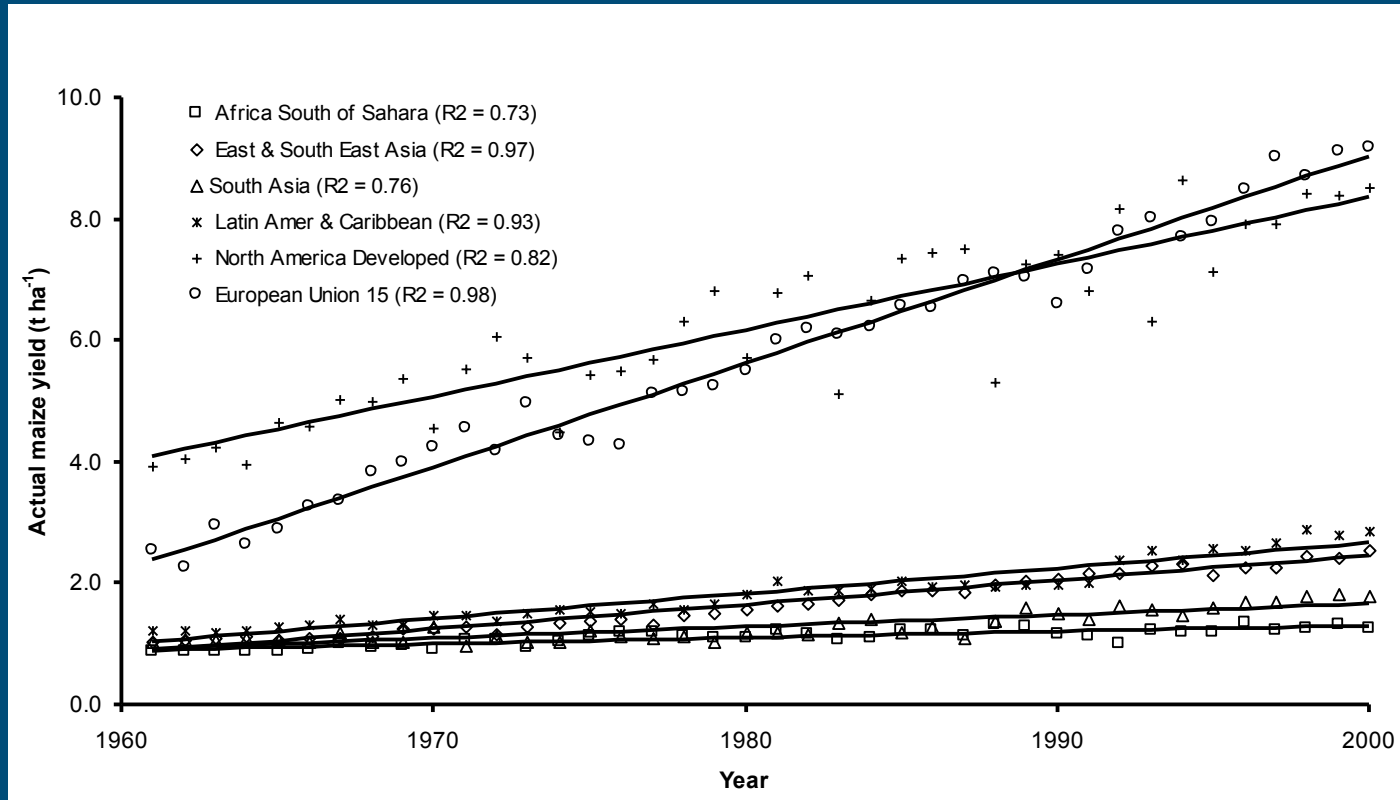
- Water management → water
 - Soil fertility → nutrients
 - New short straw varieties → breeding
 - Pest, disease, weed control
-
- No green revolutions in Africa

Rainbow evolutions

- Stagnation in productivity rise in other parts of the world
- Un-sustainability spirals due to poverty
- Un-sustainability spirals due to richness

Problems of Africa

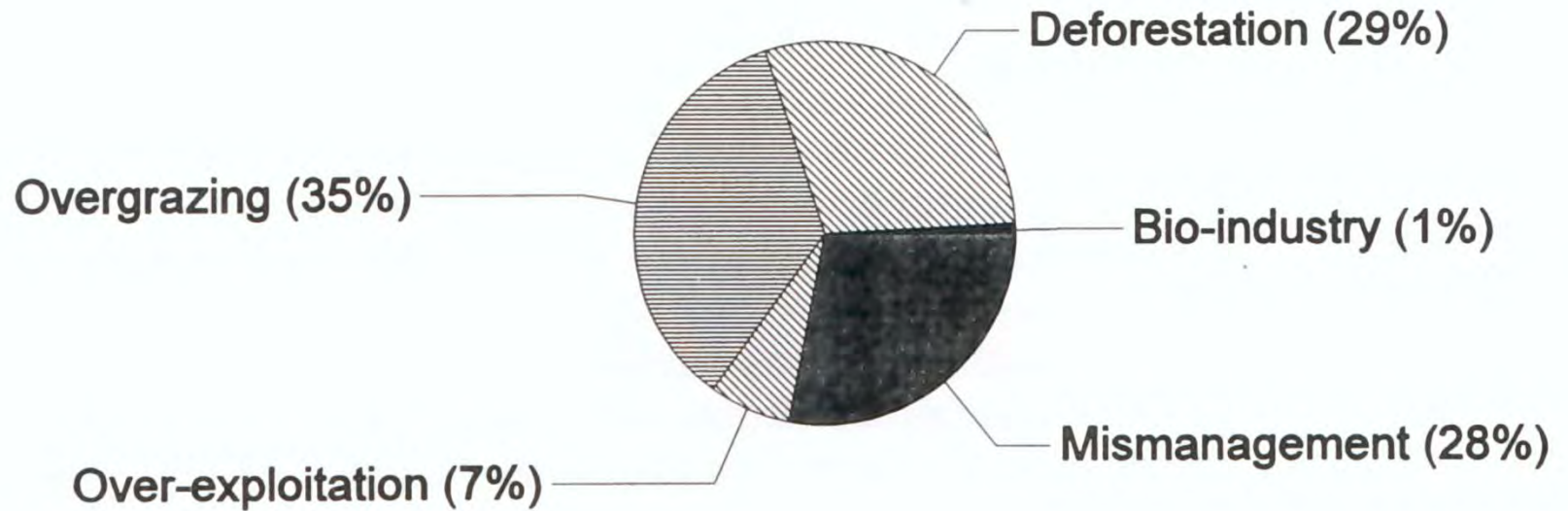
Maize yield/ha stagnates



Causes of ecological unsustainability

- Wealth in industrialised (western) countries (5%):
 - pollution through excess of nutrients
 - pesticide residues
 - CO₂ emission
 - waste of relatively scarce resources (fossil energy, water)
- Poverty in developing countries (95%):
 - desertification due to overgrazing
 - depletion of soils due to lack of fertiliser
 - erosion on slopes due to lack of fertilised soils

