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Author(s)	Riedacker, Arthur
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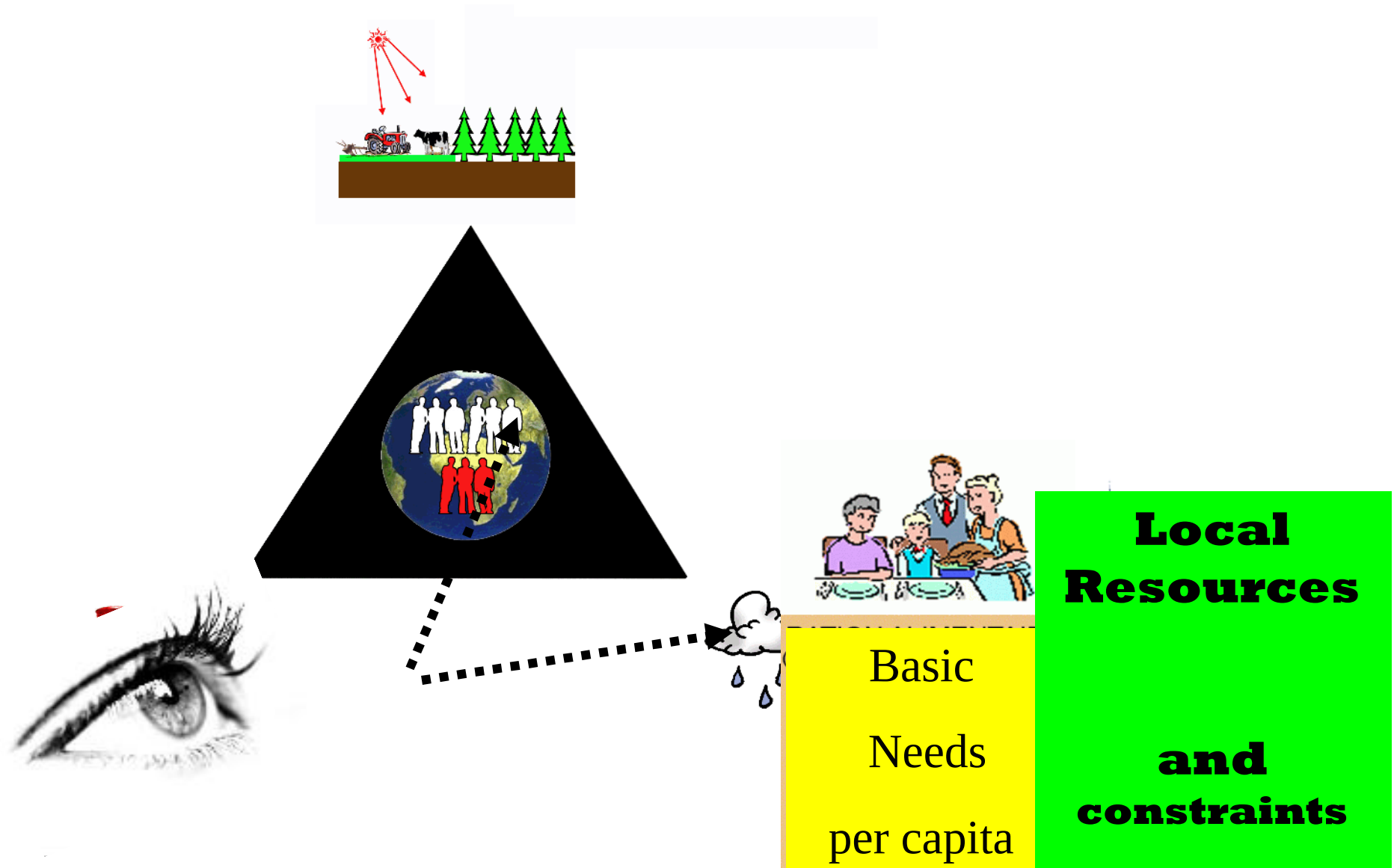


**"Food crisis,
the end of cheap oil
and climate change:**

**What should be the global
and local priorities in
agriculture and forestry?"**

Arthur Riedacker Directeur de Recherche INRA
63 Bd de Brandebourg 94205 Ivry Cedex France
a.riedacker@wanadoo.fr

For sustainable development we are
to look both at global & local level

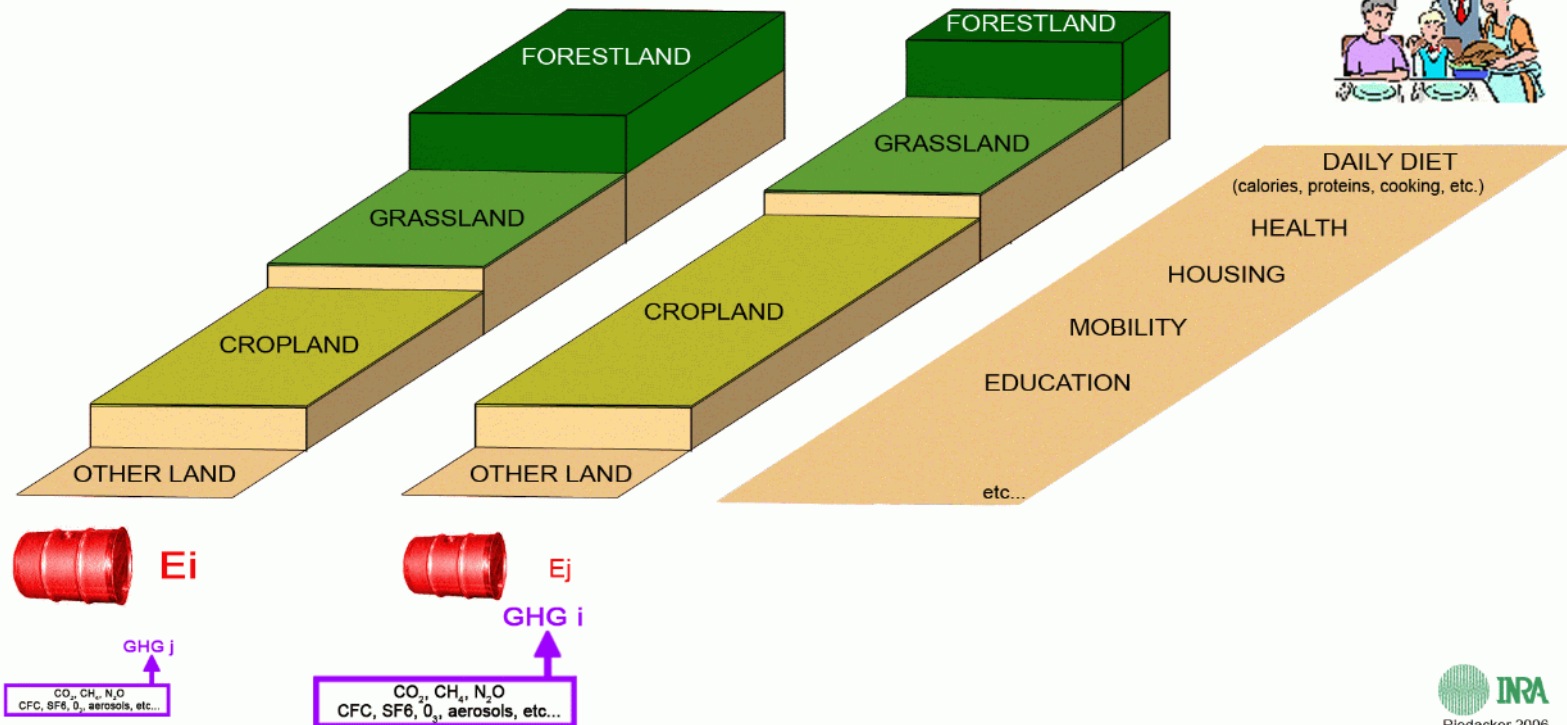


⇒ 1st conclusion
We can only compare
scenarios and not absolute values

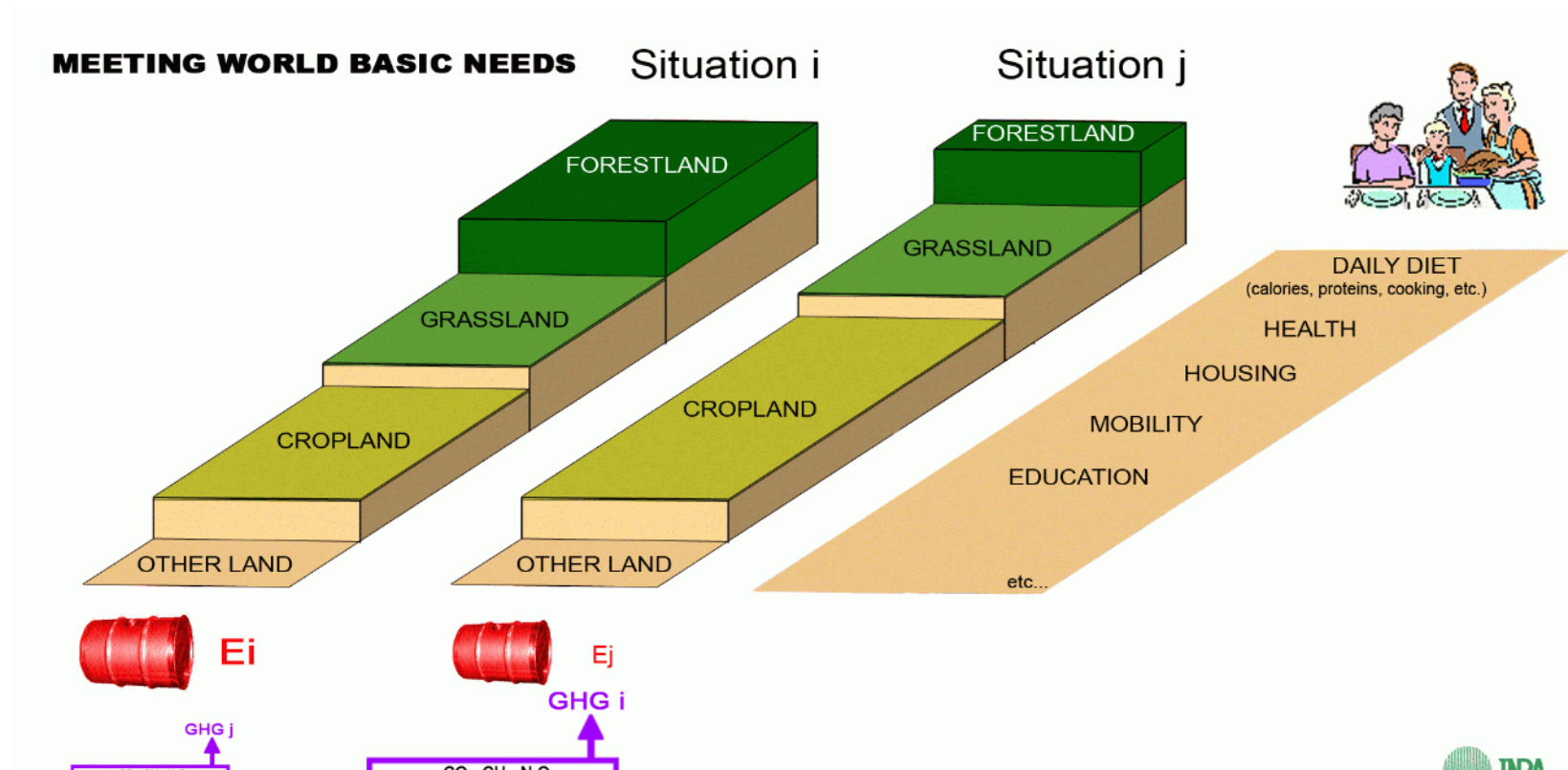
MEETING WORLD BASIC NEEDS

Situation i

Situation j

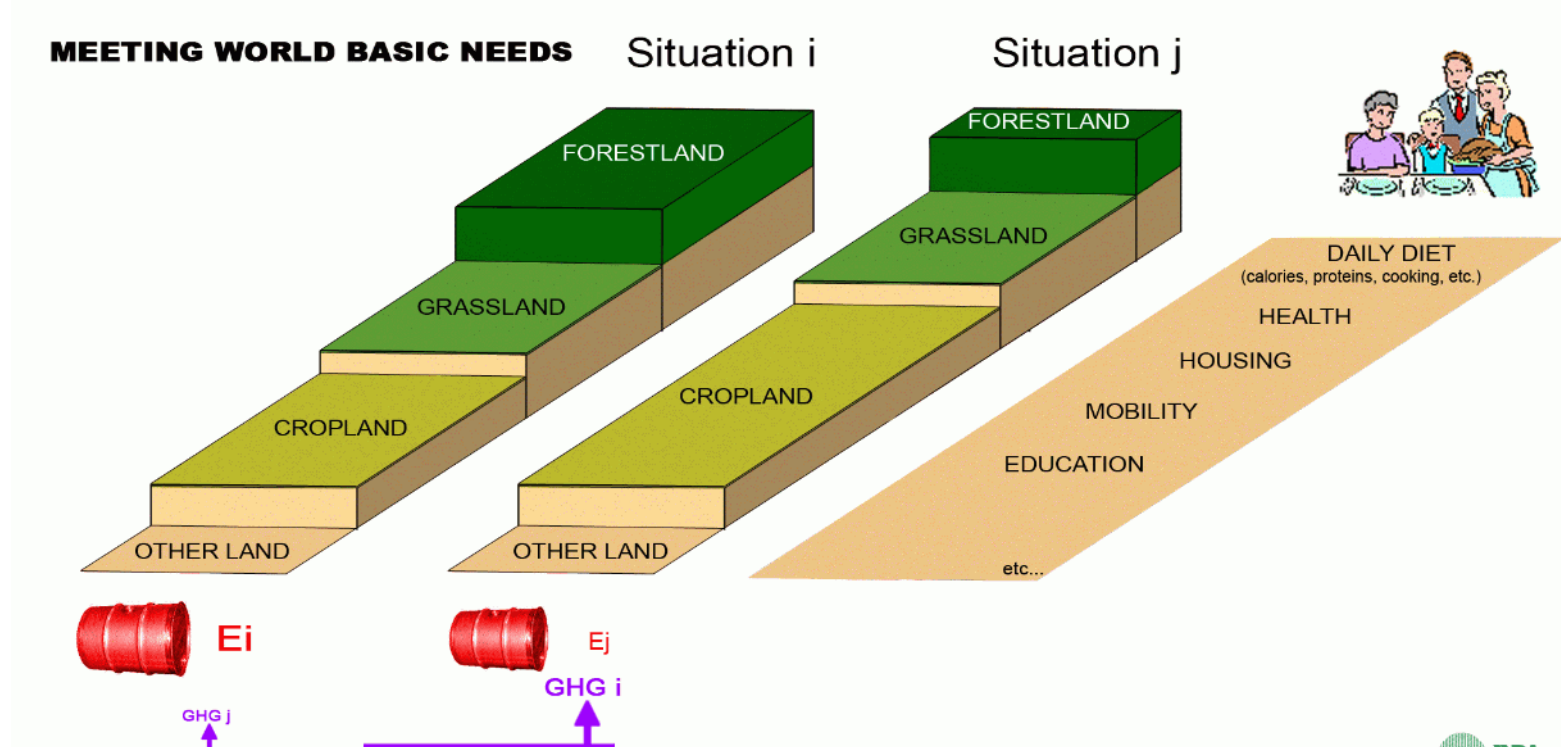


⇒ 2 d conclusion
We should increase Land use efficiency (LUEf.) where possible



⇒ 3 d conclusion

We should make LUEff be considered like ‘Energy Efficiency’ under the post 2012 Kyoto Protocol Regime



At the global level : Major constraints until 2050 are

1. Population growth **and food production**
2. End of cheap liquid fossil fuel (petrol etc.) ?
3. Climate change affecting agriculture
=> food production, particularly in densely populated regions

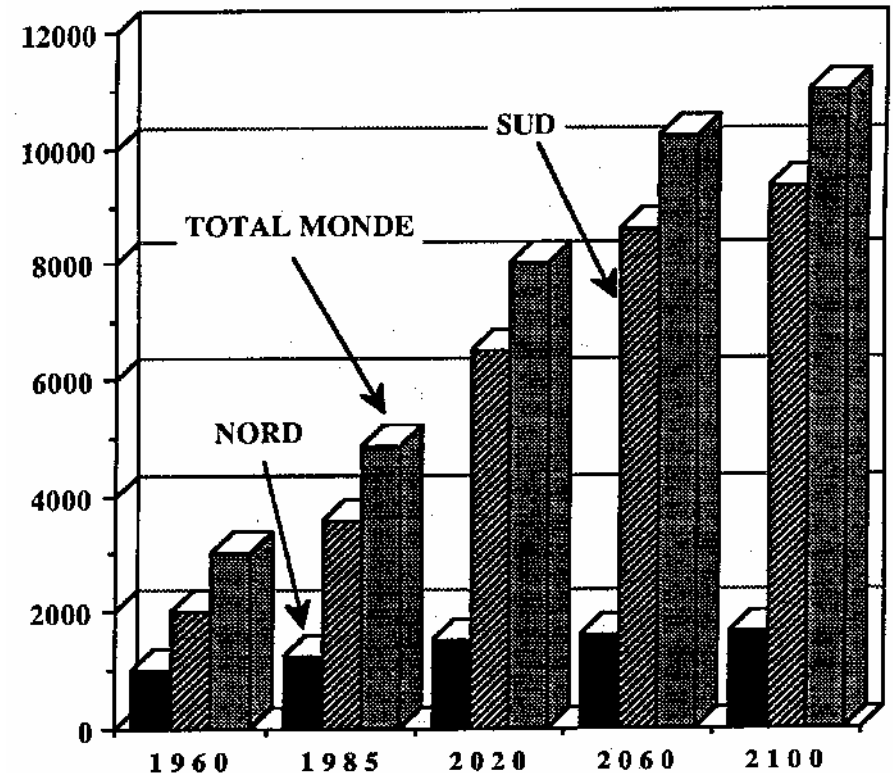
To morrow + 3 Billion people (+50%)!

And +100% in Sub-Saharan Africa

Increase of Population

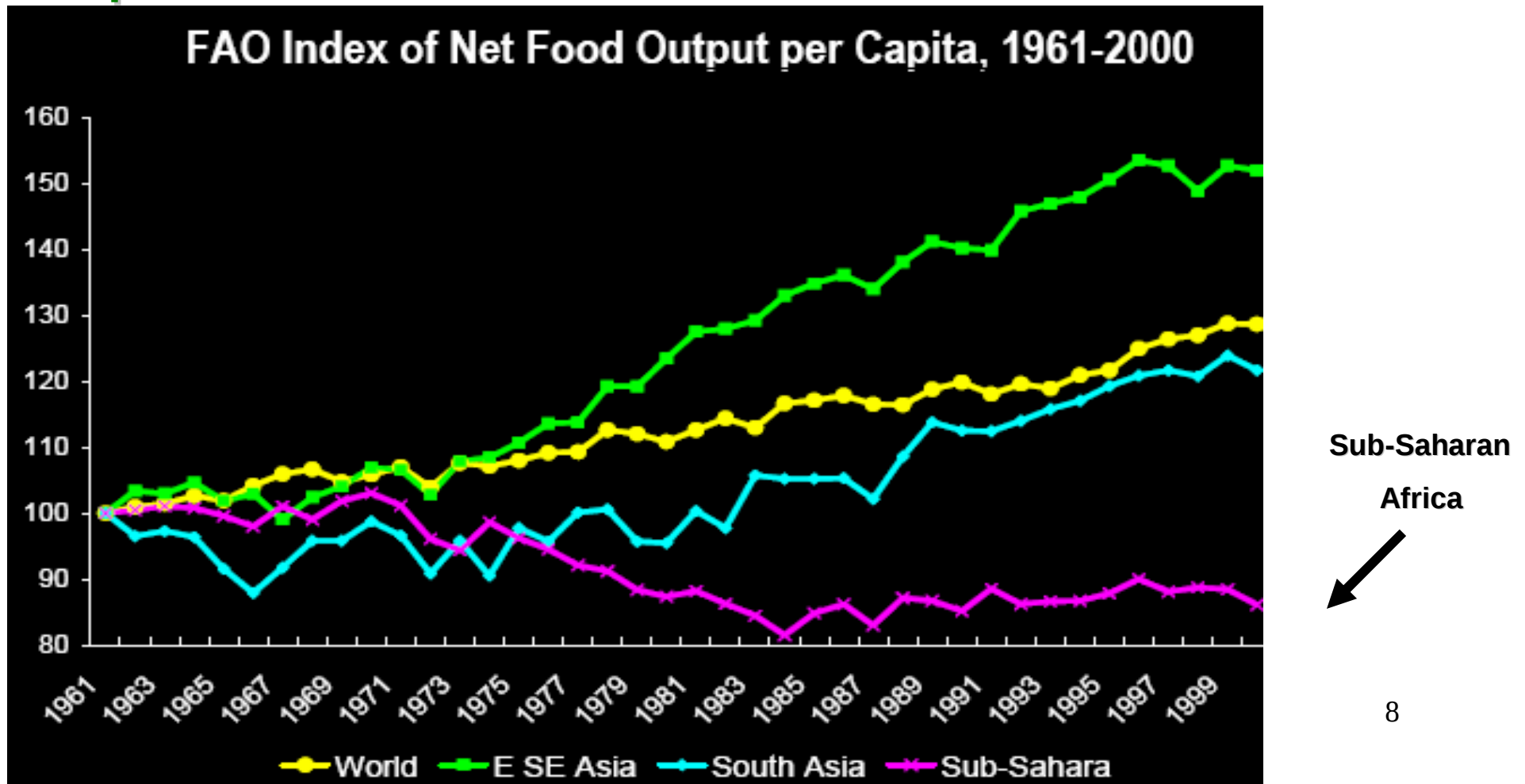
and some

**Increase in per
capita
consumption**
(more food in some
countries, more meat ?
more energy, more
goods etc.)

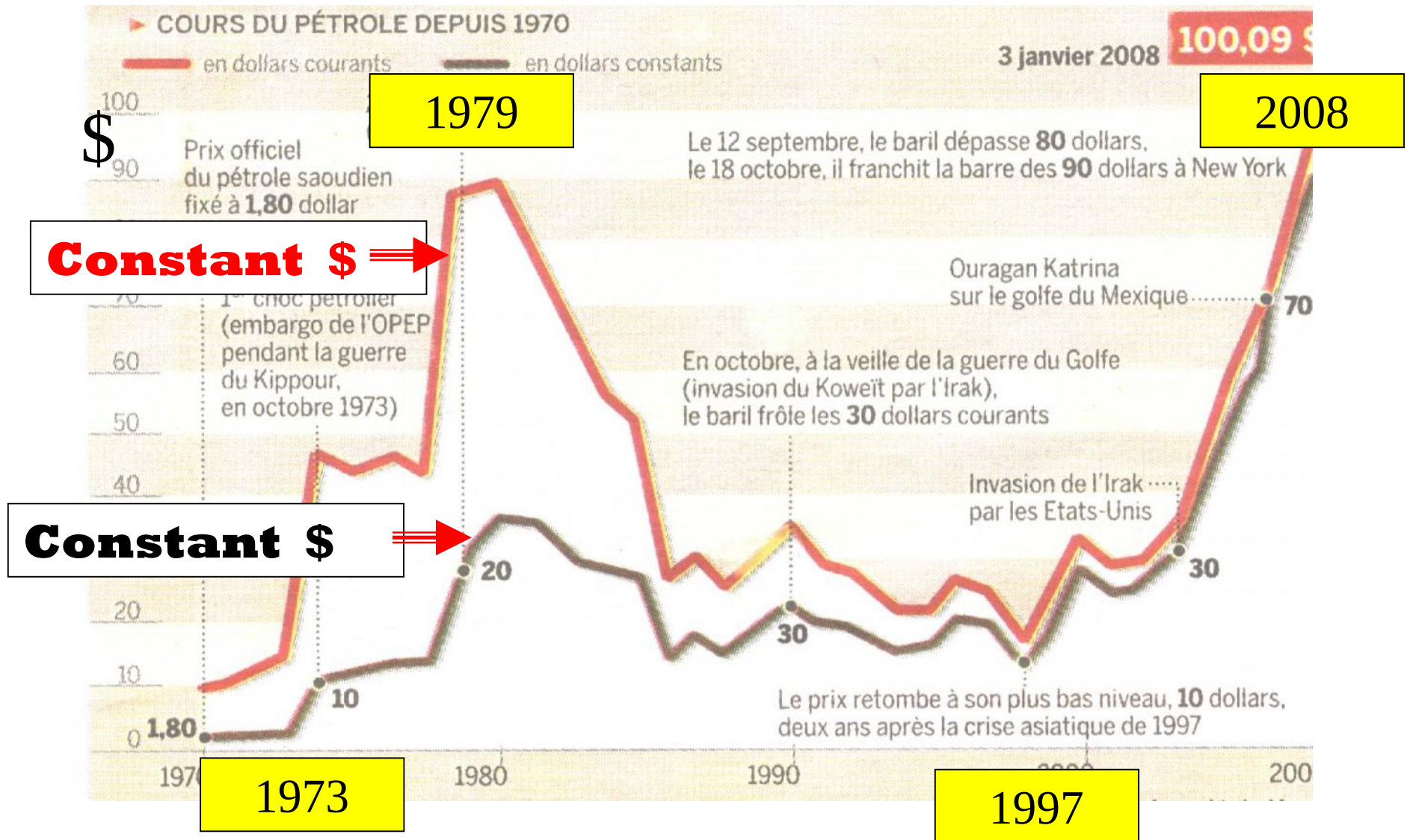


1/ Food

This is still a challenge today in Least Developed Countries, in particular in Sub Saharan Africa



