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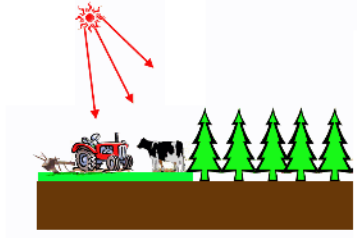
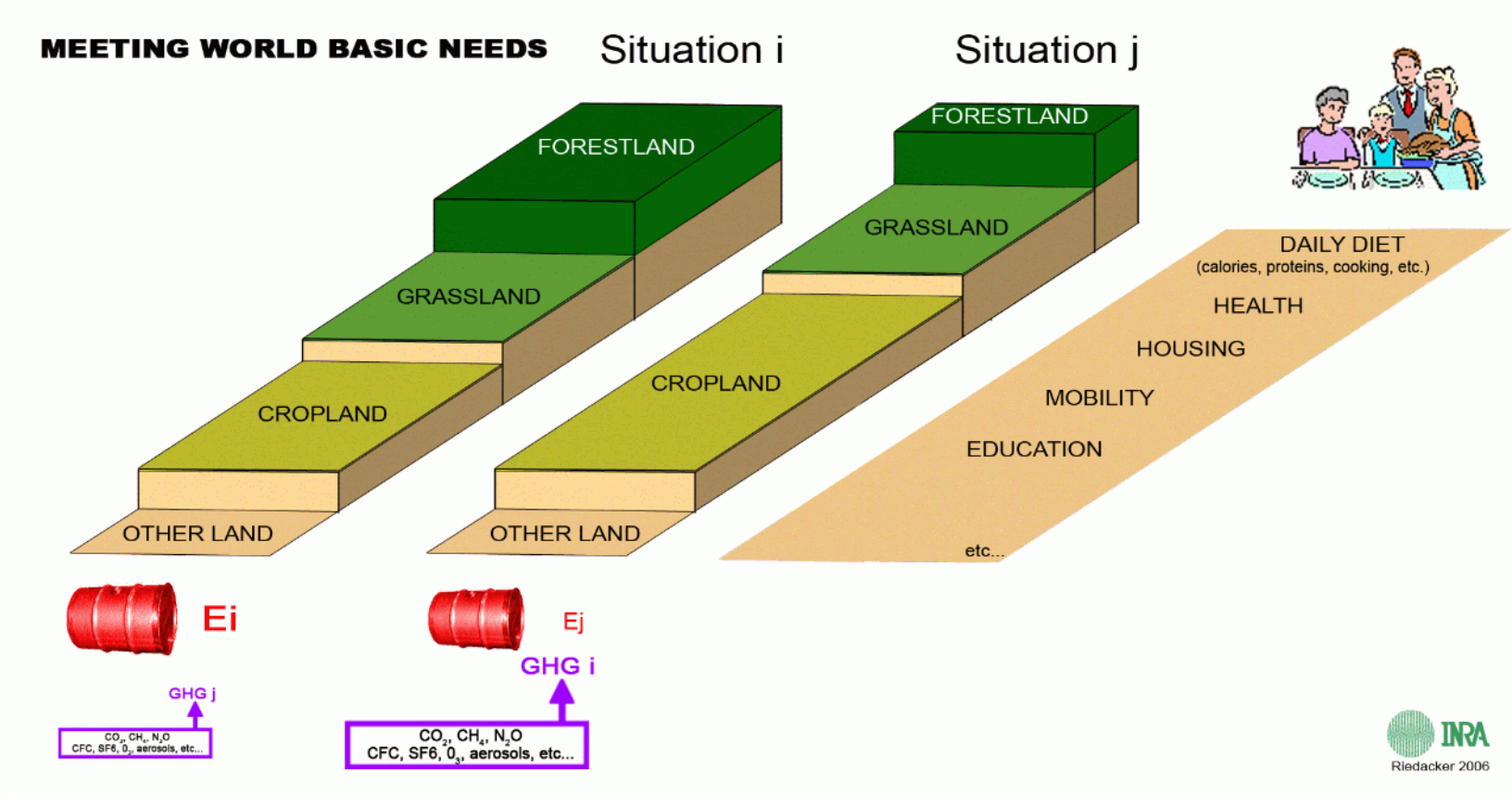
For sustainable development we are to look both at global & local level