Causes of land degradation



Problems of Africa

- Weathered soils
- Erratic rainfall
- Endemic plant and animal diseases
 - Poor resource base, vulnerable environment

- Absence of dominating food crops
- Multitude of farming systems
 - Need for many different technologies

Problems of Africa

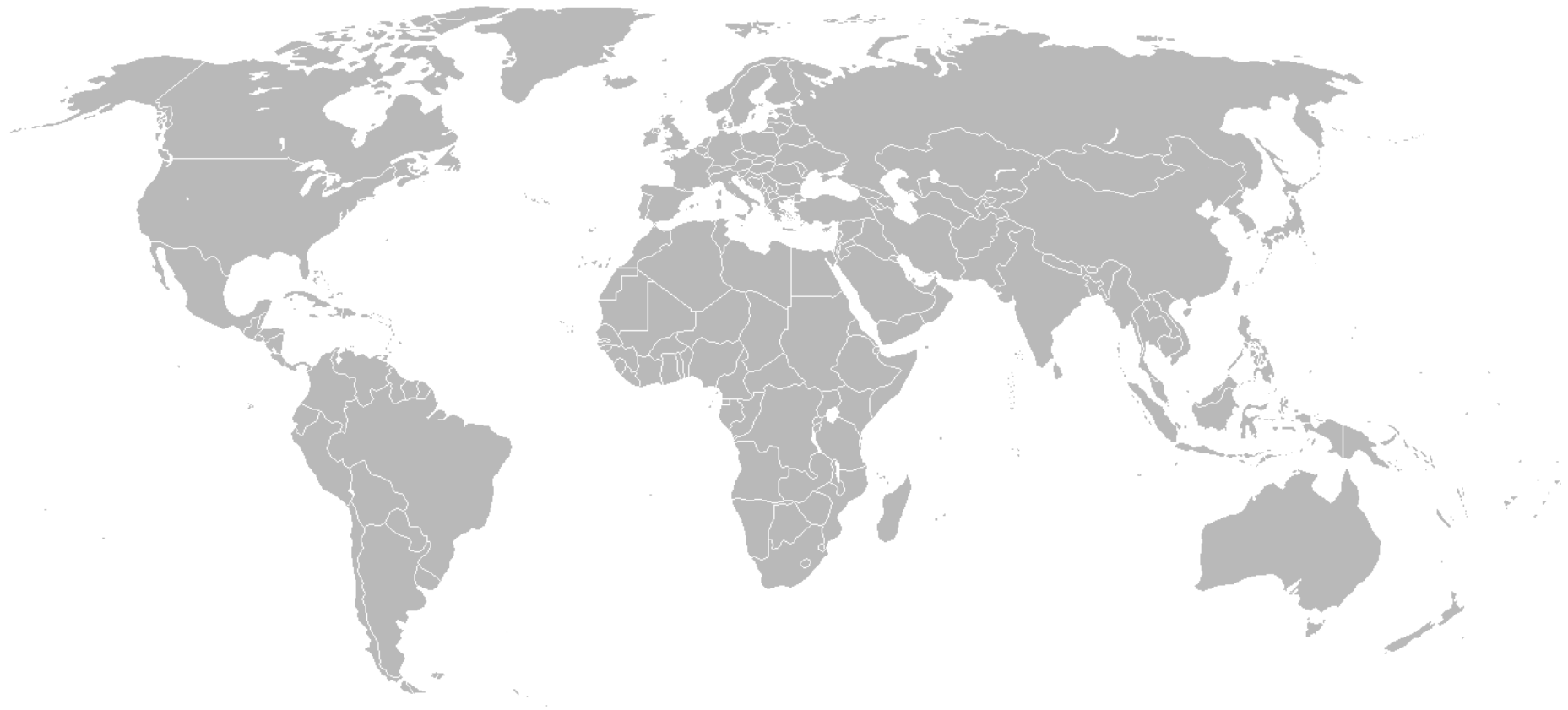
- Dominant role for women – limited access to resources
 - Land and Labor productivity low
- >How to become competitive?

- Lack of investment in agricultural research
 - Lack of knowledge infrastructure
 - Lack of functioning academic institutions
 - Brain drain
- Need for investment in research and education

Problems of Africa

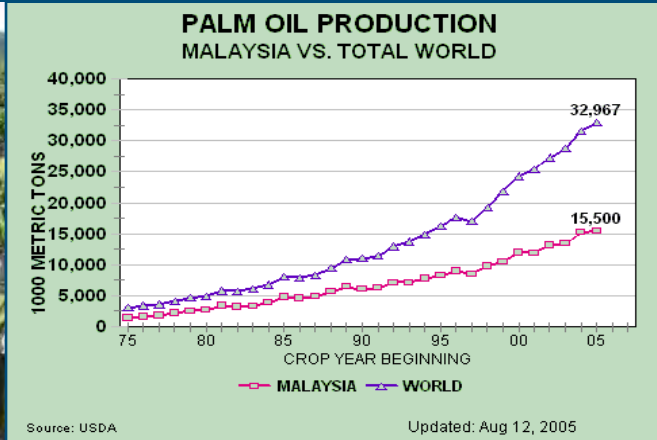
- Not functioning local and regional markets
- Land entitlement inappropriate
- No stimulating political and economic environment
- Inadequate capacity to impact global policy formulation
- Lack of good governance

