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

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

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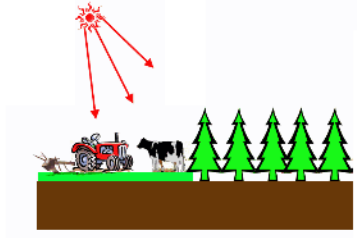
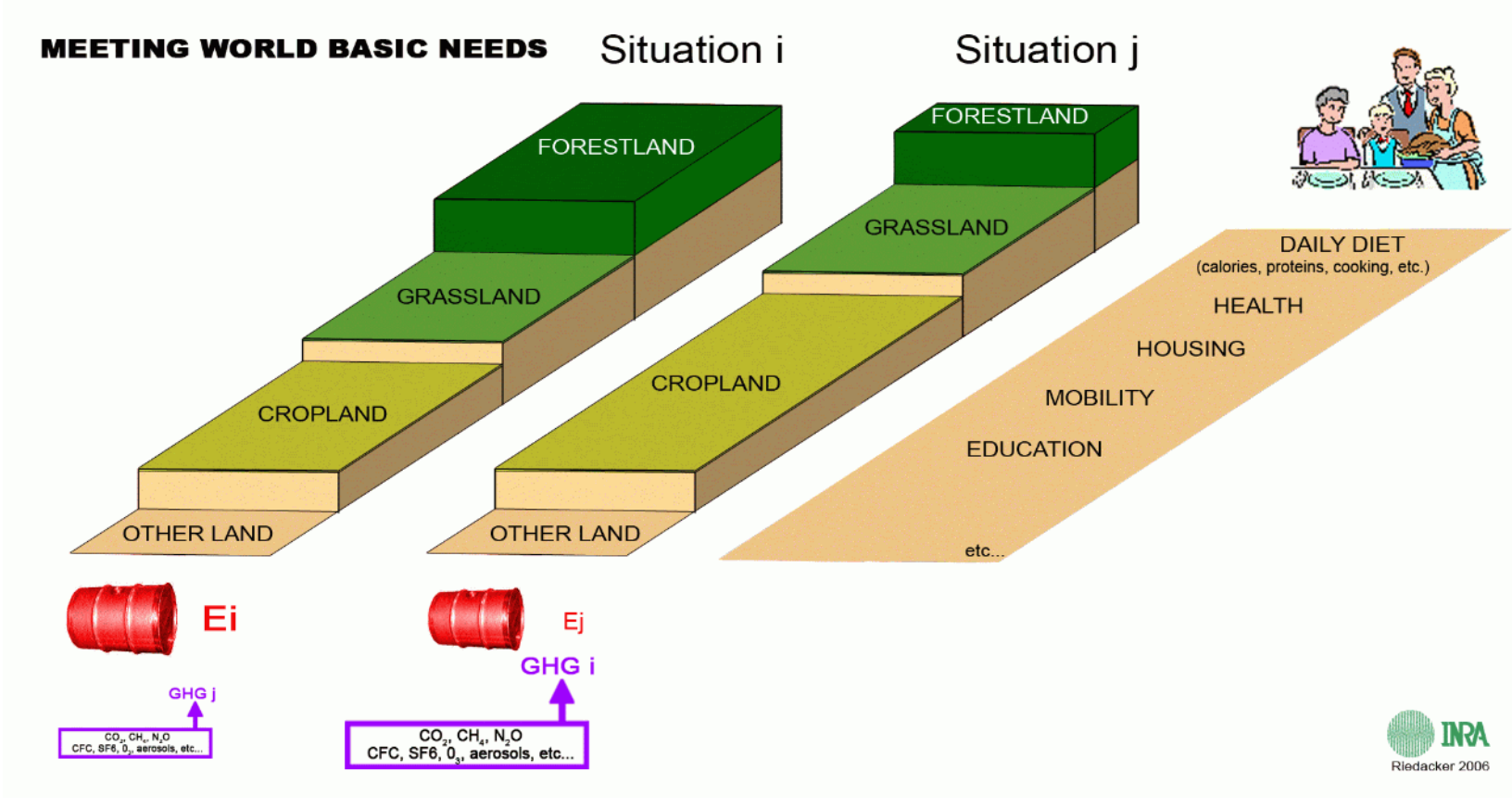
# For sustainable development we are to look both at global & local level



Basic Needs per capita

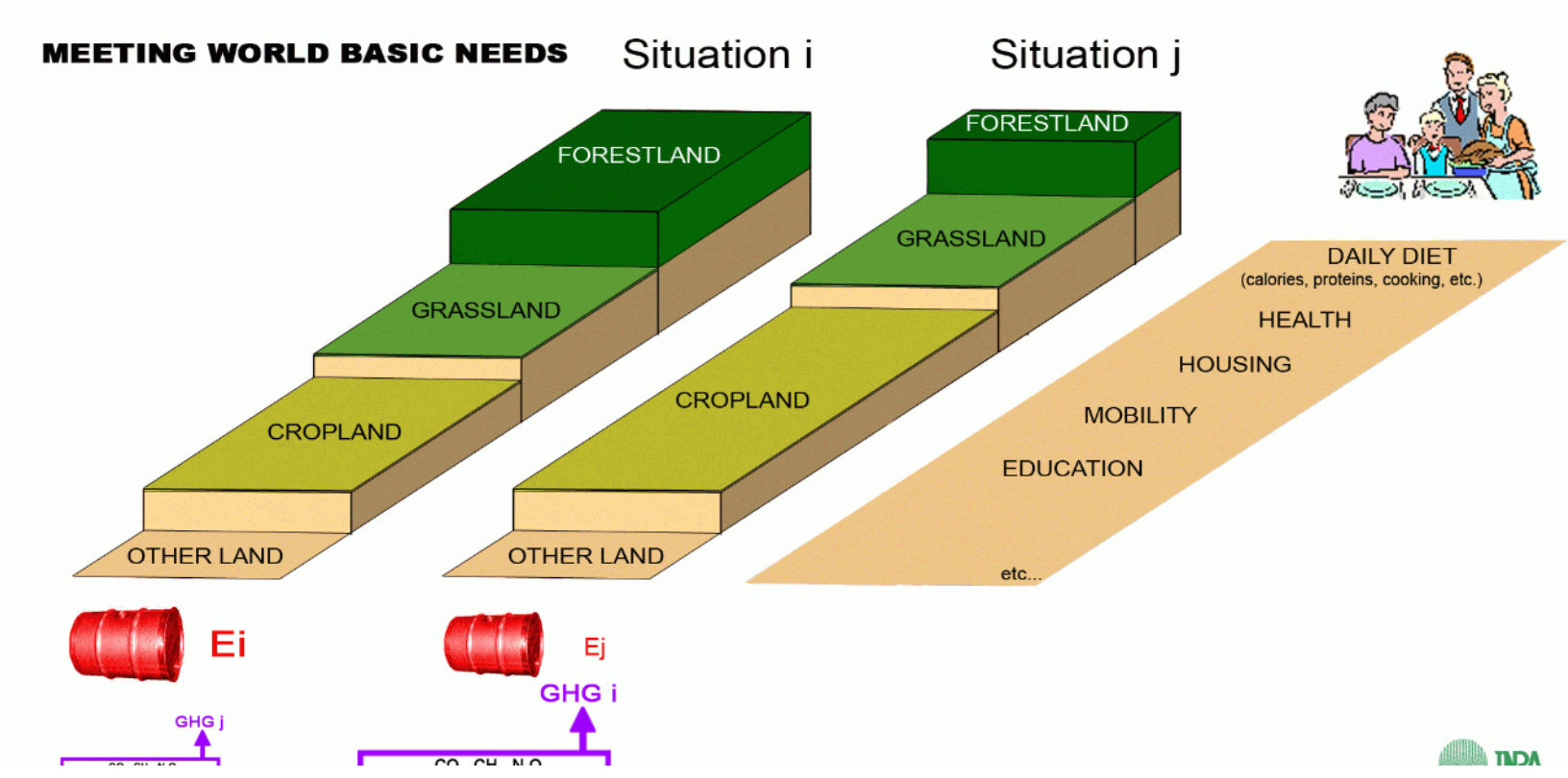
**Local Resources and constraints**

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



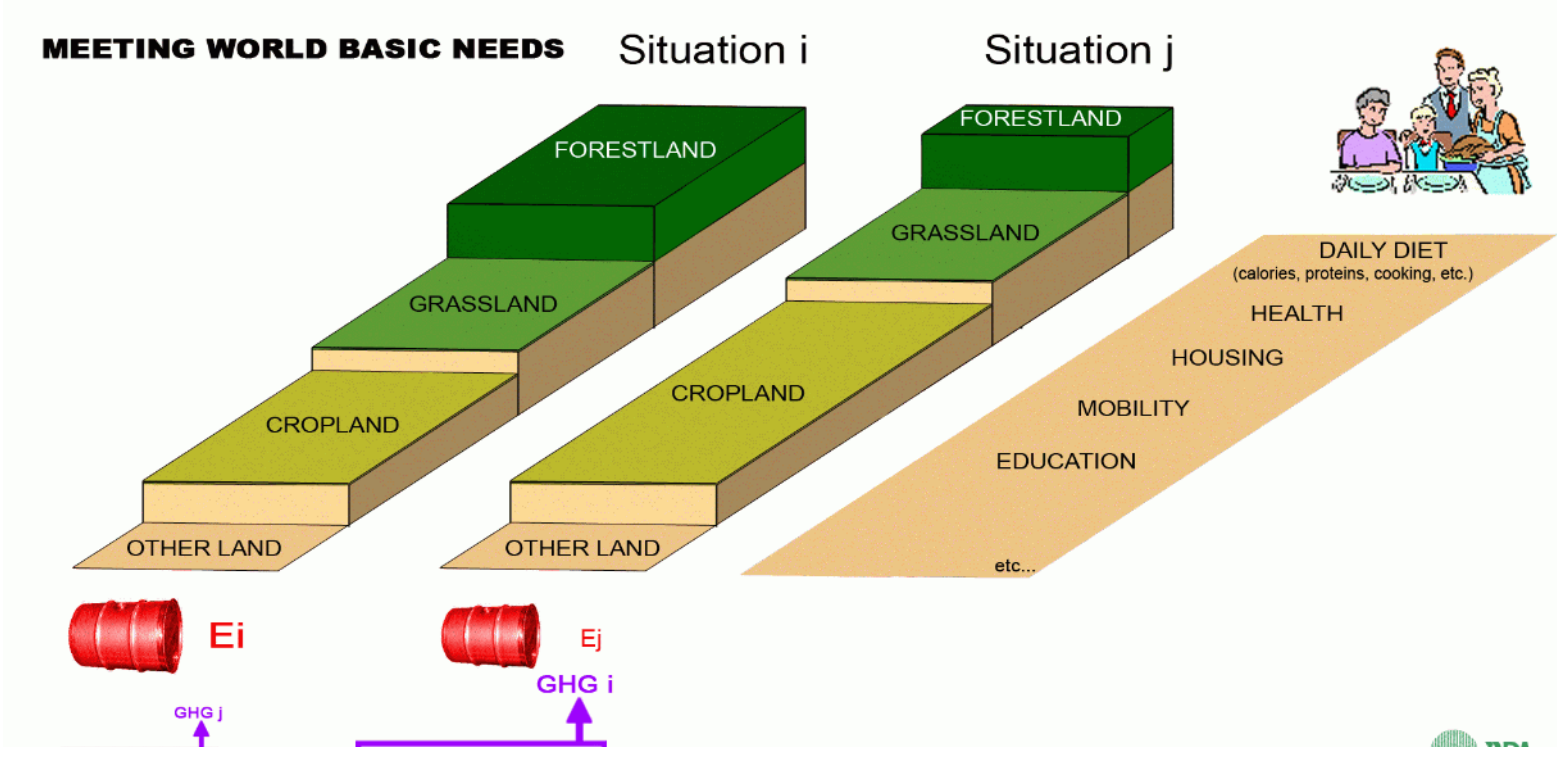
# ⇒2 d conclusion

## 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

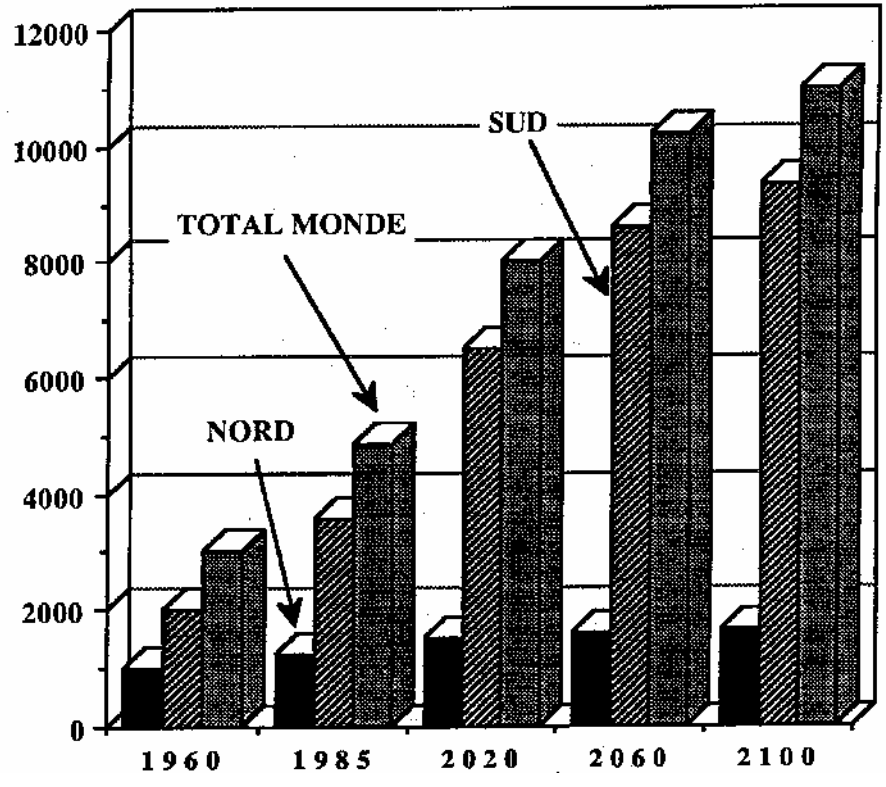
# To morrow + 3 Billion people (+50%)!

# And +100% in Sub-Saharan Africa

**Increase of Population**

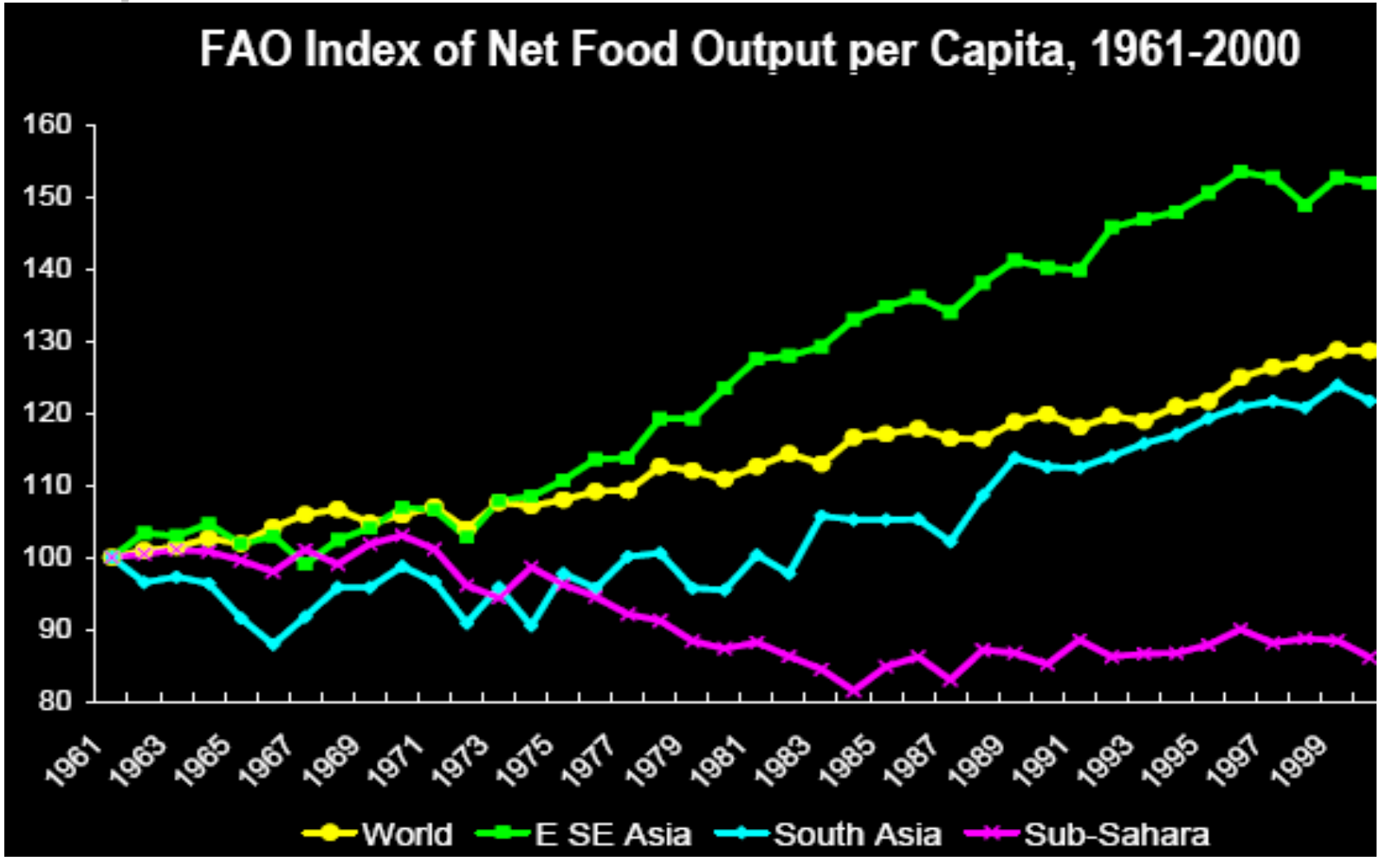
and some

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



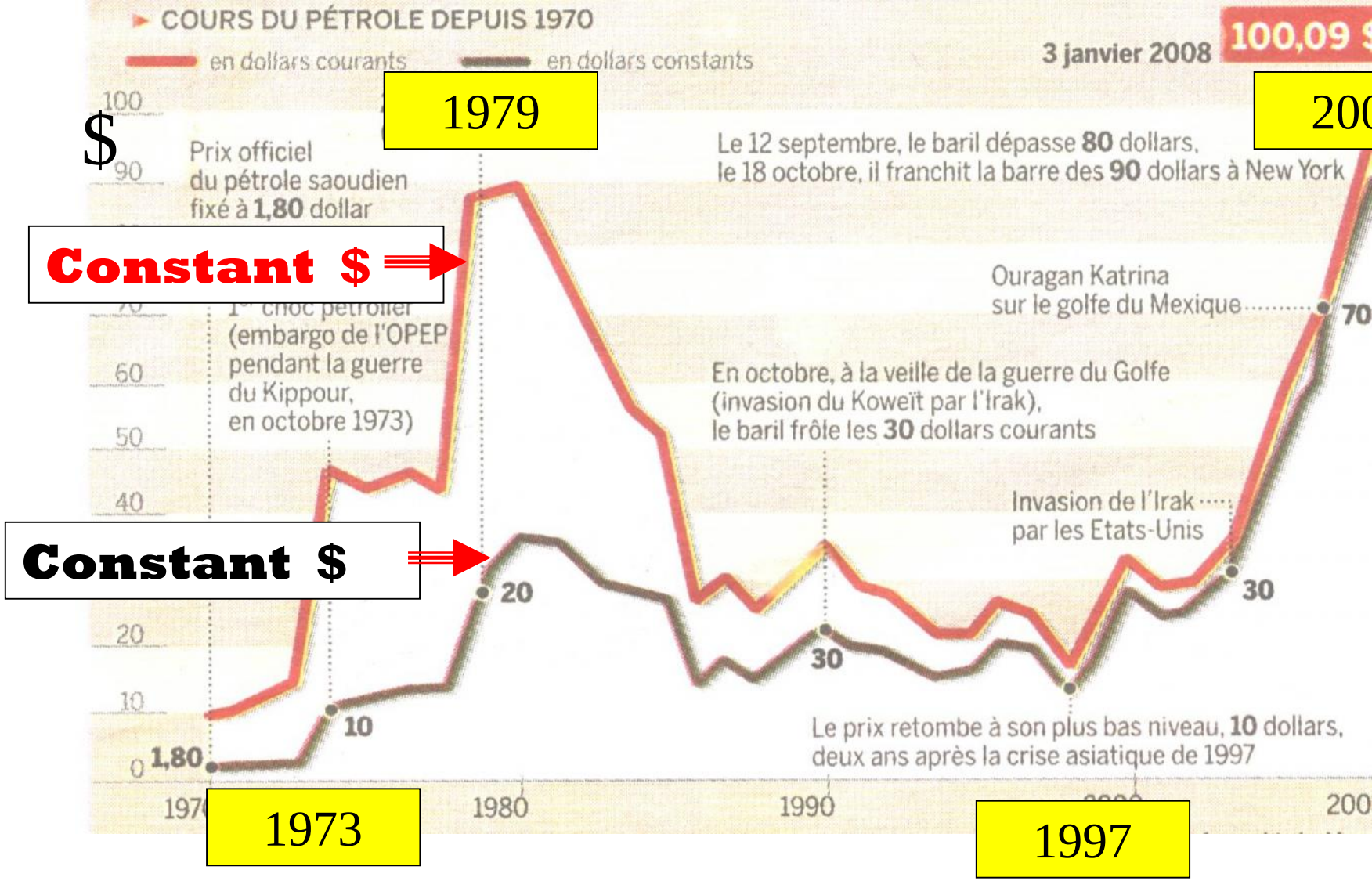
# 1/ Food

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




**Sub-Saharan Africa**

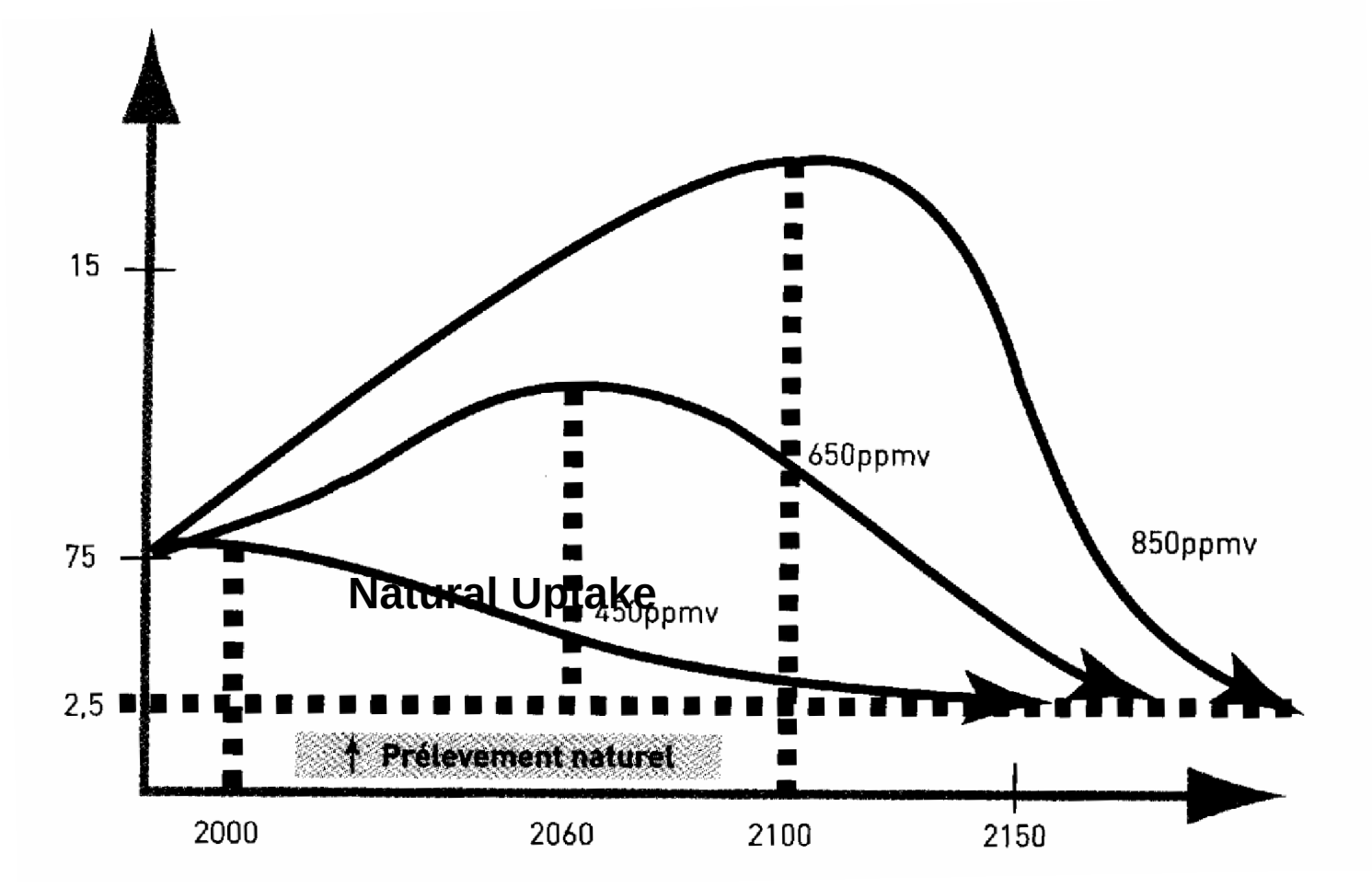
# End of cheap oil …..?