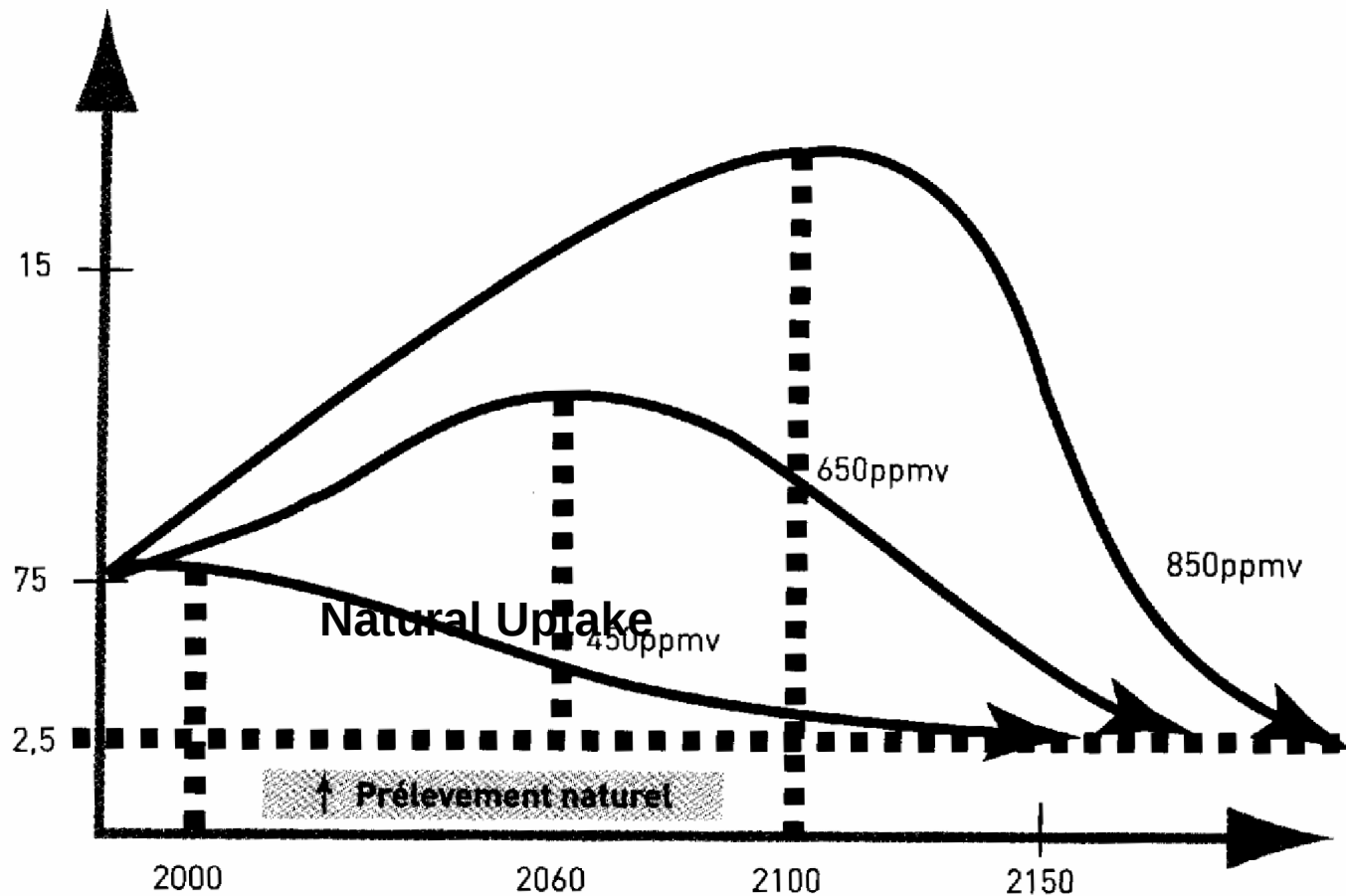
End of cheap oil

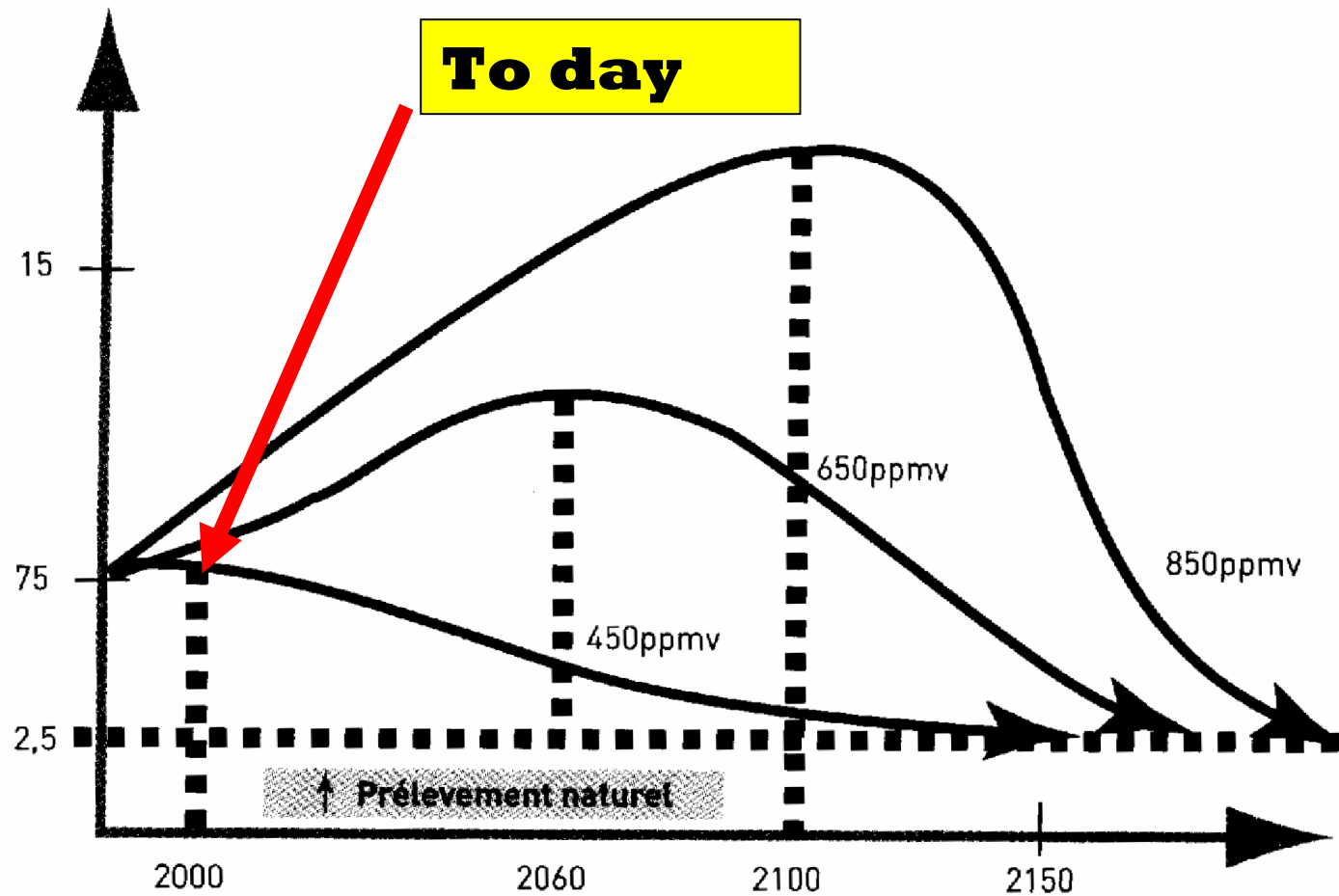


Climate Change ?

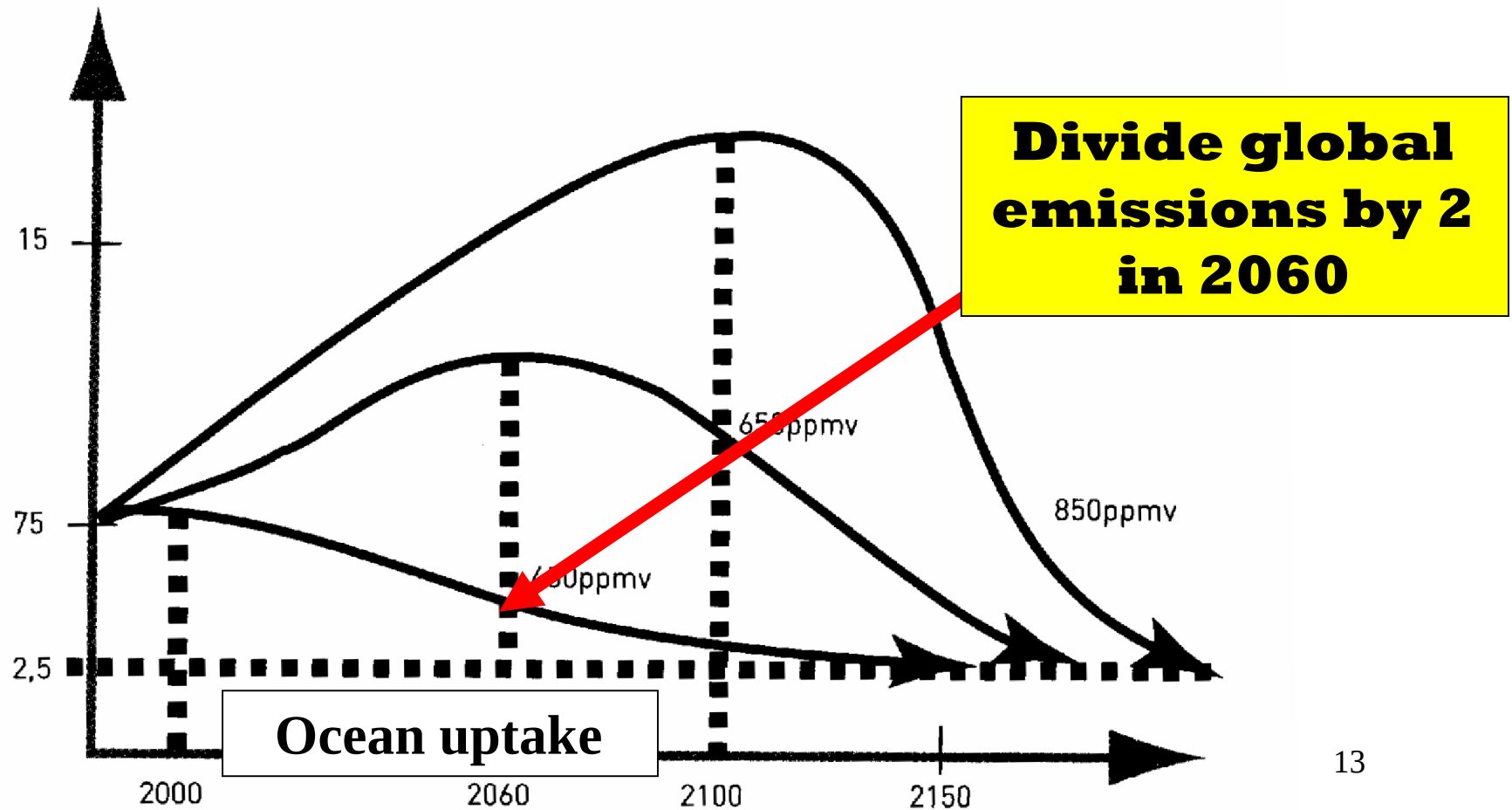
**Most important negative impact is
on agriculture in most densely
populated regions**

Emissions curves to stabilize concentrations at 450, 650 or 850 ppmv





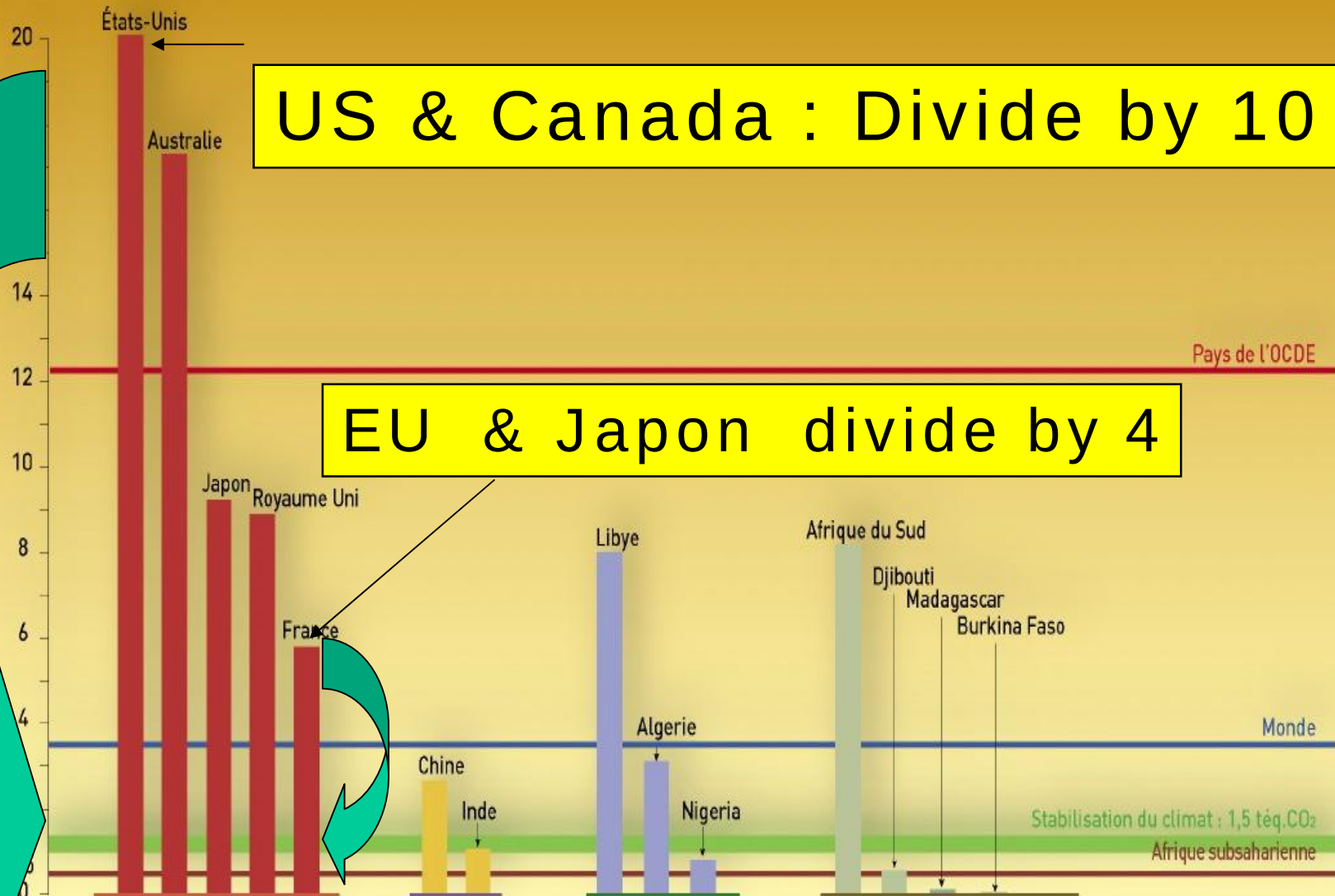
Curve to stabilize at 450 ppm



Developed countries are to show the way...

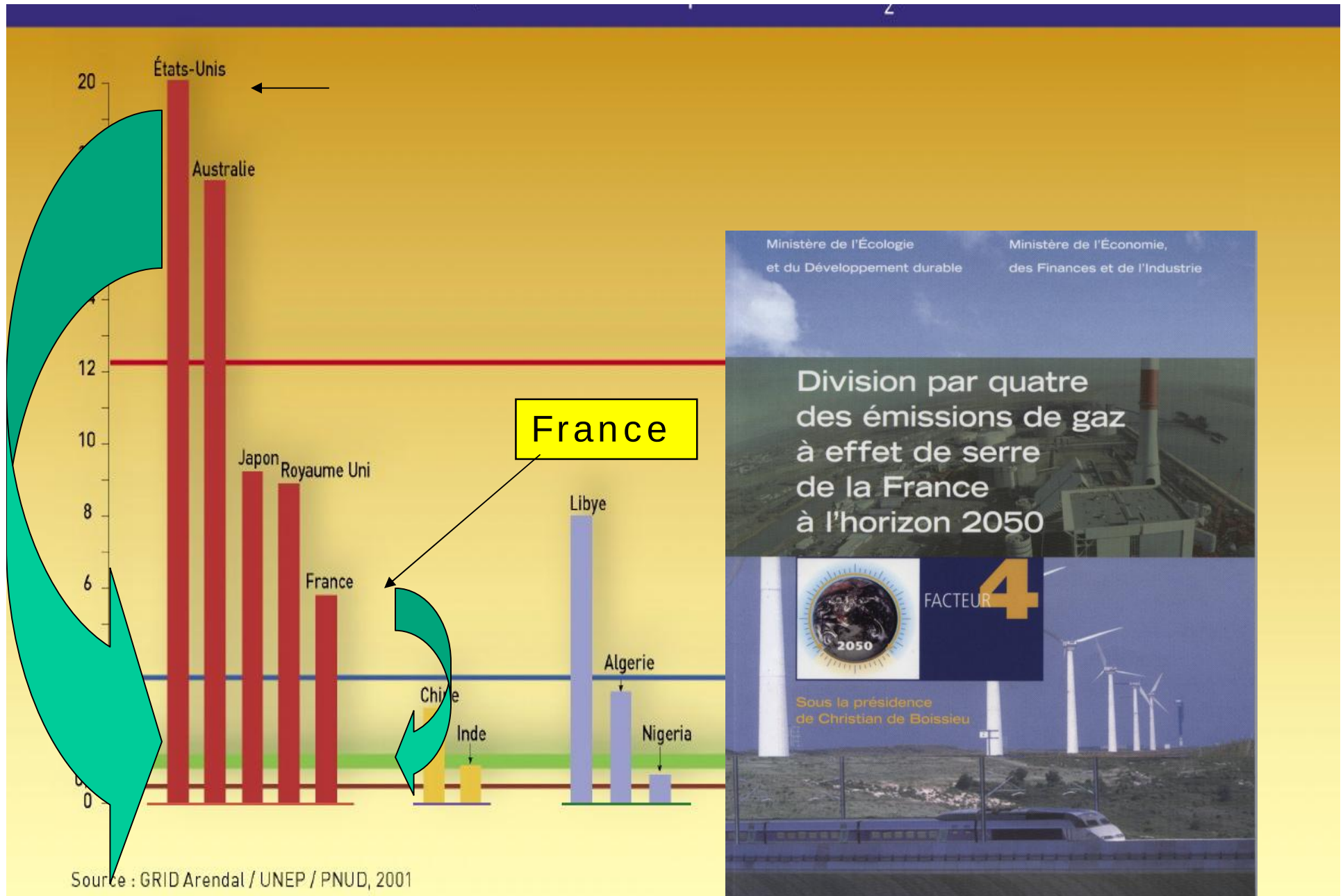
US & Canada : Divide by 10 !

EU & Japon divide by 4



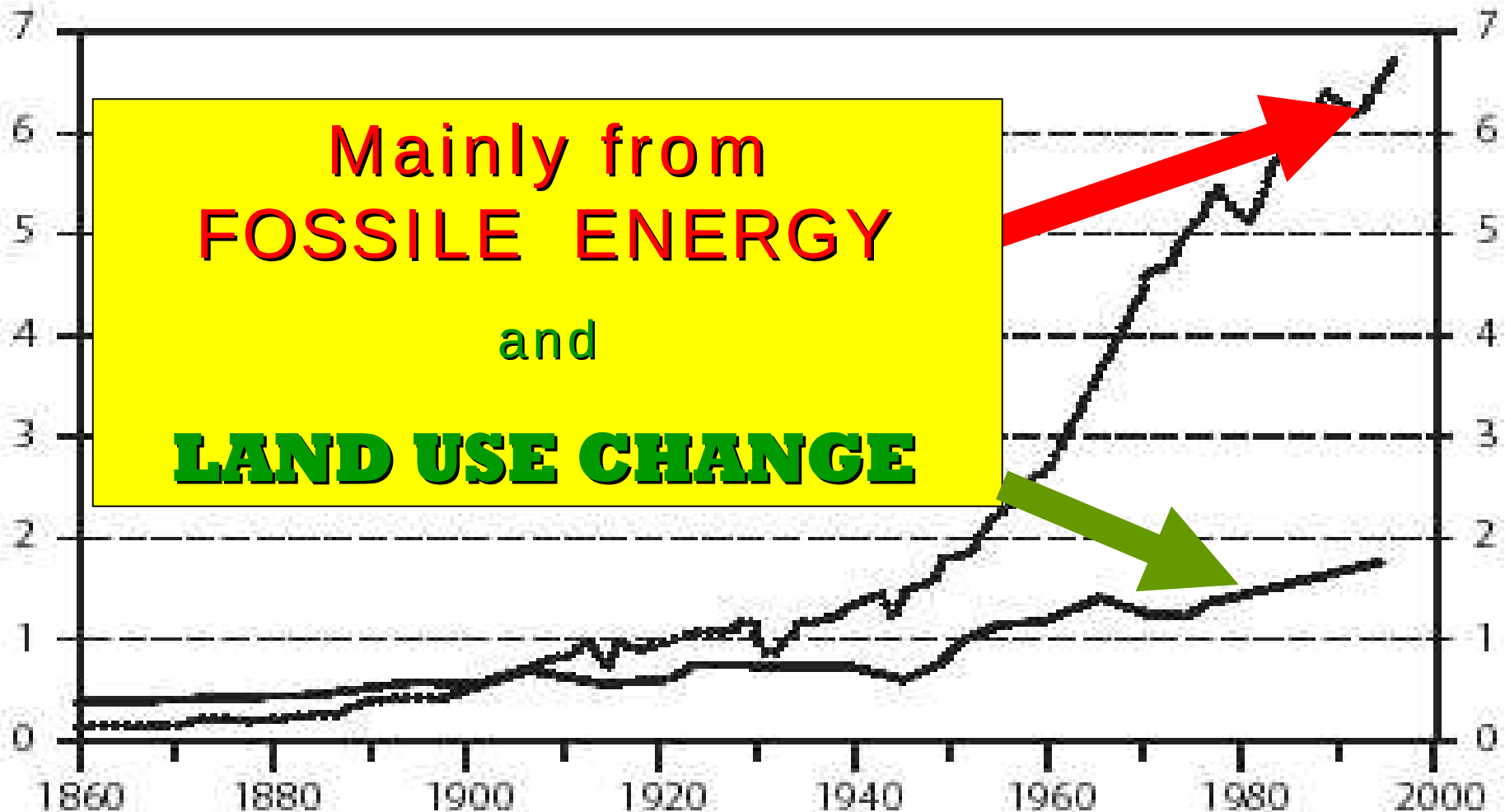
Source : GRID Arendal / UNEP / PNUD, 2001

Developed countries are to show the way...