→ Need for renewal of institutional arrangements



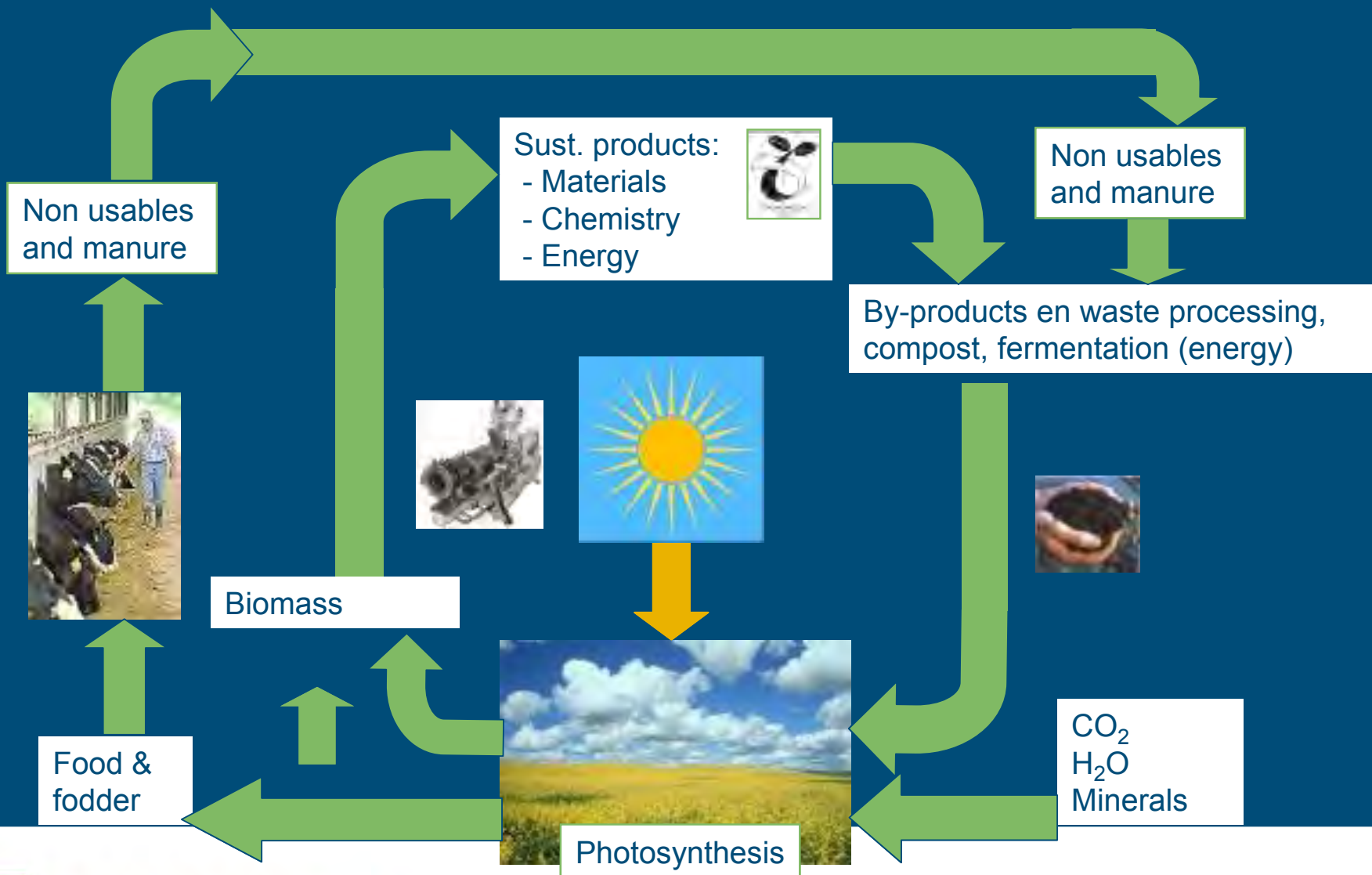
*Threats for food security
and mining of natural resources*

Energy: Competing claims

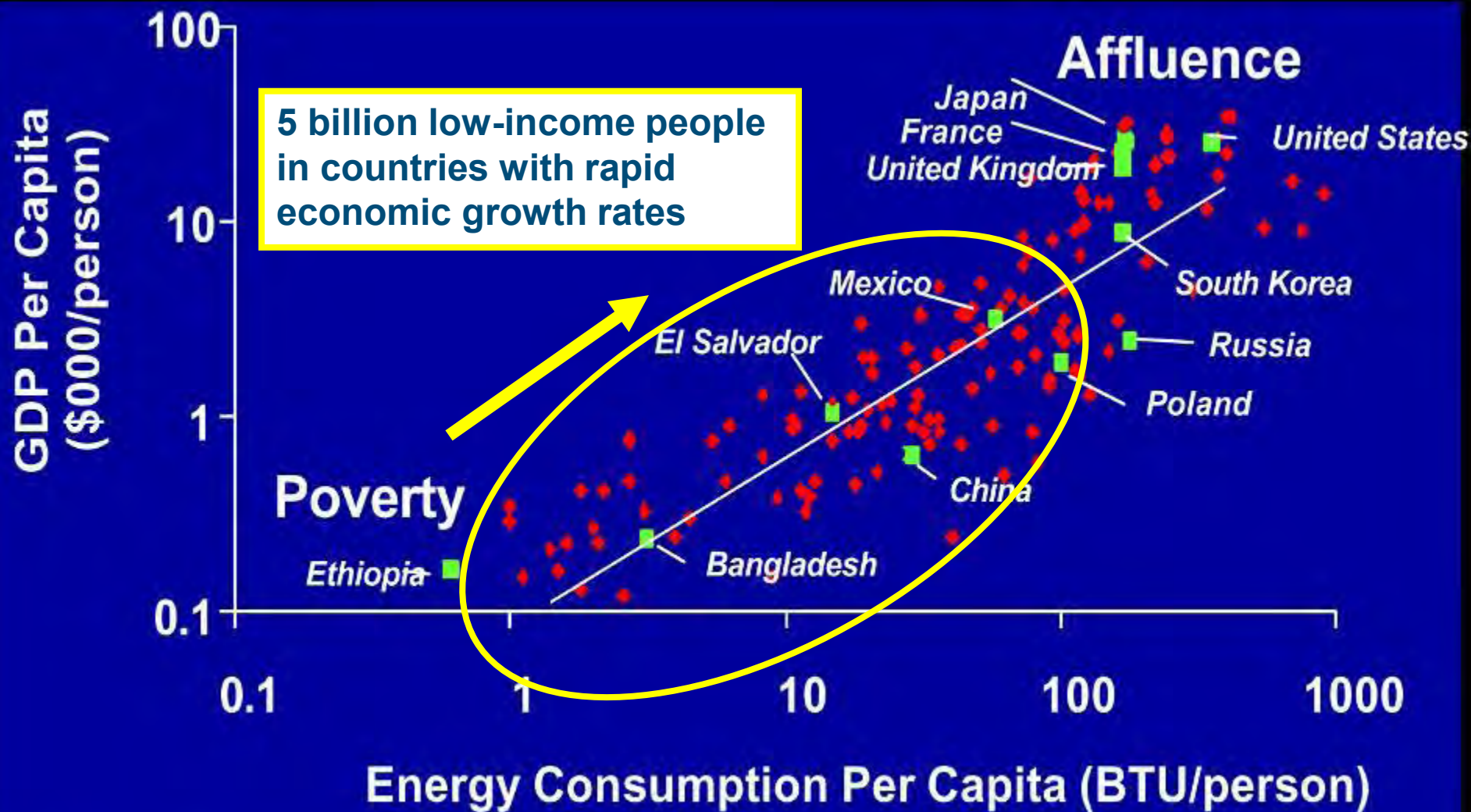


...Fuel for the Rich or Food for the Poor...