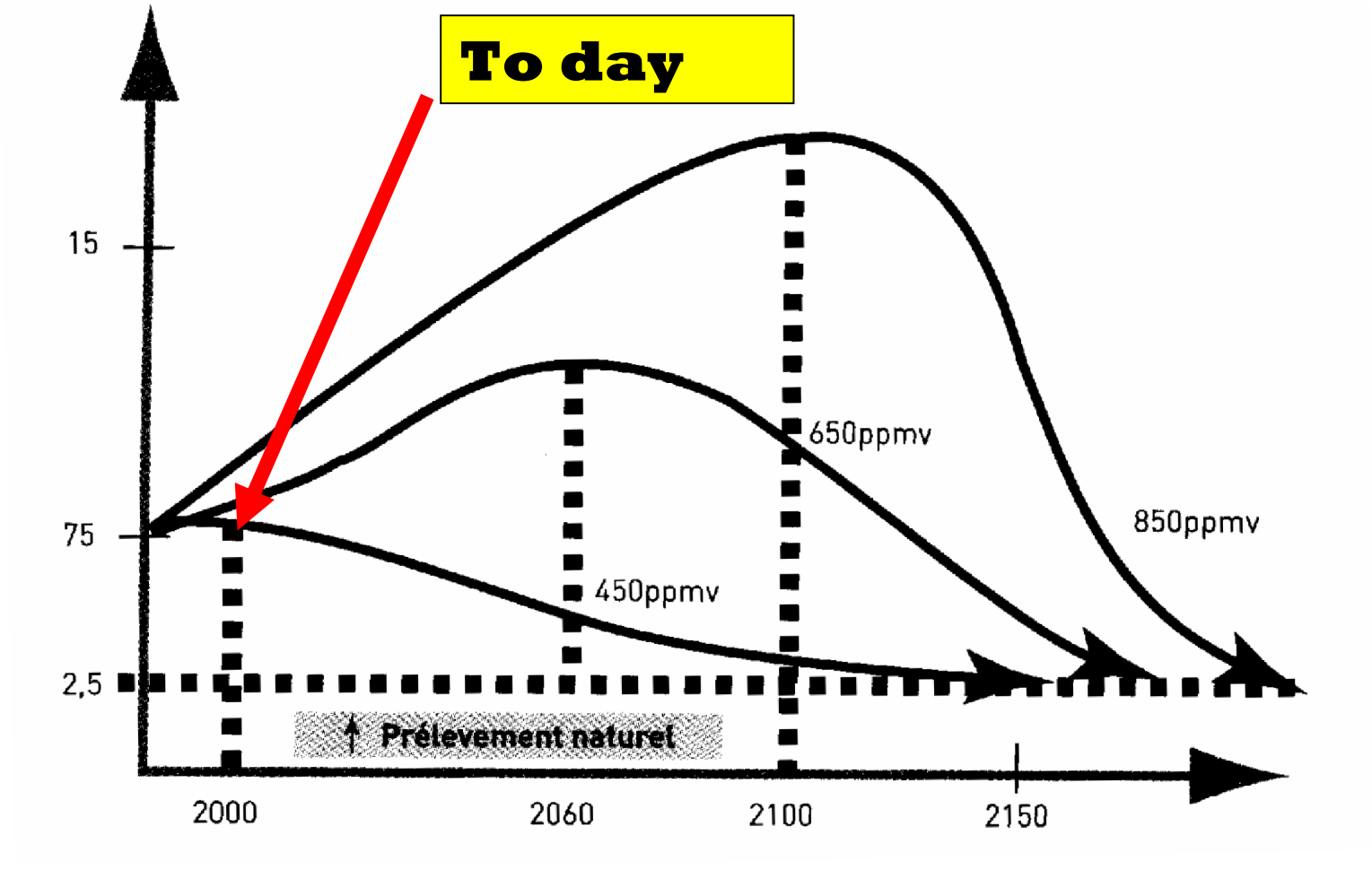


# Climate Change ?

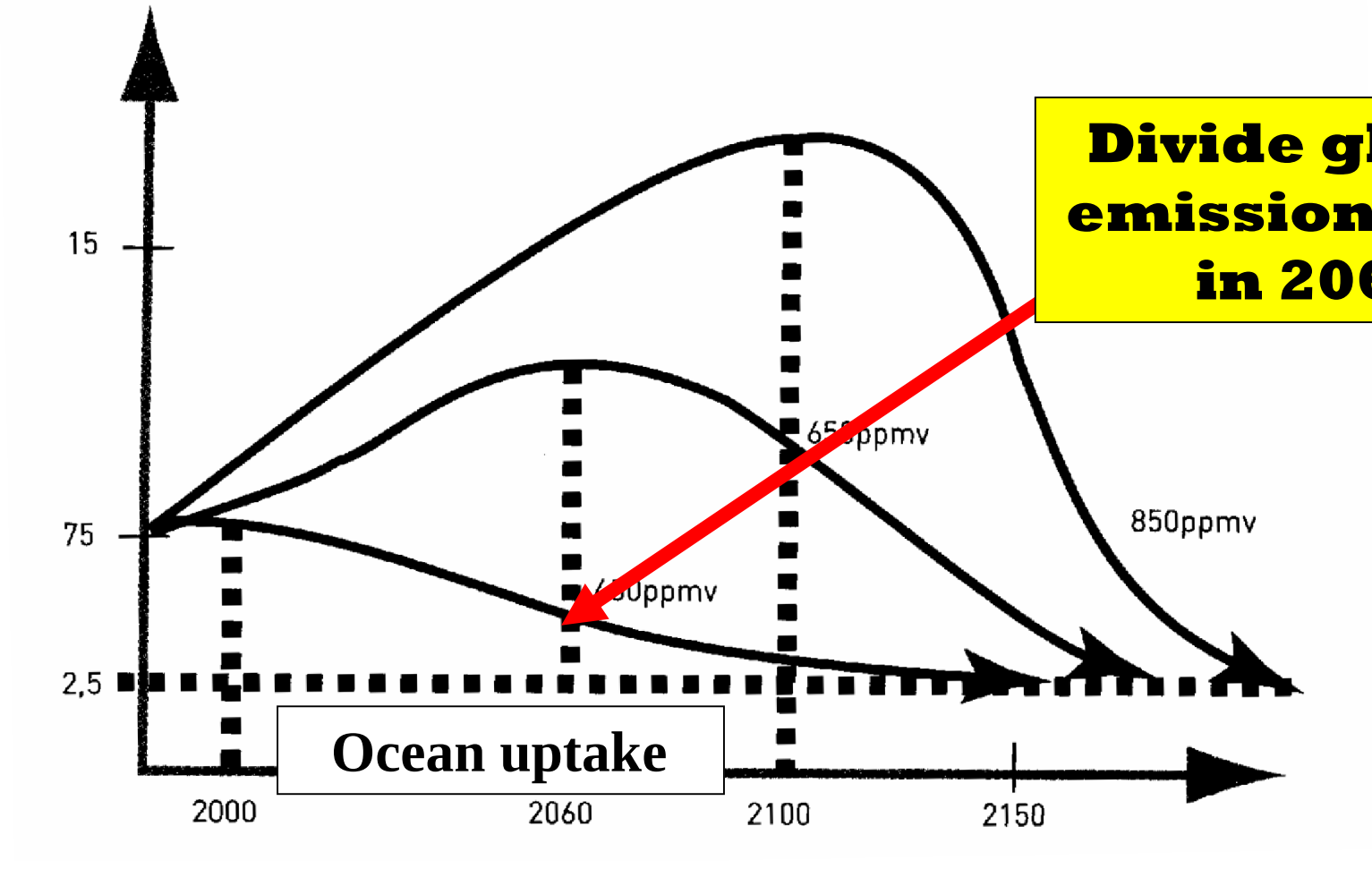
## Most important negative impact is on agriculture in most densely populated regions

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

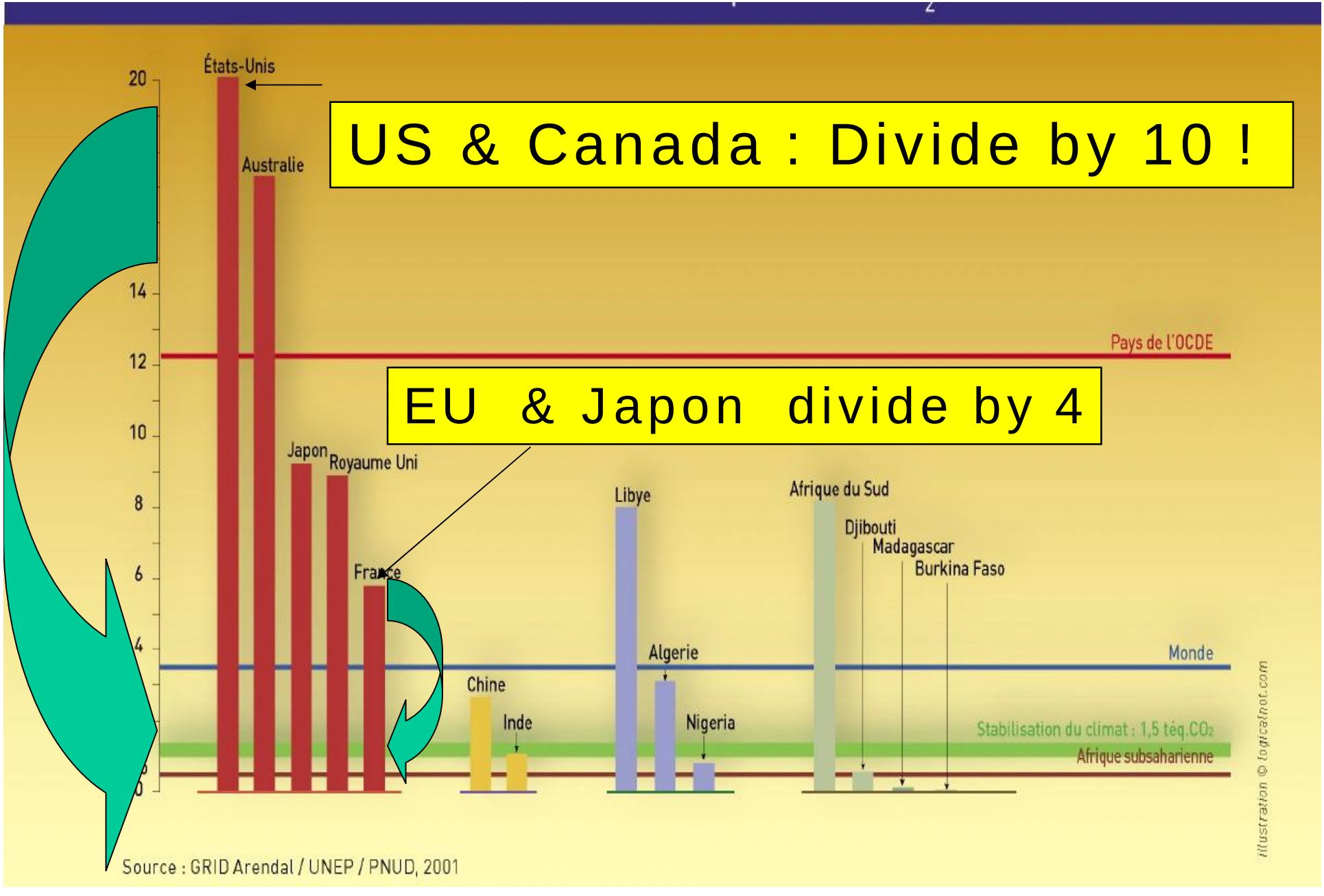



To day
15
75
2,5
650ppmv
850ppmv
450ppmv
Prélevement naturel
2000
2060
2100
2150

# Curve to stabilize at 450 ppm



# Developed countries are to show the way…



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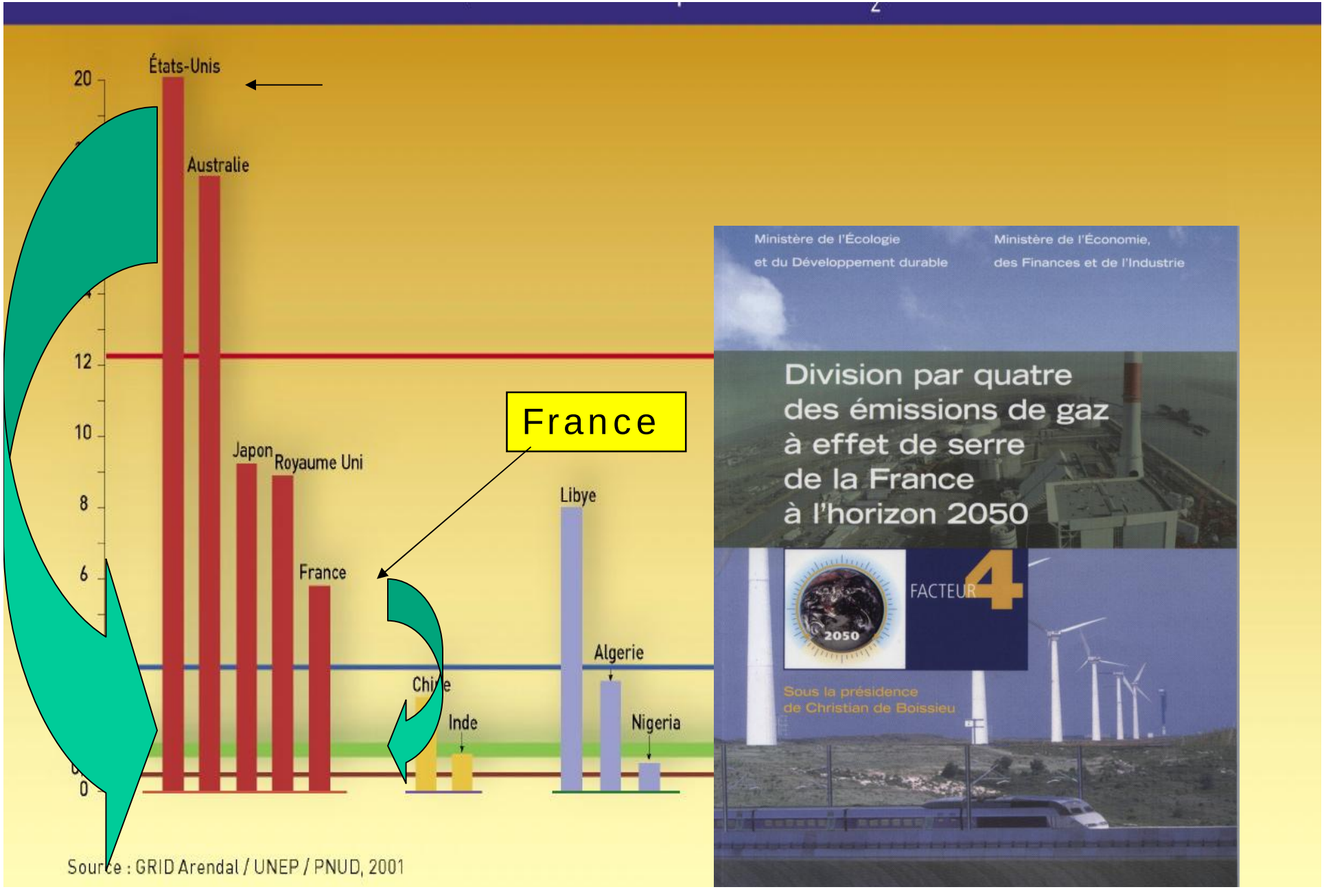
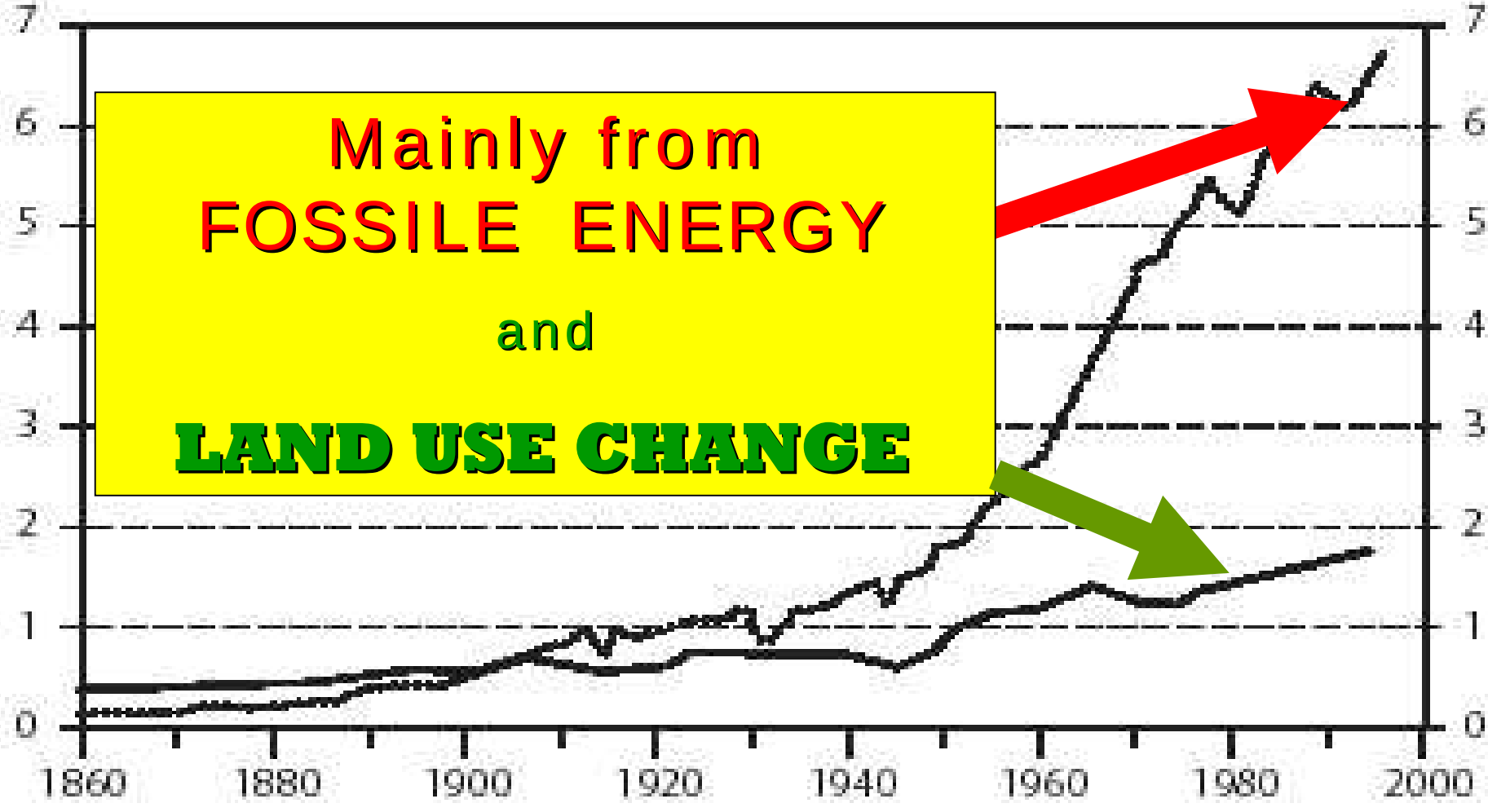
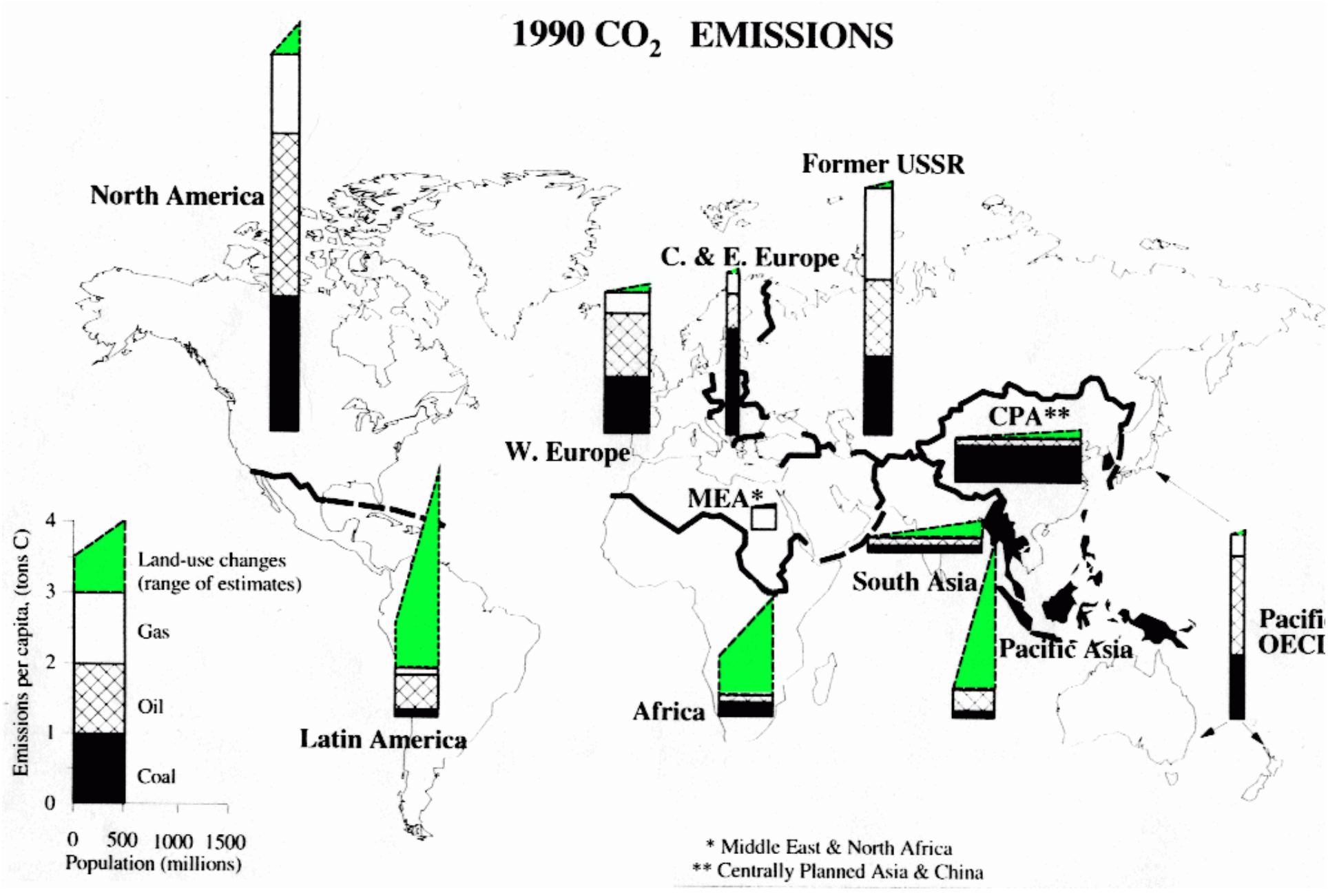