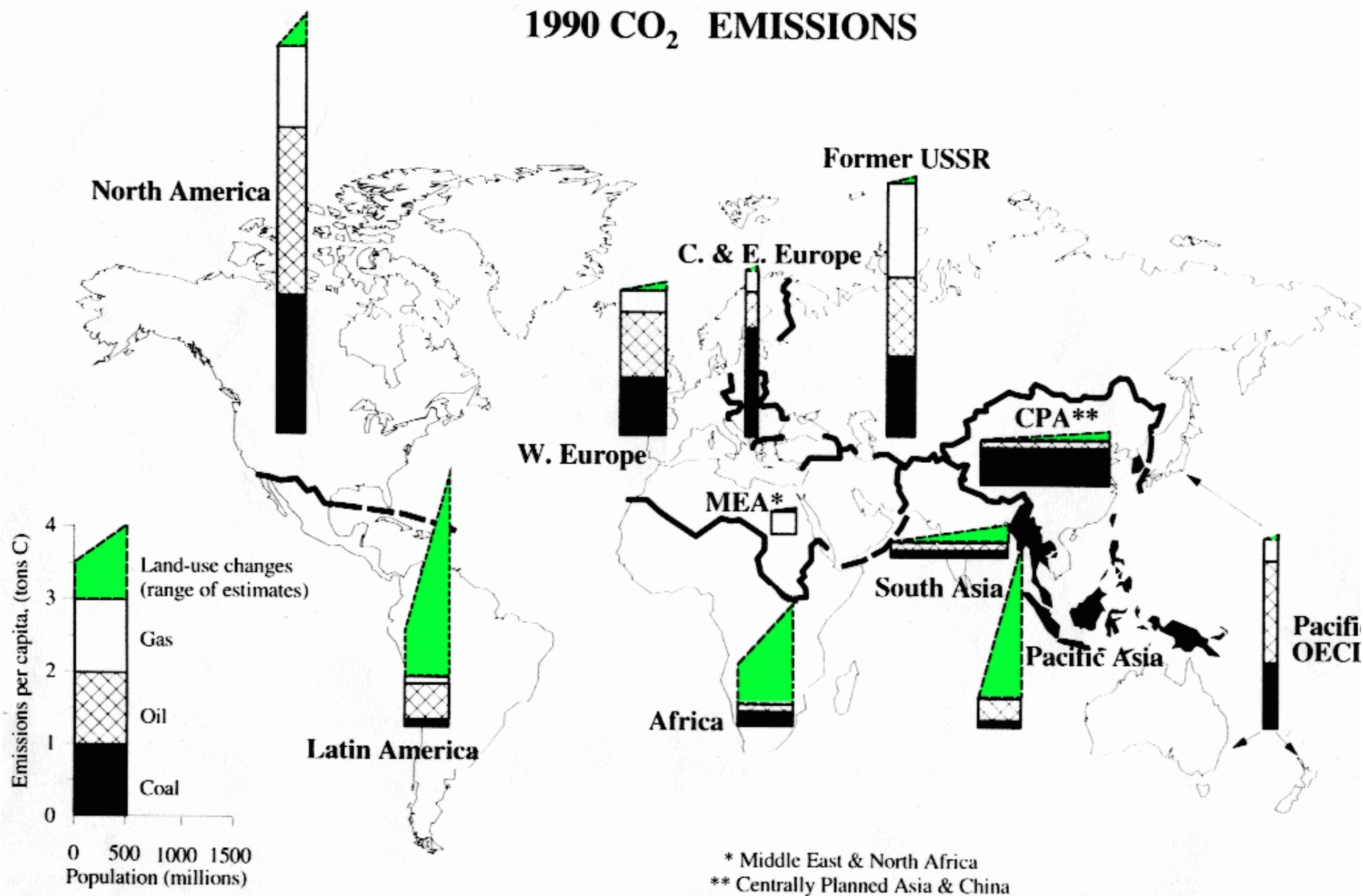


That will not be easy

Net CO₂ emissions in (GtC) since the industrial revolution



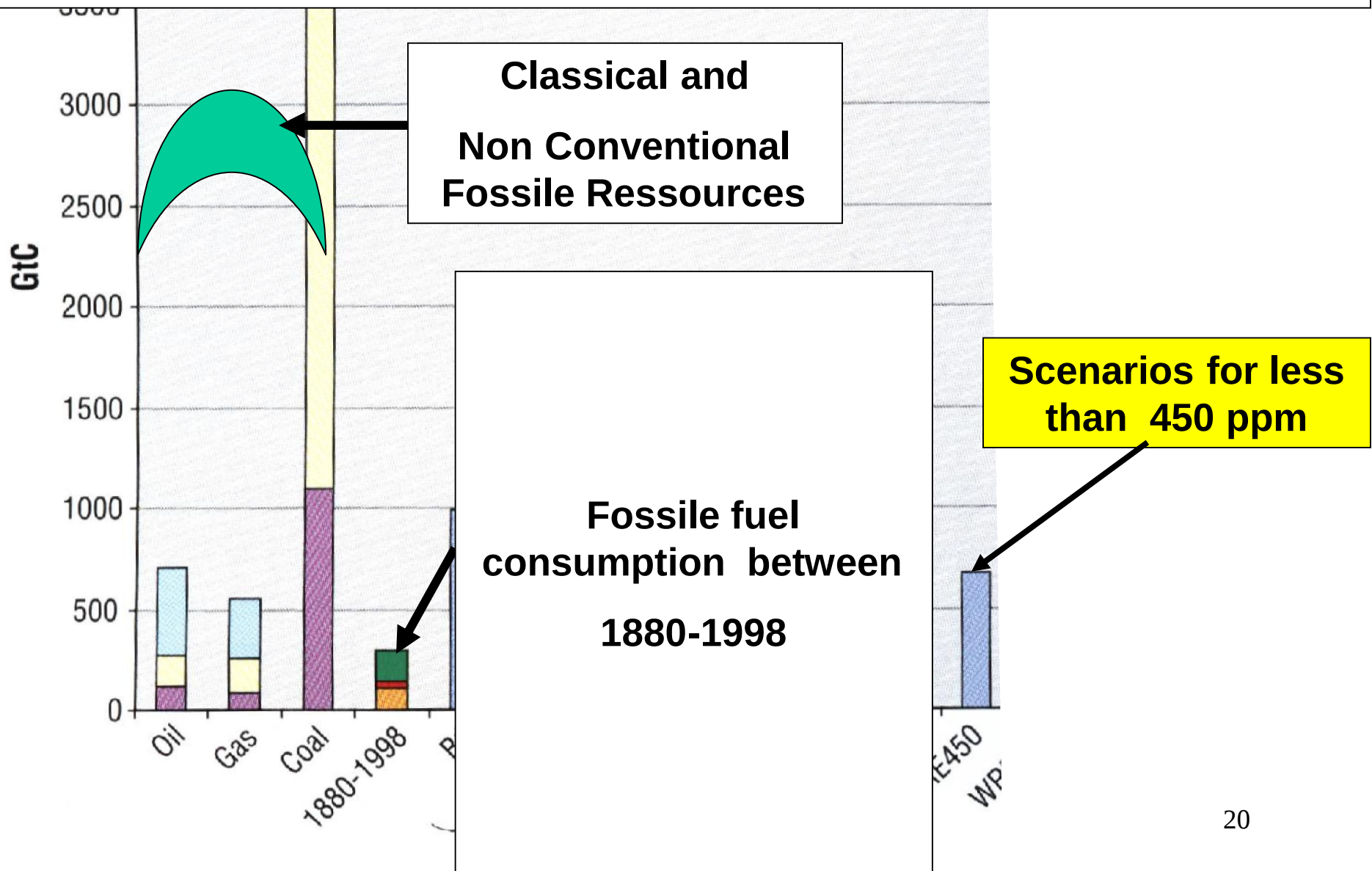
1990 CO₂ EMISSIONS



**But for climate
stabilization**

**we still have
to much fossile fuel !**

Do not expect fossile fuel shortage to solve the issue of climate change !



Since 1992

**we do know what we
should do to reduce
emissions from fossile
fuel**

Since 1992

**we do know what we
should do to reduce
emissions from fossile
fuel**

Findings from IPCC in 1992

(Bert Bolin at the UN Conference in NY)

“A comprehensive assessment of technological options for mitigation of global warming are underway. Five specific items are subject to closer analysis and some tentative findings are:

- energy conservation and improved efficiency in the production, conservation, distribution and end use of energy is one of the most effective options available now and in the future;***
- technologies to sequester carbon dioxide from fossil fuel combustion deserve investigation, considering the expected continuing dependence on fossil fuel as primary energy sources for quite some time;***

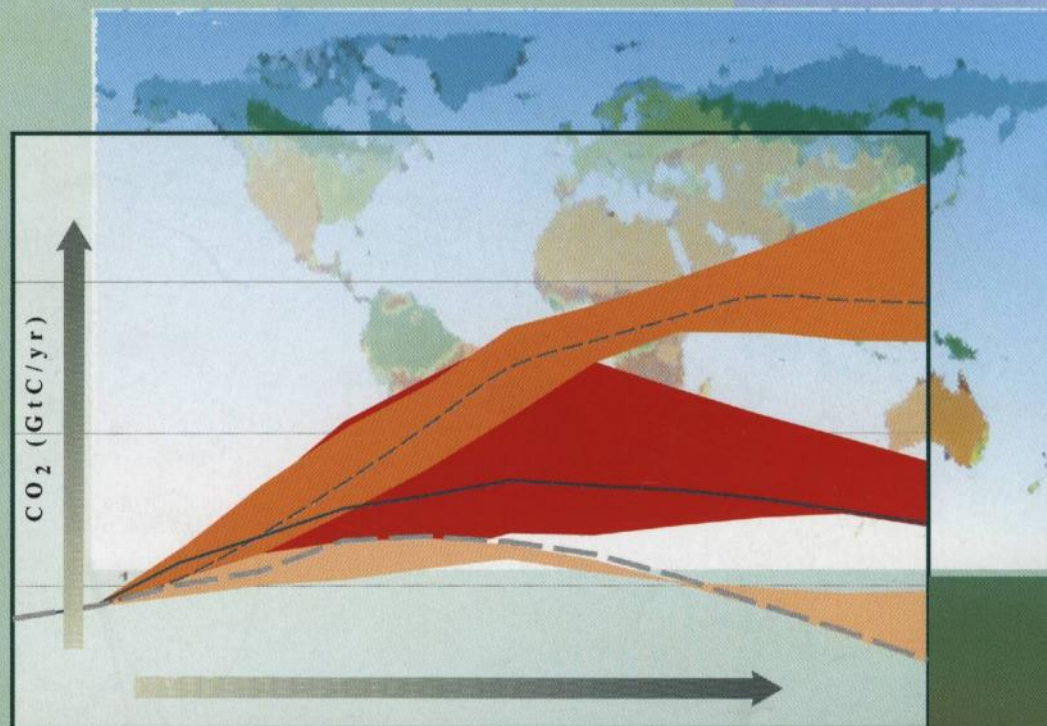
-nuclear power has the technological potential to be one of the major energy sources in the next century, but faces various socio-economic, security and safety constraints, which need further analysis;

- there are various promising fuel technologies such as photovoltaic, wind , hydropower and geothermal, biomass and solar thermal systems;

- the physical potential of biomass for energy us is high, but in some regions competition for land (for food production and other uses) may limit its production.”

The Kaya Equation for Fossil Energy

$$\begin{aligned} \text{GHG Em. from Fossil energy} &= \\ &= \text{Pop} * [\text{GDP/Pop.}] * \\ &[\text{(\Sigma of Fossil Energy)/GDP}] * \\ &[(\Sigma \text{ GHG from Fossil Energy}) \\ & / (\Sigma \text{ of Fossil Energy})] \end{aligned}$$



RAPPORT SPÉCIAL DU GIEC
SCÉNARIOS D'ÉMISSIONS

Our Equation for Land USE and Phytomass Production and Conversion

$$\begin{aligned} \text{GHG Em. from Land Use \& Phytomass} = & \\ & \text{Pop} * [\text{LU/Pop.}] \\ & * [(\sum \text{Phytomass Production and} \\ & \text{Conversion for Food and non Food}) / \text{LU}] \\ & * [(\text{GHG from Land Use and Phytomass} \\ & \text{Production and Conversion}) / (\sum \\ & \text{Phytomass Production and Conversion} \\ & \text{for Food and non Food})] \end{aligned}$$

Do notice that Land Use does also include Land use change

**This Equation for Land USE and
Phytomass Production and
Conversion can be subdivided
into sub-components : for
instance only for food**

$$\begin{aligned} \text{GHG Em. from Land Use\& Phytomass for Food} = & \\ & \text{Pop} * [\text{LU for Food / Pop.}] * \\ & [(\sum \text{Phytomass Production and Conversion for} \\ & \text{Food}) / \text{LU for Food}] * [(\text{GHG from Land Use and} \\ & \text{Food Production} / (\sum \text{Phytomass Production and} \\ & \text{Conversion for Food}))] \end{aligned}$$

Combining the two, and considering also non CO₂ industrial GHG emissions

=> **“Kaya – Riedacker” equation**

GHG Emissions from Fossil Energy, from Land Use and
Phytomass Production and Conversion and from non CO₂
Industrial GHG

= Pop*[GDP/Pop.] * [(Σ of Fossil Energy)/GDP] *

[(Σ GHG from Fossil Energy) / (Σ of Fossil Energy)]

+

+ Pop*[LU/Pop.]*

**[(Σ Phytomass Production and Conversion for Food and
non Food) /LU] ***

**[(GHG from Land Use and Phytomass Production and
Conversion) / (Σ Phytomass Production and
Conversion for Food and non Food)]**

+

Other industrial non CO₂ GHG *

“Kaya – Riedacker” equation

GHG Emissions from Fossil Energy, from Land Use
and Phytomass Production and Conversion and
from Industrial GHG

$$\begin{aligned} &= \text{Pop} * [(\text{GDP/Pop.}) * (\Sigma \text{ of Fossil Energy}) / \text{GDP}) * \\ &(\Sigma \text{ **GHG from Fossil Energy** / } \Sigma \text{ **of Fossil Energy**)} \\ &+ \text{LU/Pop.} * (\Sigma \text{ **Phytomass Production and** } \\ &\text{ **Conversion for Food and non Food /LU** } \\ &\text{ ***(GHG from Land Use and Phytomass** } \\ &\text{ **Production and Conversion / } \Sigma \text{ **Phytomass** } \\ &\text{ **Production and Conversion for Food and** } \\ &\text{ **non Food**)} \\ &+ \text{Other industrial GHG /capita}] * \end{aligned}**$$

The “Kaya – Riedacker” equation in more friendly words

GHG Emissions from Fossil Energy,
from Land Use and Bioproduction and also from
other non CO₂ GHG from Industrial Activities

= Pop*[GDP per capita] * [Fossil Energy per GDP] *
[Average GHG emissions per unit of Fossil Energy] *

+

Pop* [LU per capita] * [Land Use Efficiency of
Bioproduction]* [Average GHG emissions per unit of
Bioproducts]

+

POP* Other industrial GHG emissions (CFCs, HFC, SF6 etc...)
per capita *

Just a few indications to show how
this can be used ...

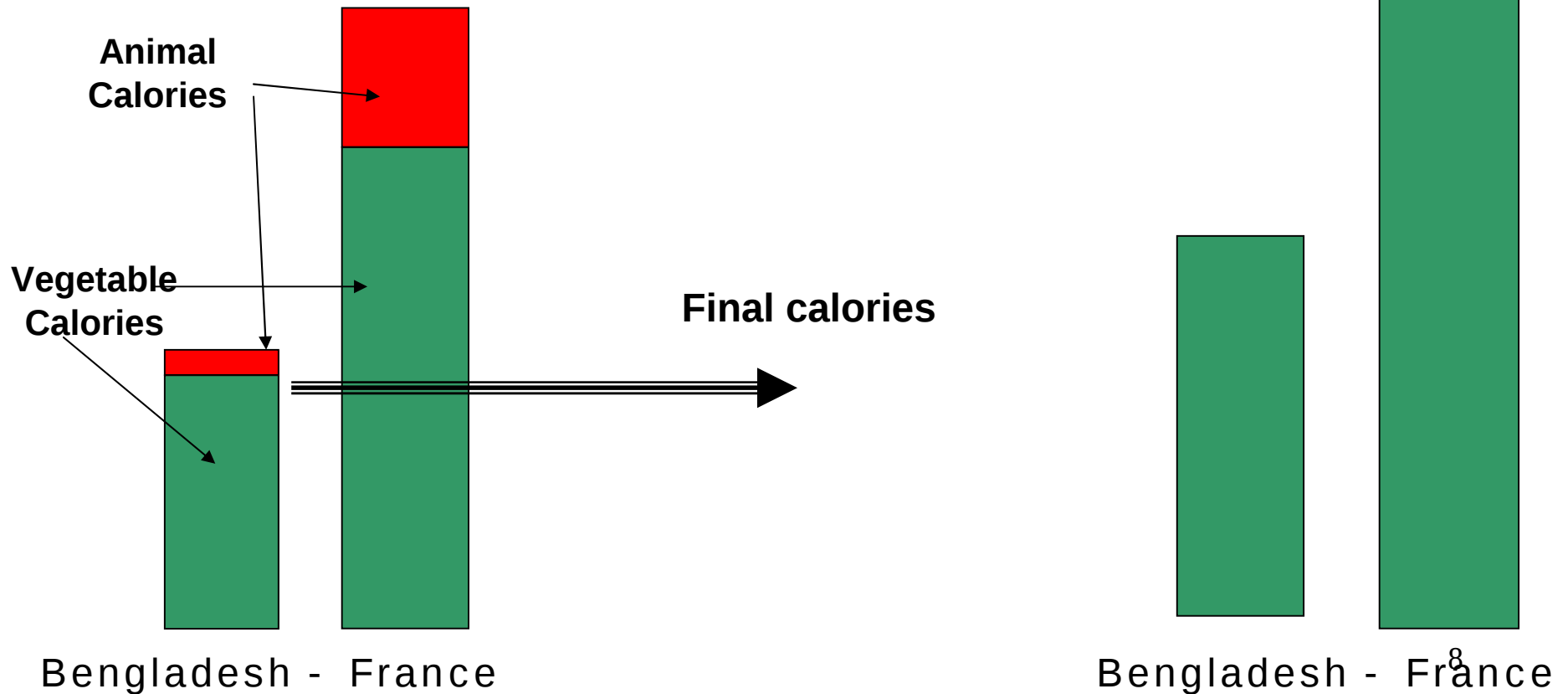
**FOOTPRINT PER CAPITA DEPENDS
ON THE DIET
AND
ON LAND USE EFFICIENCY (YIELD)**

DIET

$$\text{Final calories} = \text{VC} + 7 \text{ AC}$$

7 Vegetable Calories = 1 Animal Calorie

1 kg of cereal equivalent = 3500VC

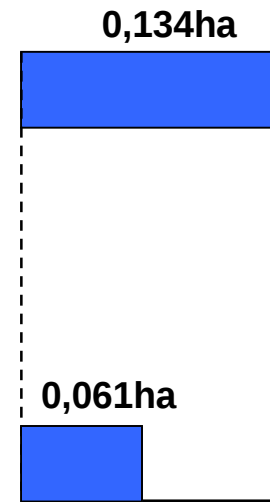


Comparison of France and Bangladesh with different yields

FRANCE

BANGLADESH

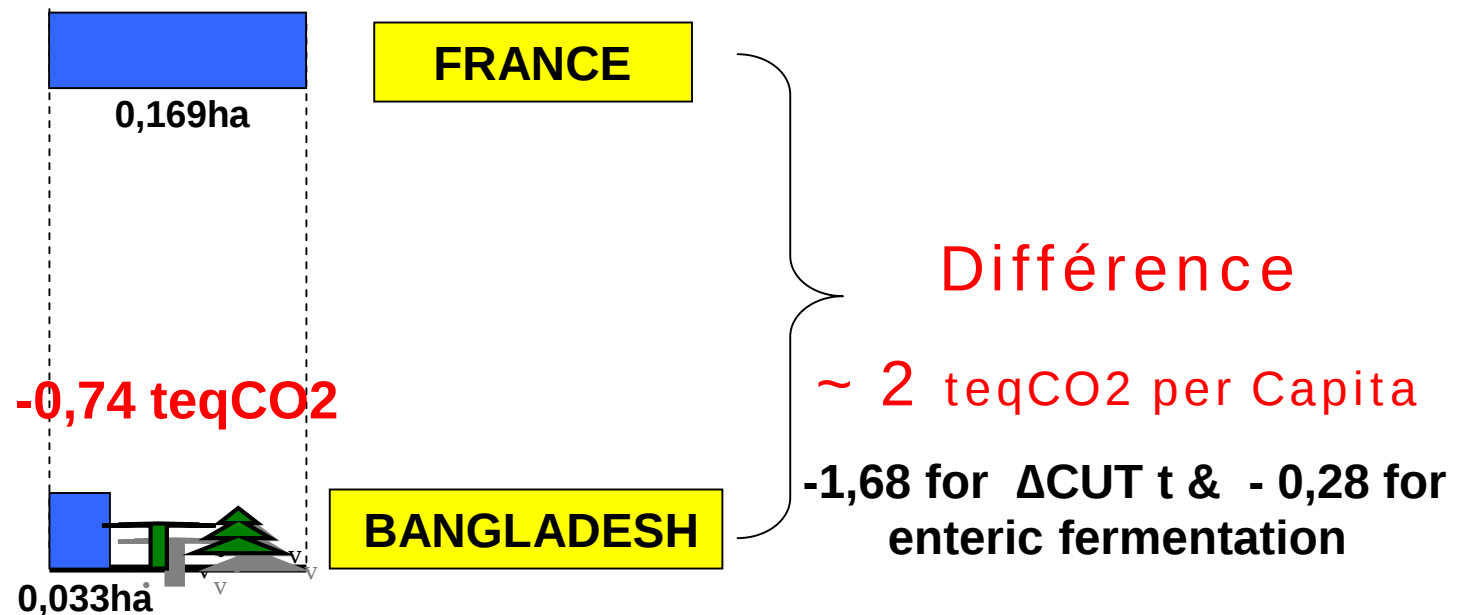
Yields : 1,83t/ha 1950



GROSS GHG EMISSIONS PER CAPITA WITH AFORESTATION ON THE AVOIDED LAND USE WITH HIGH YIELDS

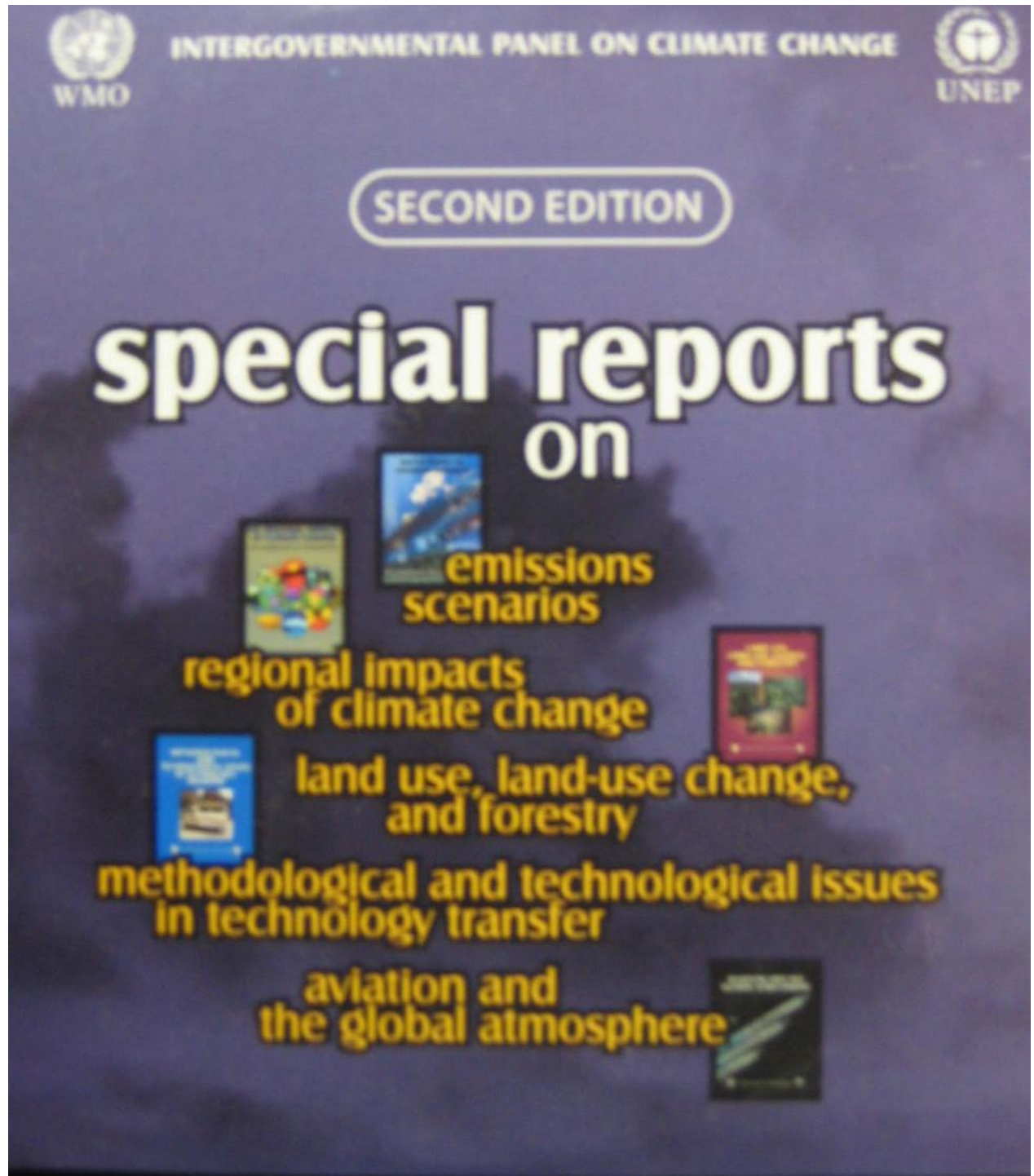
+0,94 teqCO₂

Yields 7,34t/ha (~ 2000):