Biobased economy



Energy consumption and income are linked



Source: Energy Information Administration, International Energy Annual 1998 Tables E1, B1, B2; Mike Grillo, 5/17/00
Gross Domestic Product per capita is for 1997 in 1990 dollars. Energy Consumption per capita is 1997.

Energy Use (different scenario's)

	North	South
<i>Use 2000 (EJ)</i>	<i>250</i>	<i>100</i>
<i>Prediction 2040 (EJ)</i>		
Reference	347	1064
Utilization	302	881
Saving	159	466
Managing	266	776
Caring	123	361

WRR: Duurzame risico's

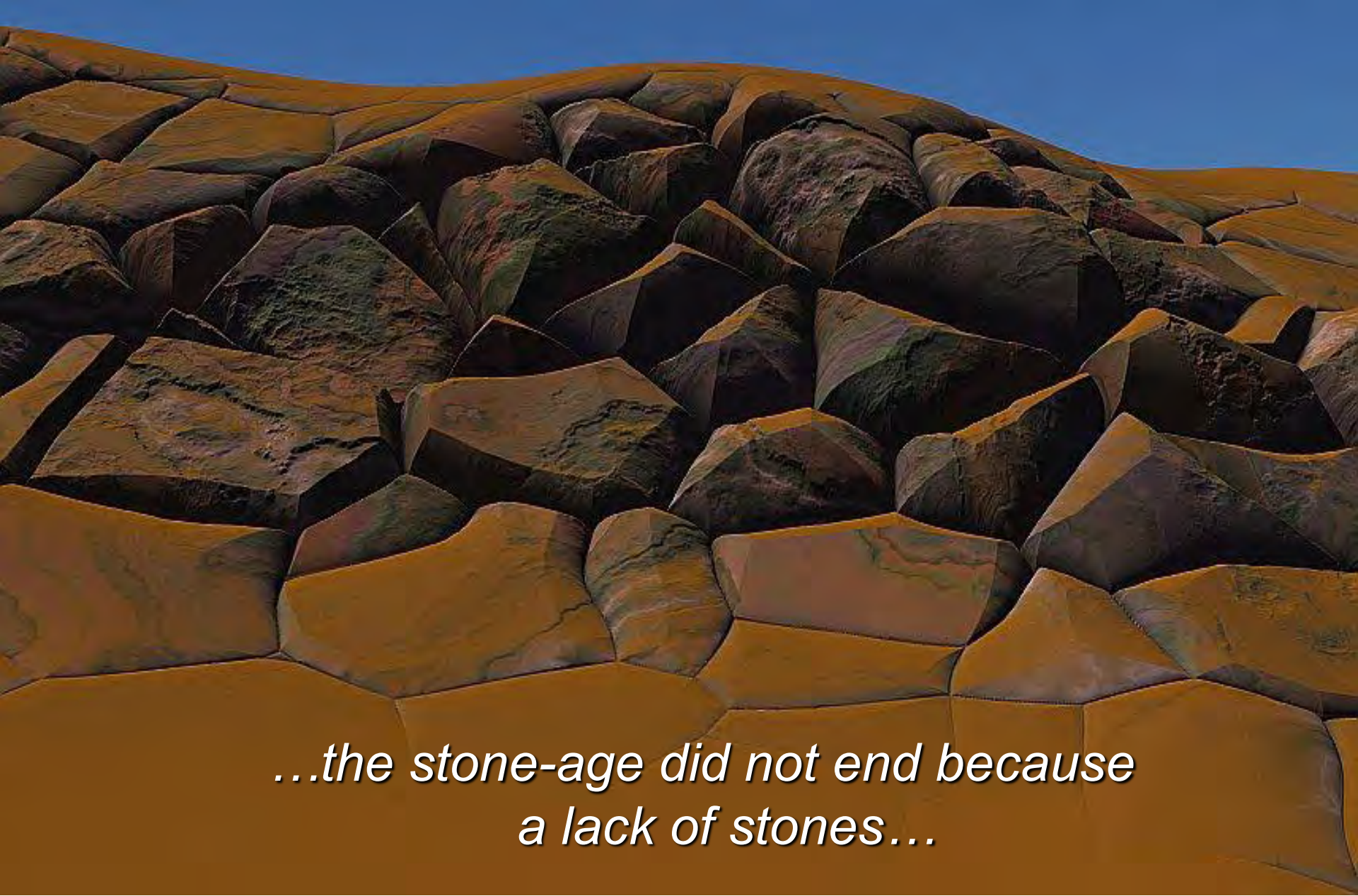
Energy

- The world faces a growing demand for energy
- Transition needed from *stored* energy to *flowing* energy
- New challenges offer new opportunities





...will the oil-age ends because a lack of oil?...