**That will not be easy**

# Net $CO_2$ emissions in (GtC) since the industrial revolution

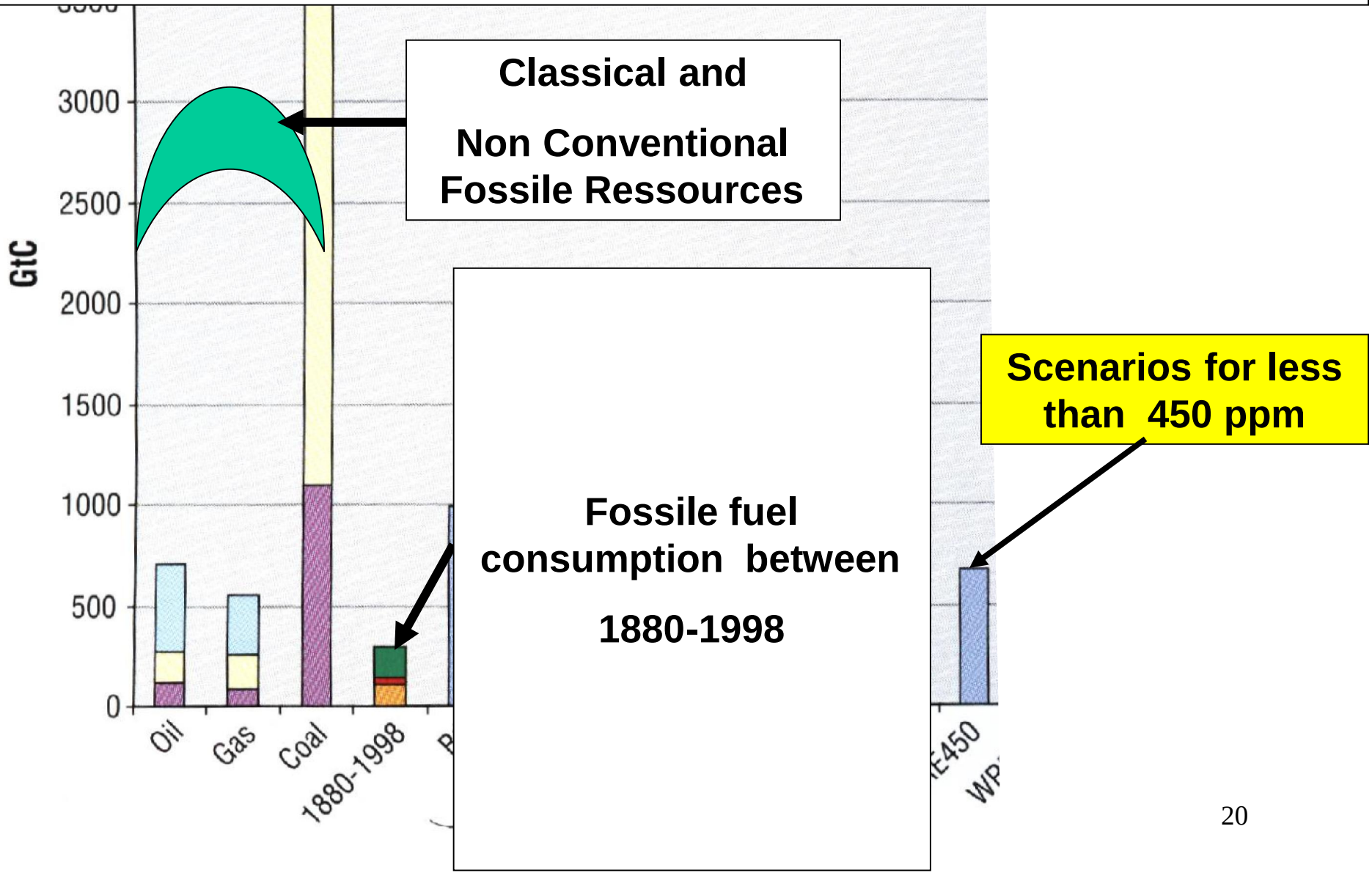



1990 $CO_2$ EMISSIONS
North America
Former USSR
C. & E. Europe
W. Europe
CPA**
MEA*
South Asia
Pacific Asia
Africa
Latin America
Pacifi
OECI
Emissions per capita, (tons C)
4
3
2
1
0
Land-use changes
(range of estimates)
Gas
Oil
Coal
0 500 1000 1500
Population (millions)
* Middle East & North Africa
** Centrally Planned Asia & China

**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

**GHG Em. from Fossil energy=**

**= Pop*[GDP/Pop.] ***

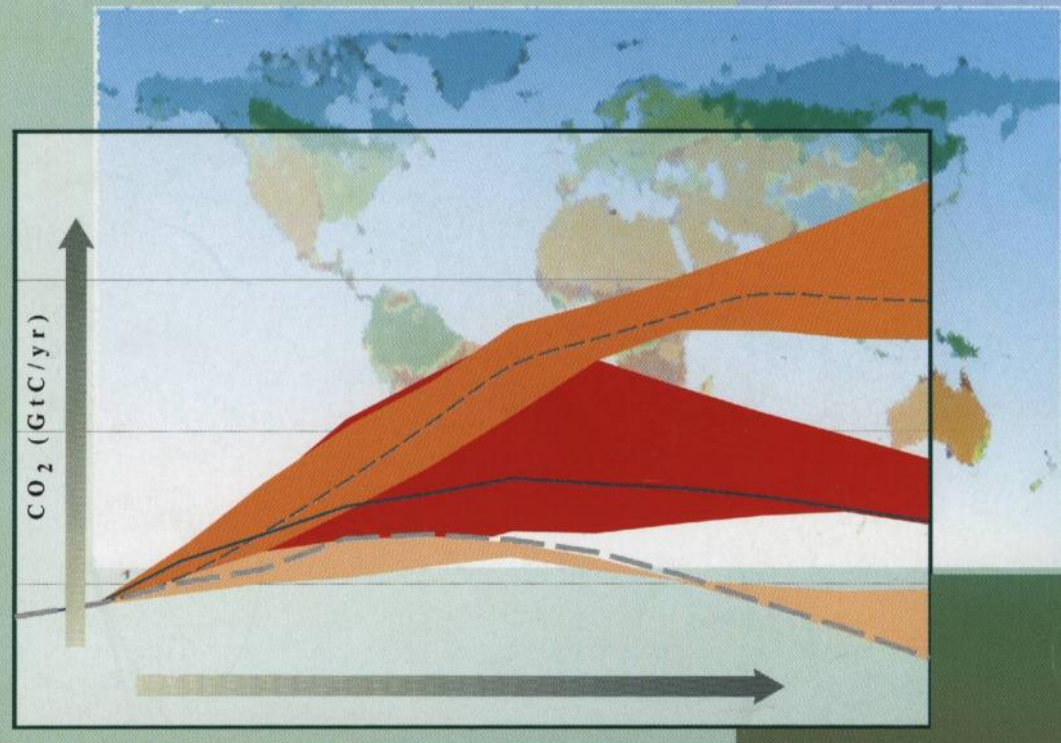
**[ (Σ of Fossil Energy)/GDP ] ***

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

OMM

GROUPE D'EXPERTS INTERGOUVERNEMENTAL
SUR L'ÉVOLUTION DU CLIMAT

PNUE




# RAPPORT SPÉCIAL DU GIEC

## SCÉNARIOS D'ÉMISSIONS

# Our Equation for Land USE and PhytomassProduction and Conversion

**GHG Em. from Land Use& Phytomass =**

**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)]**

*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-compoents : for instance only for food

**GHG Em. from Land Use& Phytomass for Food = Pop*[LU for Food /Pop.]* [(Σ Phytomass Production and Conversion for Food) /LU for Food ] *[(GHG from Land Use and Food Production/ (Σ Phytomass Production and Conversion for Food)]**

# Combining the two,

## an considering also non $CO_2$ industrial GHG emissions

# => "Kaya – Riedacker" equation

GHG Emissions from Fossil Energy, from Land Use and Phytomass Production and Conversion and from non $CO_2$ 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 $CO_2$ GHG** *

# “Kaya – Riedacker” equation

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

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

**(Σ GHG from Fossil Energy / Σ of Fossil Energy)**

+ **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 GHG /capita] .

# The "Kaya – Riedacker" equation in more friendly words

GHG Emissions from Fossil Energy, from Land Use and Bioproduction and also from other non $CO_2$ 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 …

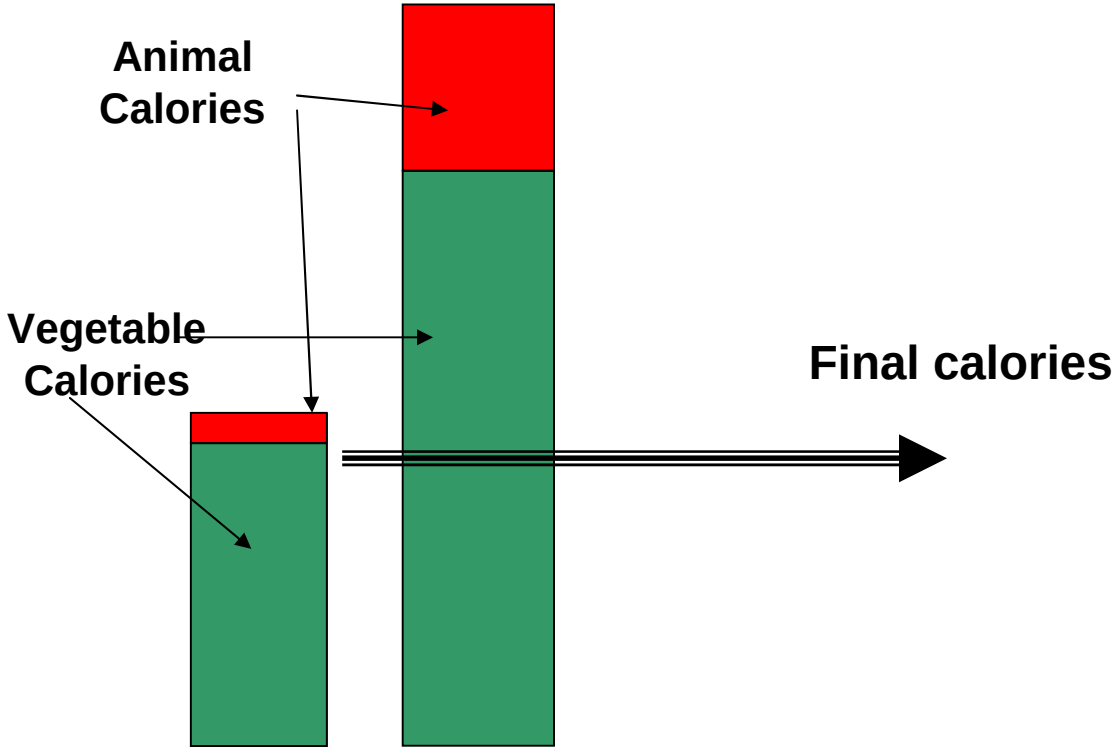
**FOOTPRINT PER CAPITA DEPENDS**
**ON THE DIET**
**AND**
**ON LAND USE EFFICIENCY** ( YIELD)

# DIET

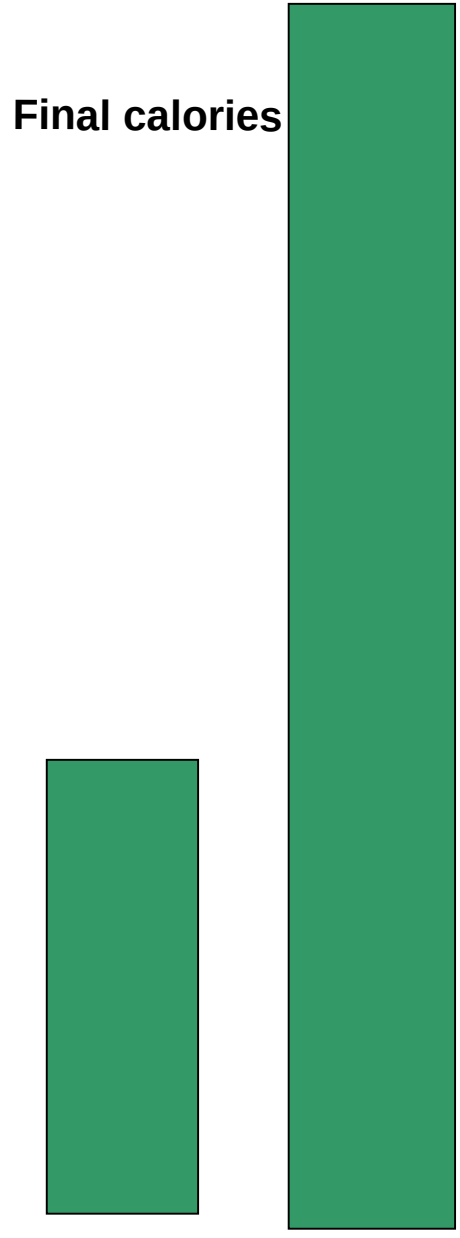
## Final calories = VC + 7 AC

7 Vegetable Calories =1 Animal Calorie

1 kg of cereal equivalent = 3500VC




Bengladesh - France



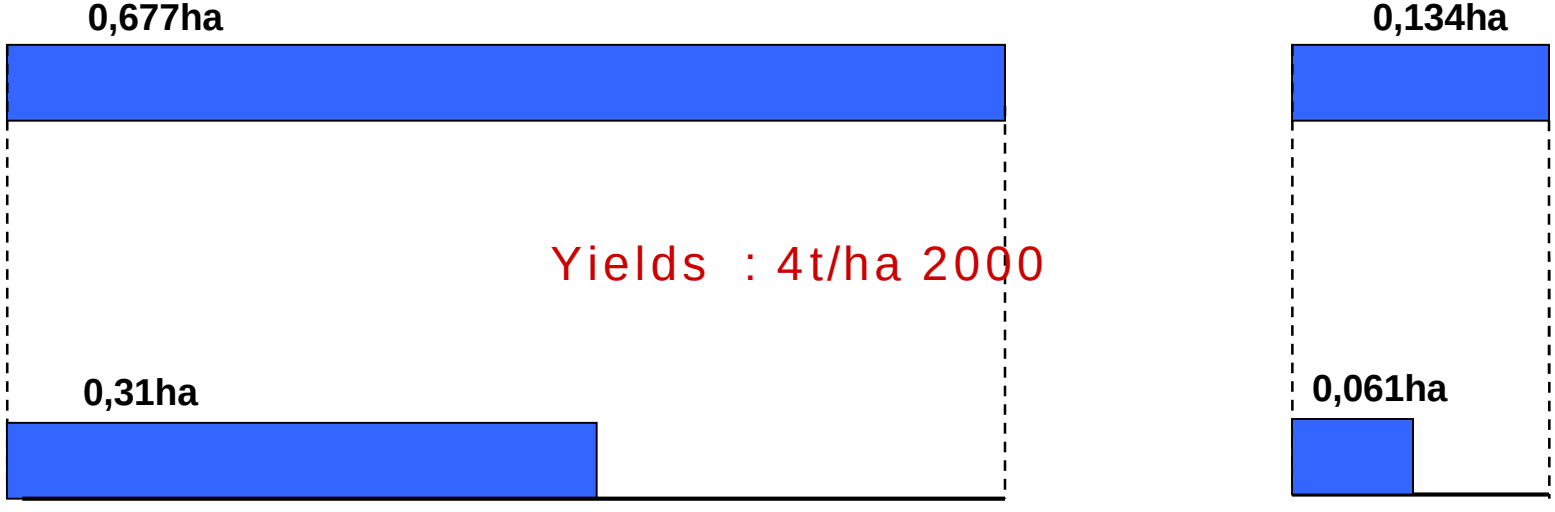

Bengladesh - France

# Comparison of France and Bangladesh with different yields

FRANCE

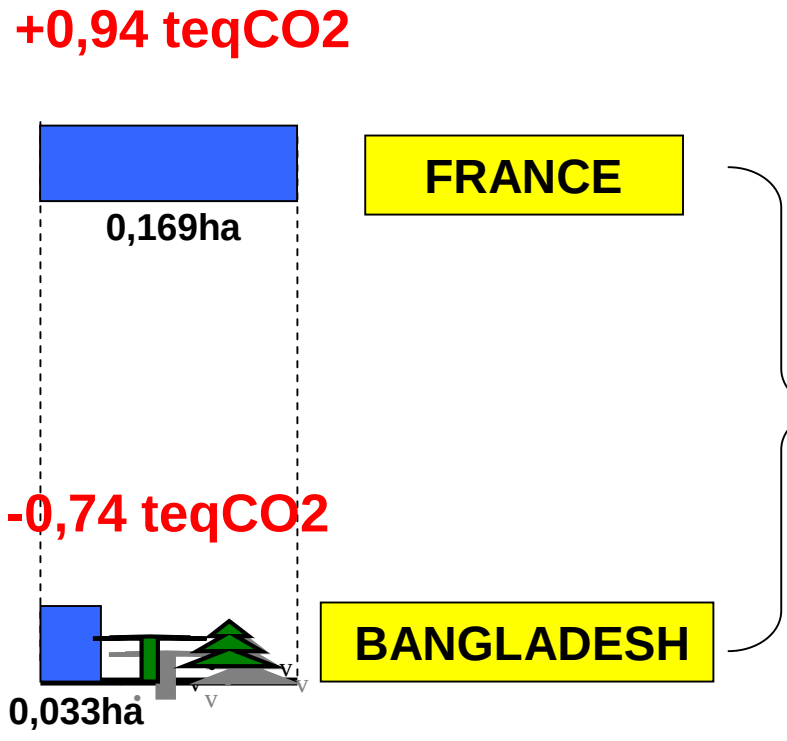
BANGLADESH

Yields : 1,83t/ha 1950



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

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




Différence

~ 2 teqCO2 per Capita

**-1,68 for ΔCUT t & - 0,28 for enteric fermentation**

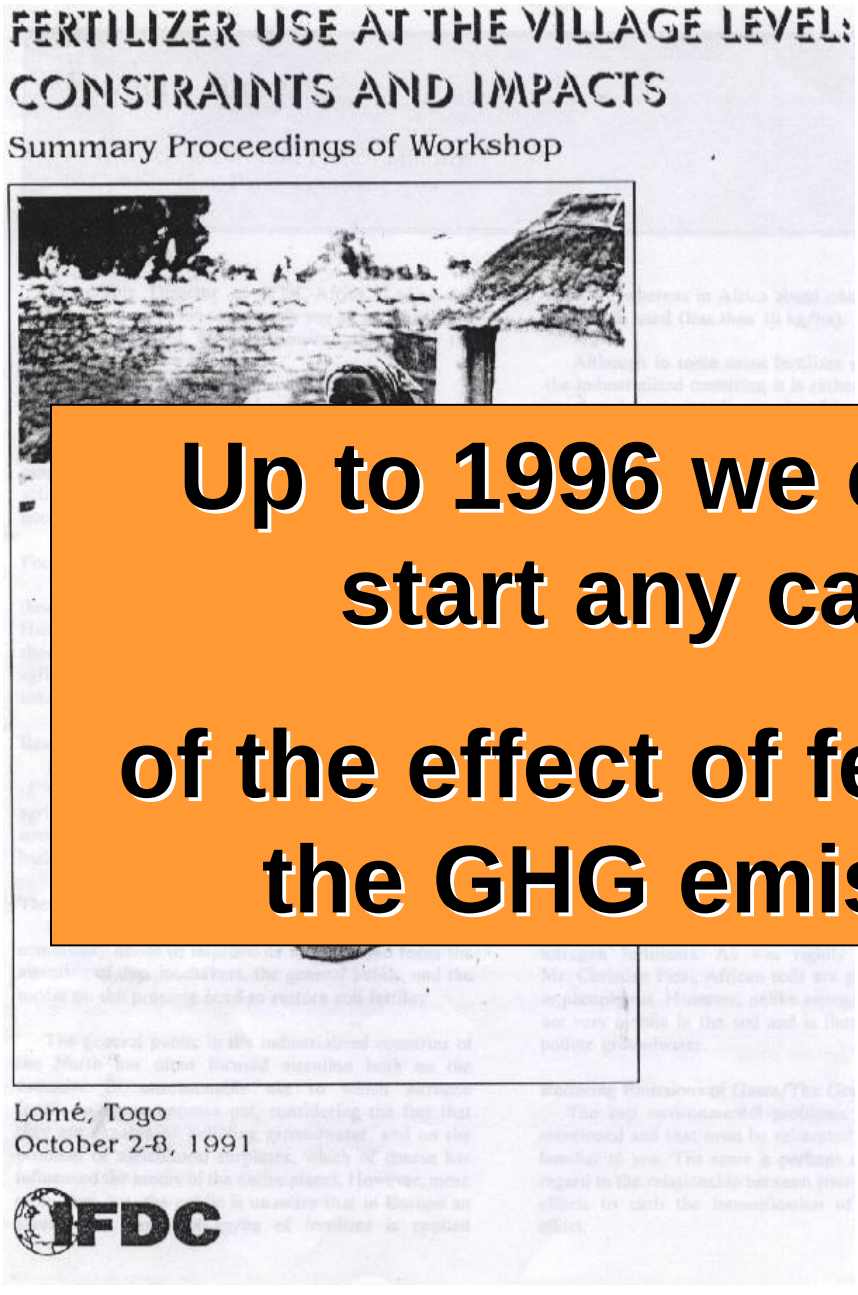
# For Phytomass

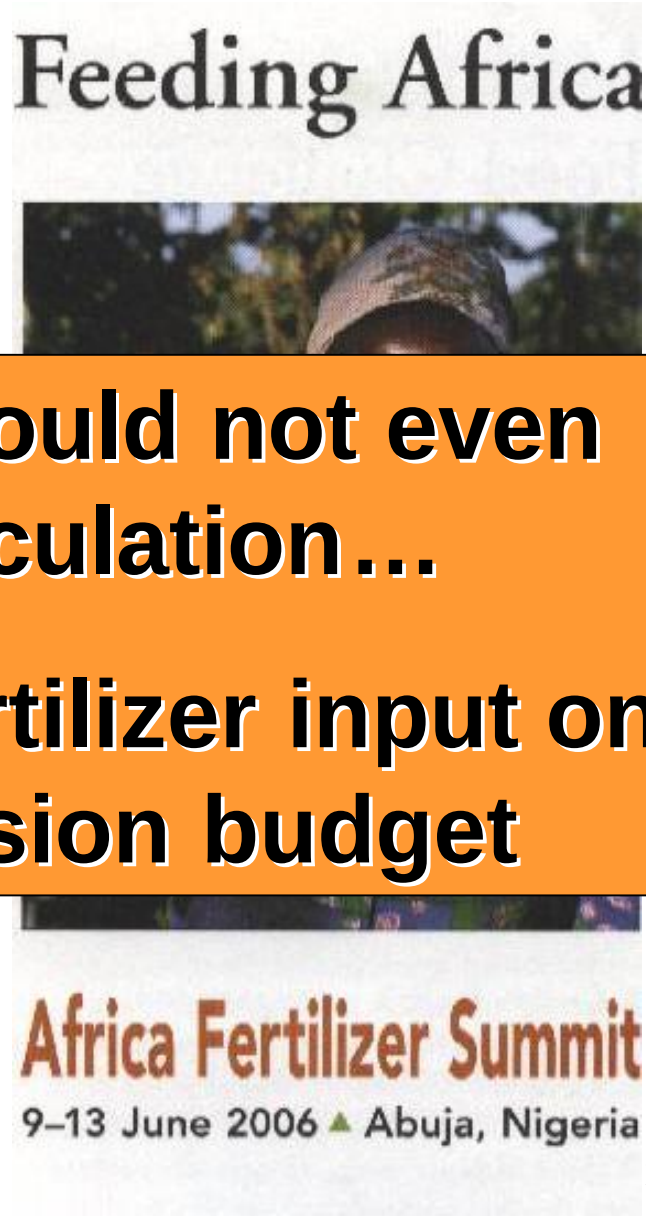
## (including food and non food production and use)