For Phytomass
(including food and non food
production and use)
it is a little more
complicated than
for fossil fuel

**In spite of
IPCC
special
Report on
LULUCF
in 2000**



IFDC 1991 and 2006

FERTILIZER USE AT THE VILLAGE LEVEL:

CONSTRAINTS AND IMPACTS

Summary Proceedings of Workshop



Lomé, Togo
October 2-8, 1991



Feeding Africa

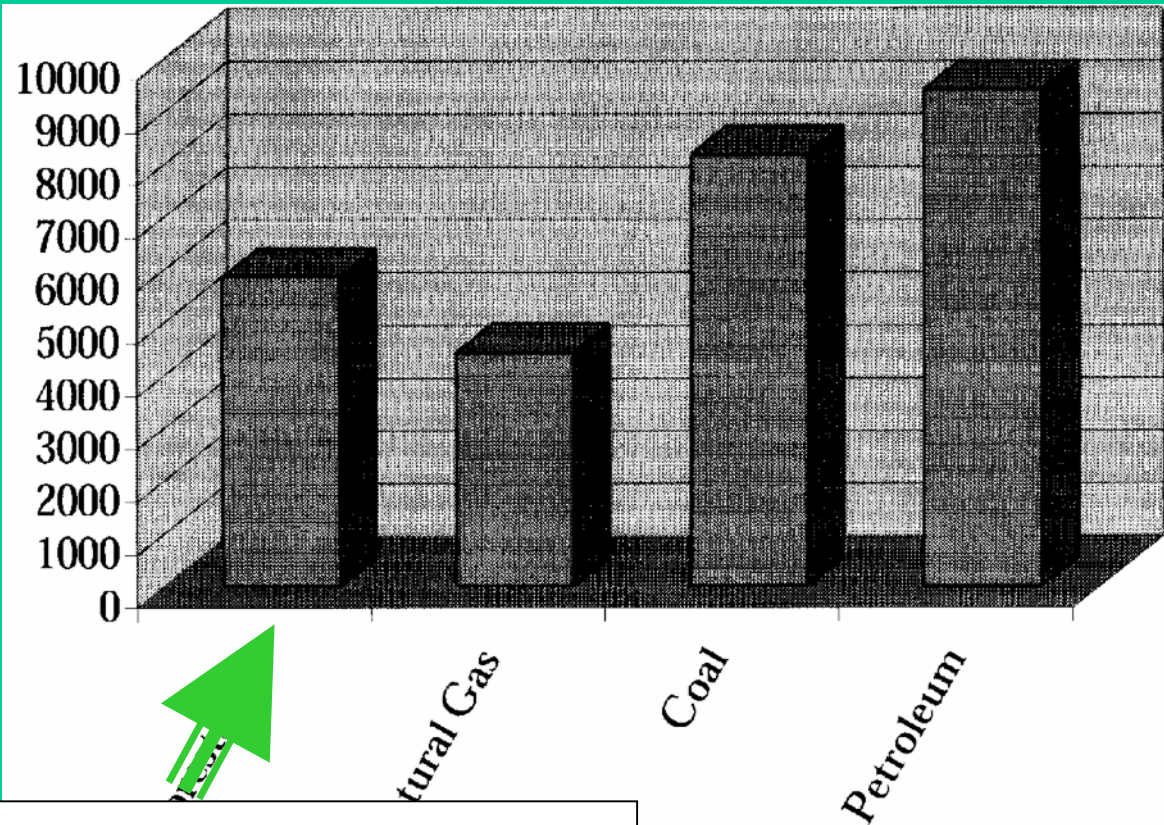


**Up to 1996 we could not even
start any calculation...
of the effect of fertilizer input on
the GHG emission budget**

Africa Fertilizer Summit

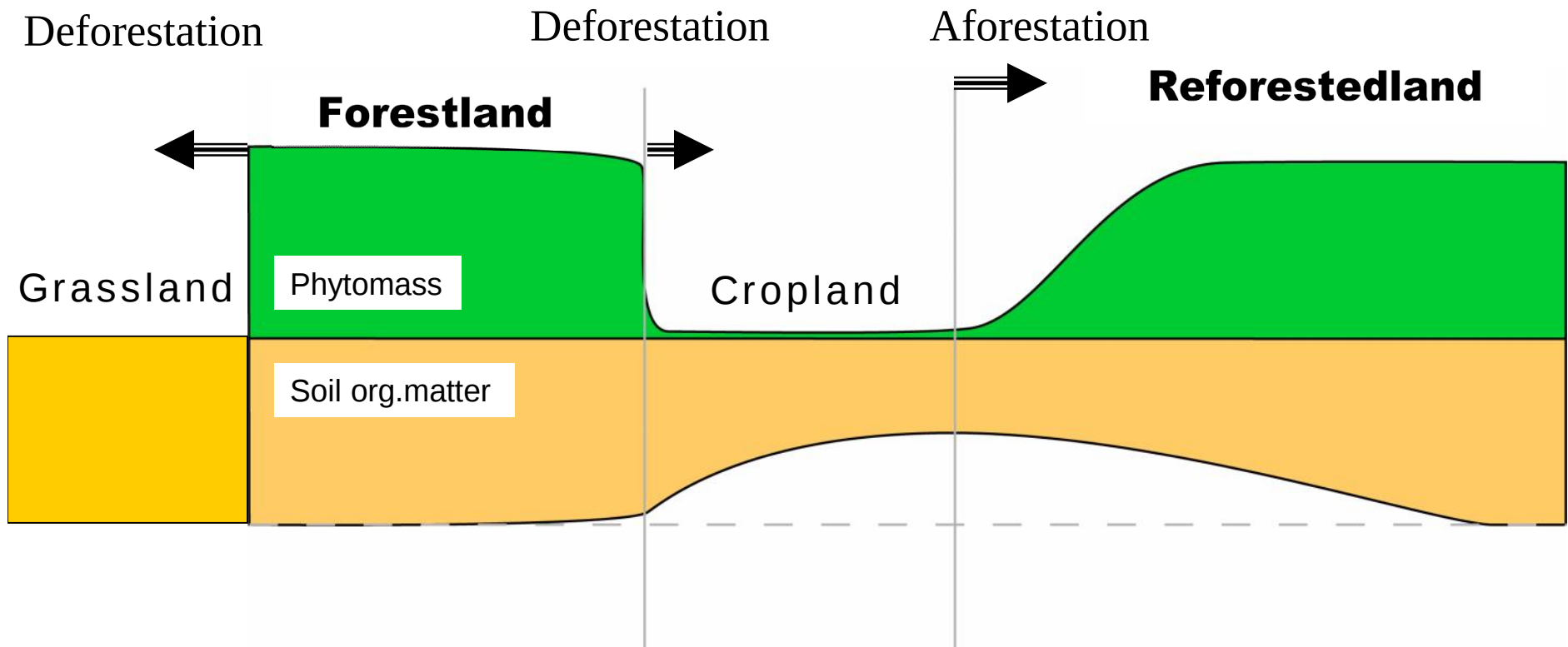
9-13 June 2006 ▲ Abuja, Nigeria

FOR CLIMATE CHANGE MITIGATION



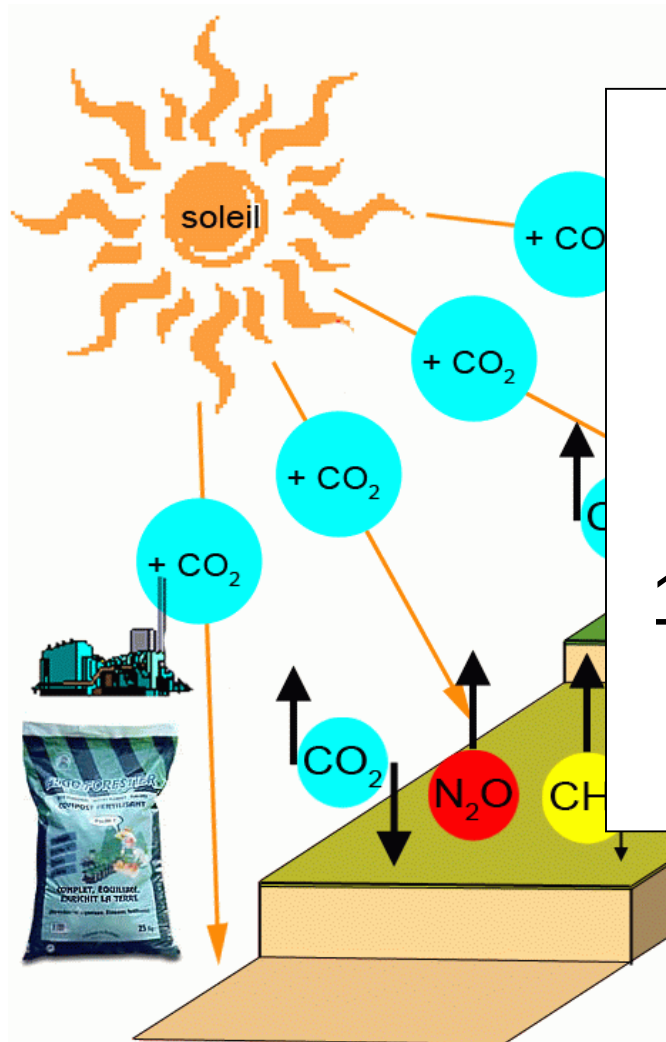
**Land Use
and
Land Use
Change**

Carbon stock change not only in soils but also in phytomass



Land Use Change

CO₂ and non CO₂ GHG



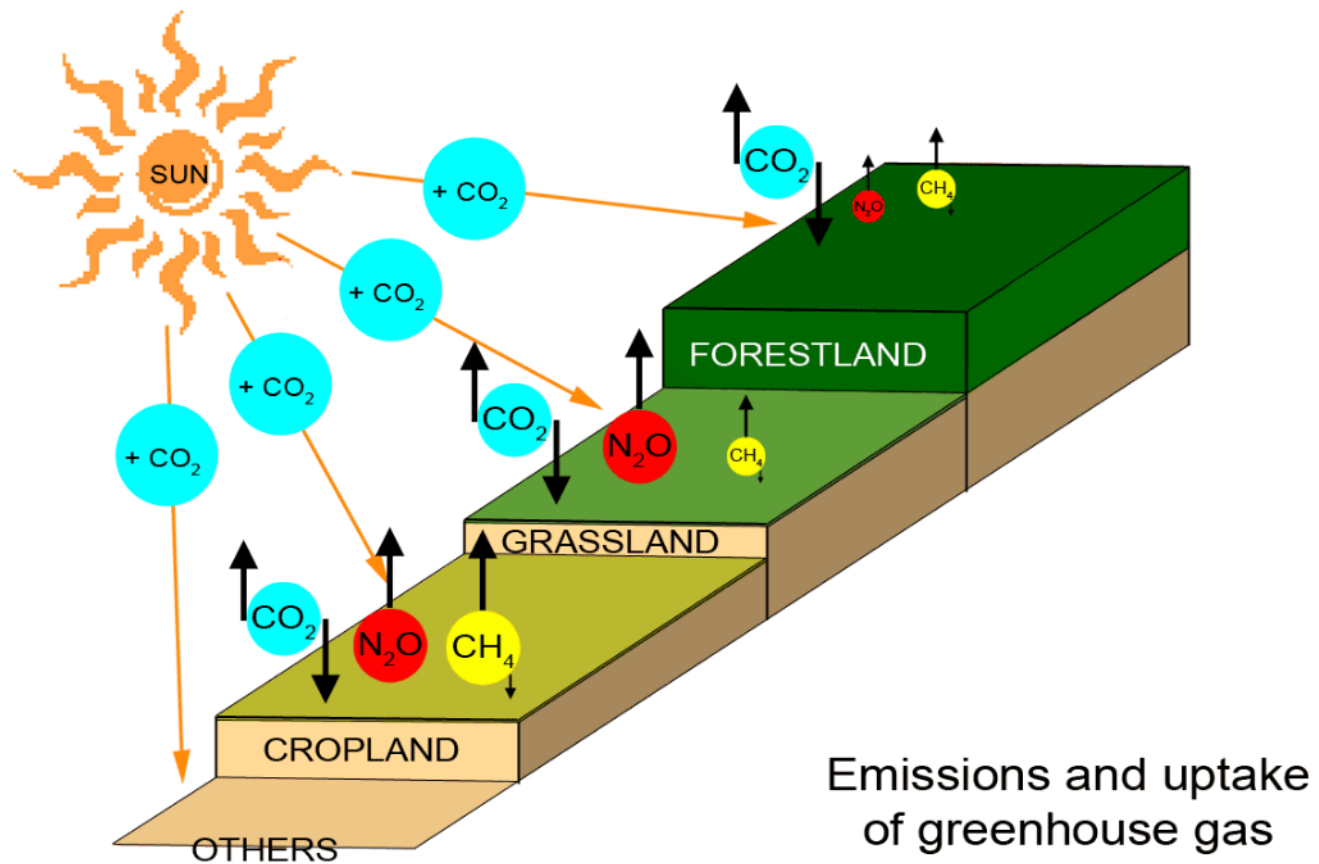
1 t of CH₄ = 23 teqCO₂

But ~ 45 teqCO₂

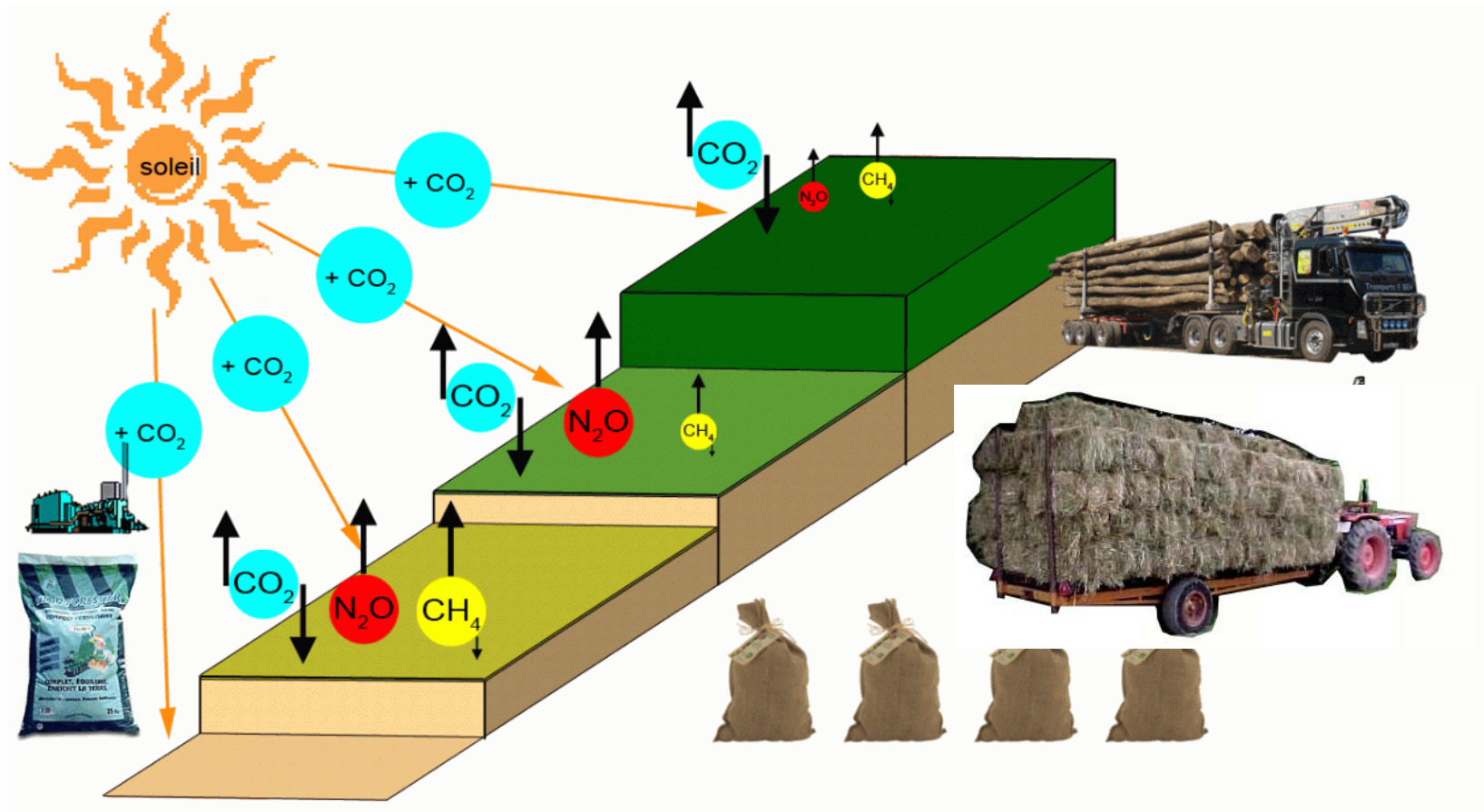
for 50 years

1 tonne of N₂O = 296 t de
CO₂

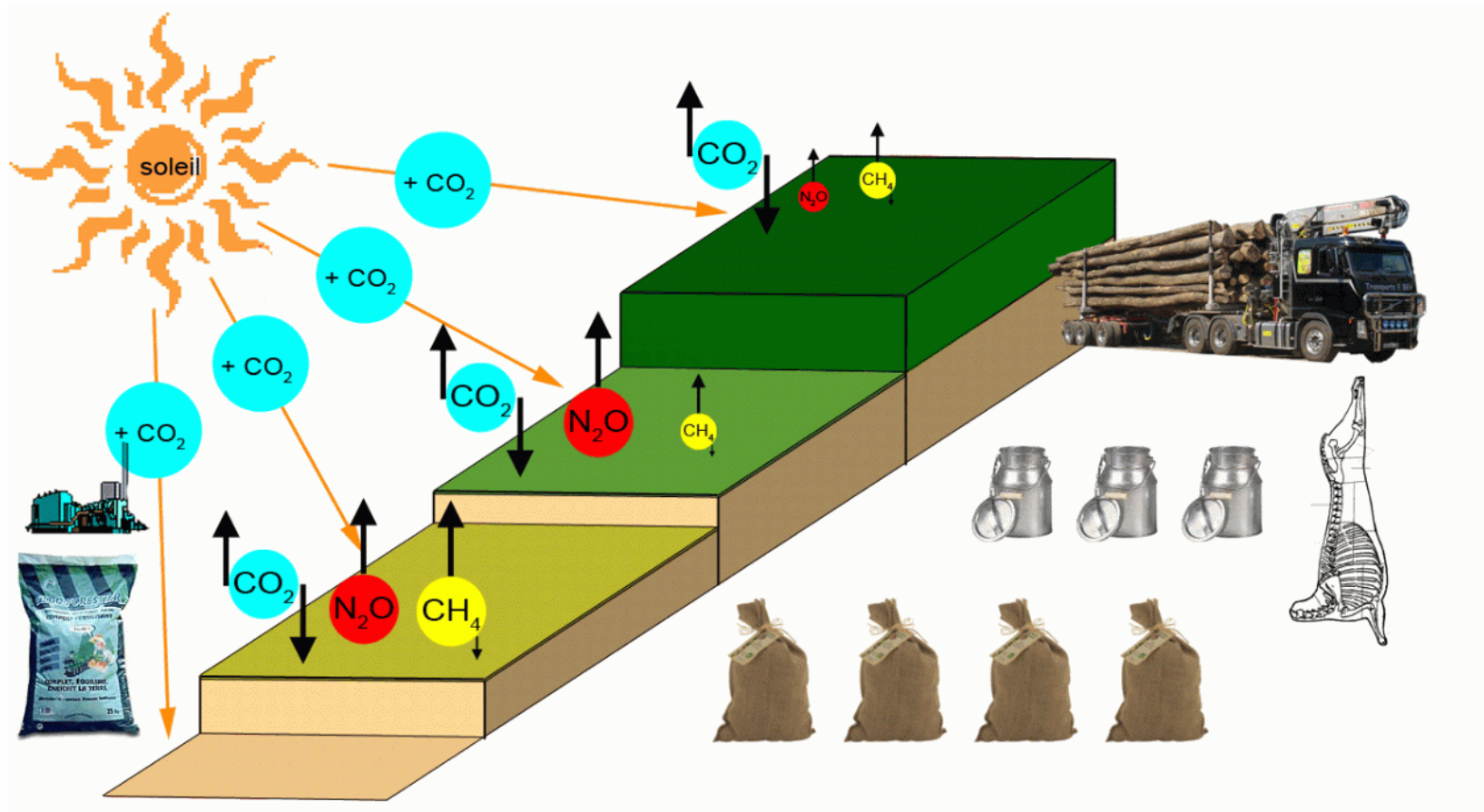
Gross Emissions



Net emissions at stage I



Net emissions at stage II

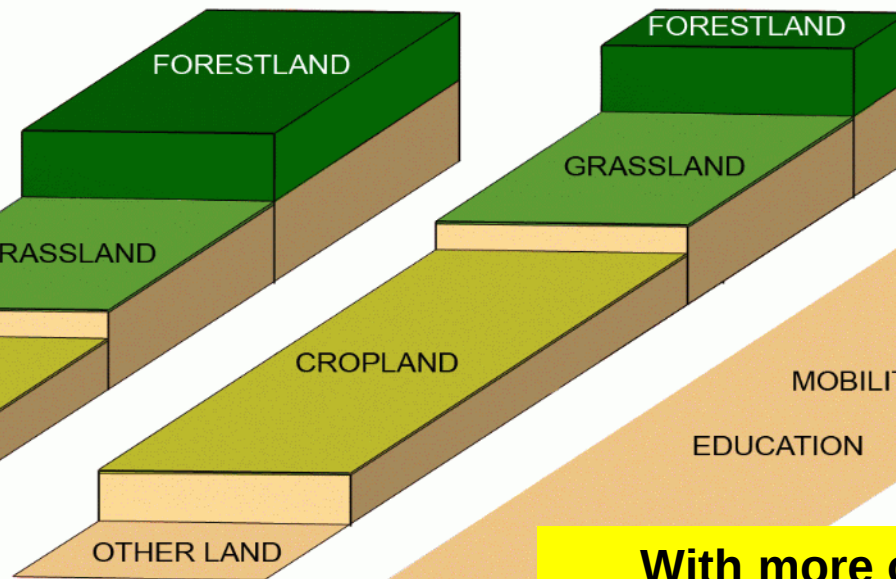
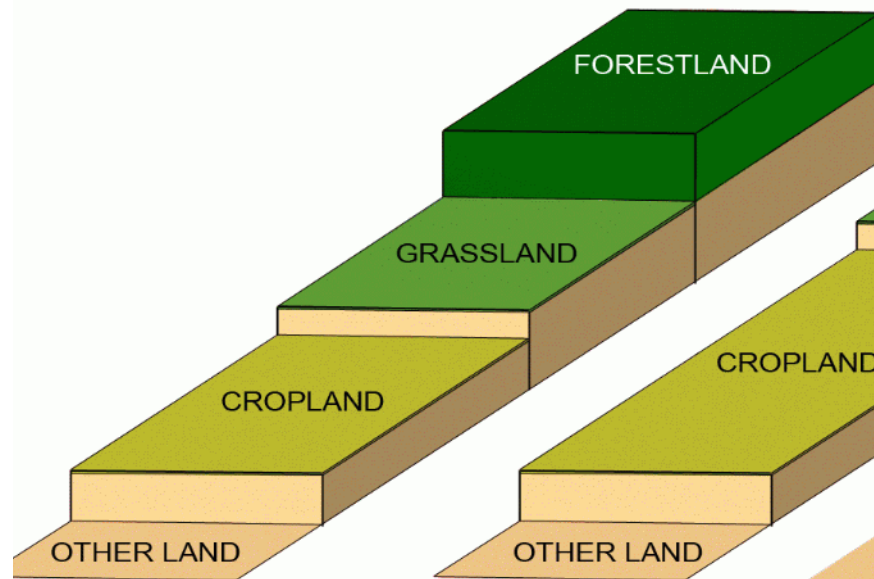


⇒ We can only compare scenarios

ETING WORLD BASIC NEEDS

Situation i

Situation j



DAILY DIET
(calories, proteins, cooking, etc.)