*...the stone-age did not end because
a lack of stones...*

First generation bio fuels

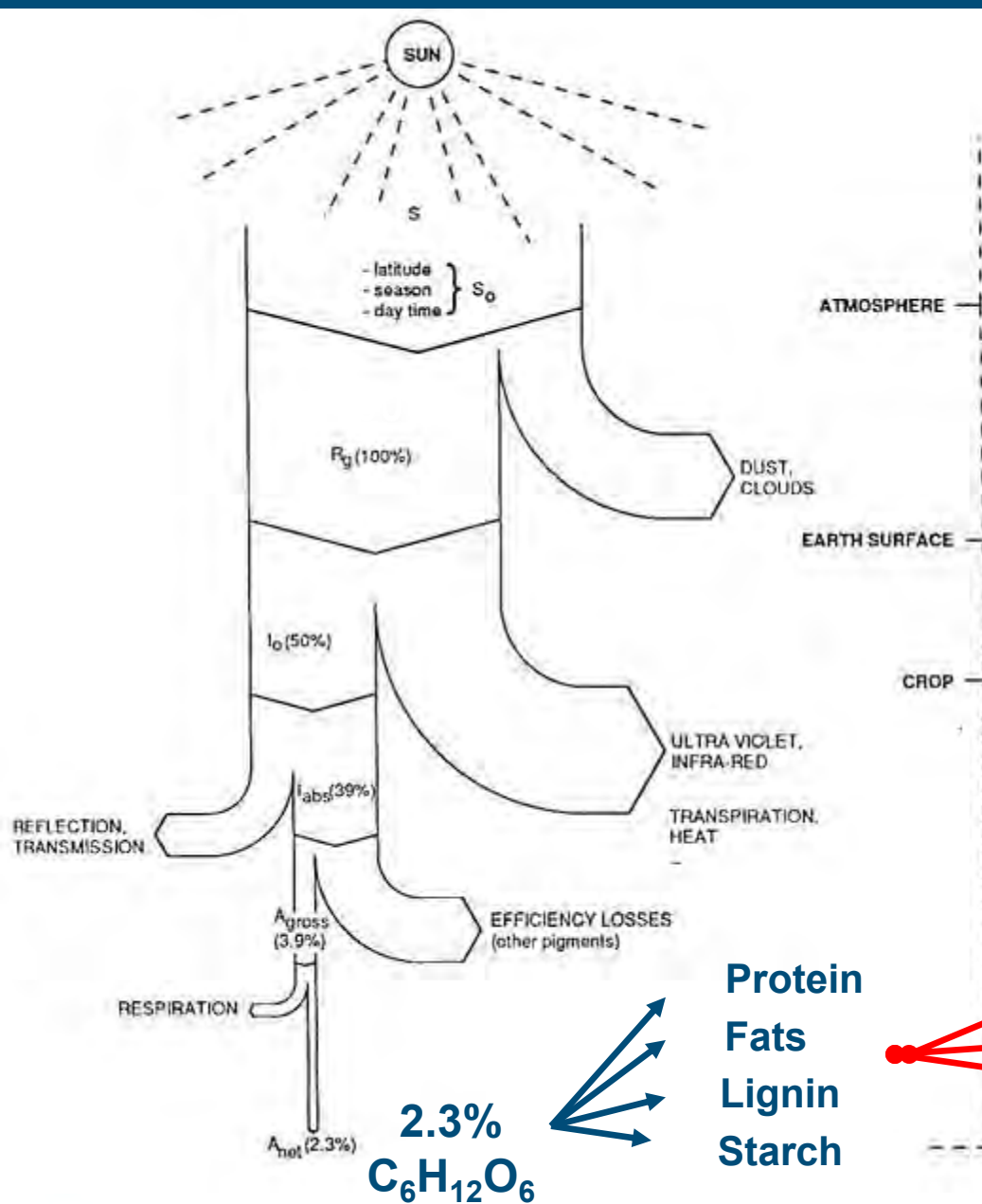


Food for energy

Plant oil, maize for ethanol, sugar for ethanol

Direct competition with food

Low efficiency



Leaf
Stem
Other organs



Annual actual efficiency

0.5 – 2.3%

Dystopy: Second generation bio fuels



*Woody parts for energy
Conversion into ethanol
or diesel*

*Indirect competition for
food*

Dystopy: Energy crops on degraded soils

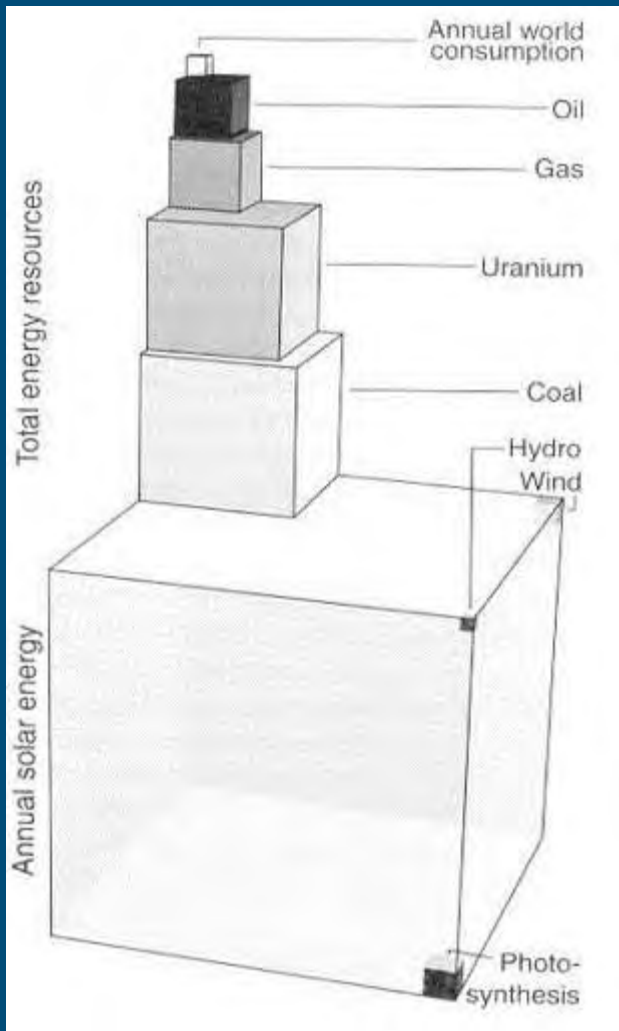


Poor soils give poor yield

Highest value crops on best soils

Not an agronomical but an economic issue

Utopy: Photosynthesis



- Enormous potential of solar energy
- Plants fix no more than 1-2 % of solar energy in sugars



Utopy: BioSolar Cells

- Compliance with Dutch policy
- Support by Dutch government
- Excellent Dutch expertise
- Joint efforts of scientific groups
- Commitment by companies



PPP
program
40 M€ FES

BioSolar Cells

Natural systems or systems based on natural processes that convert Solar Energy into a usable form



Founding parties (2008)

Center for Photosynthesis Research

Towards BioSolar Cells

Wageningen University and Research Centre
Leiden University
VU University Amsterdam
University of Groningen