# it is a little more complicated than for fossil fuel

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

# IFDC 1991 and 2006

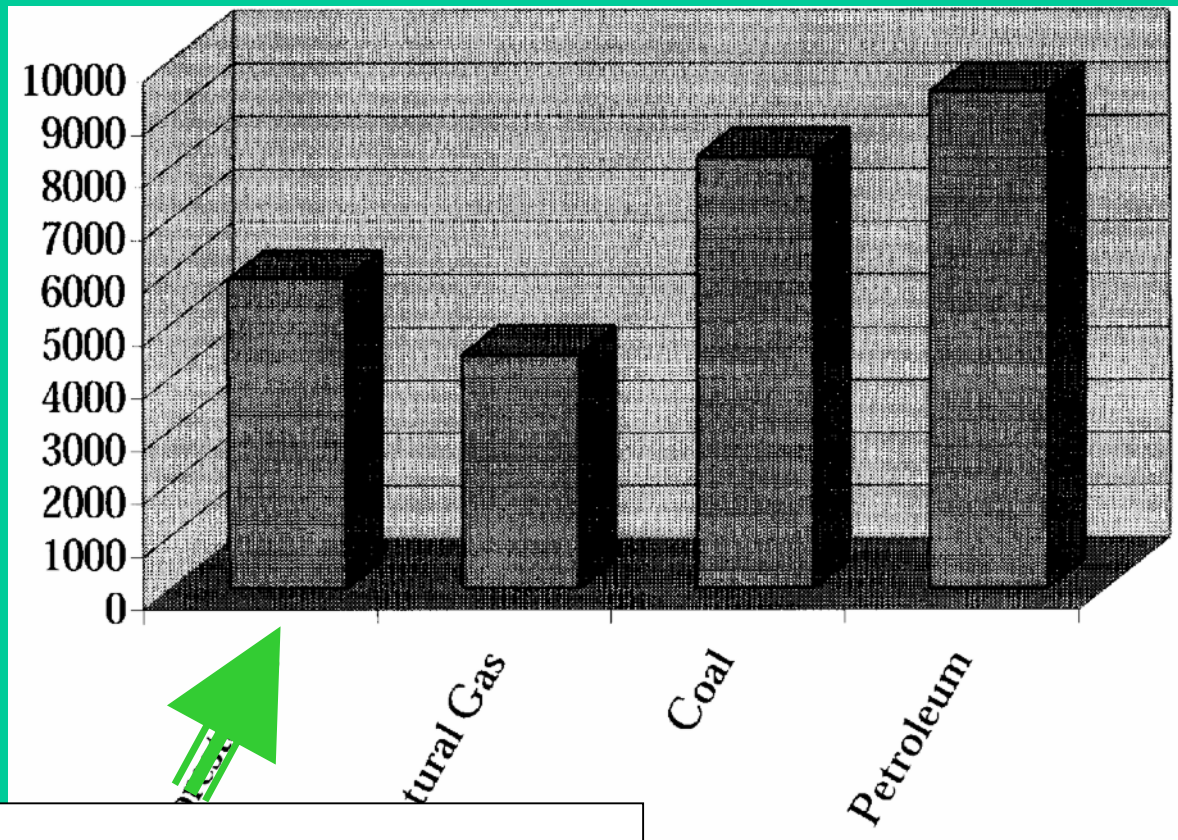



**Up to 1996 we could not even start any calculation…**

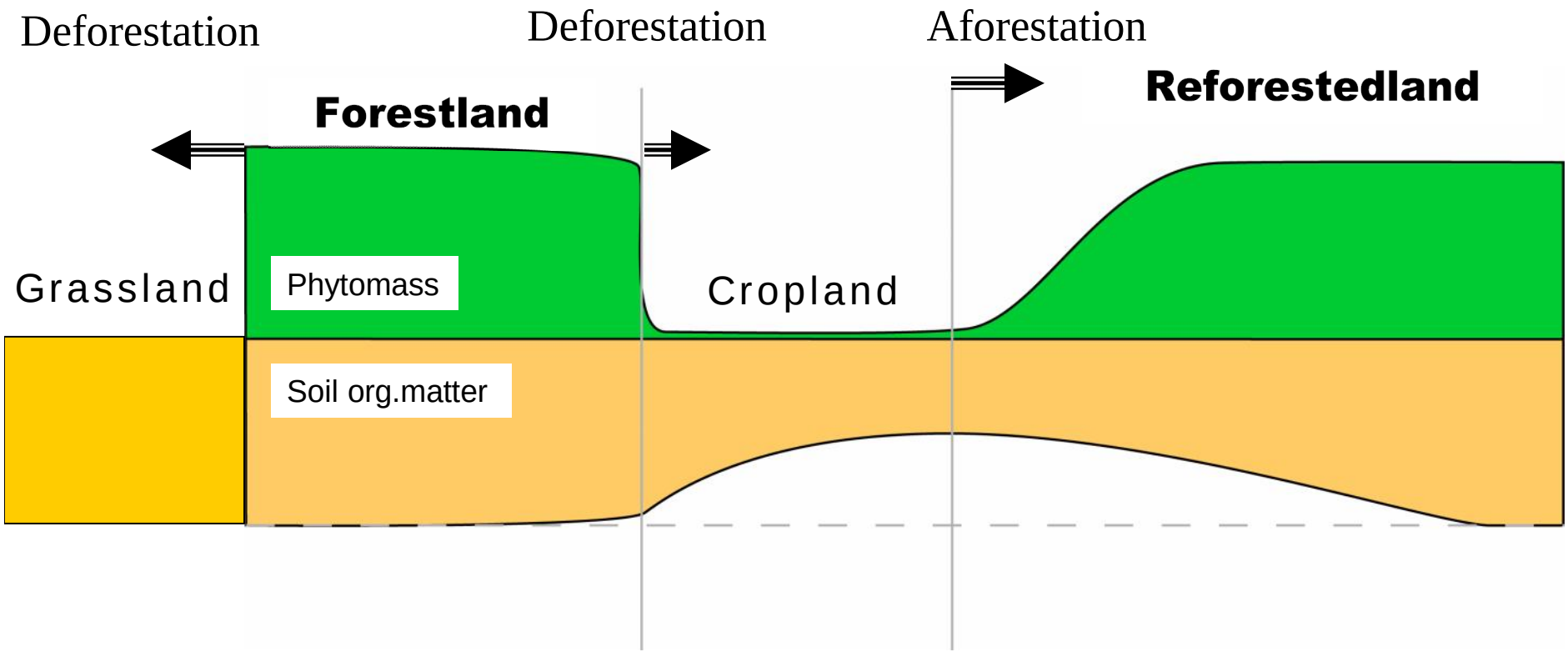
**of the effect of fertilizer input on the GHG emission budget**