HEALTH

HOUSING

MOBILITY

EDUCATION



E_i



E_j

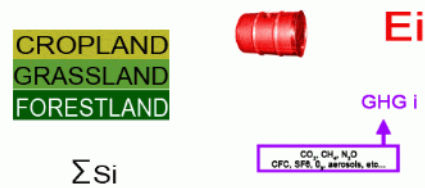
GHG i

GHG j
 $\text{CO}_2, \text{CH}_4, \text{N}_2\text{O}, \text{SF}_6, \text{O}_3, \text{aerosols, etc...}$

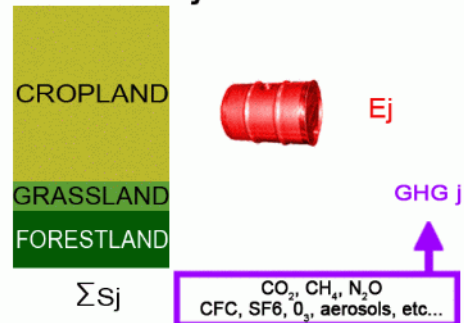
GHG i
 $\text{CO}_2, \text{CH}_4, \text{N}_2\text{O}, \text{CFC}, \text{SF}_6, \text{O}_3, \text{aerosols, etc...}$

With more or less
cropland
energy
GHG
to meet basic needs

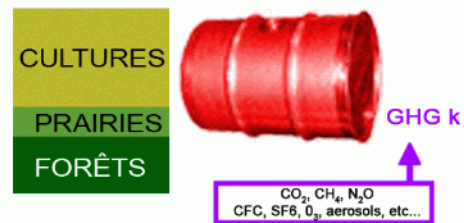
scenario i

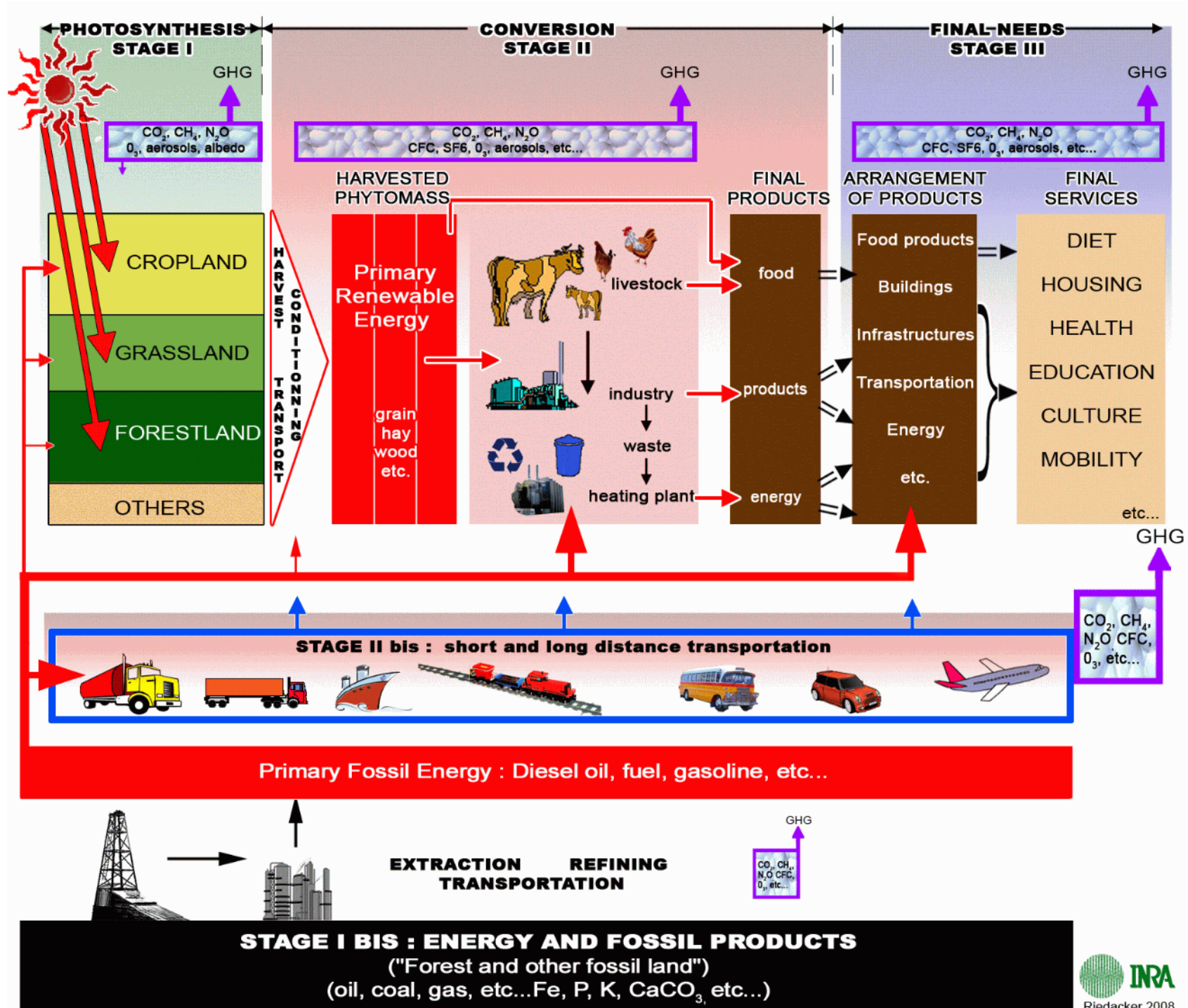


scenario j



scenario k





To appear in summer 2008 in Climate change and Global Warming Editor Velma Grover .
Oxford & IBH ltd India by Science Publisher USA

17

CHAPTER

Reconsidering Approaches for Land Use to Mitigate Climate Change and to Promote Sustainable Development

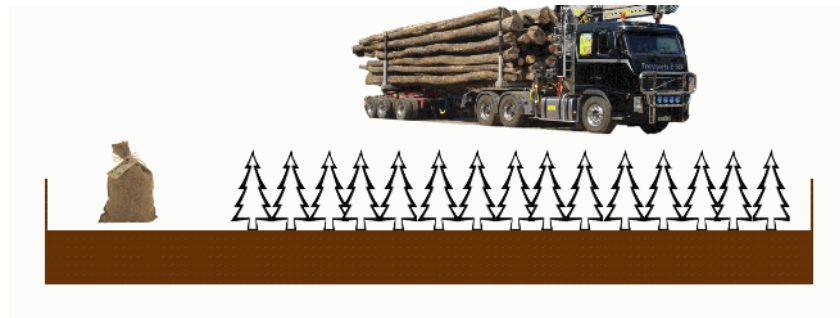
Arthur Riedacker

INRA Unité Mona, 63 Bd de Brandebourg 94205 Ivry Cedex France

E-mail: arthur.riedacker@ivry.inra.fr

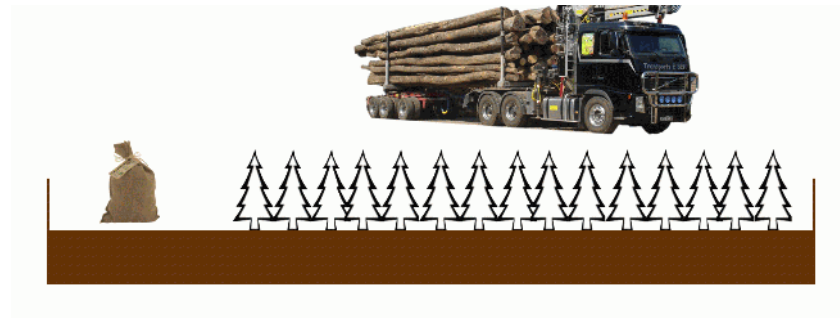
See also Global Land Use and Biomass Approach to Reduce GHG Emissions, Fossil Fuel Use and to Preserve Biodiversity. Triest e 2006
Down load from www.bepress.com/feem/paper12 12

To feed more people
=> Double crop
production

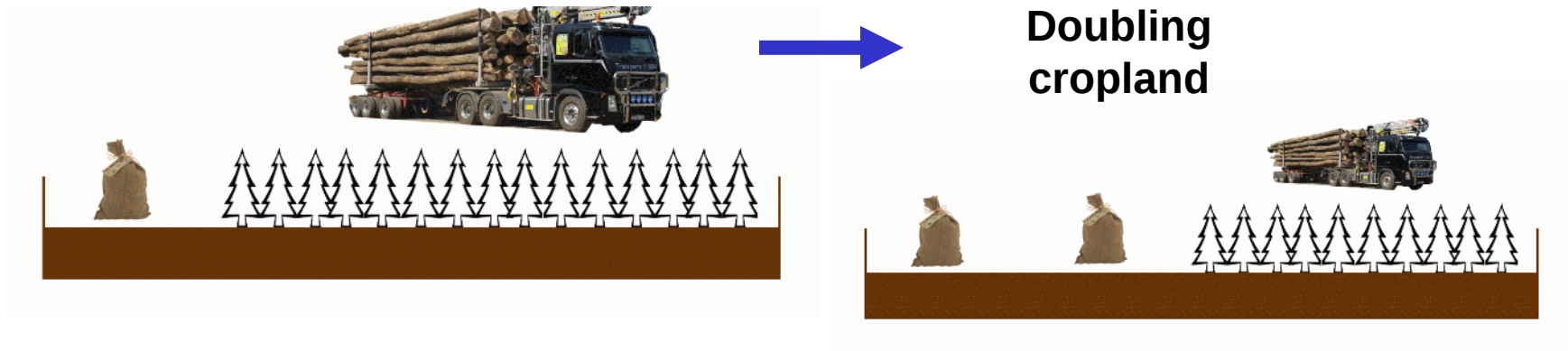


doubling land cultivated ?

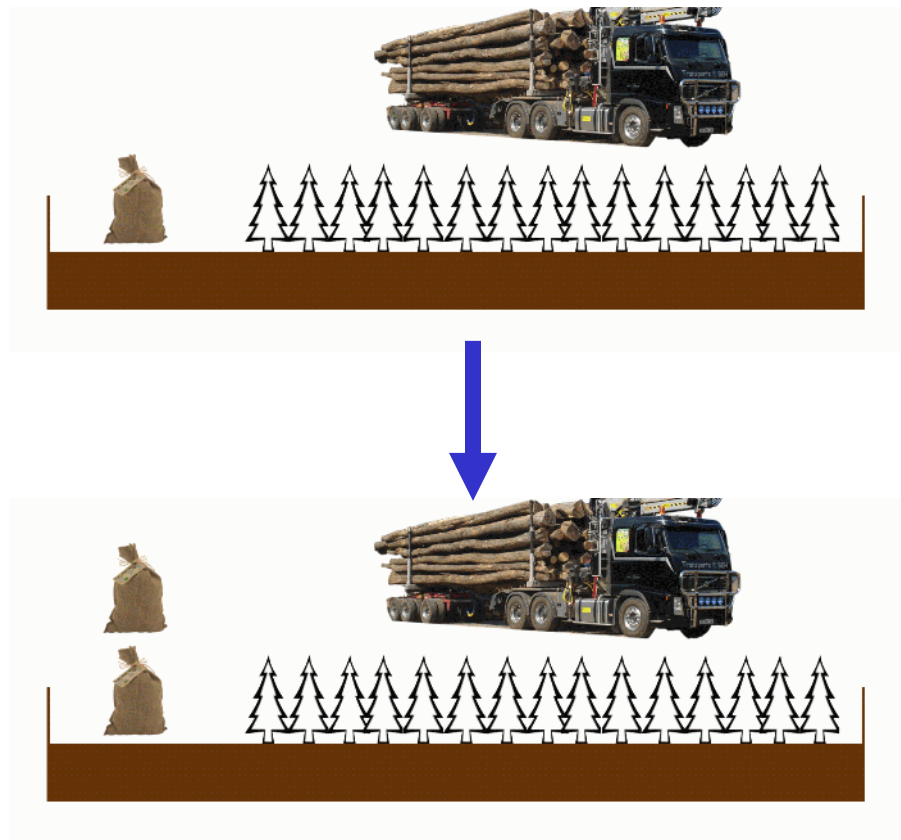
doubling yields?



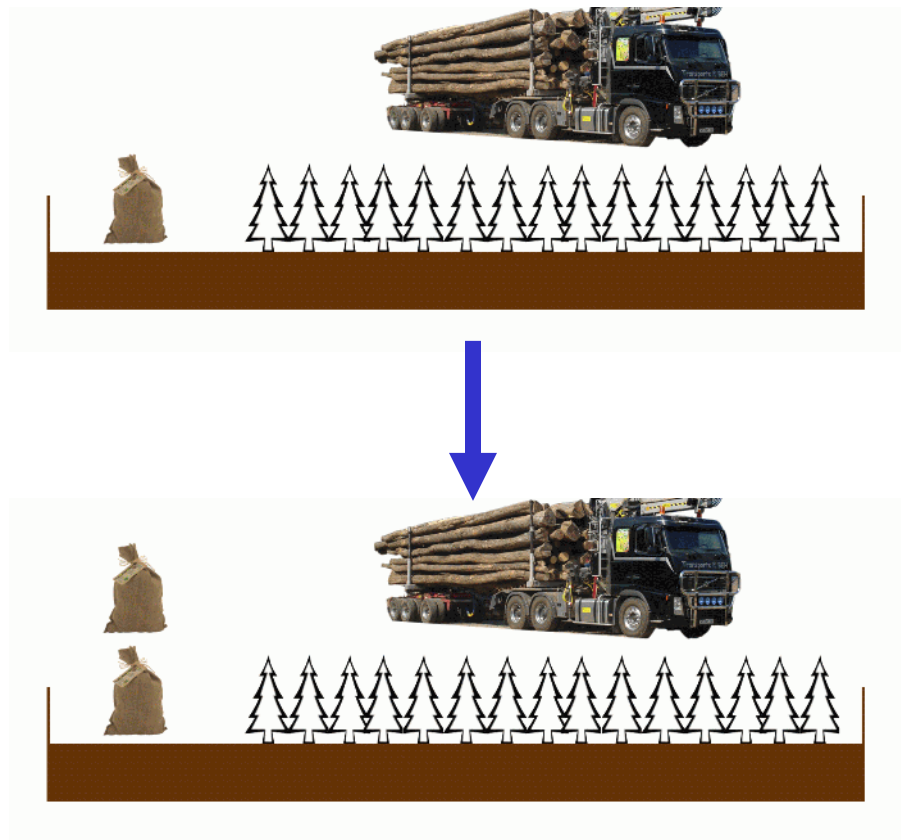
Doubling cropland



Doubling Yields?

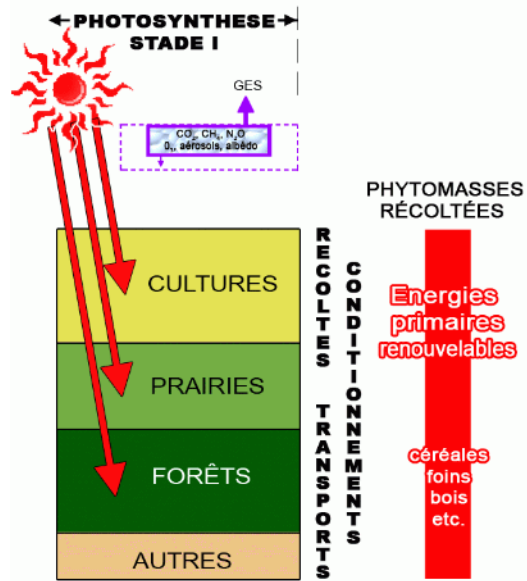


Doubling Yields?

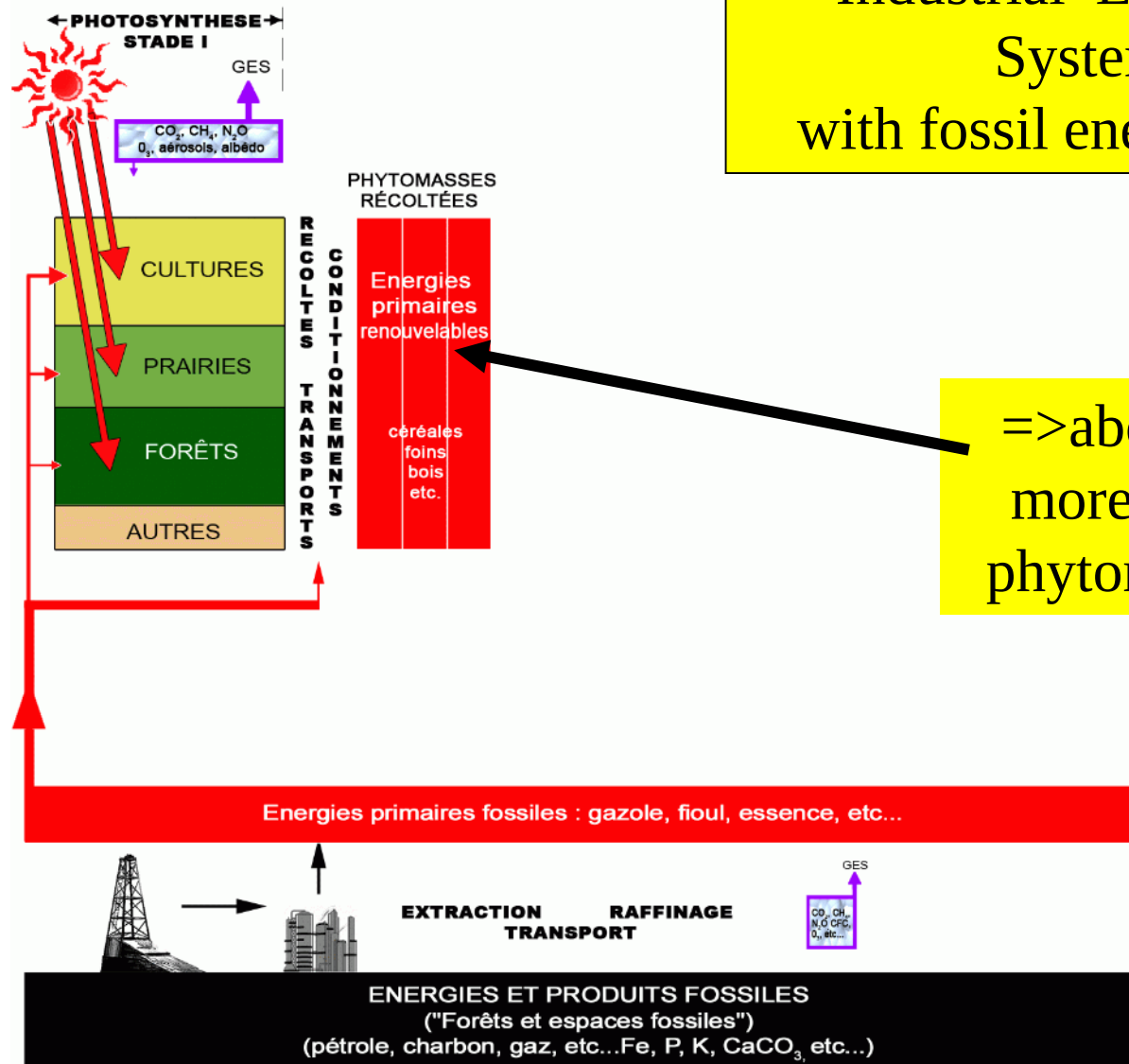


**By increasing
inputs
and /or
by choosing
more productive
plants (per ha)**

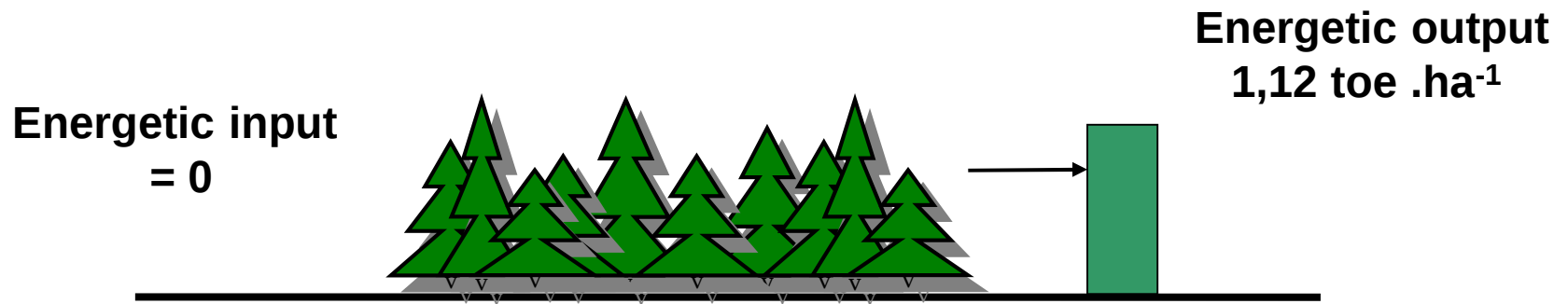
Pre- Industrial Land Use System without any fossil energy input