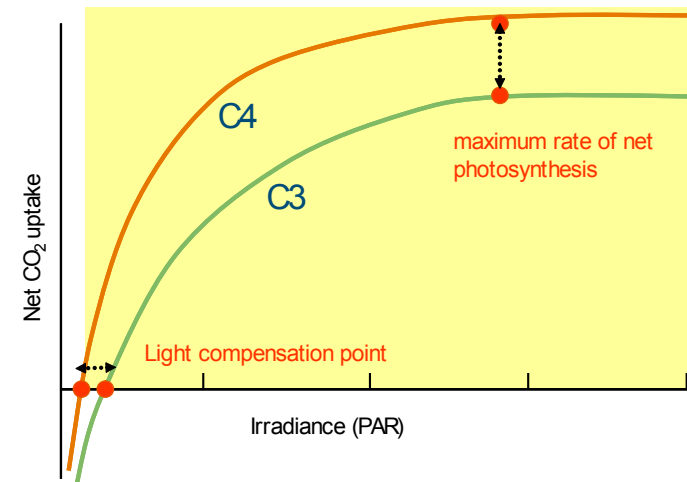
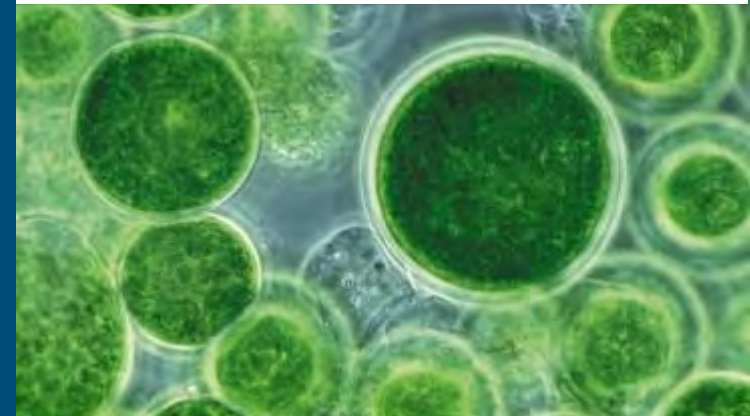
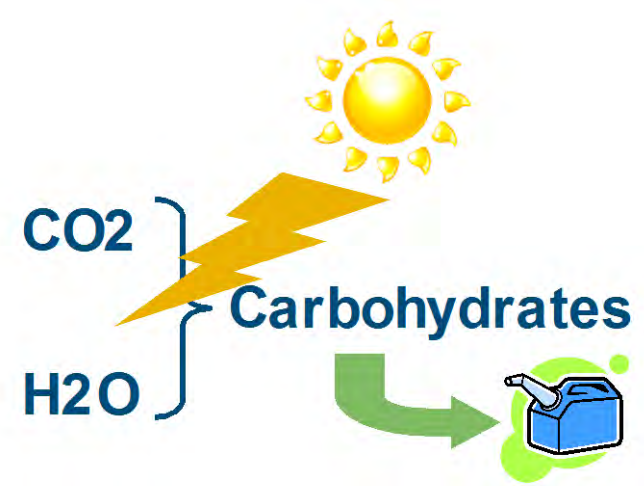
- Wageningen Universiteit & Research Centre
- Free University Amsterdam
- University Leiden
- University Groningen

Three Research themes

(Semi)-artificial systems

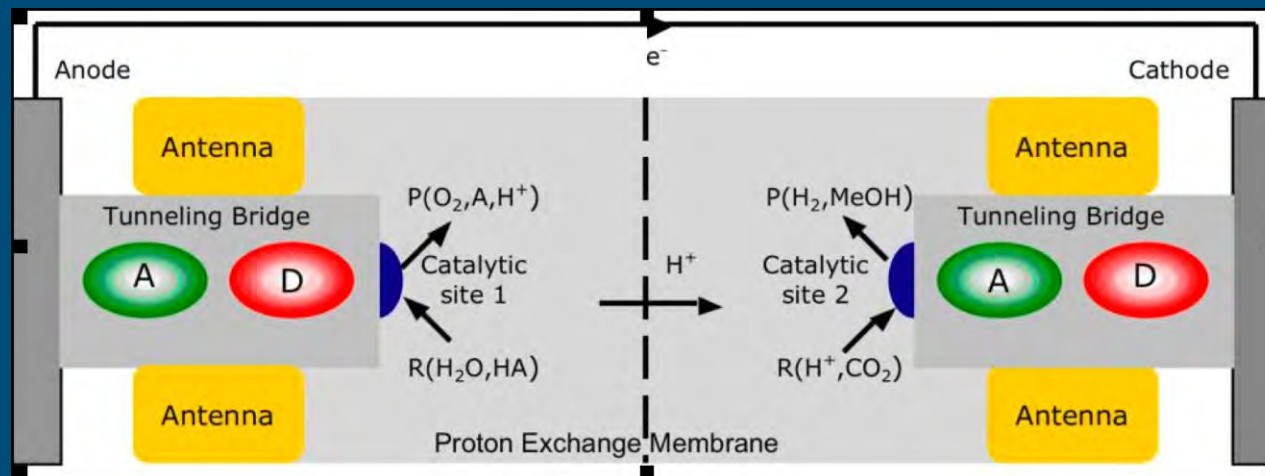
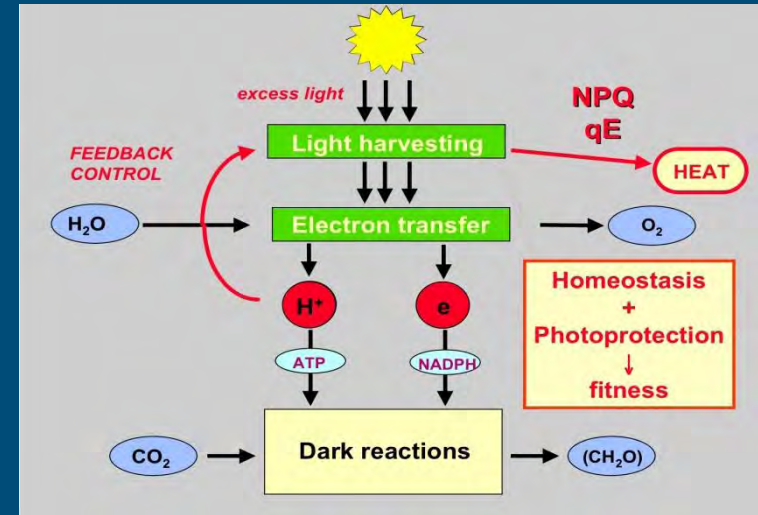
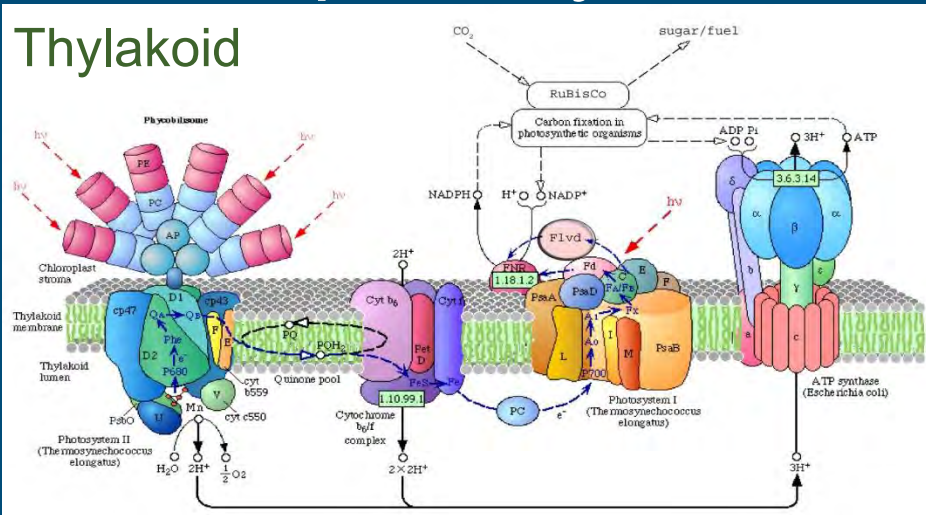
Cell level (algae and cyanobacteria)