# FOR CLIMATE CHANGE MITIGATION



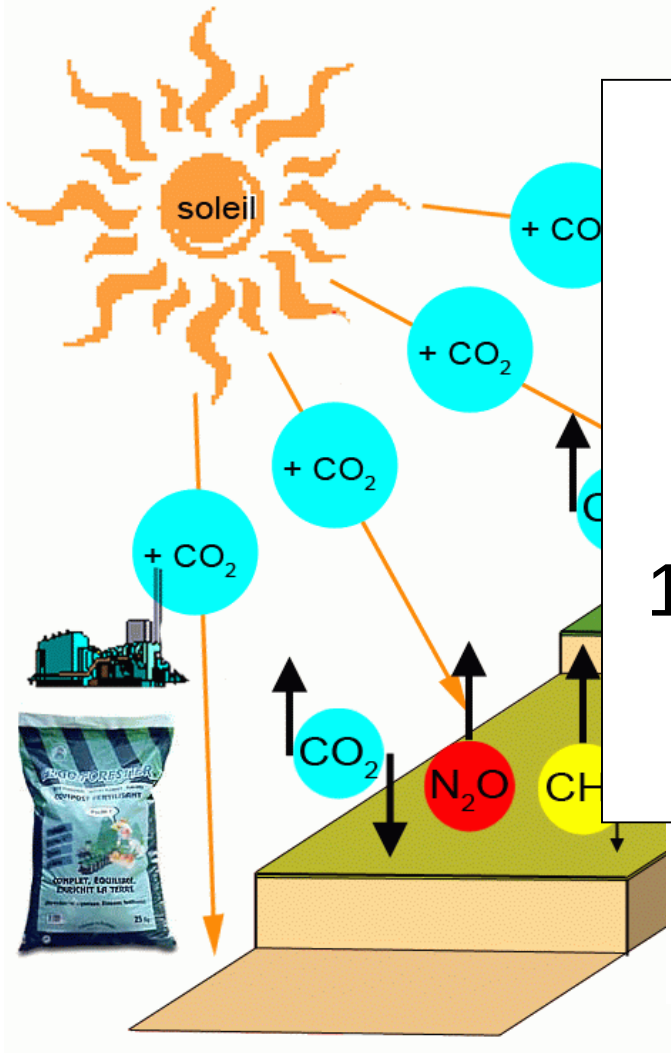

**Land Use and Land Use Change**

# Carbon stock change not only in soils but also in phytomass



# Land Use Change

# CO2 and non CO2 GHG



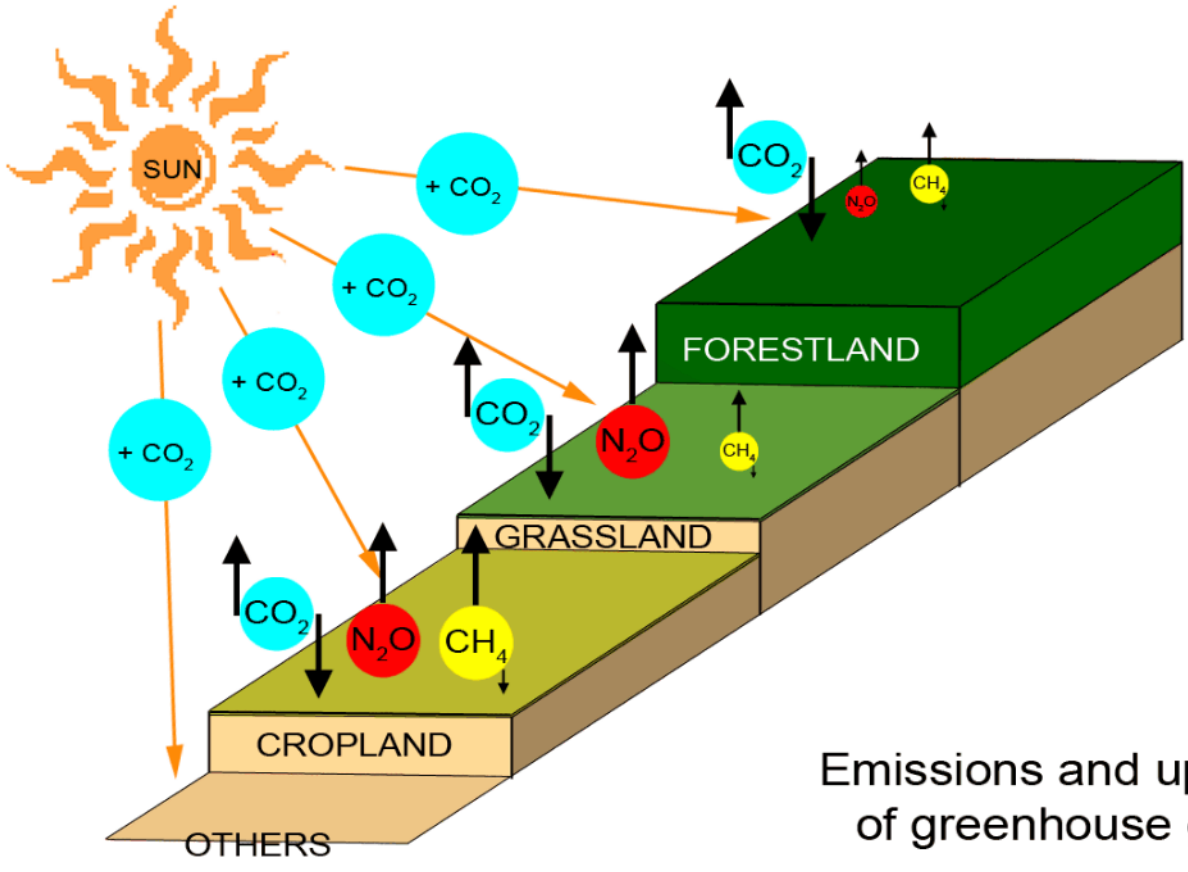

1 t of **$CH_4$= 23 teqCO2**

**But ~ 45 teqCO2**

**for 50 years**

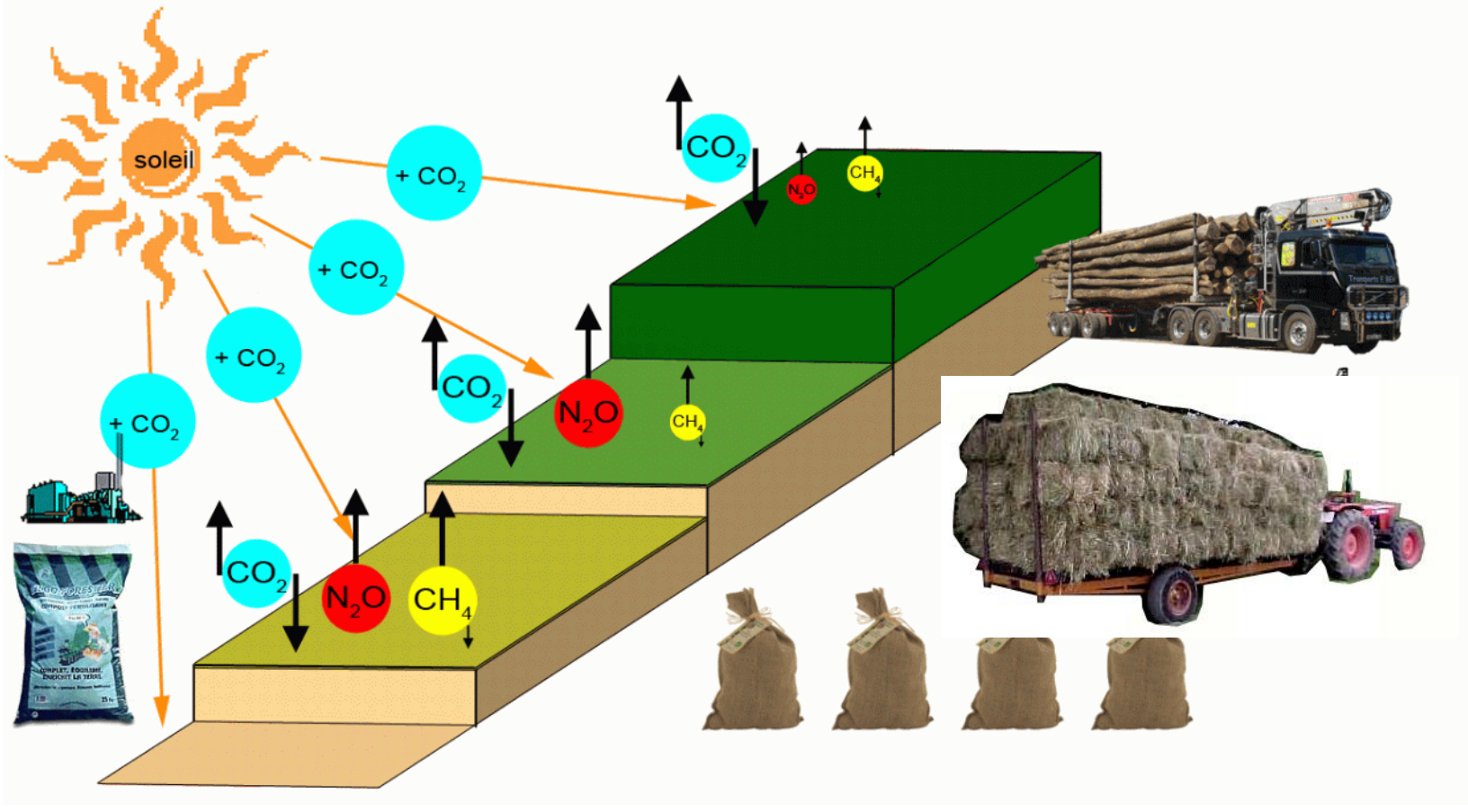
1 tonne of **$N_20$** = 296 t de $CO_2$

# Gross Emissions

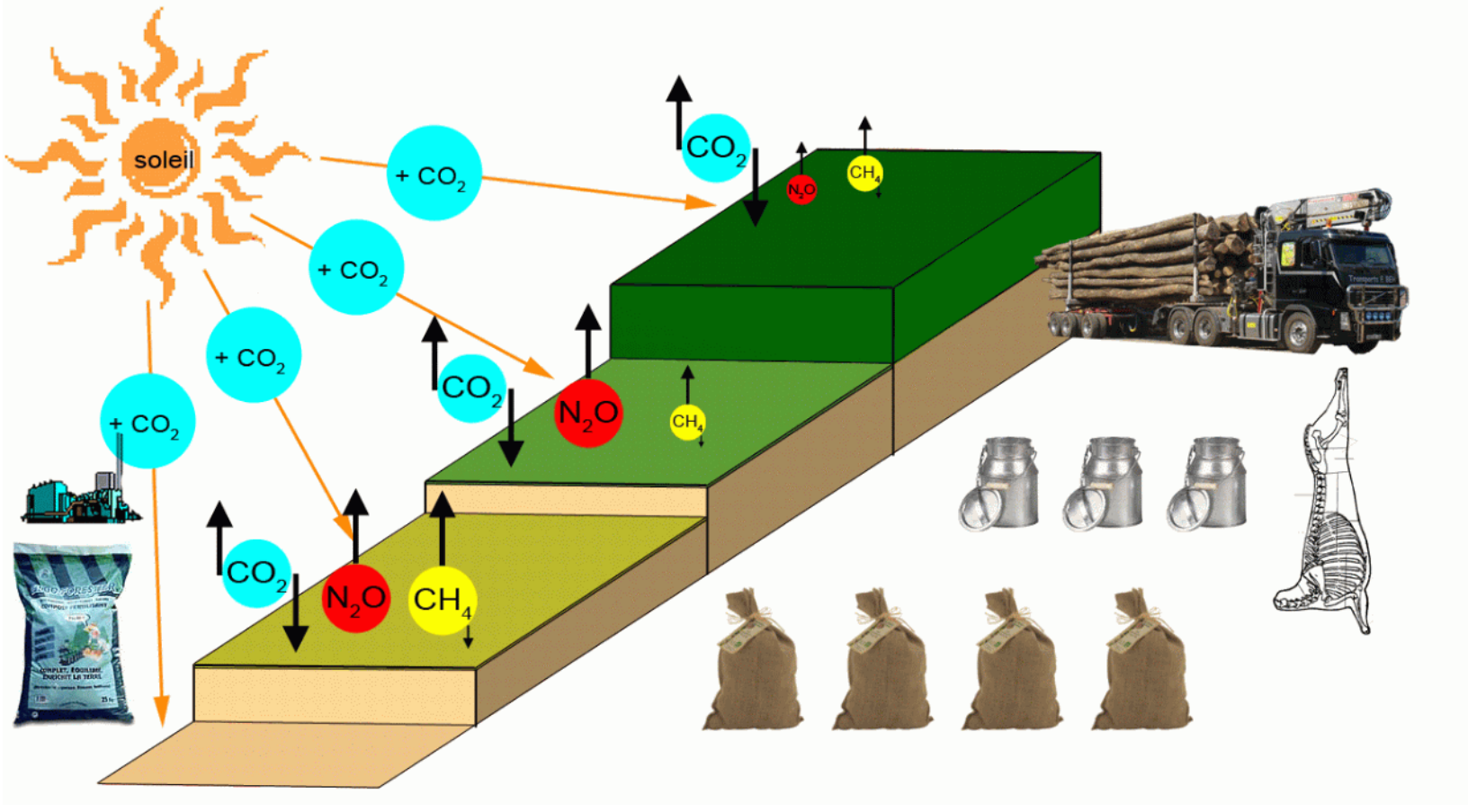



Emissions and uptake of greenhouse gas

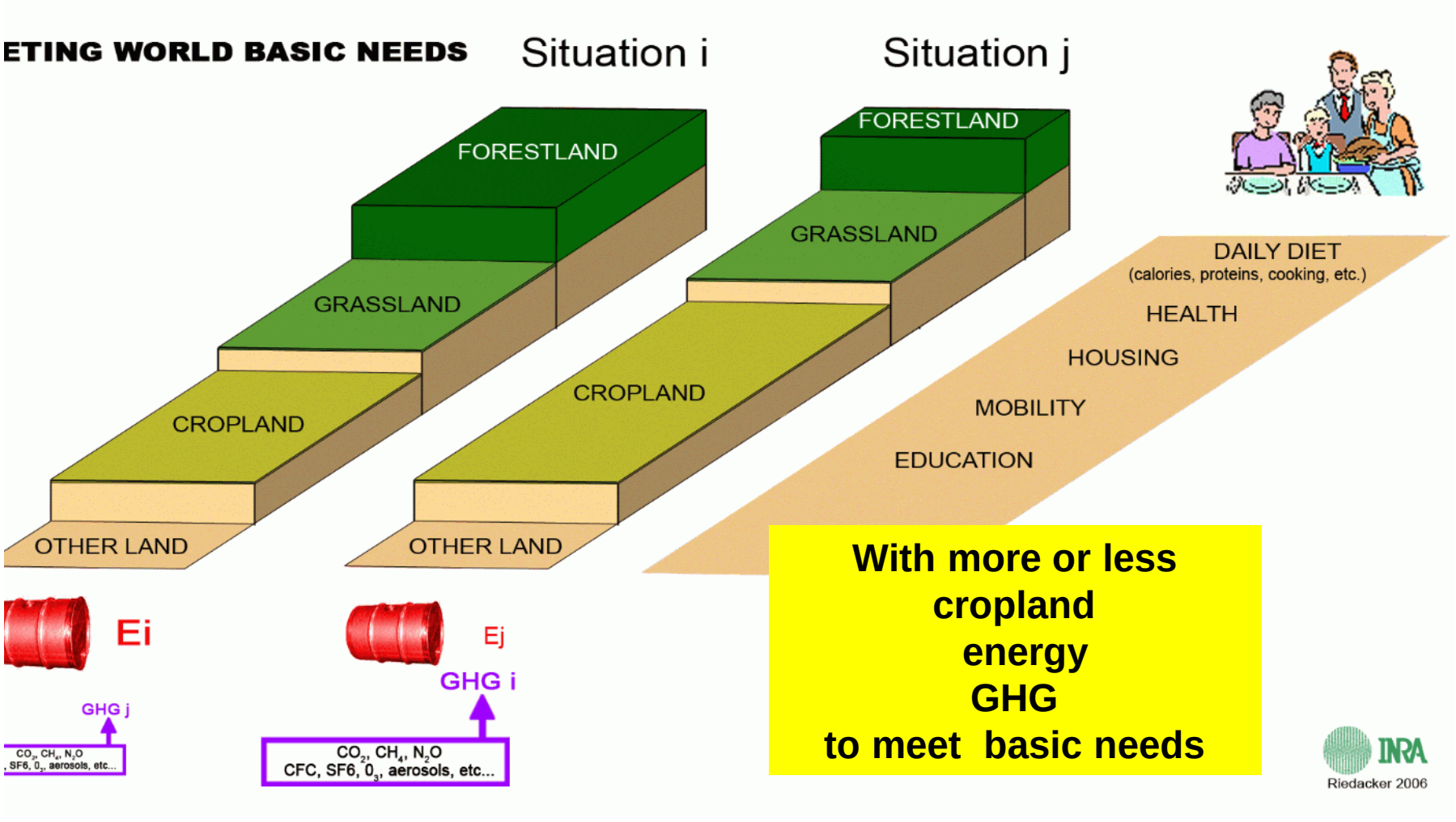
# Net emissions at stage I

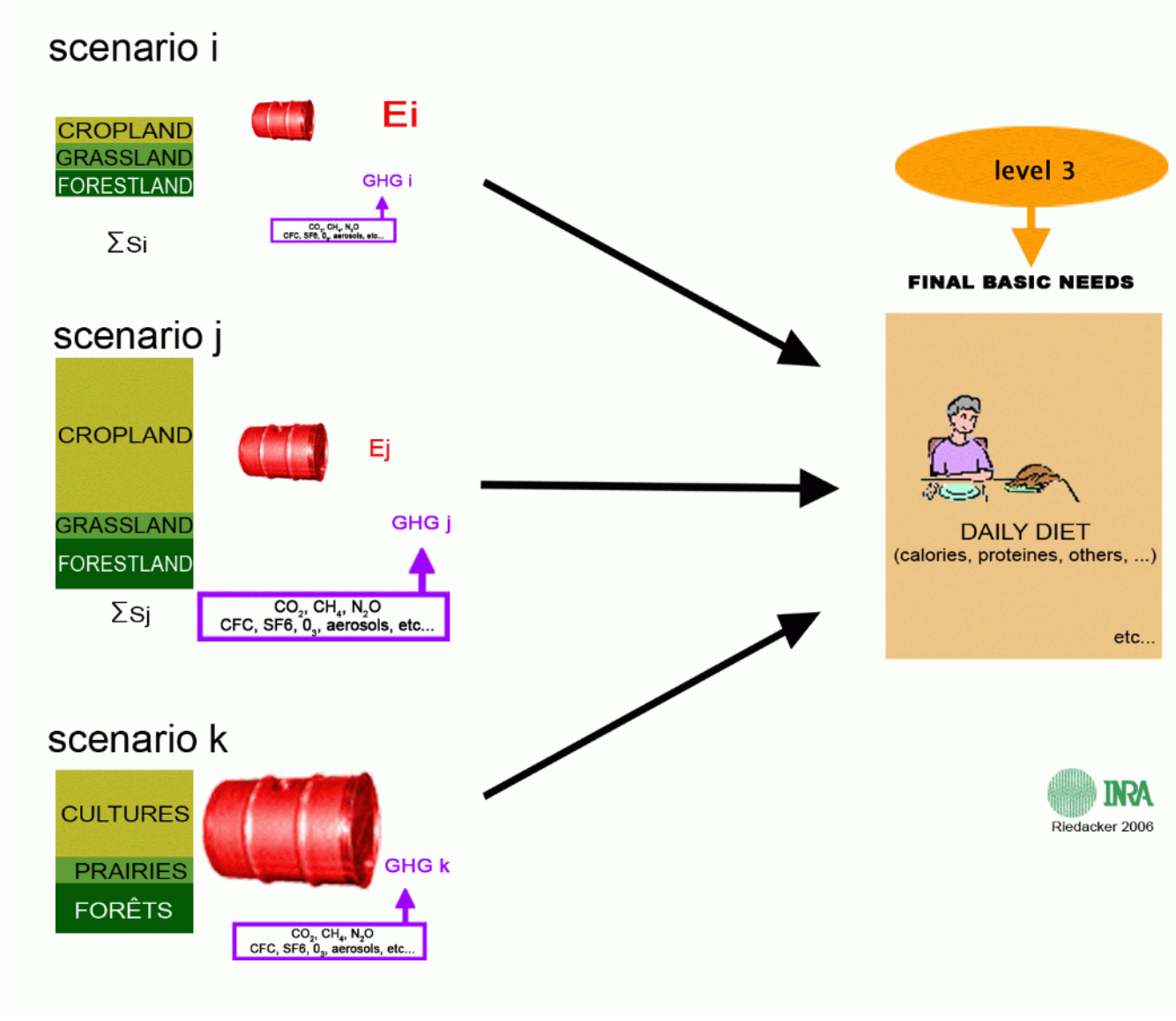


# Net emissions at stage II



# ⇒ We can only compare scenarios




scenario i
CROPLAND
GRASSLAND
FORESTLAND
ΣSi
Ei
GHG i
$CO_2$, $CH_4$, $N_2O$
CFC, SF6, $0_3$, aerosols, etc...
level 3
FINAL BASIC NEEDS
scenario j
CROPLAND
GRASSLAND
FORESTLAND
ΣSj
Ej
GHG j
$CO_2$, $CH_4$, $N_2O$
CFC, SF6, $0_3$, aerosols, etc...
DAILY DIET
(calories, proteines, others, ...)
etc...
scenario k
CULTURES
PRAIRIES
FORÊTS
GHG k
$CO_2$, $CH_4$, $N_2O$
CFC, SF6, $0_3$, aerosols, etc...
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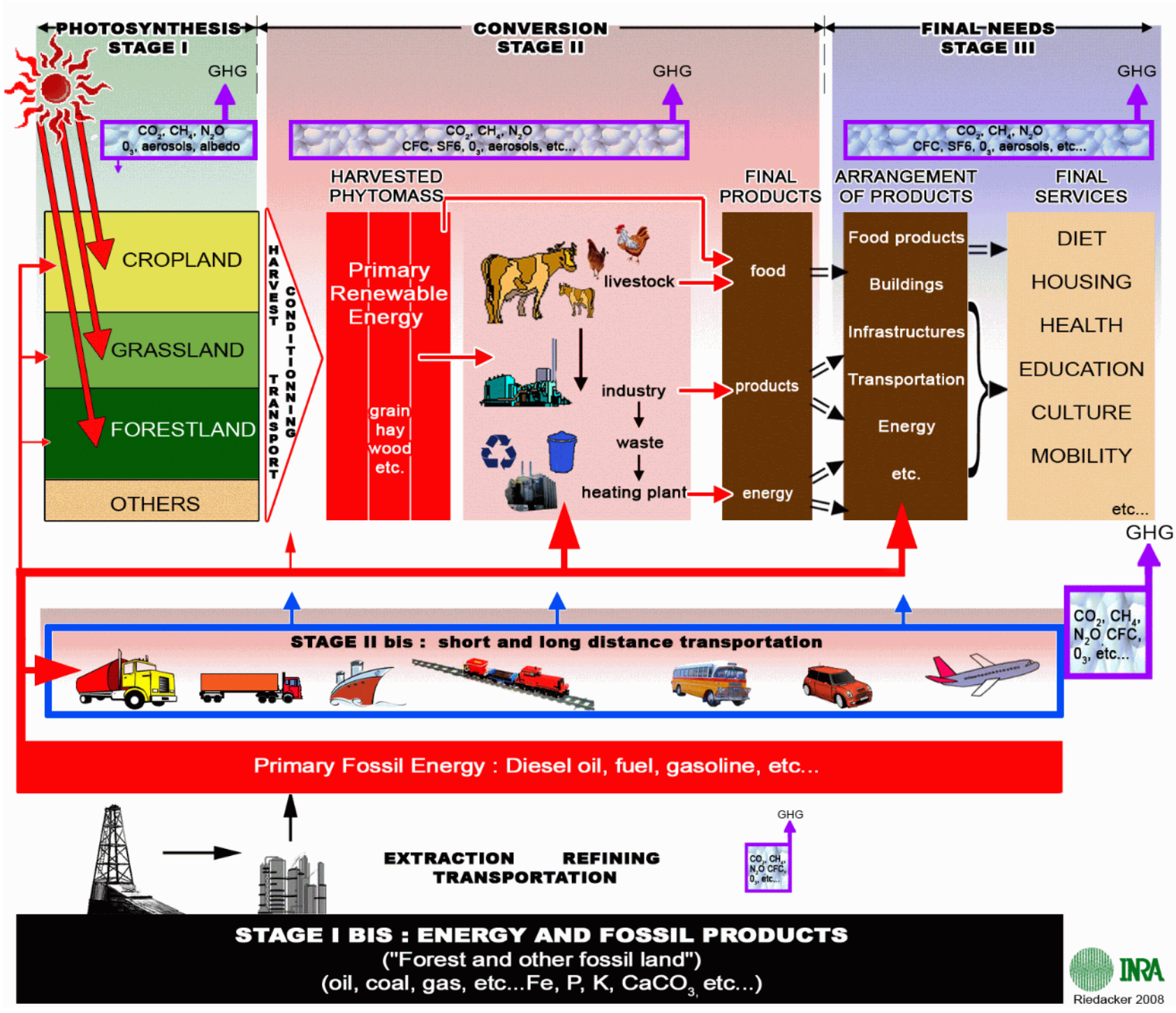
Riedacker 2006


PHOTOSYNTHESIS
STAGE I
CONVERSION
STAGE II
FINAL NEEDS
STAGE III
GHG
$CO_2$, $CH_4$, $N_2O$
$O_3$, aerosols, albedo
$CO_2$, $CH_4$, $N_2O$
CFC, SF6, $O_3$, aerosols, etc...
HARVESTED PHYTOMASS
FINAL PRODUCTS
ARRANGEMENT OF PRODUCTS
FINAL SERVICES
CROPLAND
GRASSLAND
FORESTLAND
OTHERS
HARVEST TRANSPORT CONDITIONNING
Primary Renewable Energy
grain
hay
wood
etc.
livestock
industry
waste
heating plant
food
products
energy
Food products
Buildings
Infrastructures
Transportation
Energy
etc.
DIET
HOUSING
HEALTH
EDUCATION
CULTURE
MOBILITY
etc...
STAGE II bis : short and long distance transportation
Primary Fossil Energy : Diesel oil, fuel, gasoline, etc...
EXTRACTION REFINING
TRANSPORTATION
STAGE I BIS : ENERGY AND FOSSIL PRODUCTS
("Forest and other fossil land")
(oil, coal, gas, etc...Fe, P, K, $CaCO_3$, etc...)
INRA
Riedacker 2008

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

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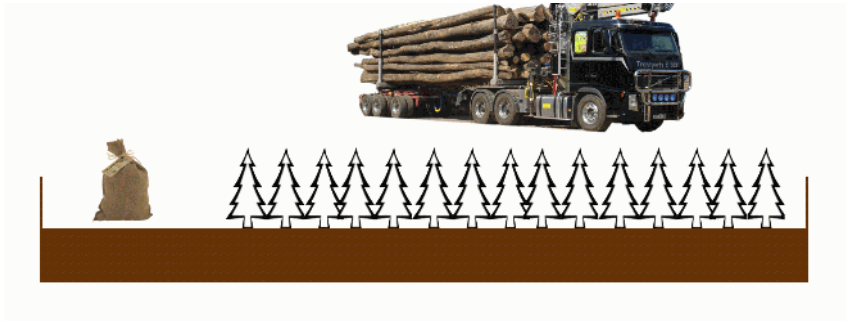
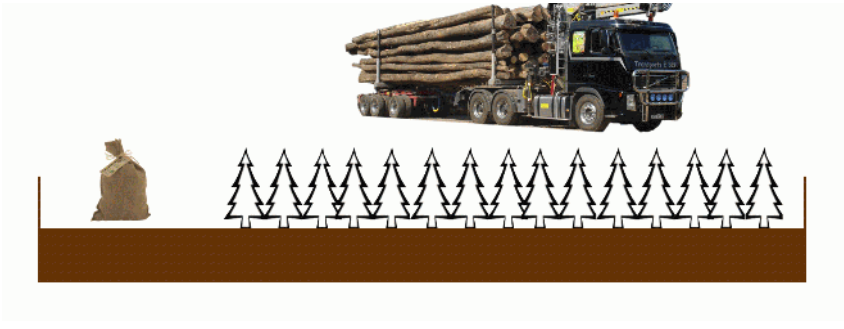
See also Global Land Use and Biomass Approch to Reduce GHG Emissions, Fossil Fuel Use and to Preserve Biodiversity. Triest e 2006
Down load from www.bepress.com/feem/paper12 12

# To feed more people => Double crop production

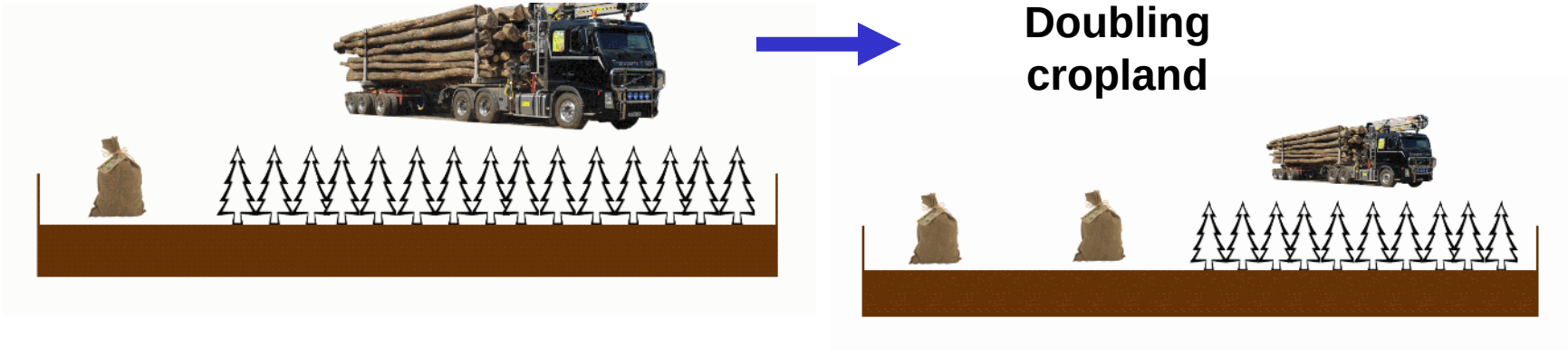


# doubling land cultivated ?

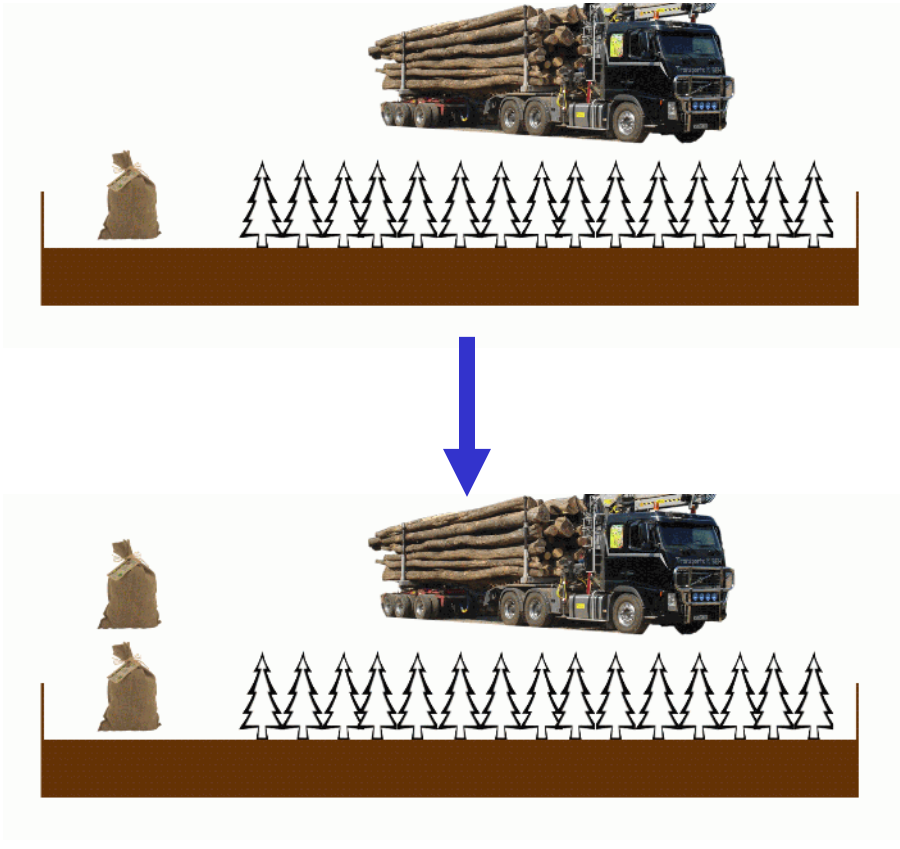
# doubling yields?



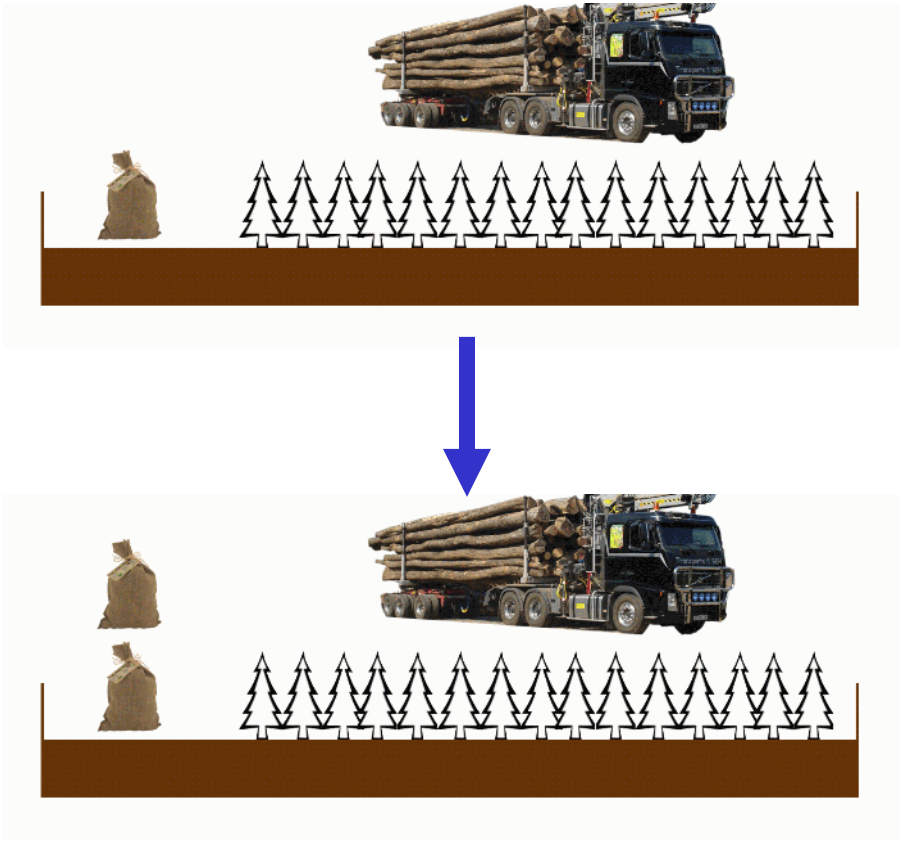
# Doubling cropland



# Doubling Yields?



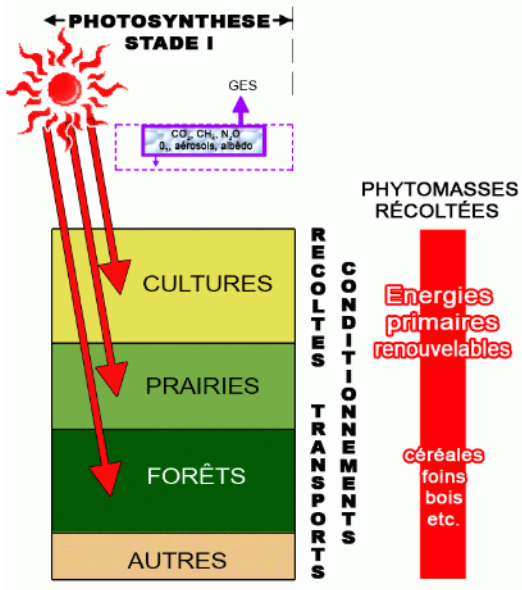
# Doubling Yields?



**By increasing inputs**

**and /or**

**by choosing more productive plants (per ha )**




Pre- Industrial Land Use System
without any fossil energy input

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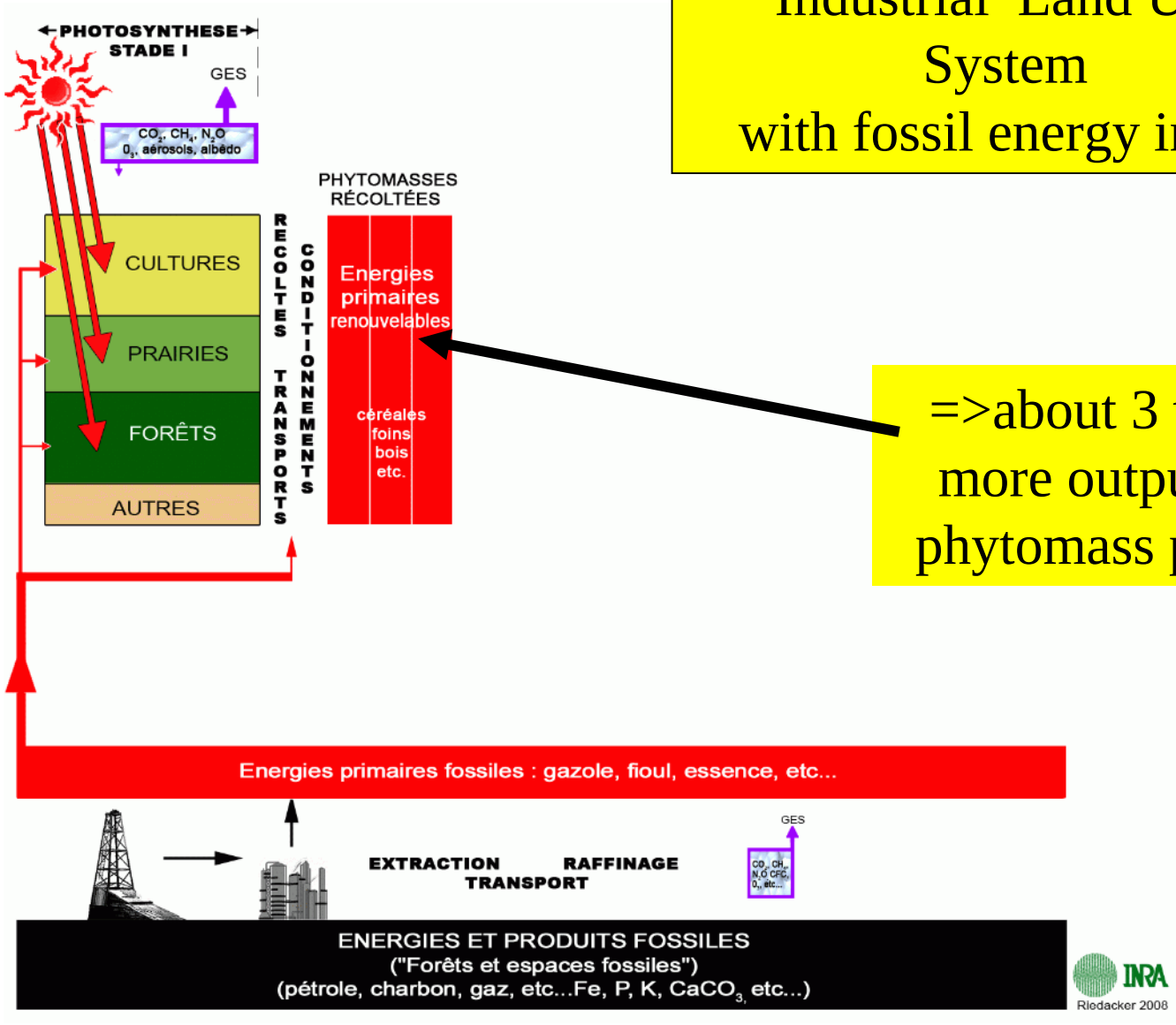
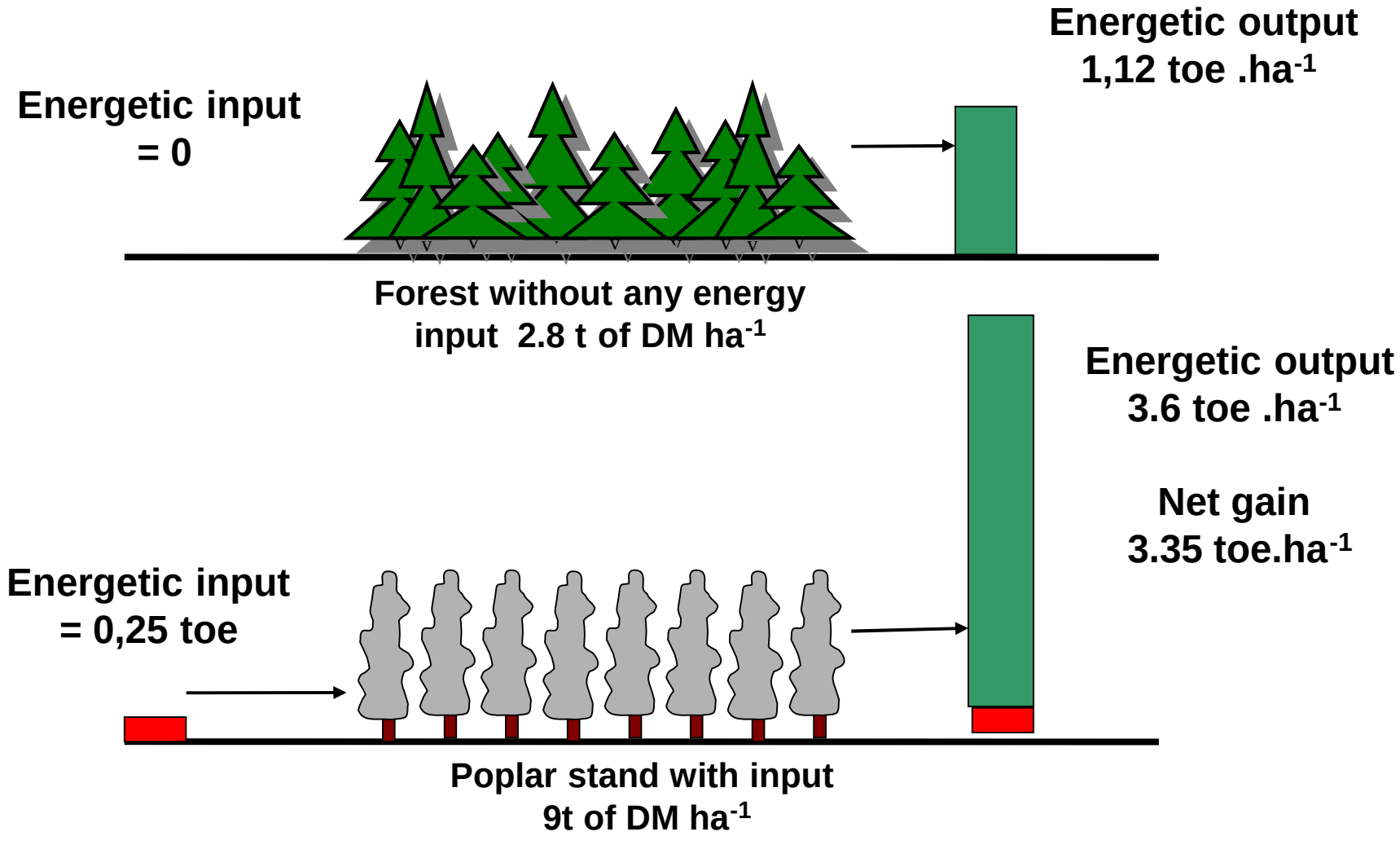
Riedacker 2008