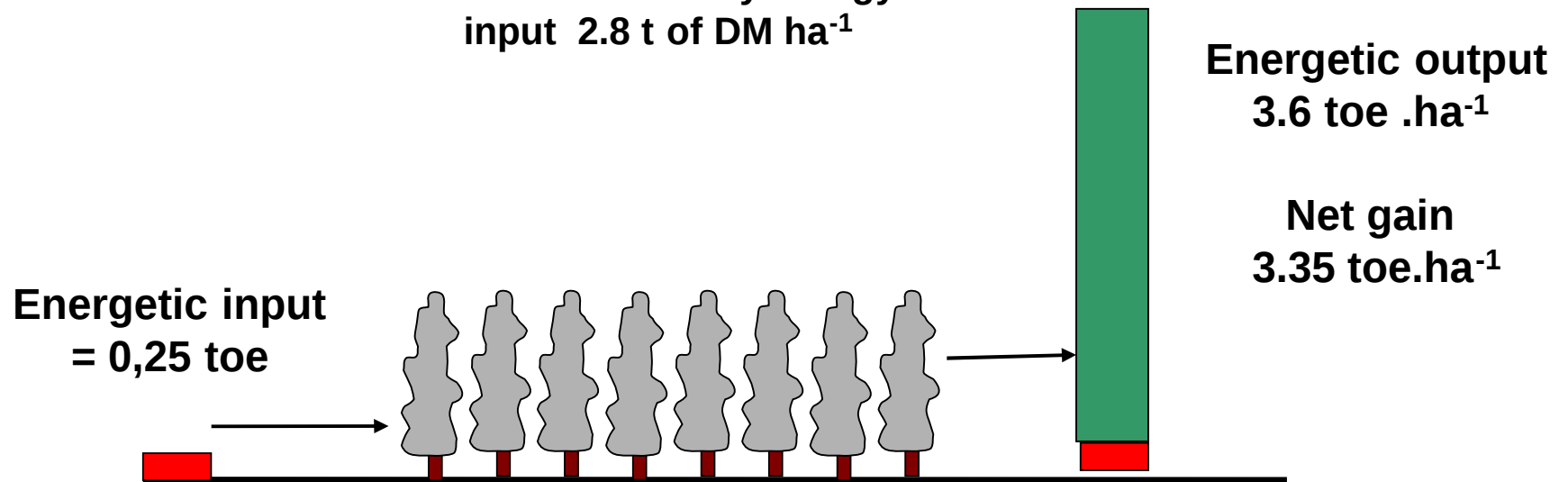
Industrial Land Use System with fossil energy input



=> about 3 times more output of phytomass per ha



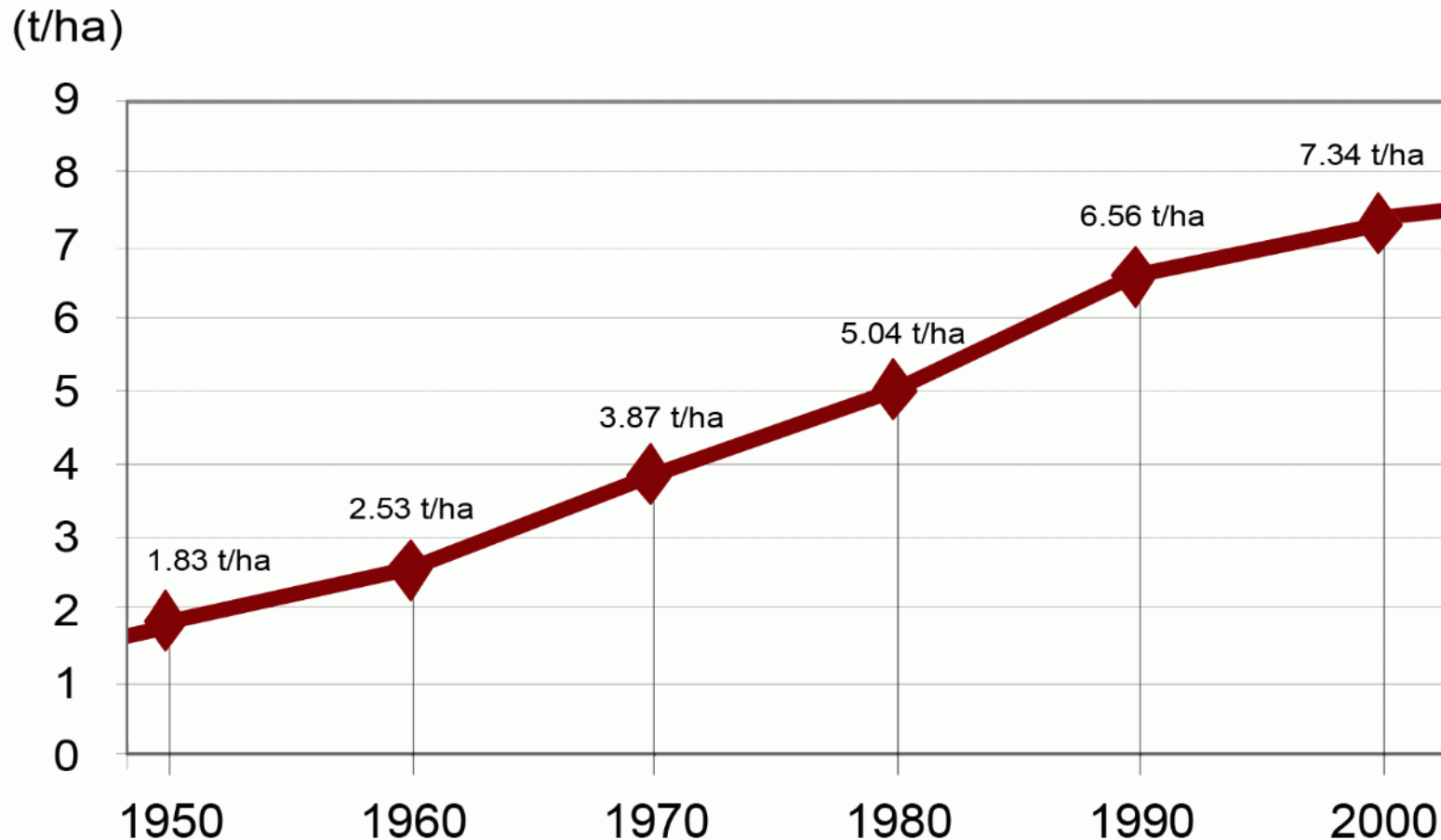
**Forest without any energy
input 2.8 t of DM ha⁻¹**



**Net gain
3.35 toe.ha⁻¹**

**Poplar stand with input
9t of DM ha⁻¹**

Between 1950 and 2000 wheat yields have been X4 in France



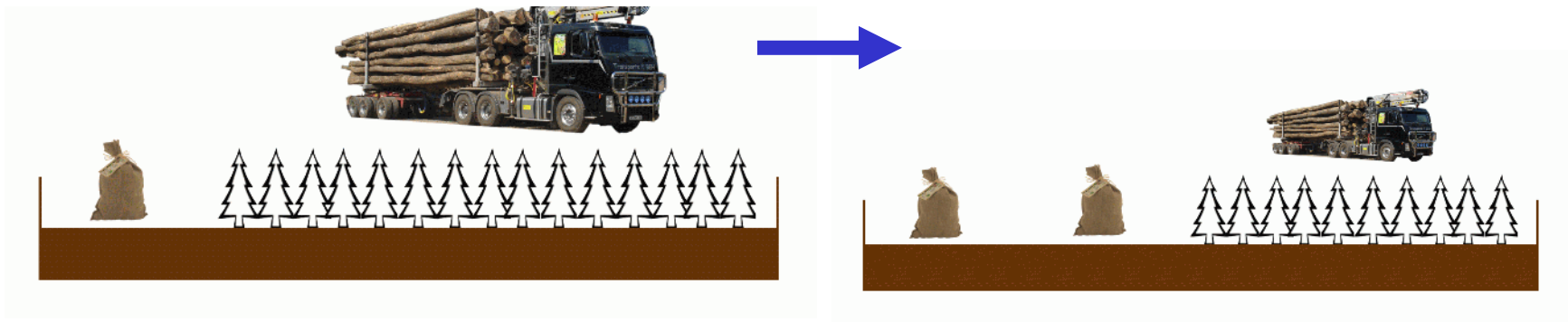
Change in Energy Budget

	1950	2000	Changes
Energy consumption/ha	0.26	0.45	+ 0.19
Net Energy Gain /ha *	1.2	3.9	+ 2.7
Net Energy Gain /ton of grain	0.63	0,54	-0.09

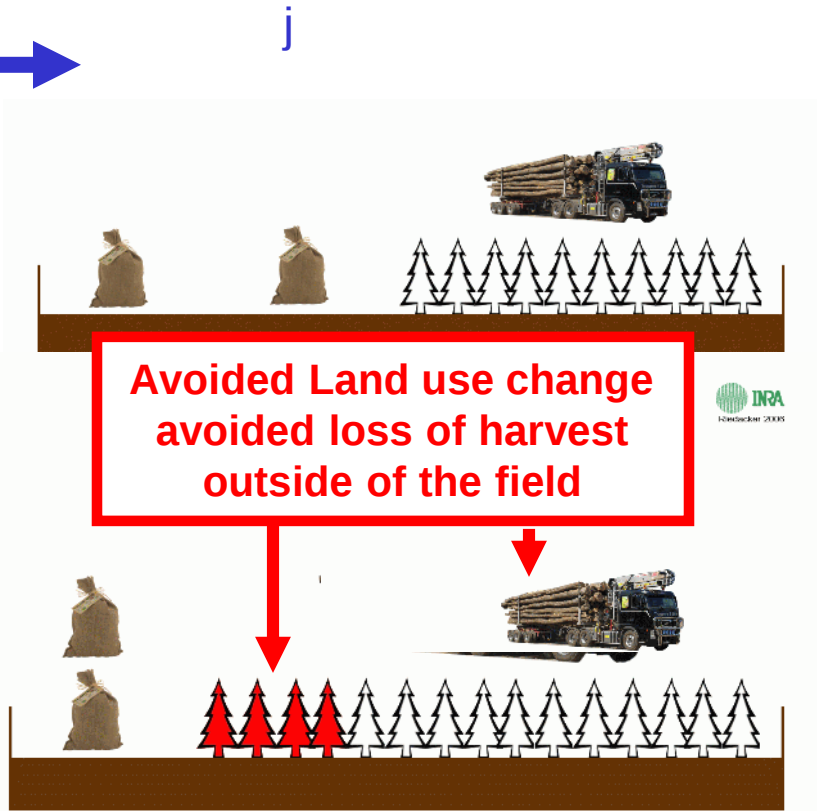
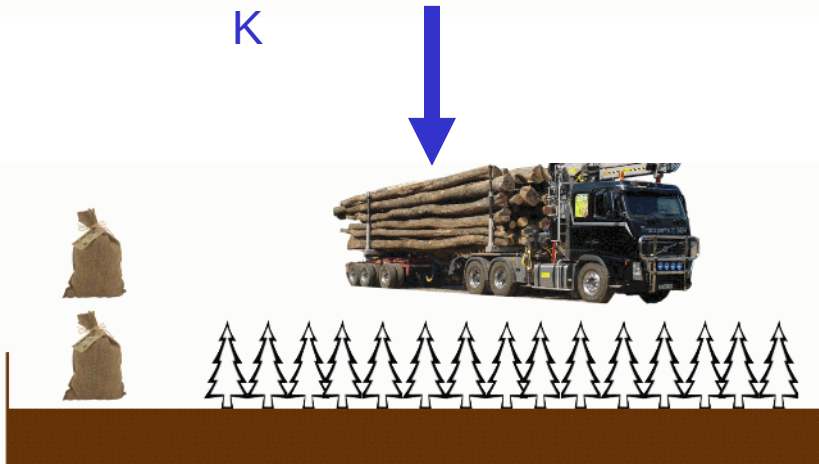
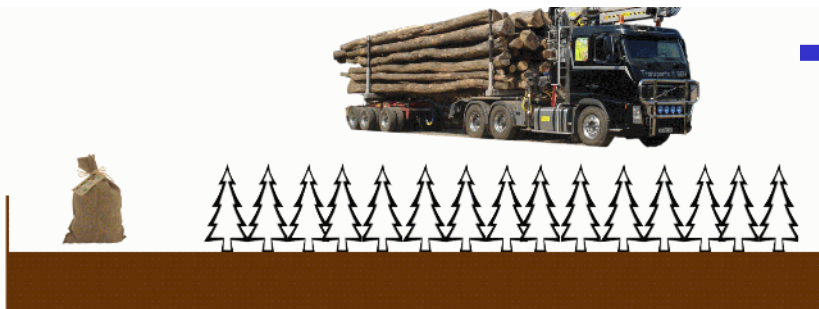
Change in GHG Budget is also positive

Average GHG budget tCO ₂ eq			
Gross emissions /ha of wheat	1.39	3.12	+ 1.73
Gross emissions /t of grain*	0.76	0.43	- 0.33
Primary Mitigation Potential /ha* for wheat	-2.32**	-9.52**	-7.20**

Doubling cropland



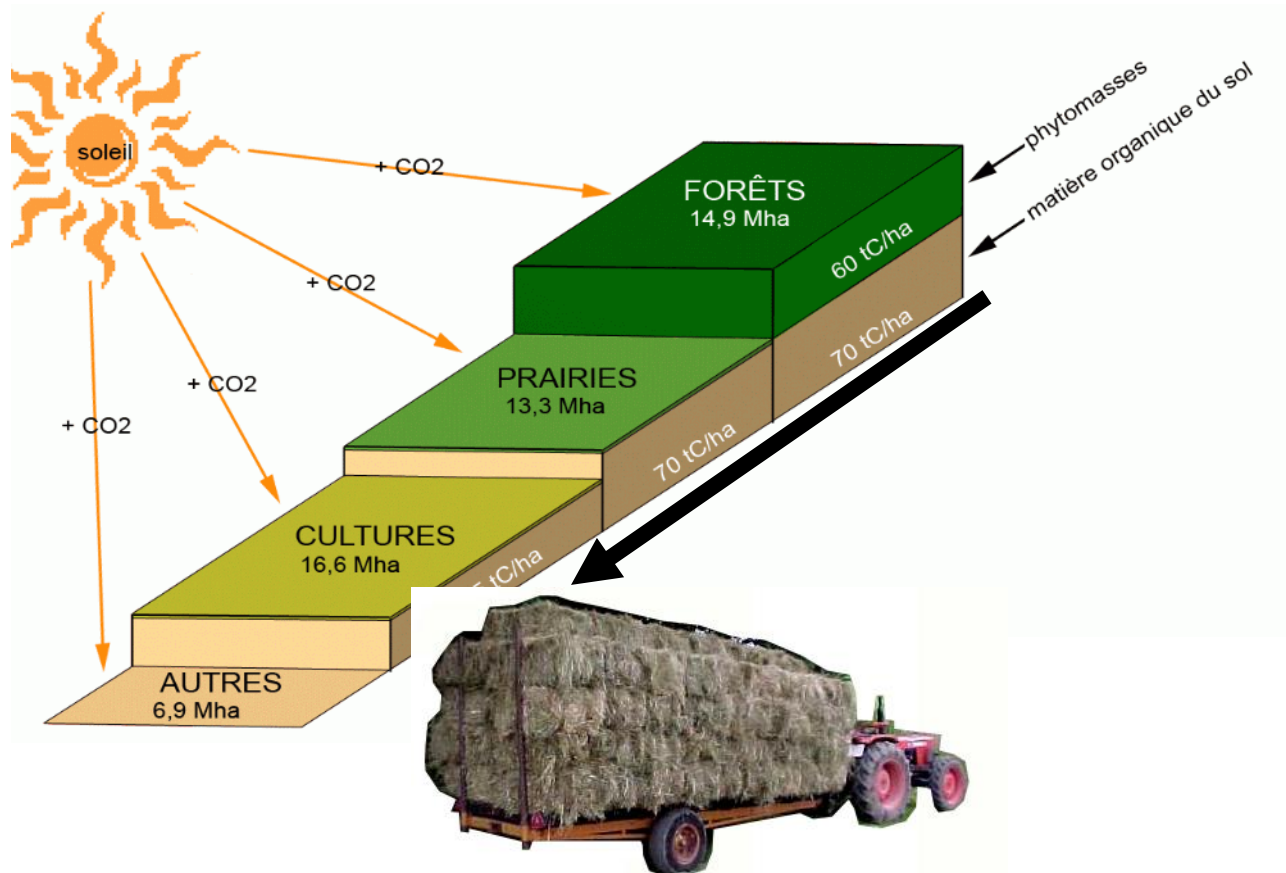
Differences between the two scenarios



LAND USE CHANGE

Forest ~312 t CO₂ per ha

Gross Emissions

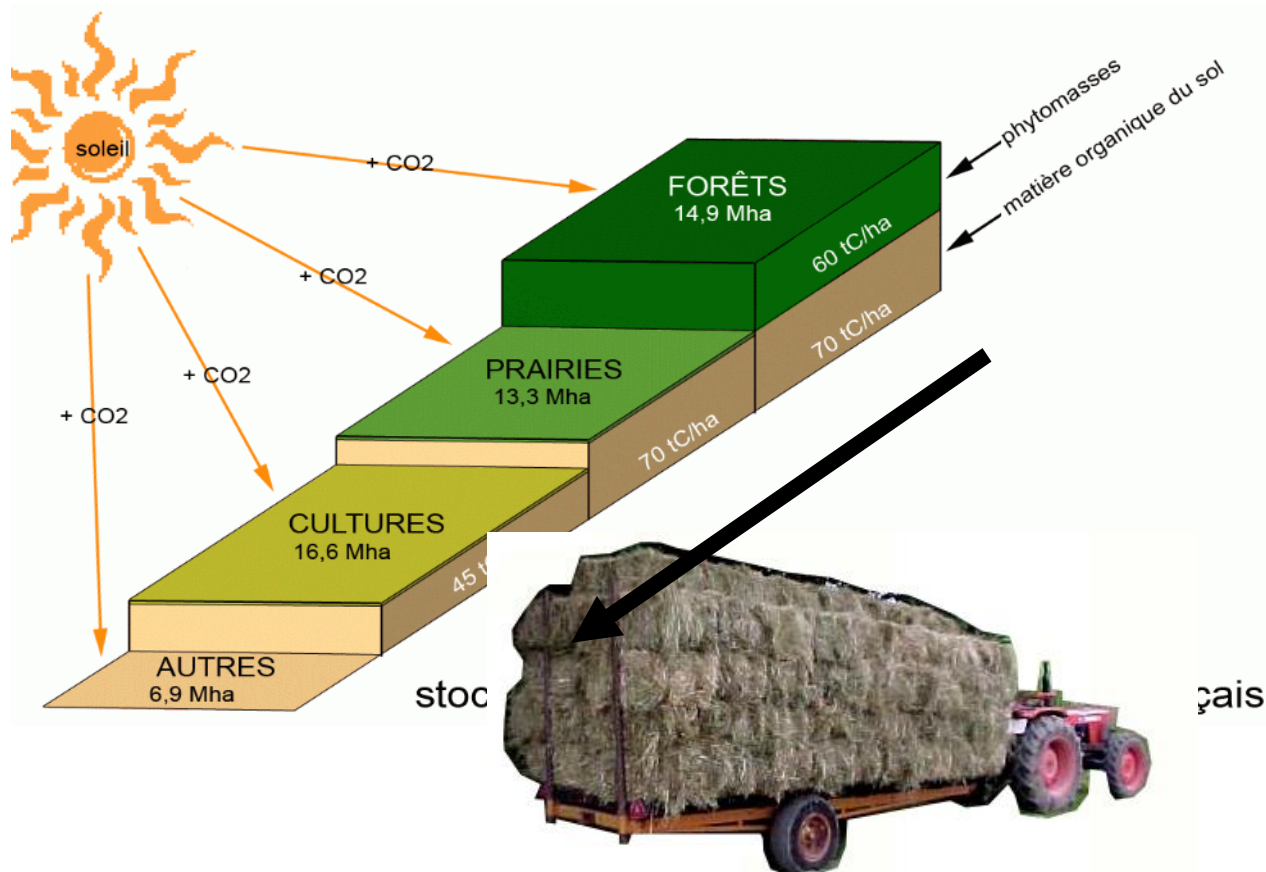


Deforestation
of 1 ha
emits as much as
1 ha of wheat
with high
inputs
during one
century

LAND USE CHANGE

Grassland ~ 92 t CO₂ per ha

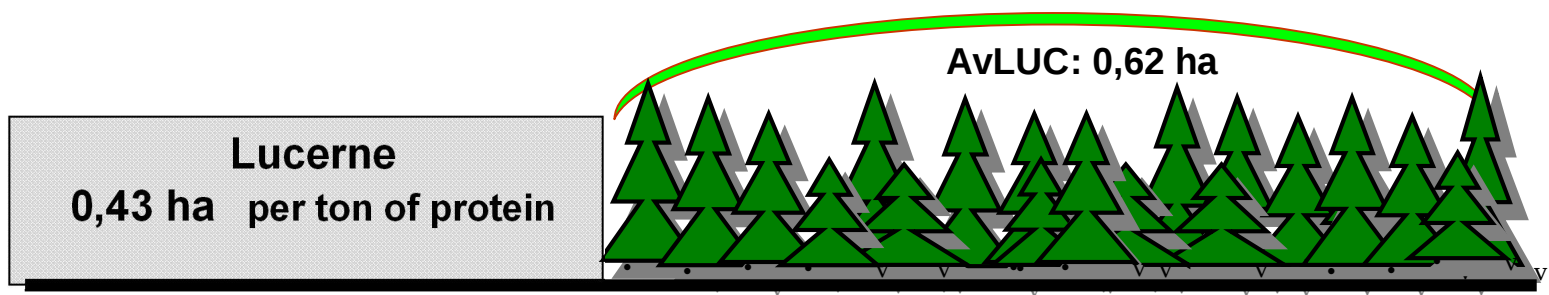
Gross Émissions



Grassland conversion of 1 ha emits as much as 1 ha of wheat with high inputs during 30 years

**It is also possible to
increase
Land Use Efficiency

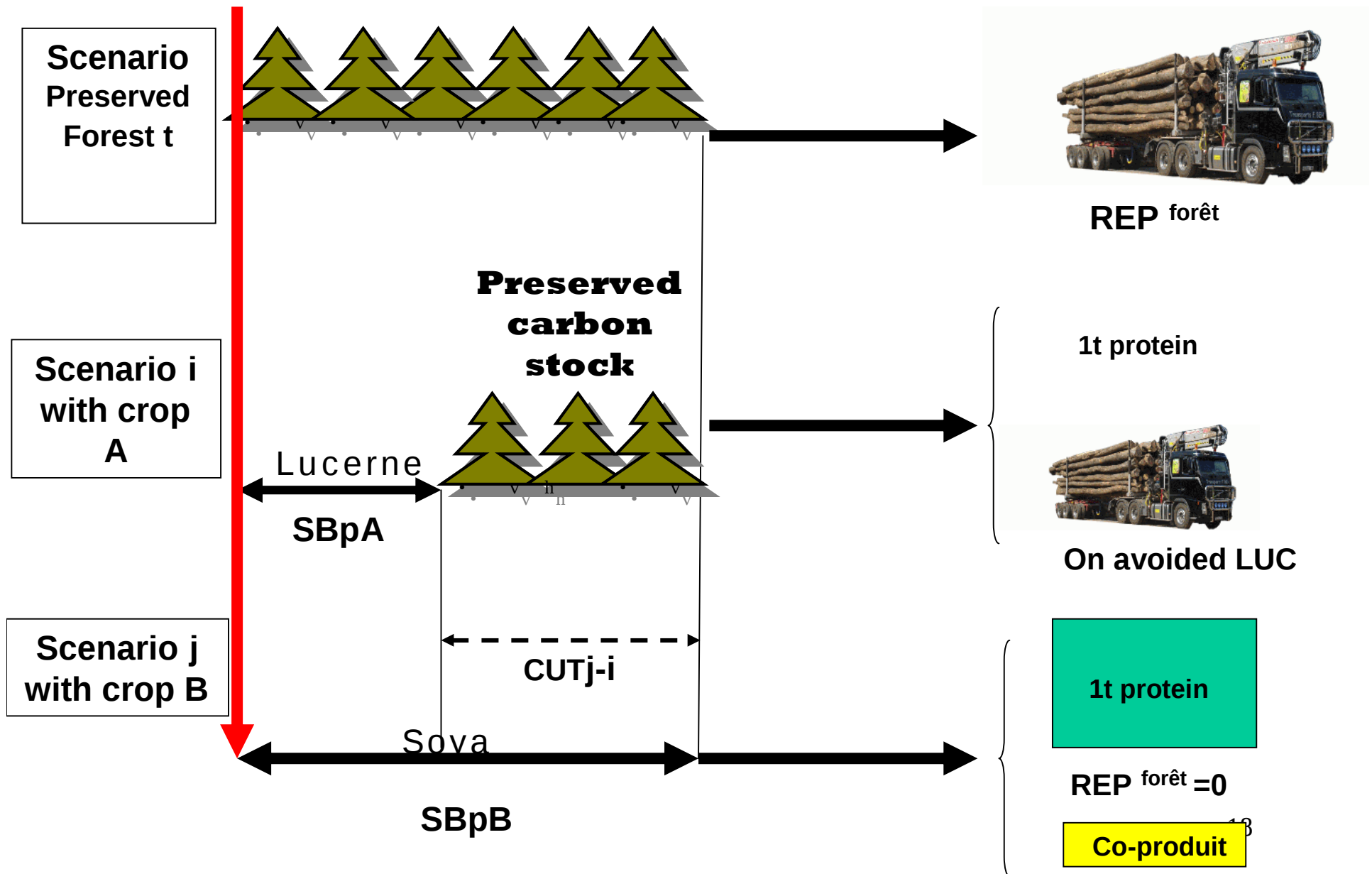
by changing crops**



Land required to produce 1 t of protein

Carbon stock decrease 312
teqCO₂ /ha

Harvest of Primary Energy



Which conclusions for Food Security and Climate change mitigation ?