Plant level



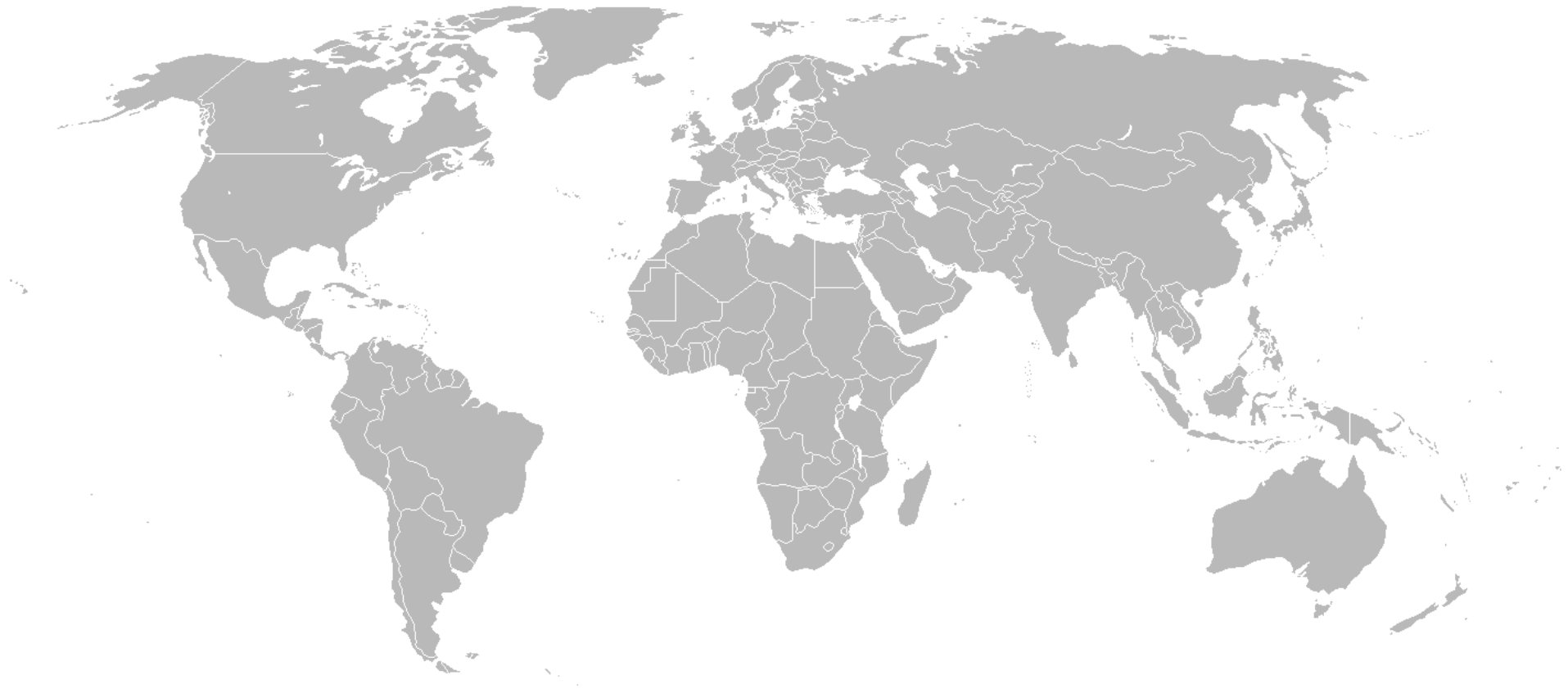
From photosynthesis to BioSolar Cells

Thylakoid



Green economy

- Leading role private sector
 - from marketing and corporate responsibility
 - to mainstream activity
- Facilitating and stimulating role government
 - (not financing and leading)
- Broadened objectives and possibilities new economy



Land and water use

Global water problems

Freshwater withdrawals

- Total : 4000 Gm³
- Agriculture: 2800 Gm³ (70%)

Future developments:

- Growing population (6 to 8 billion in 2025)
- Water-demanding diets (meat)
- Competition with other sectors
- Water pollution
- Large infrastructure (for irrigation) debated