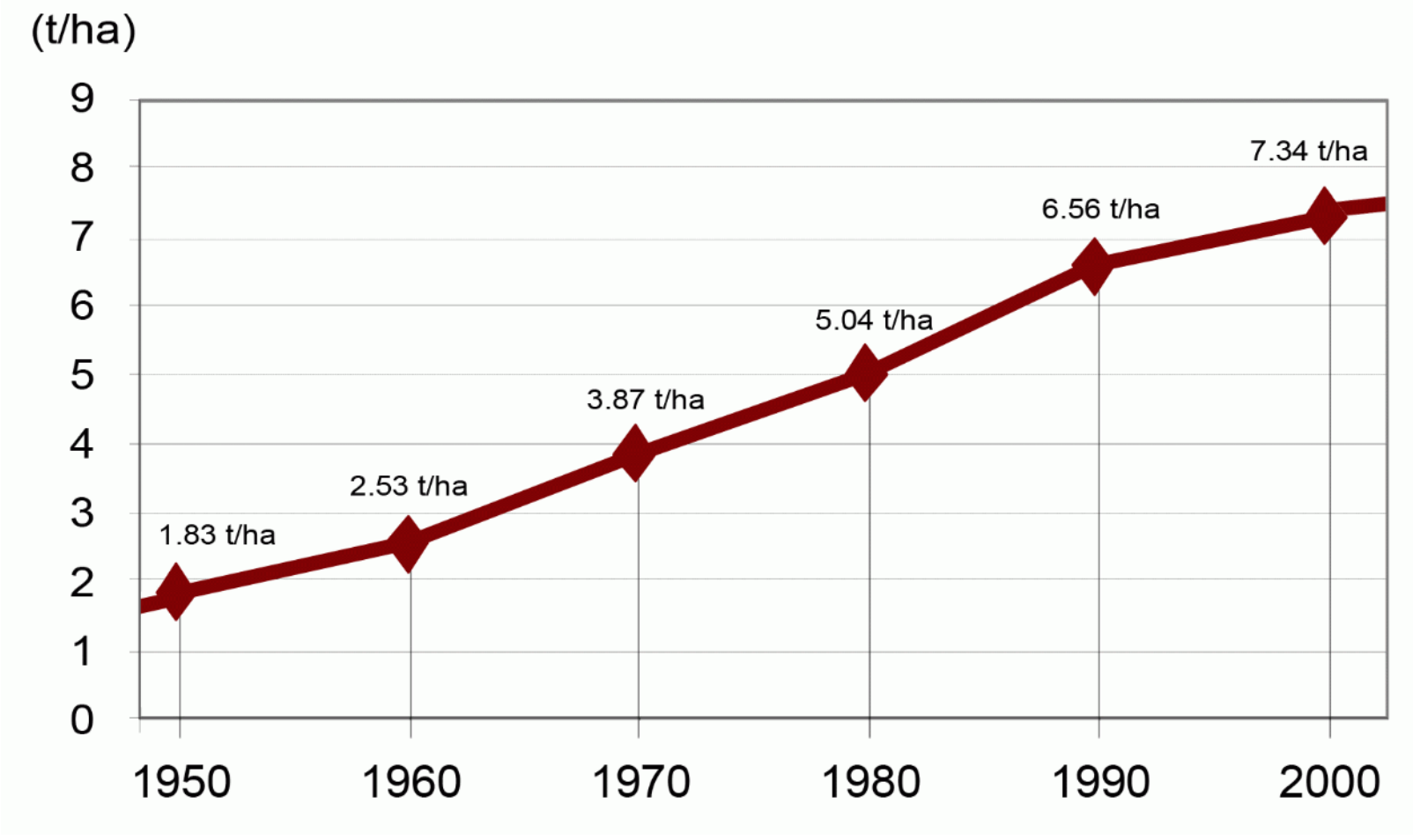
# Industrial Land Use System with fossil energy input




=>about 3 times more output of phytomass per ha


Energetic output
1,12 toe .ha-1
Energetic input
= 0
Forest without any energy
input 2.8 t of DM ha-1
Energetic output
3.6 toe .ha-1
Net gain
3.35 toe.ha-1
Energetic input
= 0,25 toe
Poplar stand with input
9t of DM ha-1

# Between 1950 and 2000 wheat yields have been X4 in France



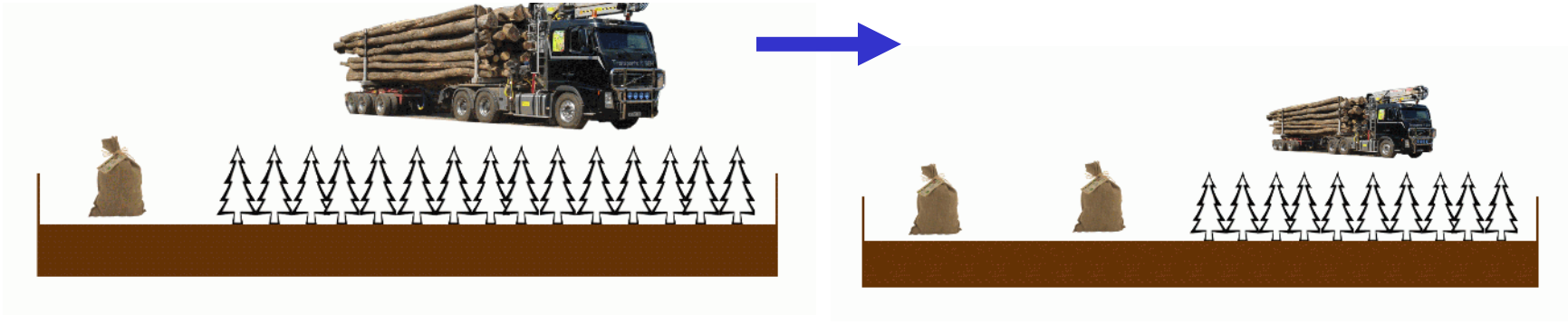
# Change in Energy Budget

| | 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 |

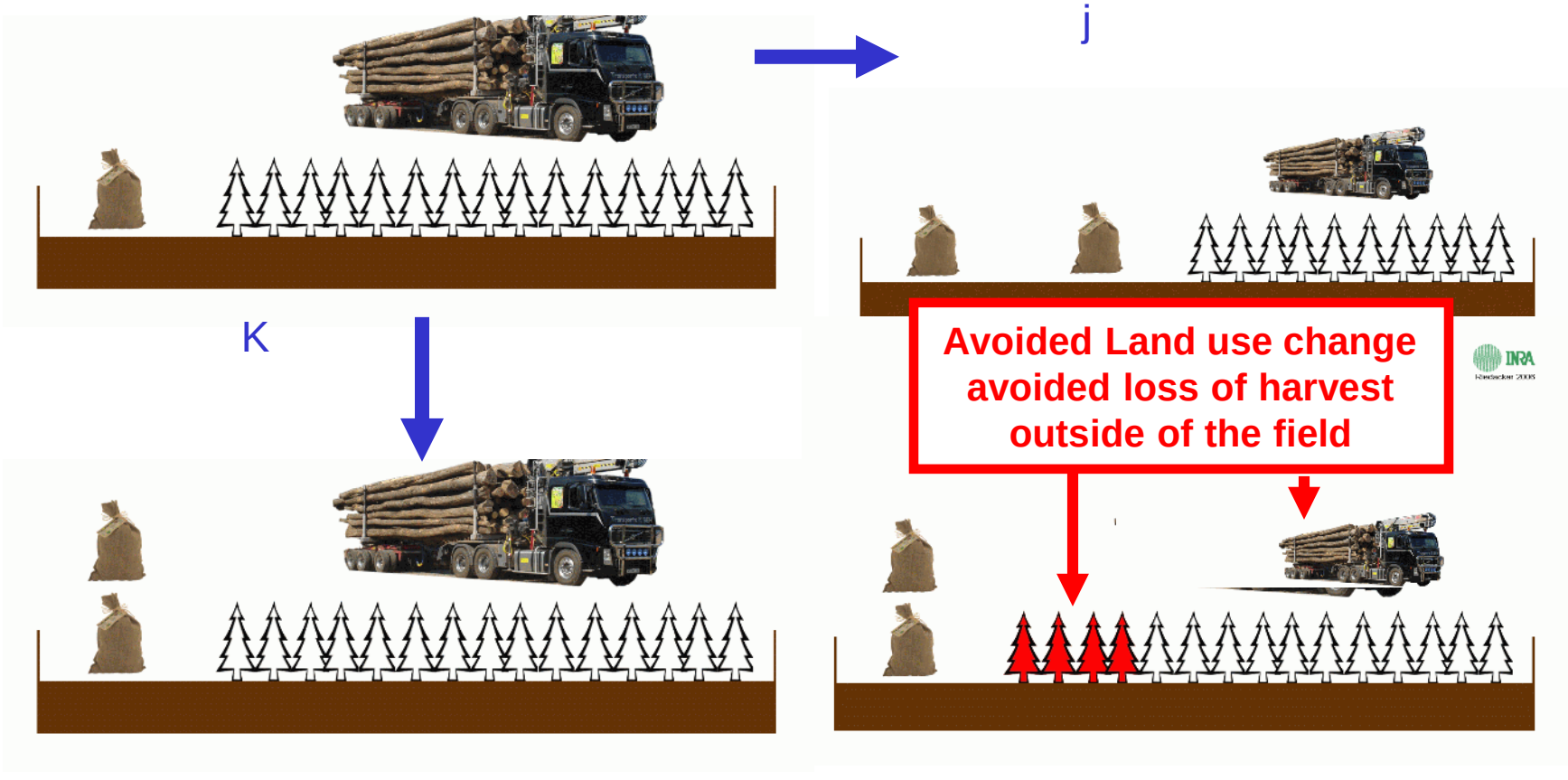
# Change in GHG Budget is also positive

| Average GHG budget tCO2eq | | | |
|---|---|---|---|
| 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