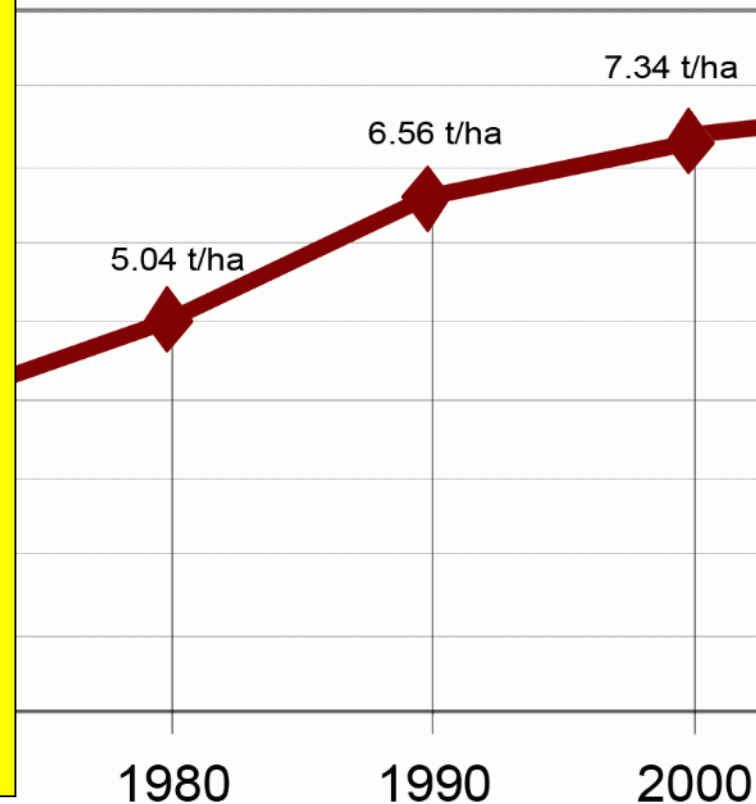
Between 1950 and 2000 due to
increase in cereal yields

we saved in France

• 27 Mha

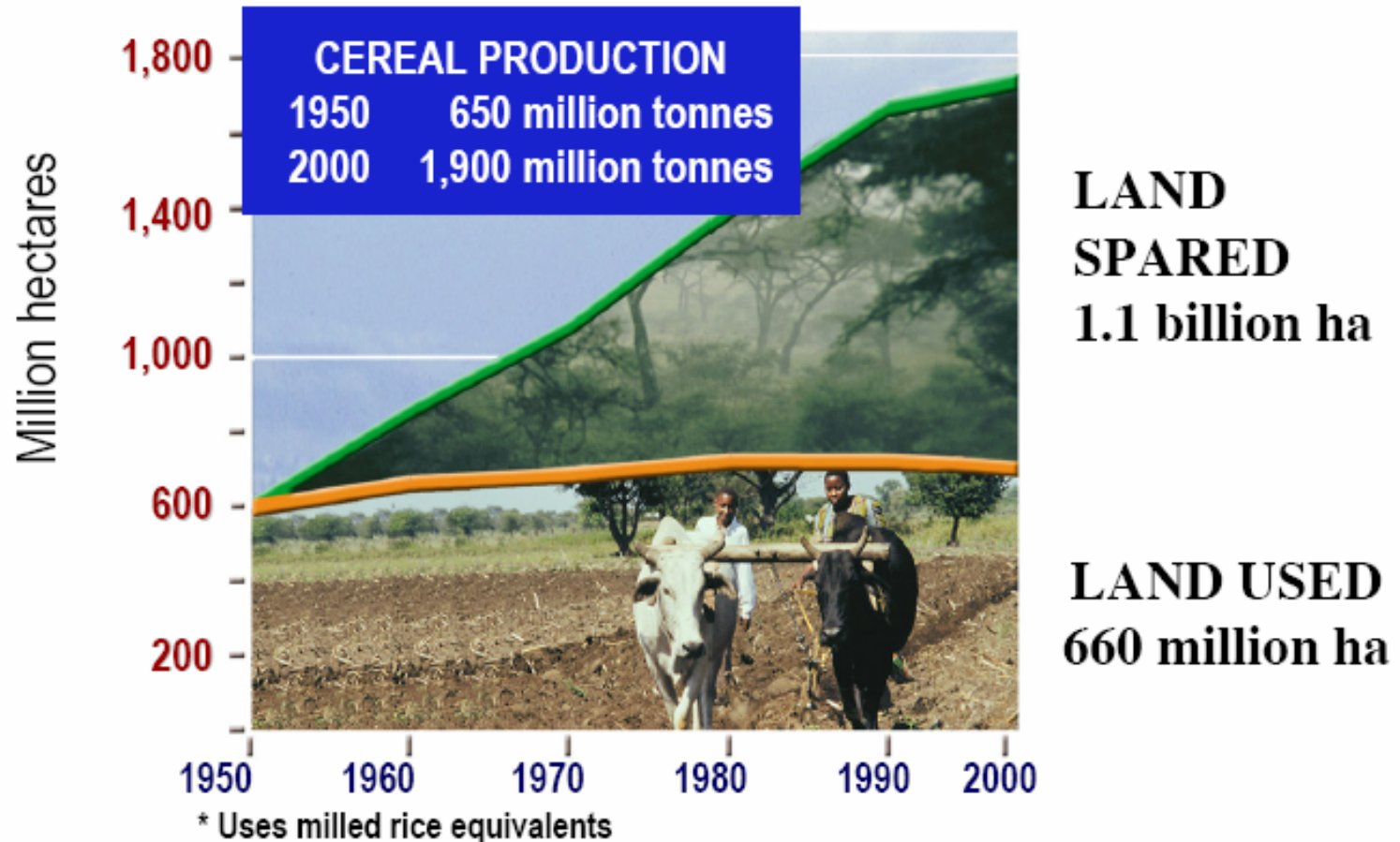
**and in spite of
increased inputs**

**• 60 millions tCO₂
equivalent per year**



At the world level increasing LUEf has save 1.1 billion ha since 1950

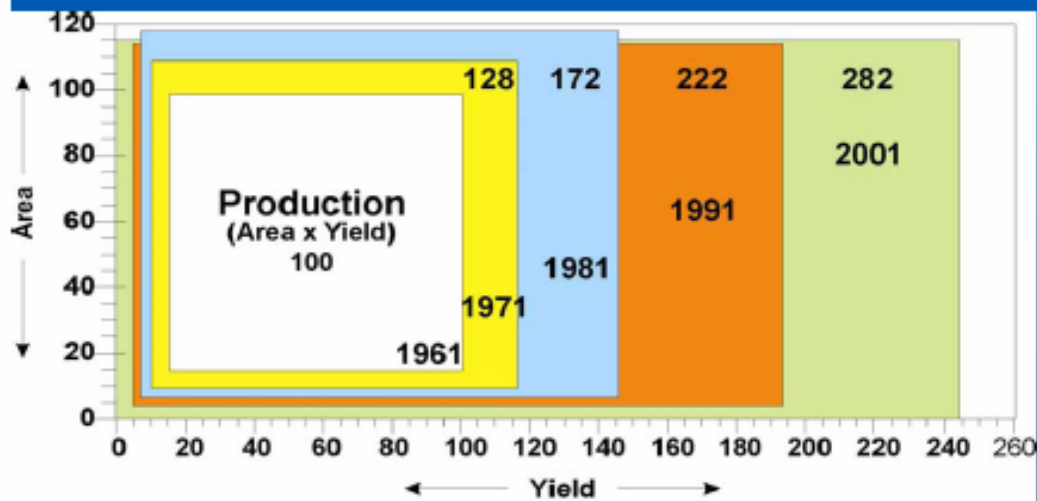
World Cereal* Production–Areas Saved Through Improved Technology, 1950-2000



LUEf has increased in the world except
in Sub Saharan Africa

South Asia and SSA, 1961-2001

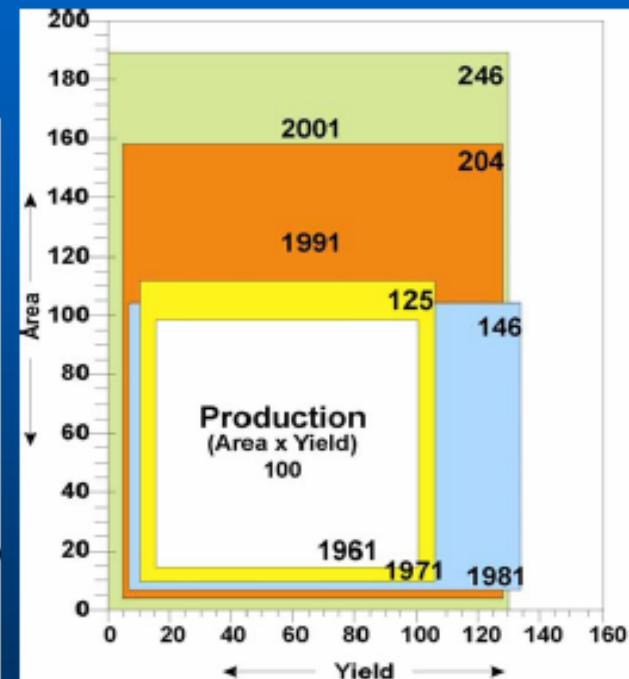
1961=100 for area and yield



Source: Derived from FAOSTAT data, December 6, 2005 <<http://FAOSTAT.fao.org>>

South Asia

From IFDC



Source: Derived from FAOSTAT data, December 6, 2005 <<http://FAOSTAT.fao.org>>

Sub-Saharan Africa

MONITORING LAND COVER DYNAMICS IN SUB-SAHARAN AFRICA

H.D. Eva, A. Brink and D. Simonetti



Between 1975 and 2000

The area covered by agriculture increased from 215 Mha to 338 Mha at the expense of forest (55%) and non forest natural vegetation (45%)=>

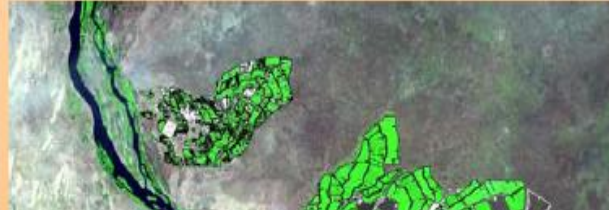
~ 5Mha per year

Consequences

**In the JRC Study : not the FAO definition of forests
But more than 30 % land cover**

MONITORING LAND COVER DYNAMICS IN SUB-SAHARAN AFRICA

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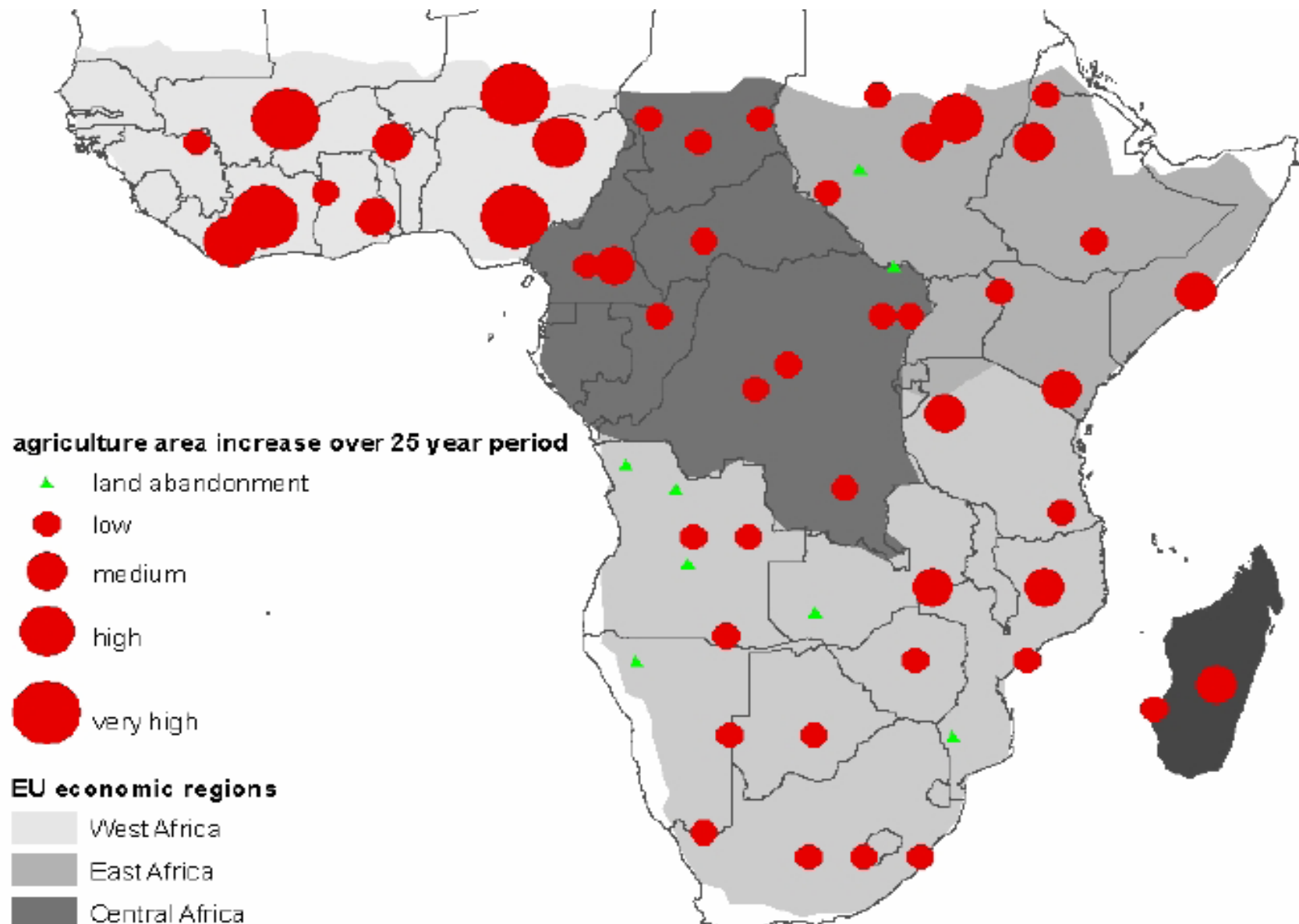


Between 1975 and 2000

**~ 1 billions ton of CO₂
per year**

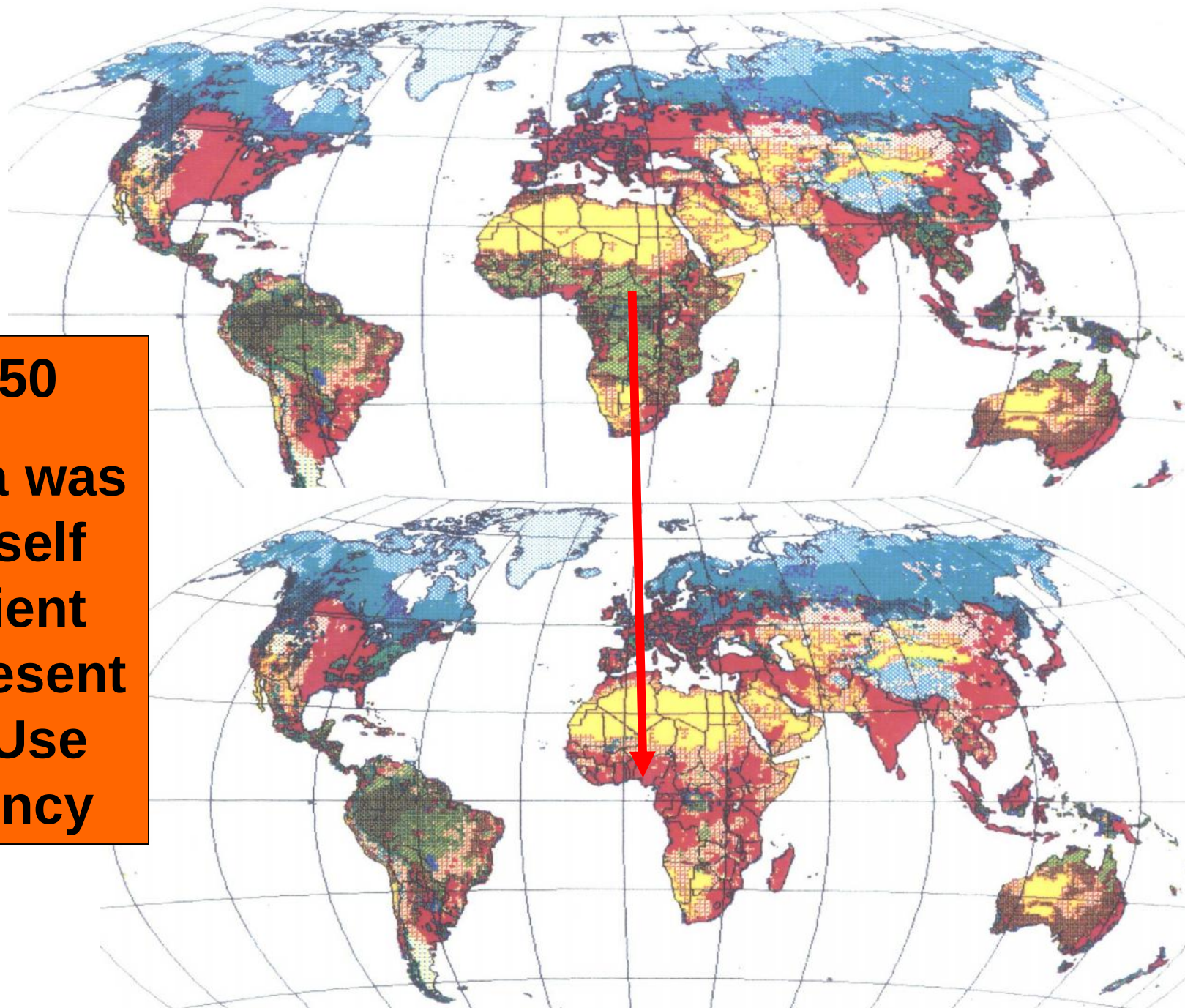
**About twice the annual
emissions of France**

Land Use Change

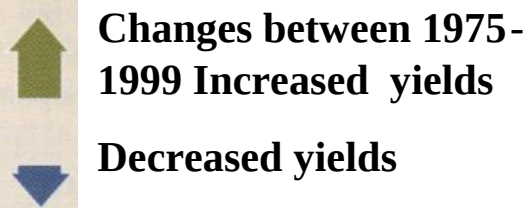


1990

**In 2050
if Africa was
to be self
sufficient
with present
Land Use
Efficiency**



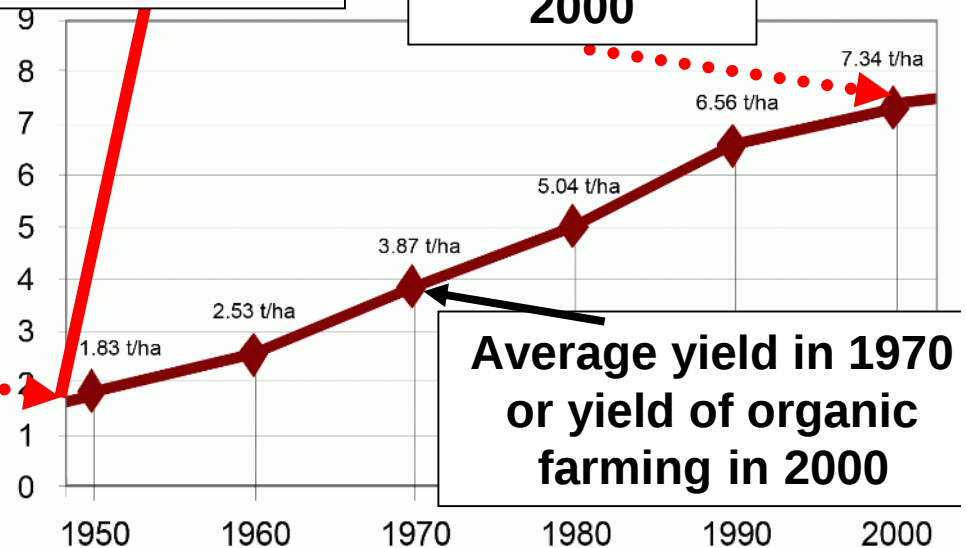
Cereal yield per ha in the world



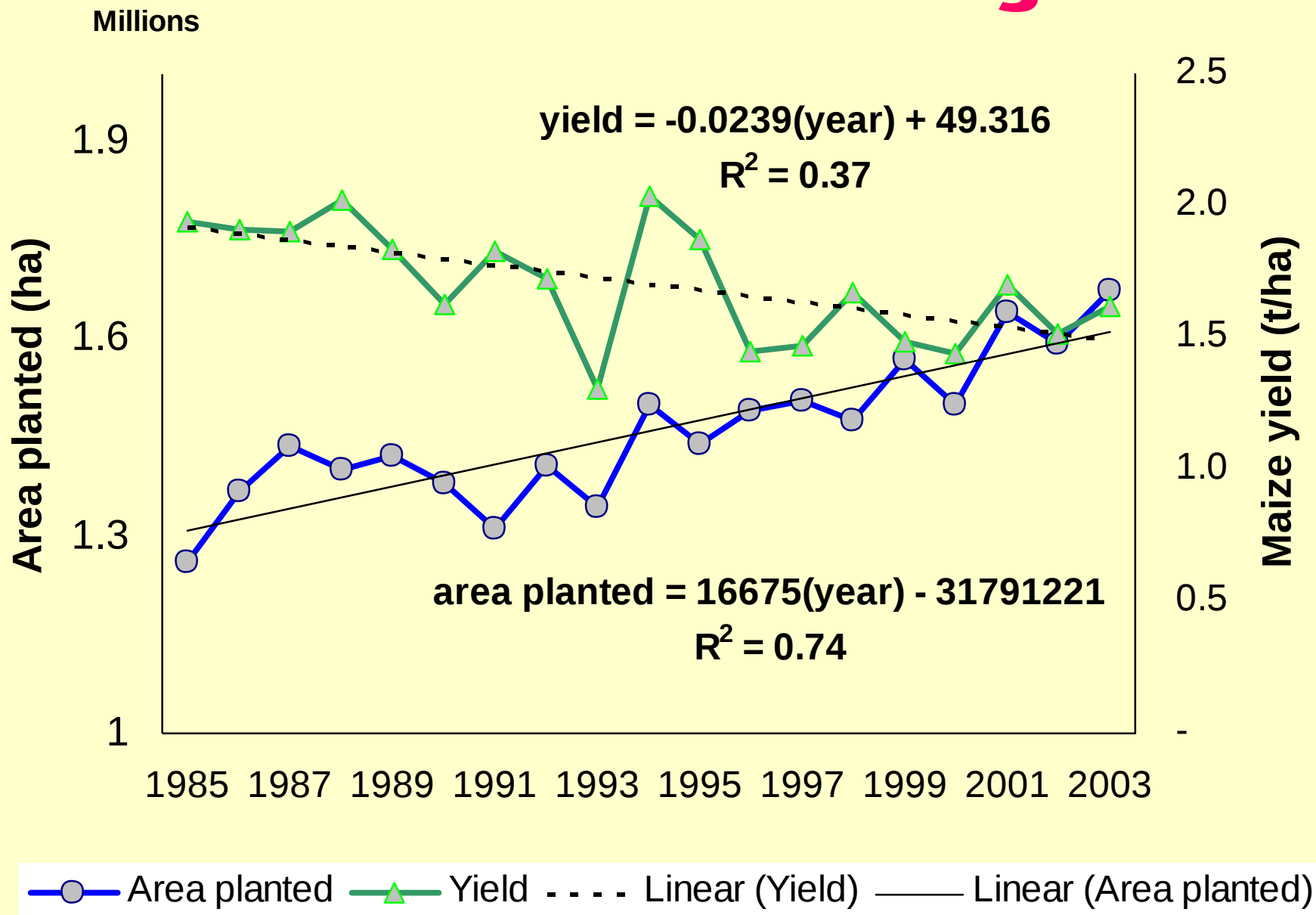
Cereal yield in Africa 2000
Yields comparable to Developed countries in 1950