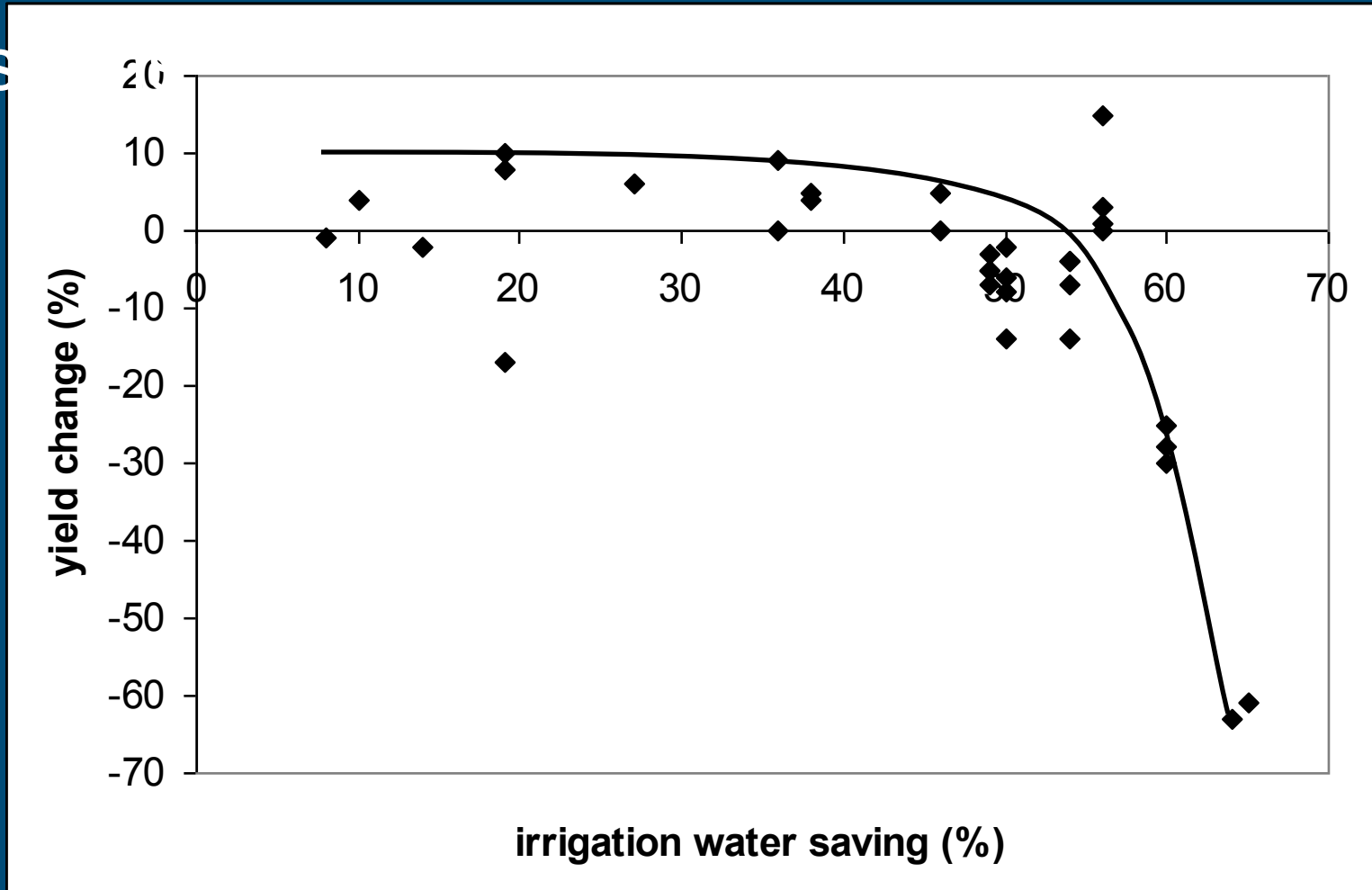
Water-less rice

Converting inundated rice cultivation into dry rice



Field - Design of water-use efficient rice

sys



Farm - opportunities and consequences

■ Indonesia

- Water saving practices economically attractive
- Implementation difficult - infrastructure, communication between farmers and irrigation engineers, farmer skills, risk

■ India

- Farmers are testing practices
- Government supports farm trials

■ Madagascar

- System of rice intensification increases yields
- Adoption limited - requires much labour at moment that cash income is needed → little time for labour demanding planting

■ Overall opportunities

- Introduction other crops (expands windows of opportunity)
- Water for irrigating other / more land



River basin

Implications for water availability and alternative use

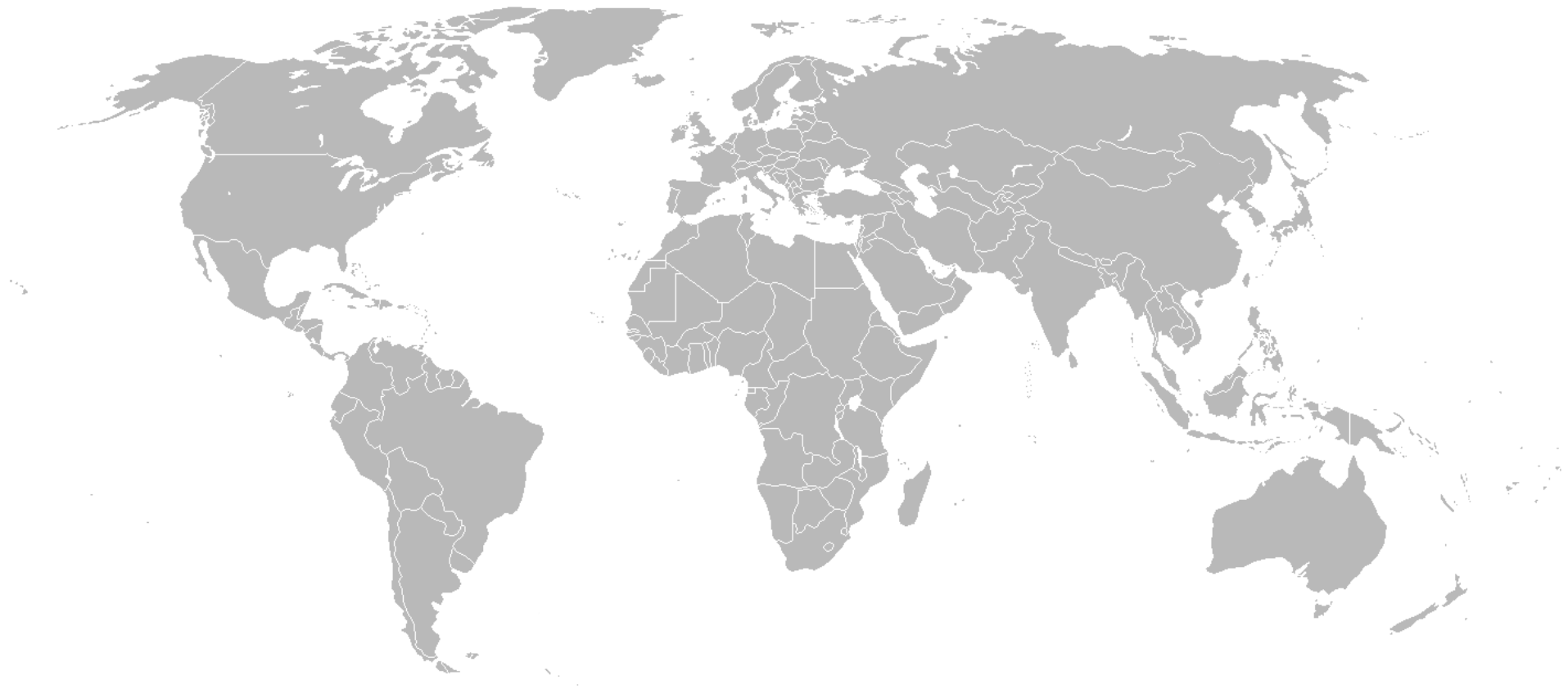
■ Indonesia (Citarum basin)

- 10% change in land use → new water reservoir unnecessary
- Water saving practices rice → twice as much water for Jakarta

■ Other options

- Expand irrigated land for food
- Allocate to nature conservation
- Allocate to industrial and household use





Conclusions

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- Food security possible
- Water security requires considerable change
- Rainbow evolution urgently needed
- Ecological literacy a way to go

Thank you for your attention