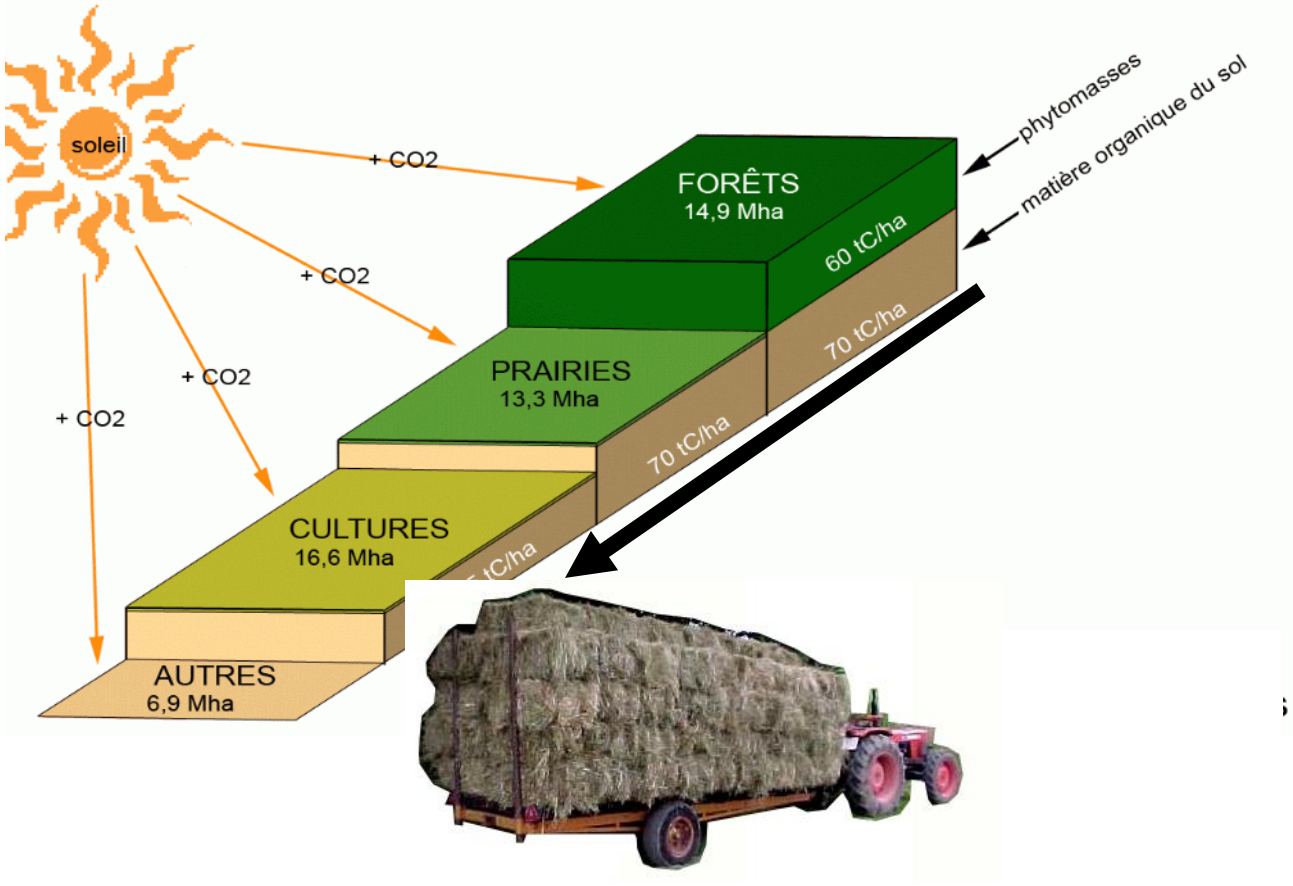


# Differences between the two scenarios



# LAND USE CHANGE

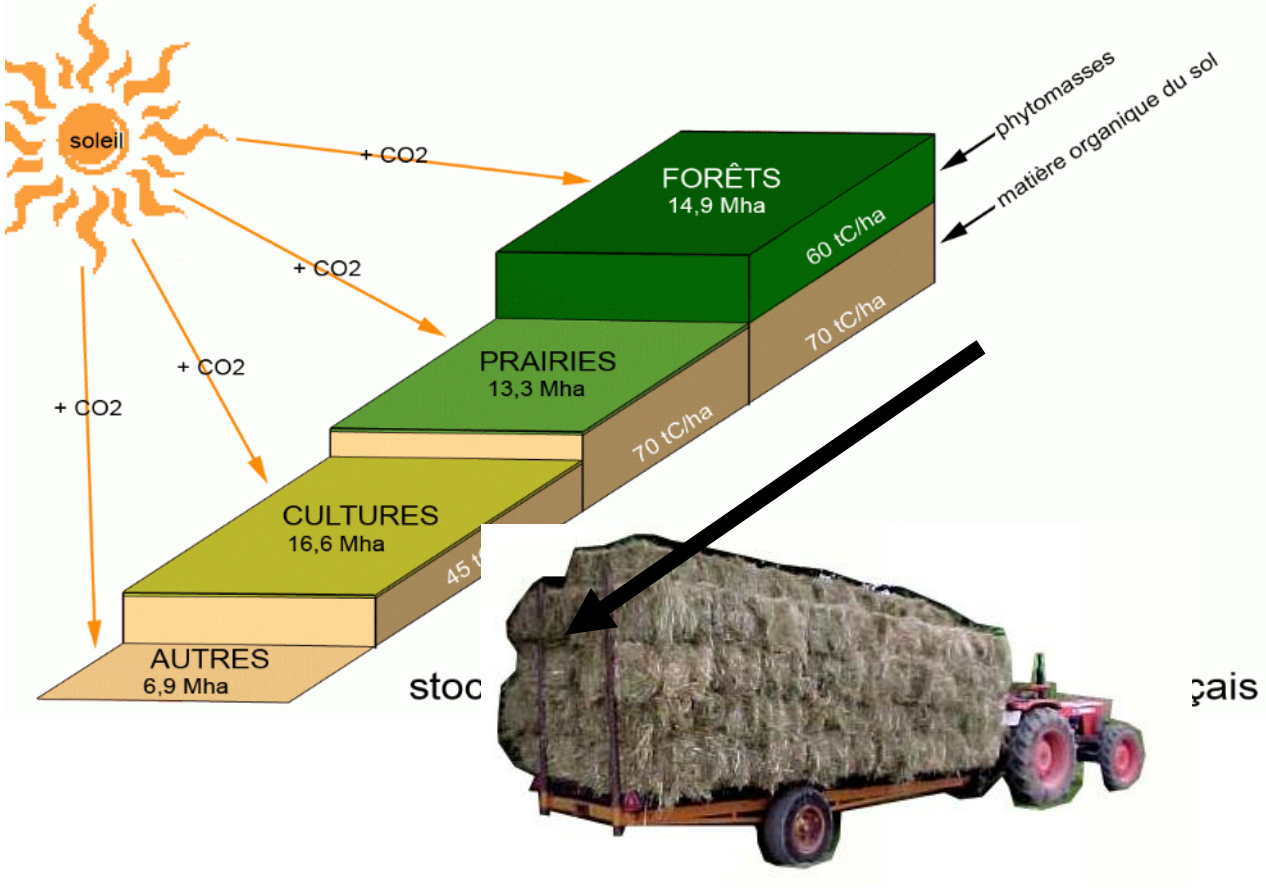
# Forest ~312 t CO2 per ha




**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

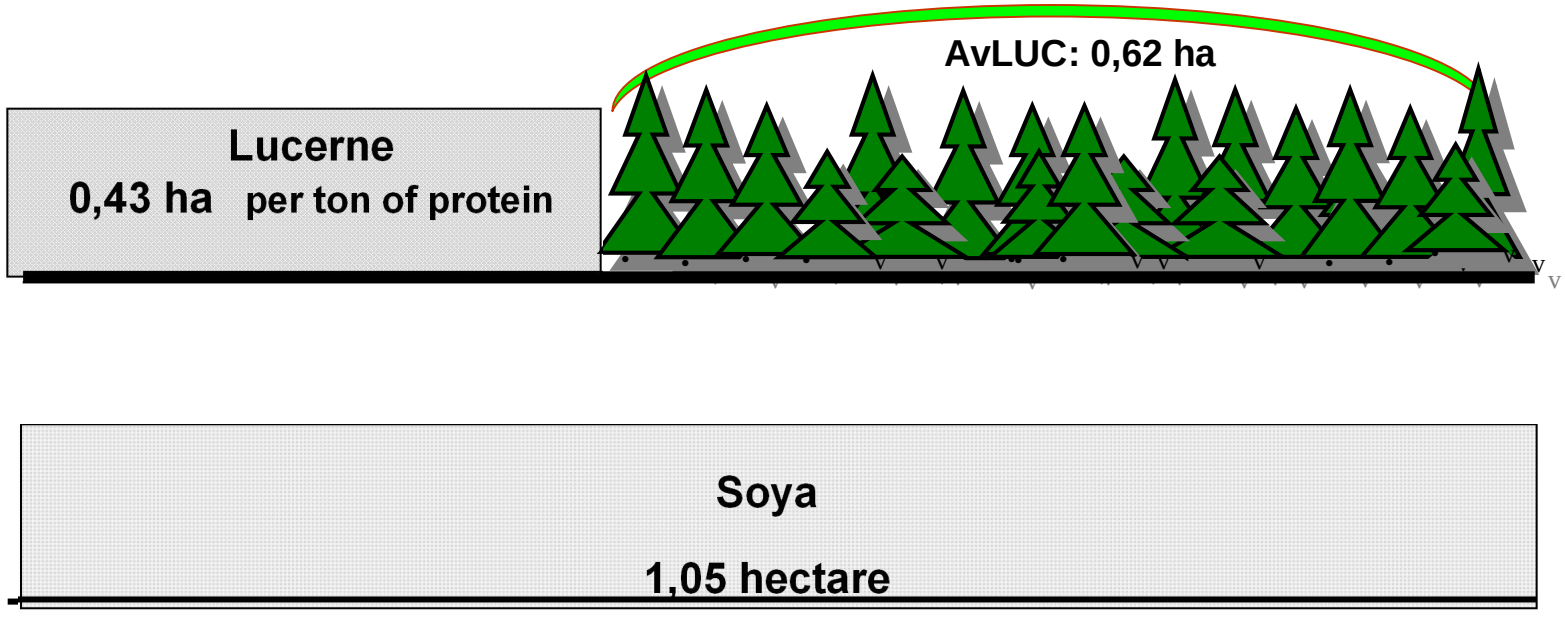



**Gross Émissions**

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

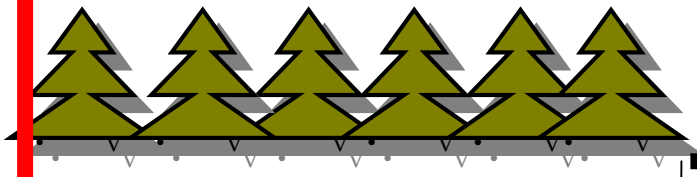



# Land required to produce 1 t of protein

**Carbon stock decrease 312 teqCO2 /ha**

**Harvest of Primary Energy**

**Scenario Preserved Forest t**



**REP forêt**

**Preserved carbon stock**

**Scenario i with crop A**

Lucerne

**SBpA**

**1t protein**

**On avoided LUC**

**Scenario j with crop B**

**CUTj-i**

Sova

**SBpB**

**1t protein**

**REP forêt =0**

**Co-produit**

# Which conclusions for Food Security and Climate change mitigation ?

# Between 1950 and 2000 due to increase in cereal yields

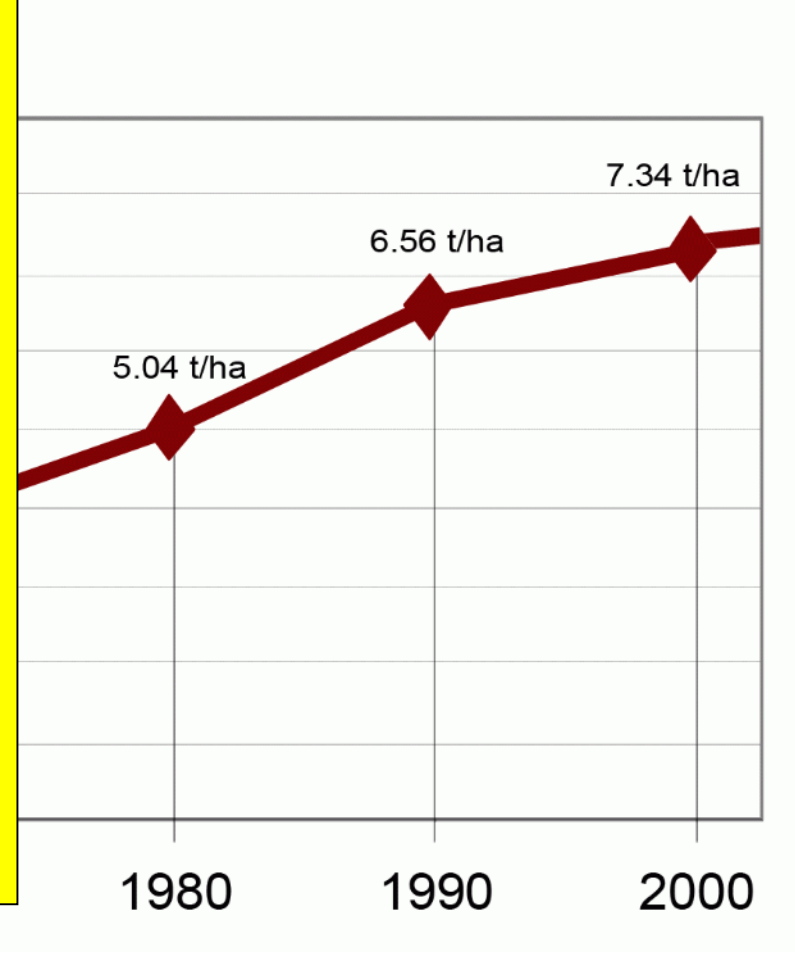
**we saved in France**

- **27 Mha**

**and in spite of**

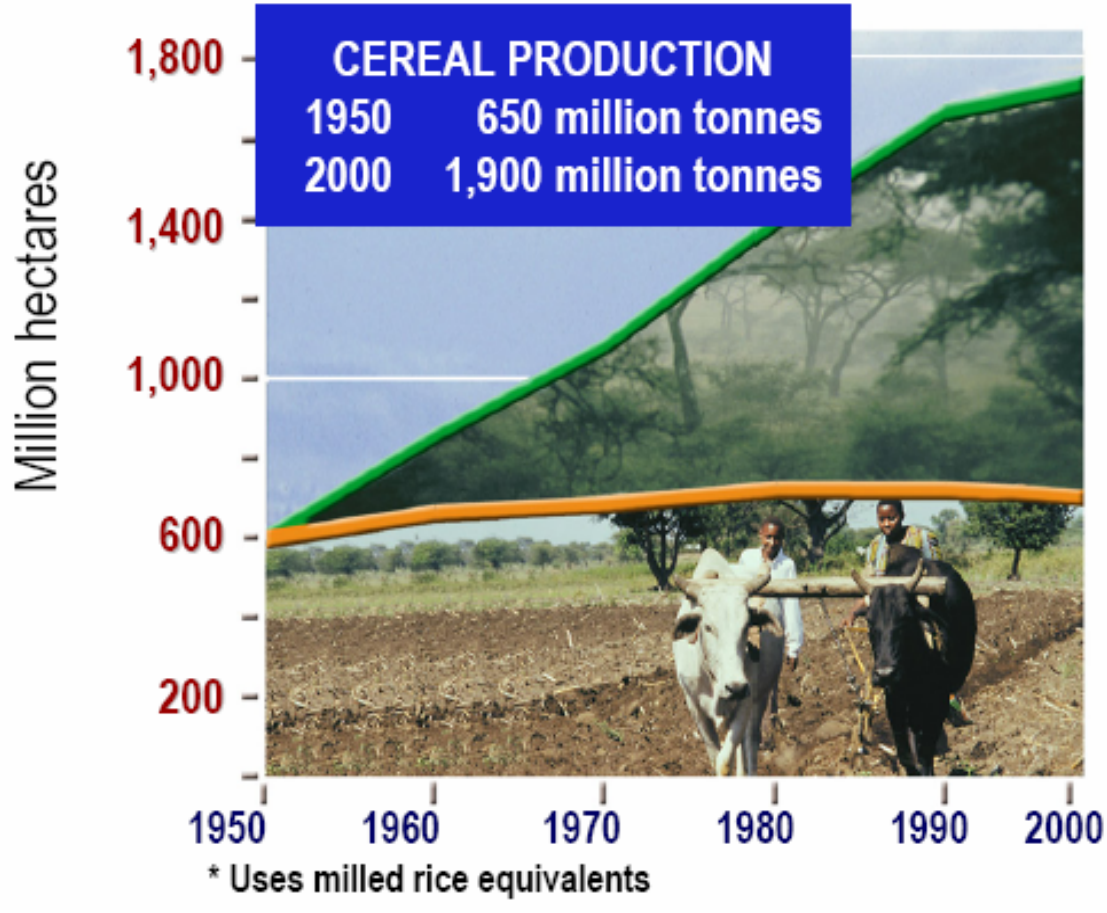
**increased inputs**

- **60 millions tCO2 equivalent per year**



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

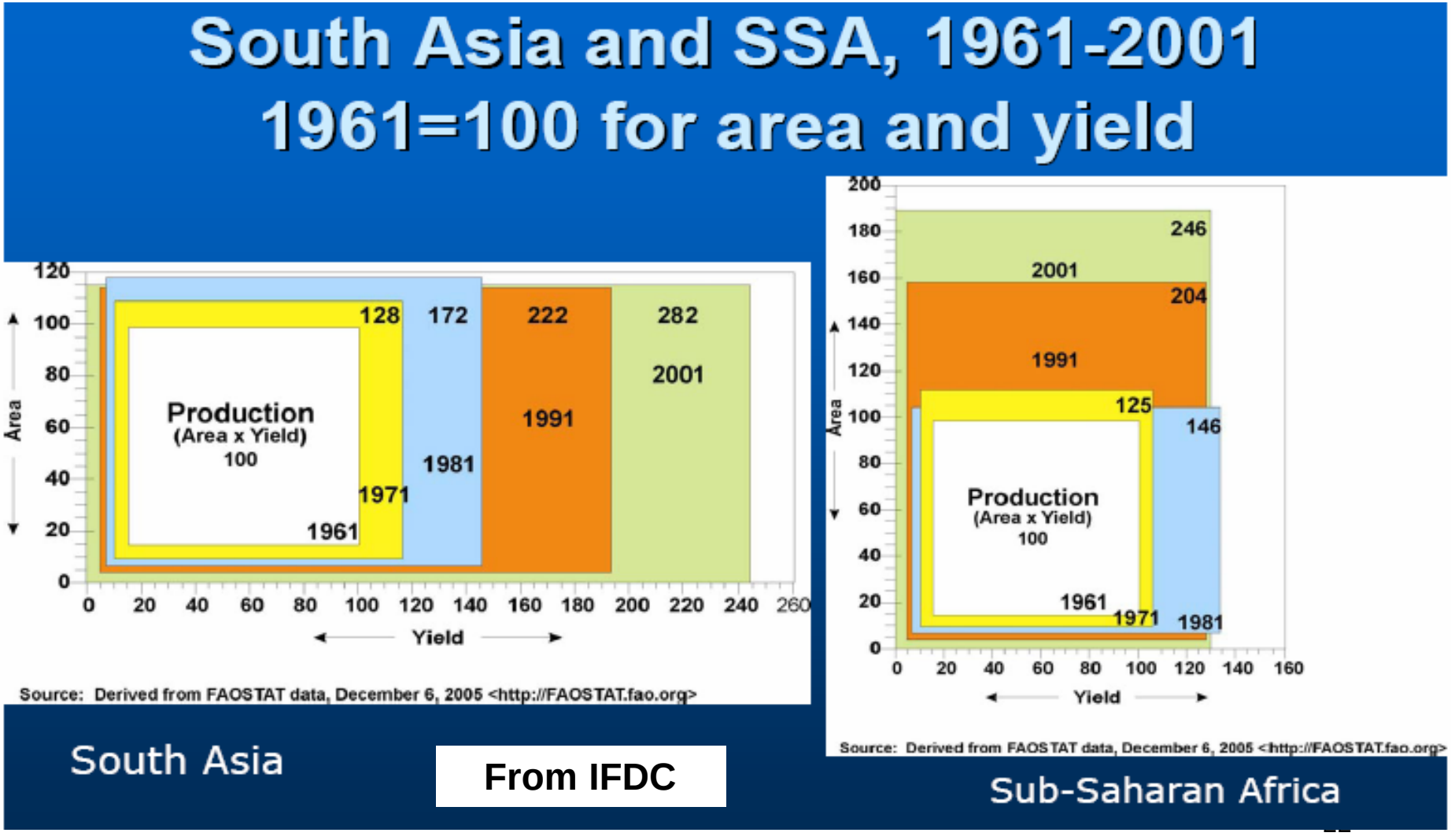
## World Cereal* Production–Areas Saved Through Improved Technology, 1950-2000




**LAND SPARED 1.1 billion ha**

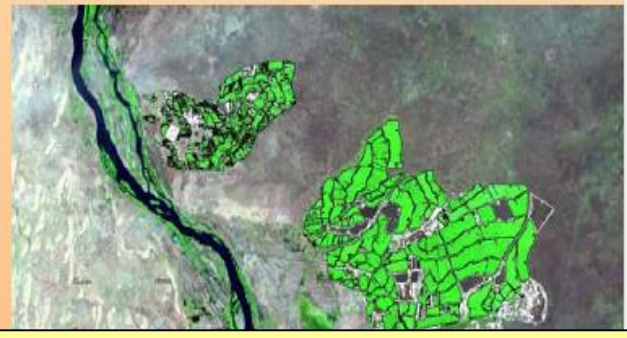
**LAND USED 660 million ha**

# LUEf has increased in the world except in 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 expanse 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