Average wheat yields in France in 2000

Average wheat yields in France in 1950



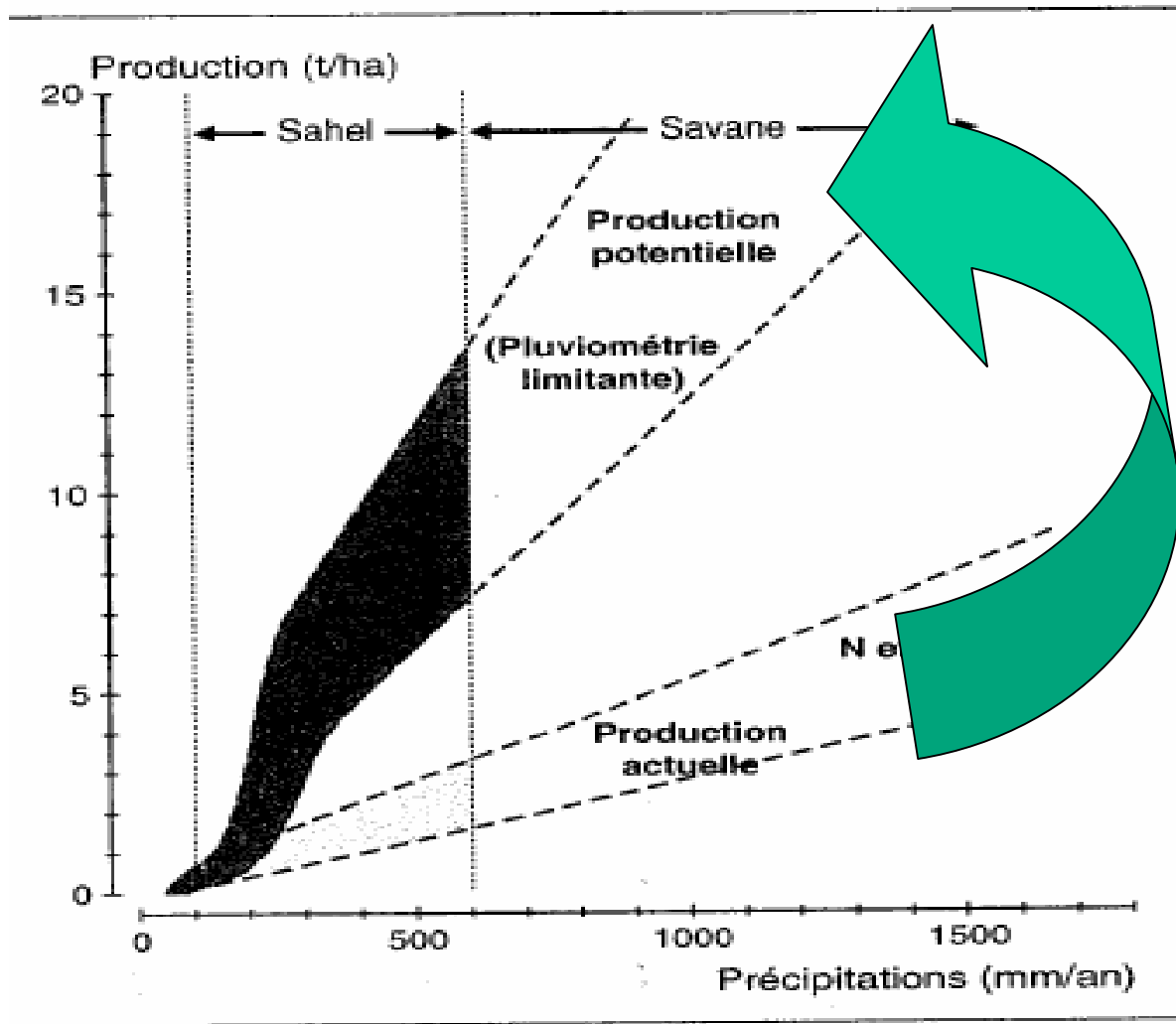
And even decreasing



Maize Yield and area trends for Kenya (nat. statistics)

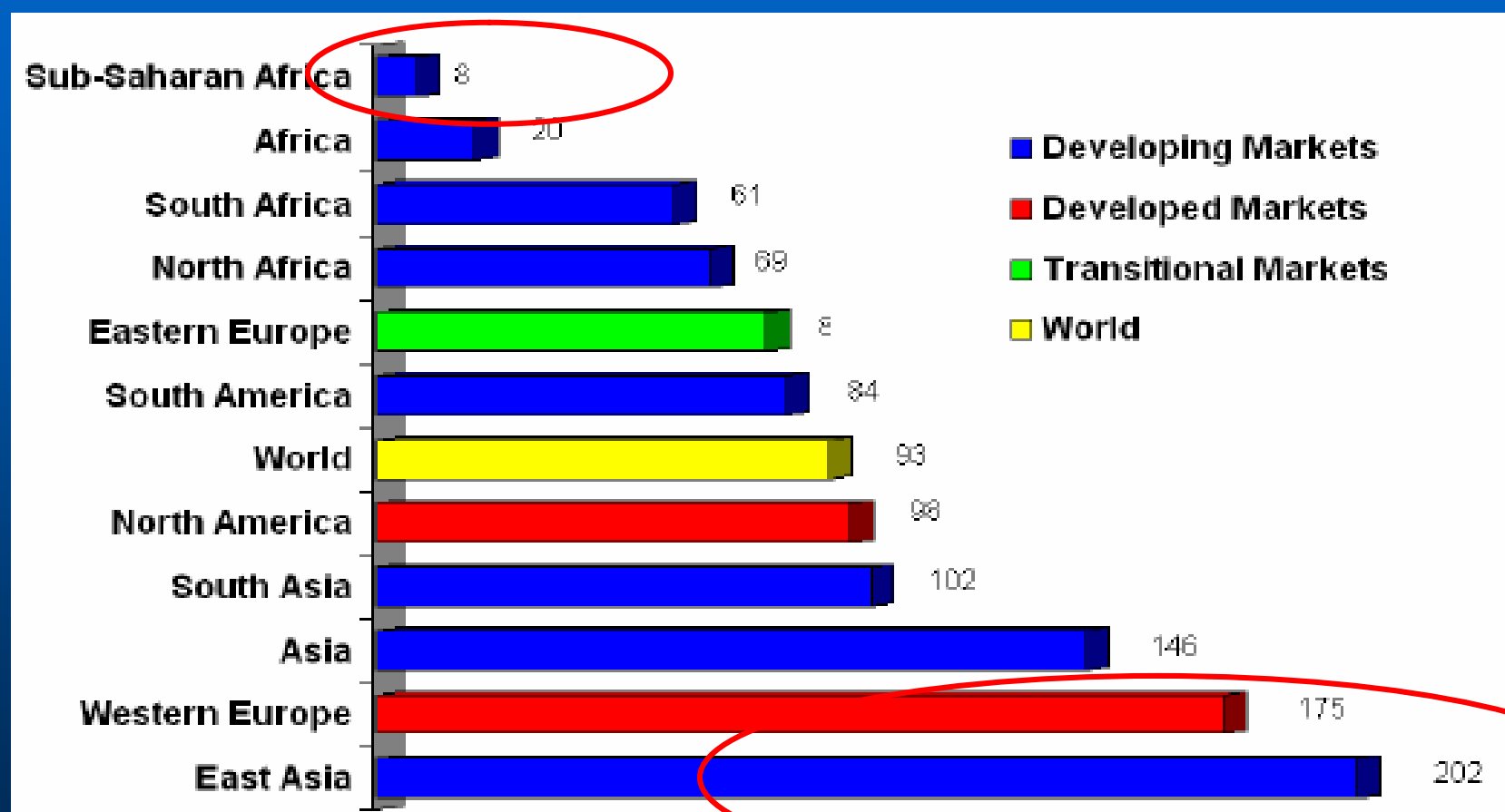
Yields can be increased with some fertilizer





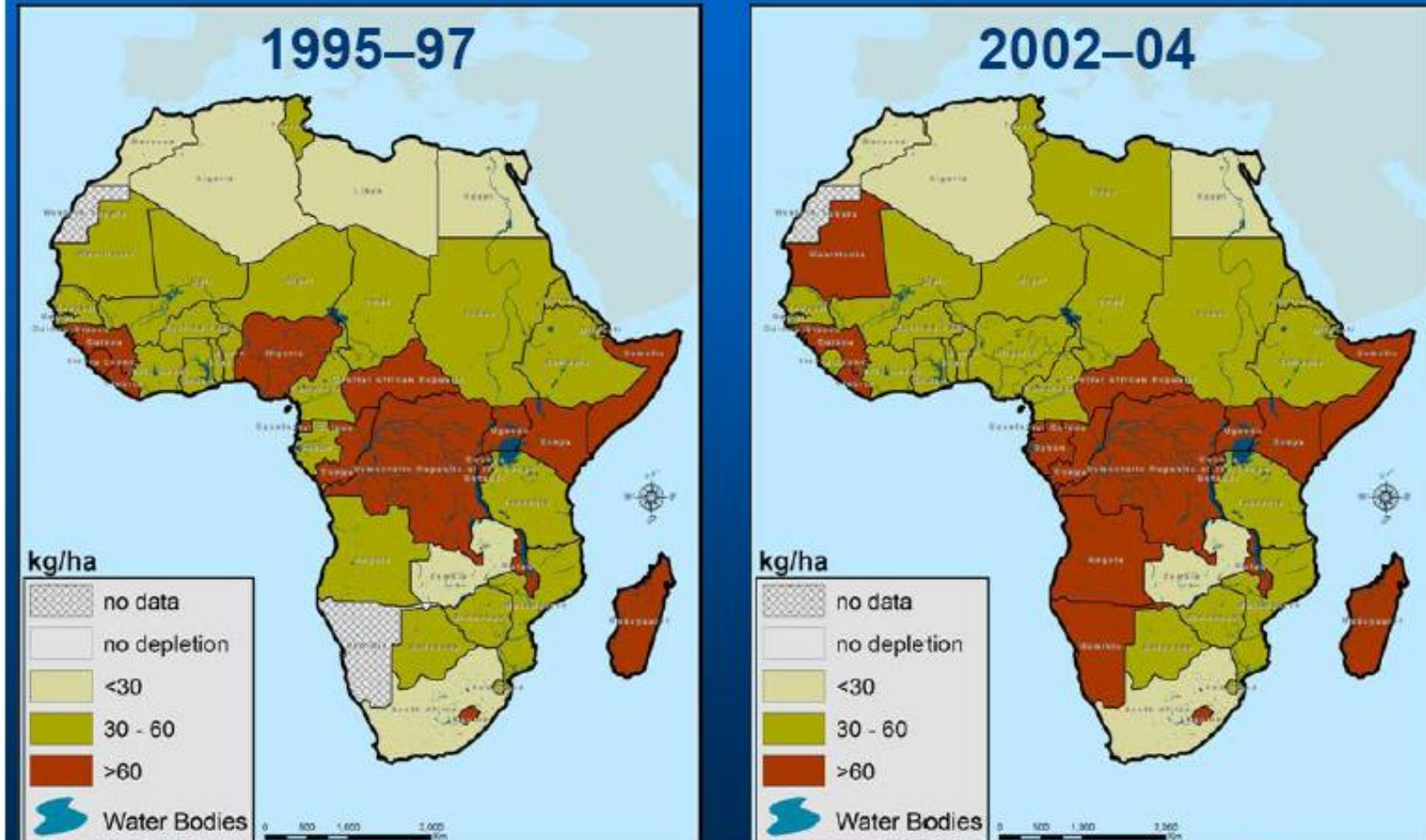
Yields are too low due to mineral deficiency

Per Hectare Fertilizer Use by Markets 2002/03 (kg/ha)

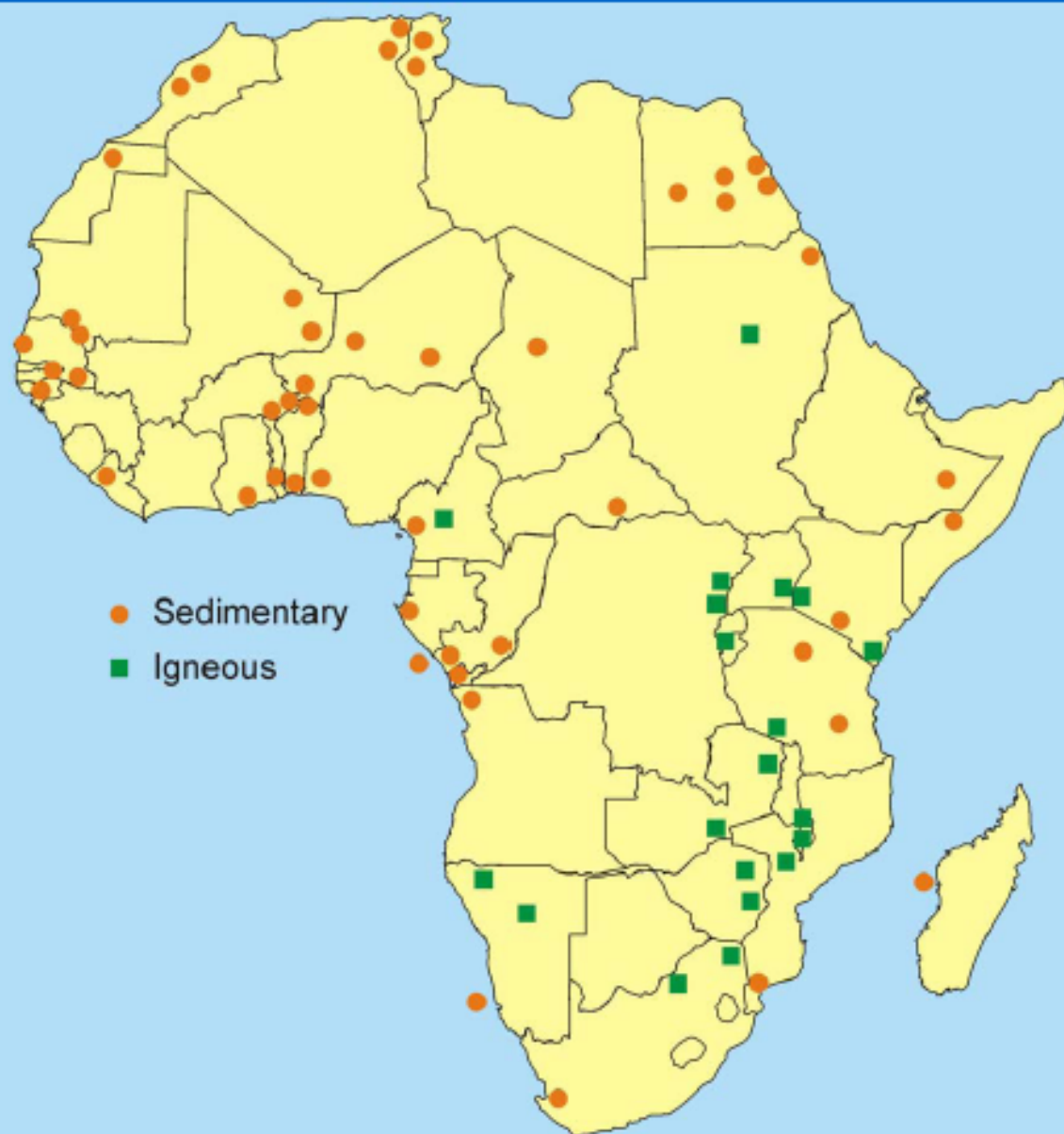


Agriculture is not sustainable

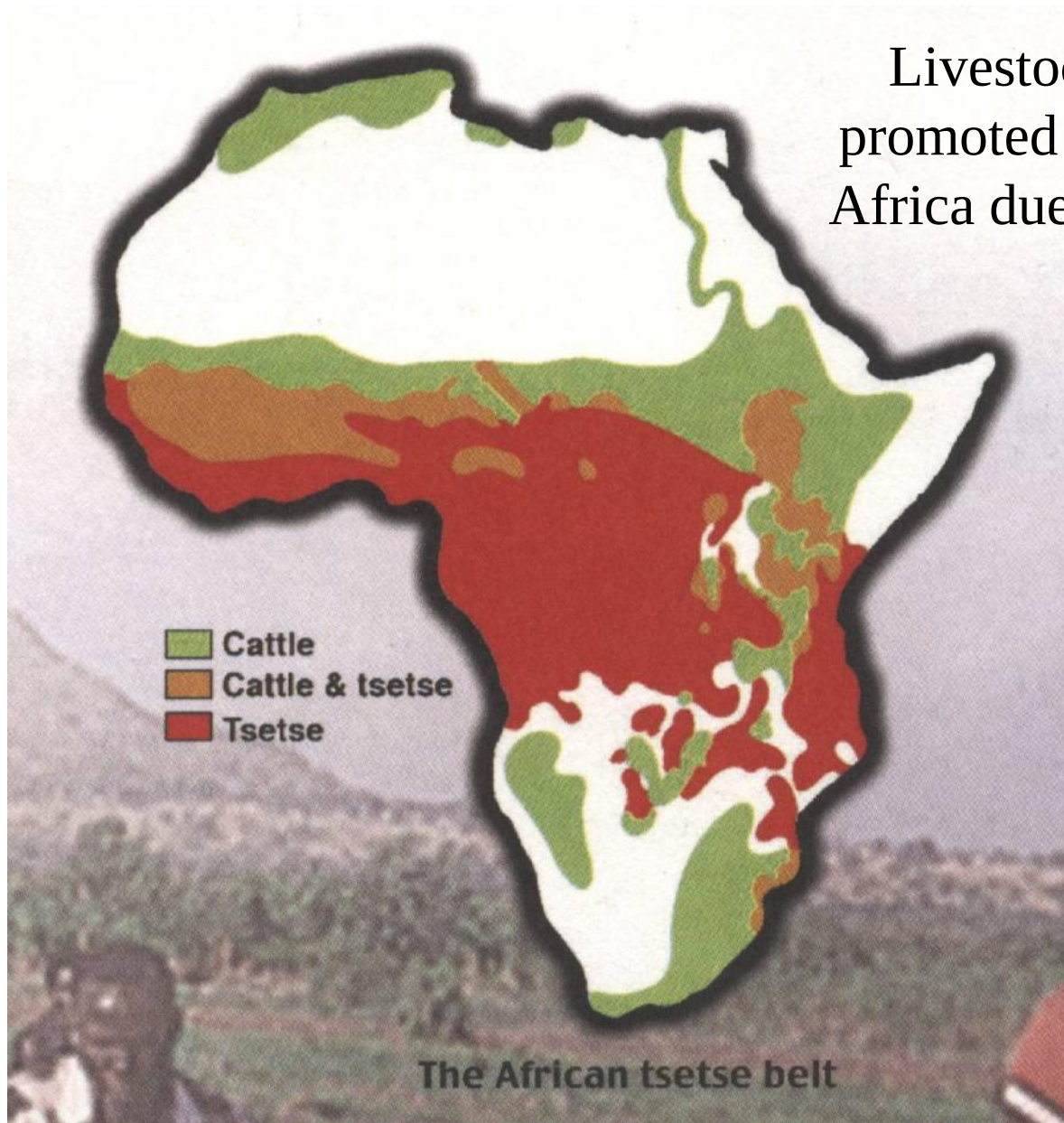
Nutrient Mining in Agricultural Lands of Africa



Significant Phosphate Deposits of Africa



Livestock cannot be promoted everywhere in Africa due to the Tse Tse fly



**Decreasing GHG emissions
by paying 50 % of the cost of
fertilizer in Africa
is much cheaper than
reducing GHG in Developed
Countries
(annex 1 countries)
Less than 20 \$ / € per tCO₂ eq**

**Decreasing GHG emissions
by paying 50 % of the cost of
fertilizer in Africa is much
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in Developed Countries
(annex 1 countries)
Less than 20 \$ / € per tCO₂ eq**

**And at the same time it would
increase food production
and food security**

For Post 2012 Kyoto agreements....

- **Land Use efficiency should be included like energy efficiency at least for “Less Developed Countries”**

Under

- a new CDM**
- or under a special fund for “food security and climate change” mitigation (not an adaptation)**

If we can achieve that

The world will become
more sustainable

If we can achieve that

**The world will become
more sustainable**

**We do thank you for supporting
that proposal**

**And also for supporting
the next
Conference in Ethiopia
of IFSDAA
(International Foundation
for Sustainable
Development in Asia and
Africa)**

**February - Février 2010
Adis Abeba Ethiopia - Ethiopie**

International Conference for Sustainable Development and to Increase Carrying Capacity

Conférence Internationale pour le Développement Durable

et pour Augmenter la Capacité d'Accueil

February - Février 2010

Adis Abeba Ethiopia - Ethiopie

Main topics - Principaux thèmes

- **Ressources Management - Gestion des ressources**
- **Eco-efficiency - Eco-Efficacité**
- **Agro-entrepreneurship - Agro-Entreprenariat**
- **Agropolicy - Politiques Agricoles**

Contact Arthur Riedacker Vice President of IFSDAA a.riedacker@wanadoo.fr

[r](#)and AASF aasf@gwdg.de