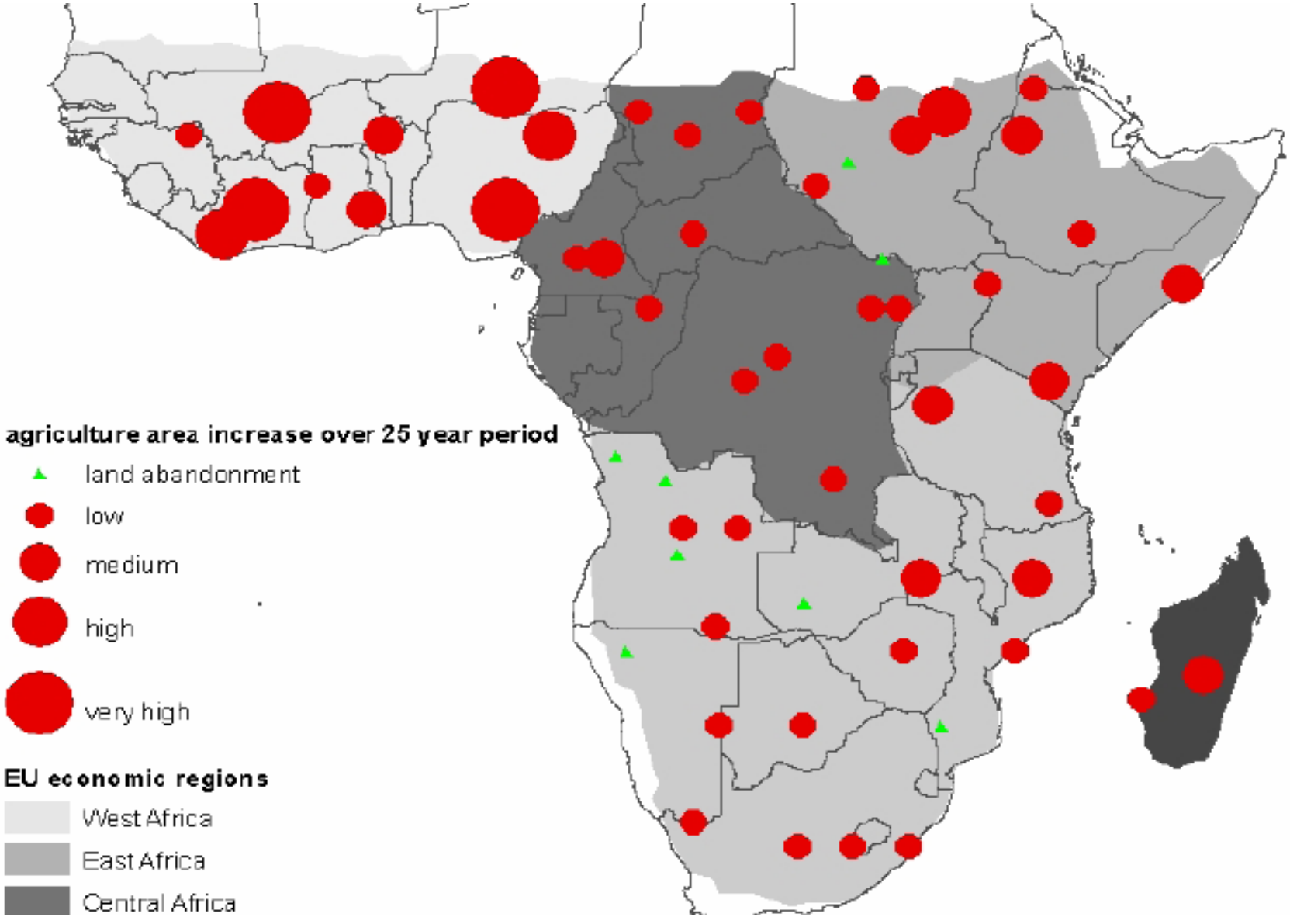
*H.D. Eva, A. Brink and D. Simonetti*

**Between 1975 and 2000**

**~1 billions ton of CO2 per year**

**About twice the annual emissions of France**

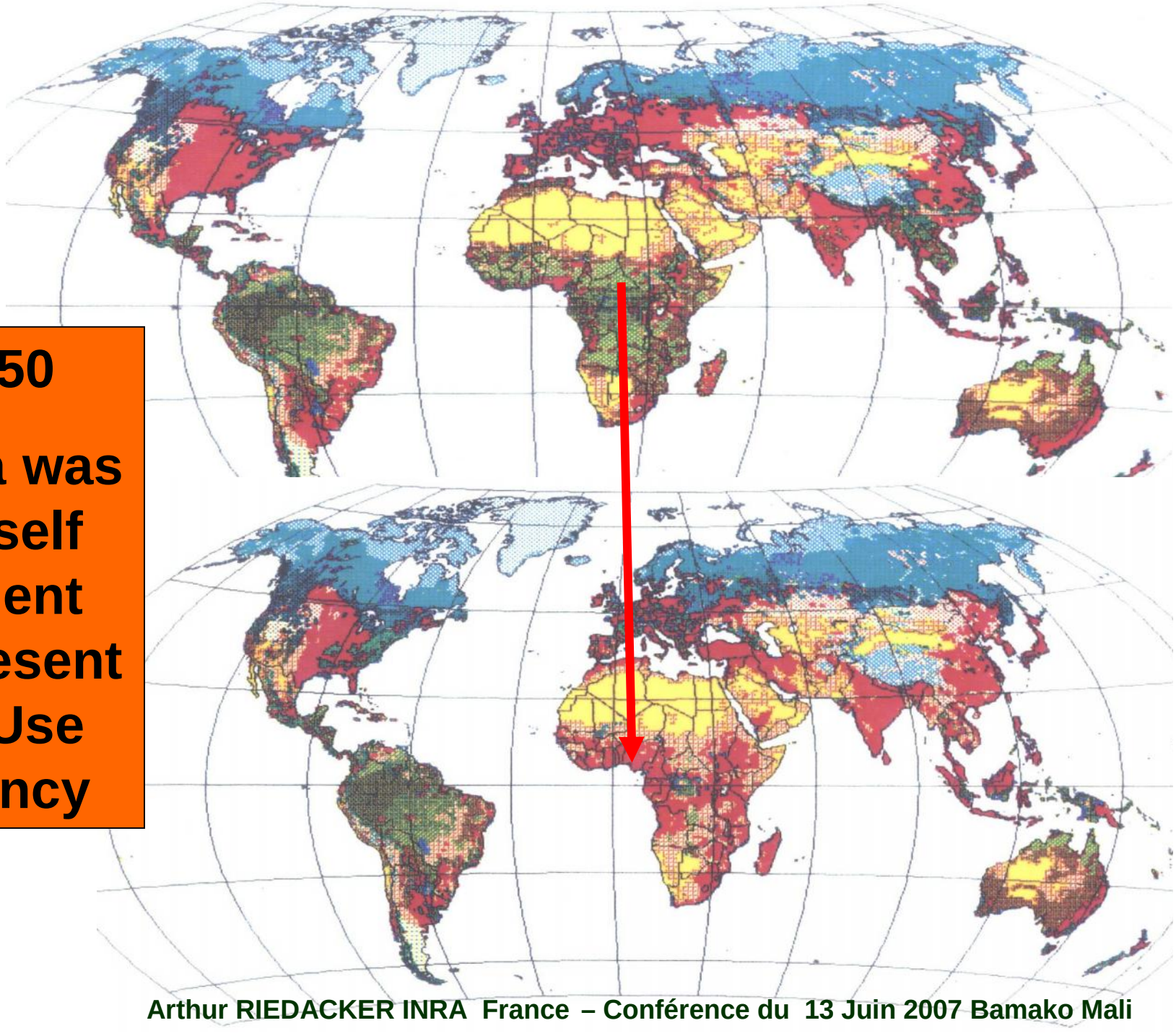
# Land Use Change



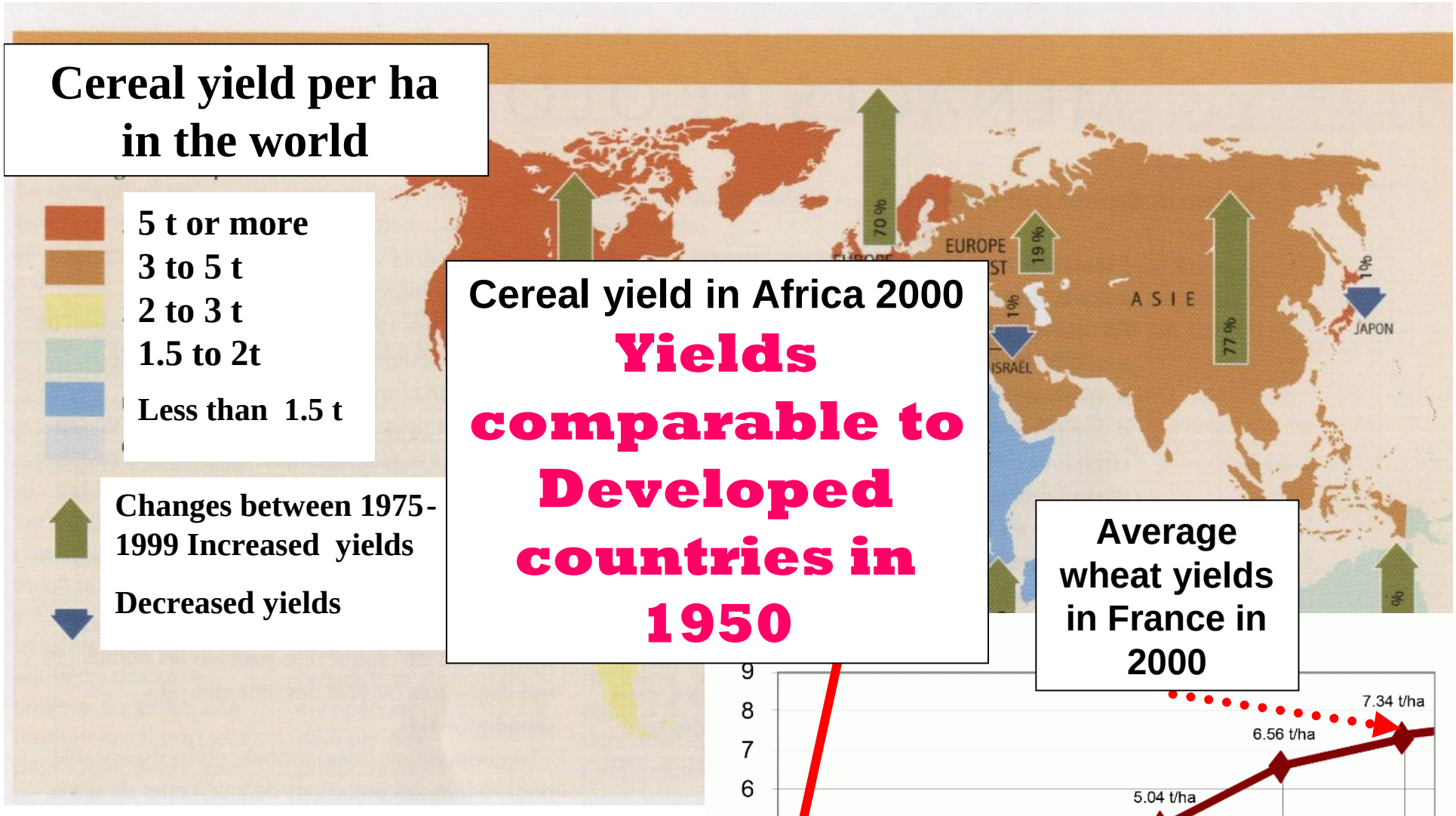
1990

**In 2050**

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



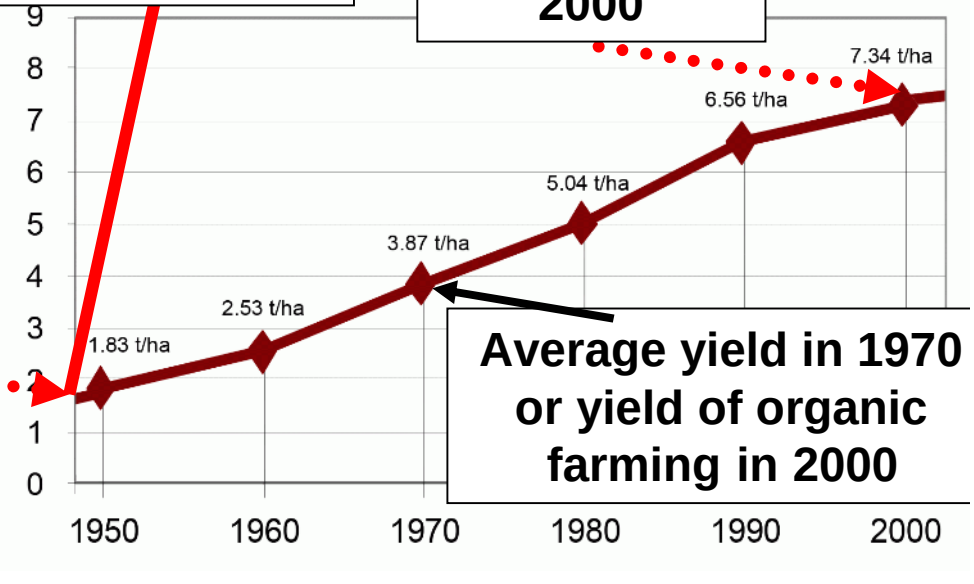
# Cereal yield per ha in the world




## Cereal yield in Africa 2000

## Yields comparable to Developed countries in 1950

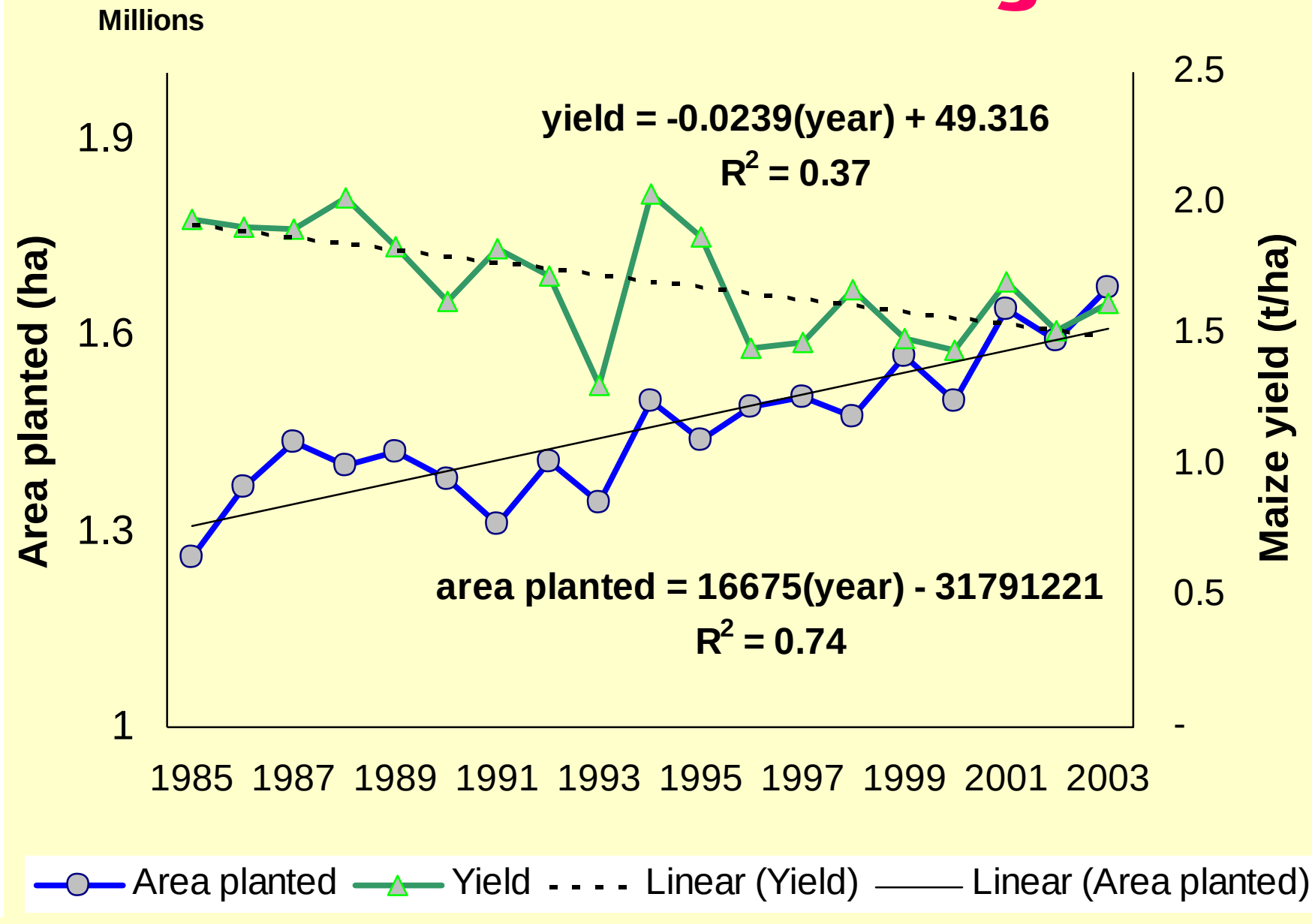
**Average wheat yields in France in 1950**




**Average wheat yields in France in 2000**

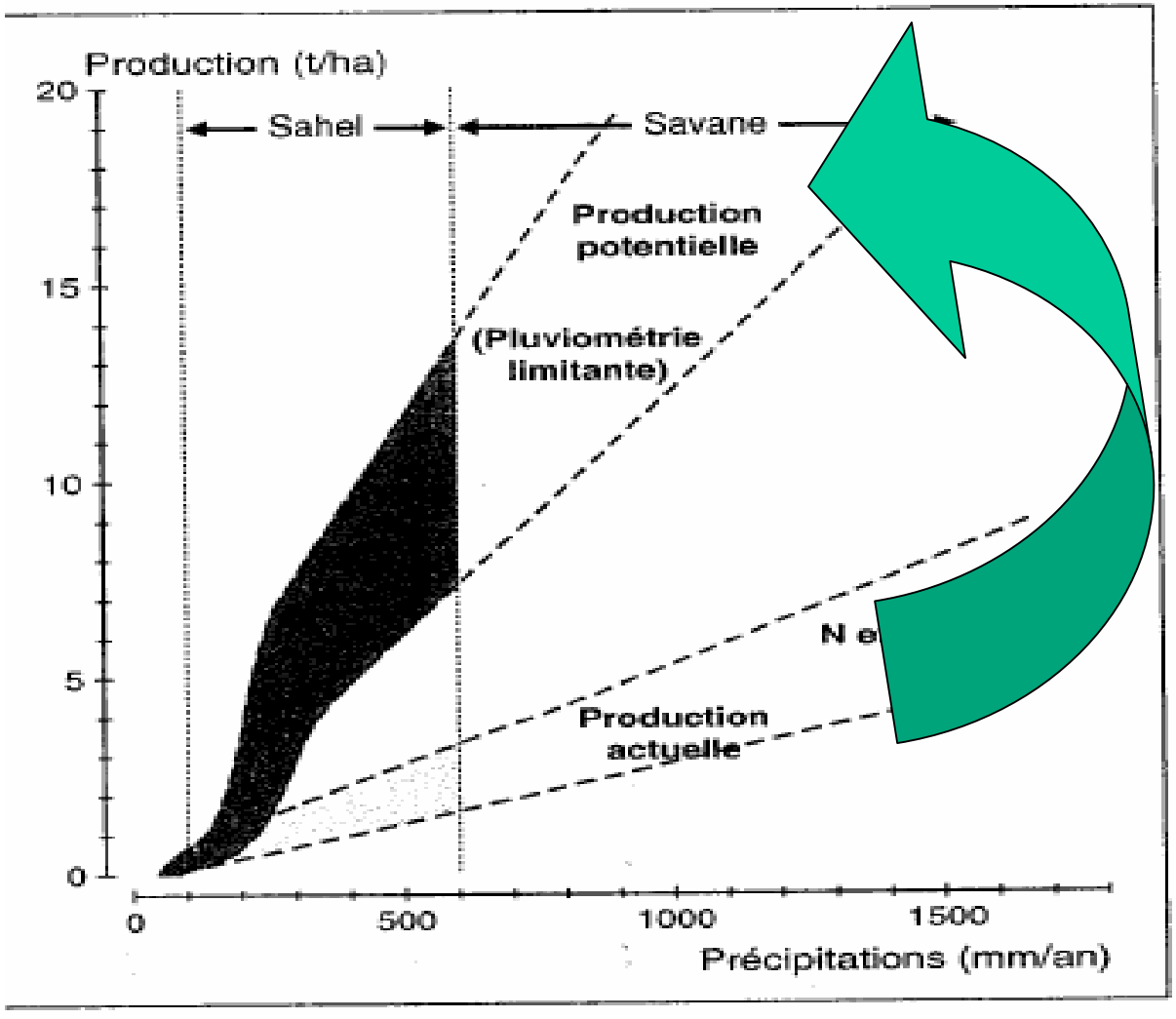
**Average yield in 1970 or yield of organic farming in 2000**

# And even decreasing



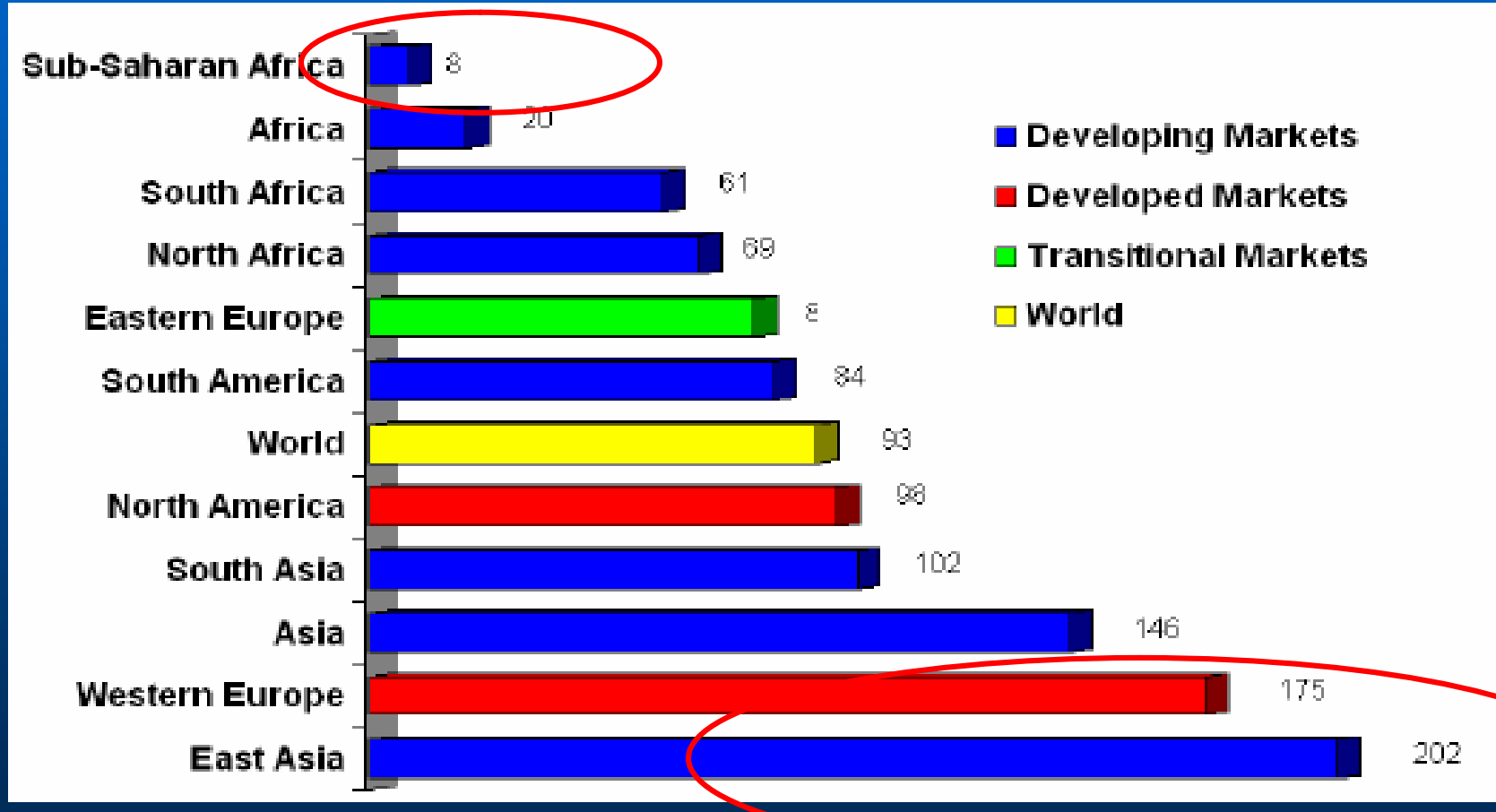

Maize Yield and area trends for Kenya (nat. statistics)

# Yields can be increased with some fertilizer




# Yields are to low due to mineral deficiency

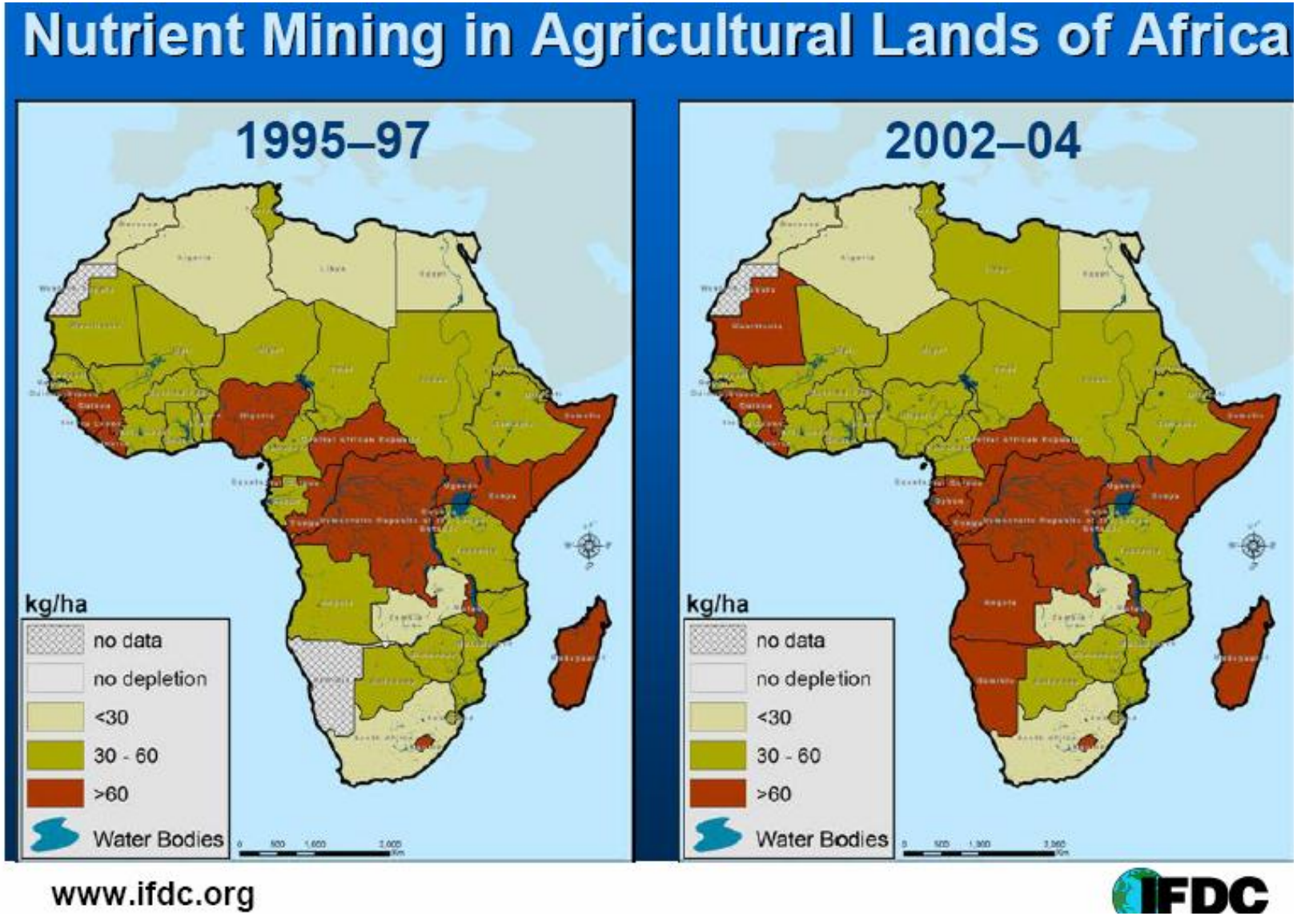
# Per Hectare Fertilizer Use by Markets 2002/03 (kg/ha)



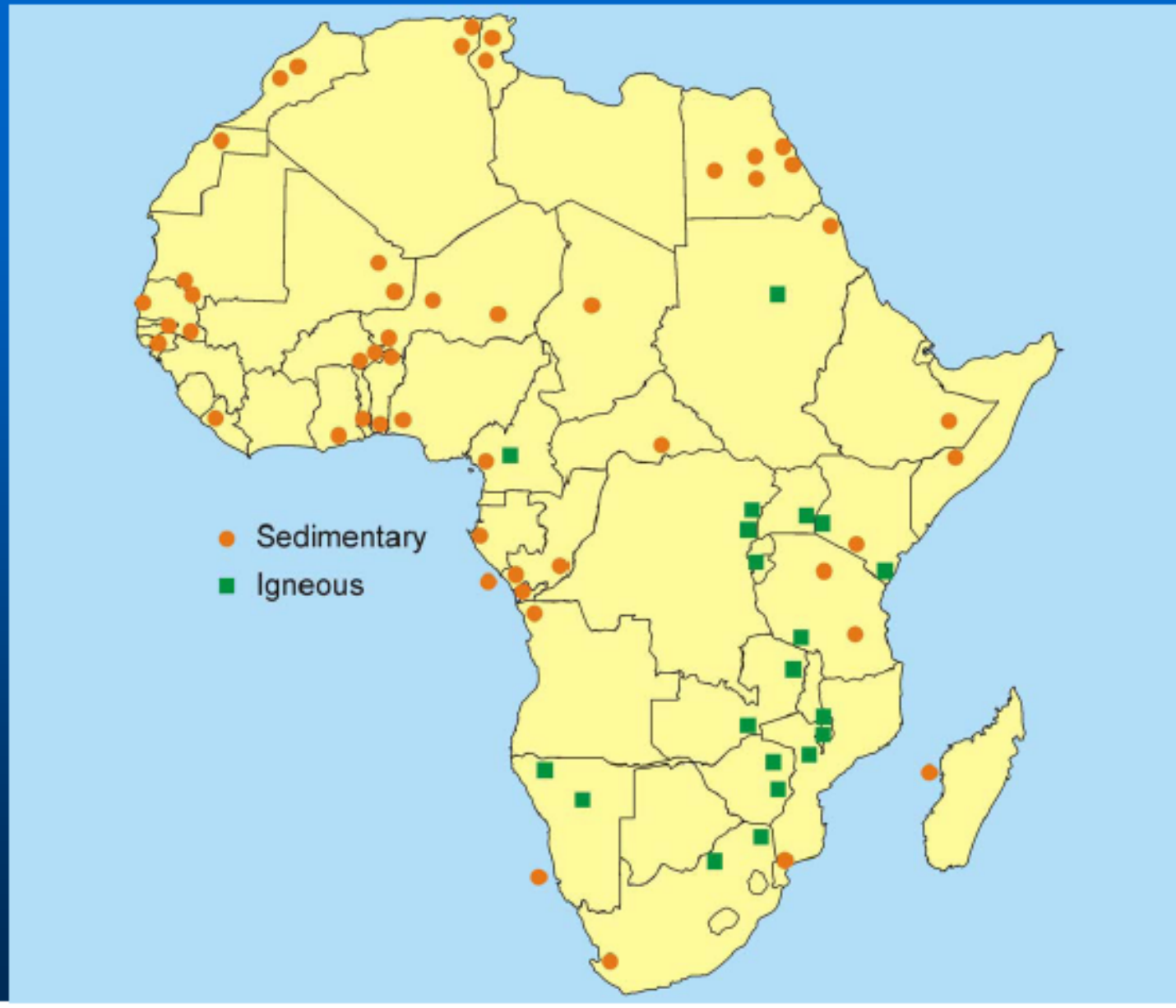

www.ifdc.org

IFDC

# Agriculture is not sustainable



# Significant Phosphate Deposits of Africa

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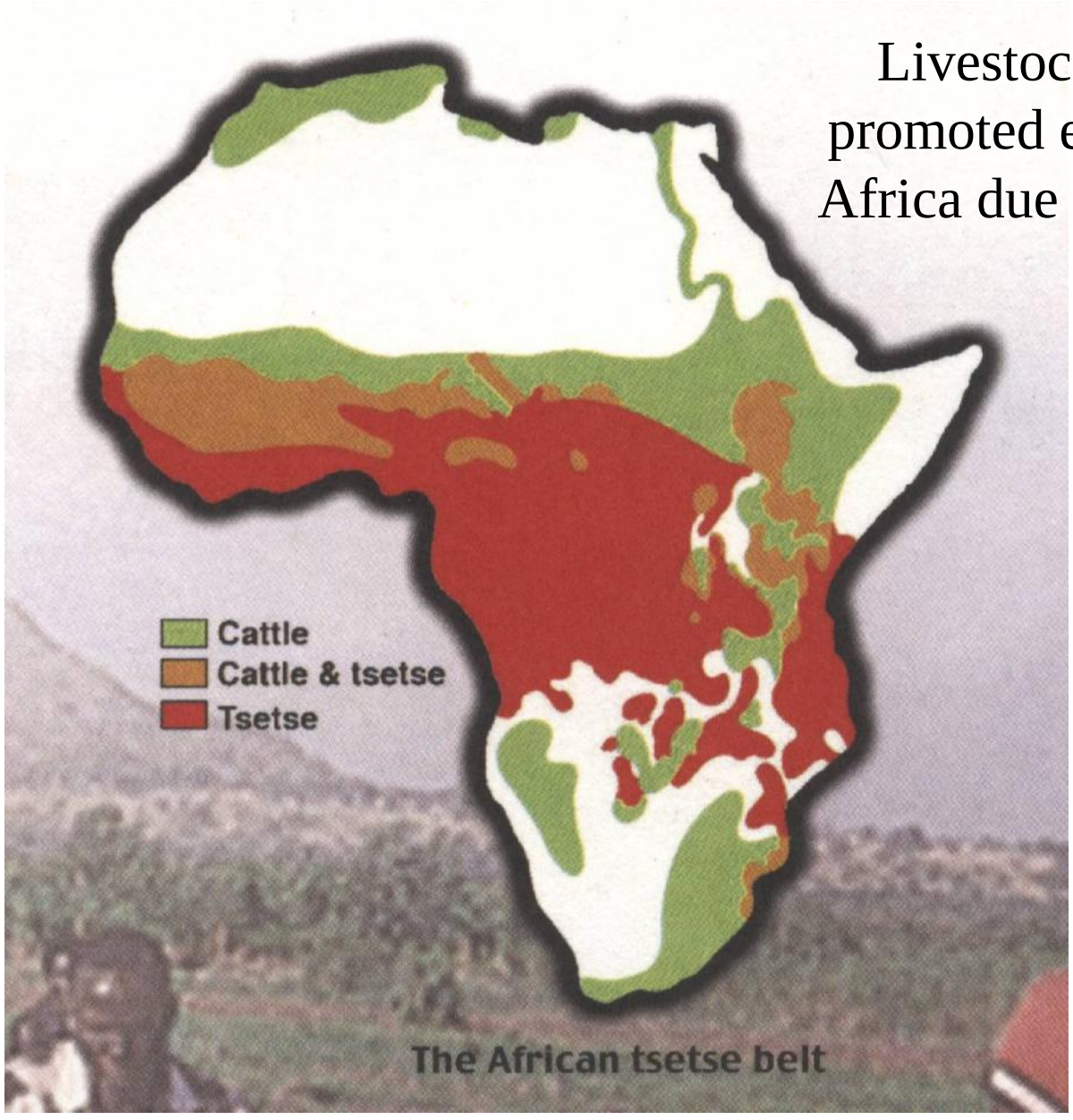


Livestock cannot be promoted everywhere in Africa due to the Tse Tse fly

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

**Decreasing GHG emissions by paying 50 % of the cost of fertilizer in Africa is much cheaper than reducing GHG in Developed Countries (annex 1countries ) 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 <u>at least</u> for "Less Developped 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
**and AASF** aasf@gwdg.de