Basic Needs per capita

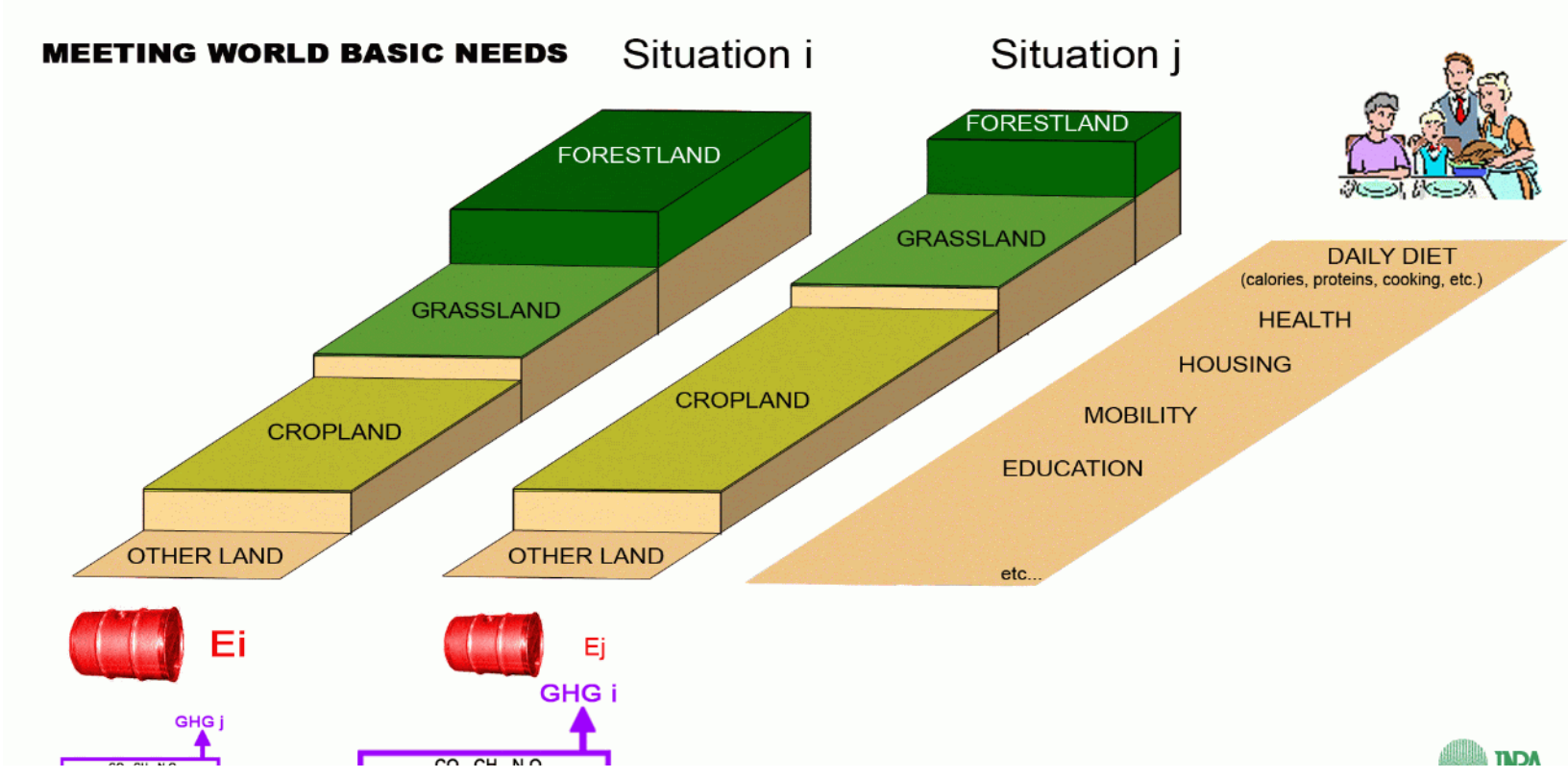
Local Resources and constraints

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



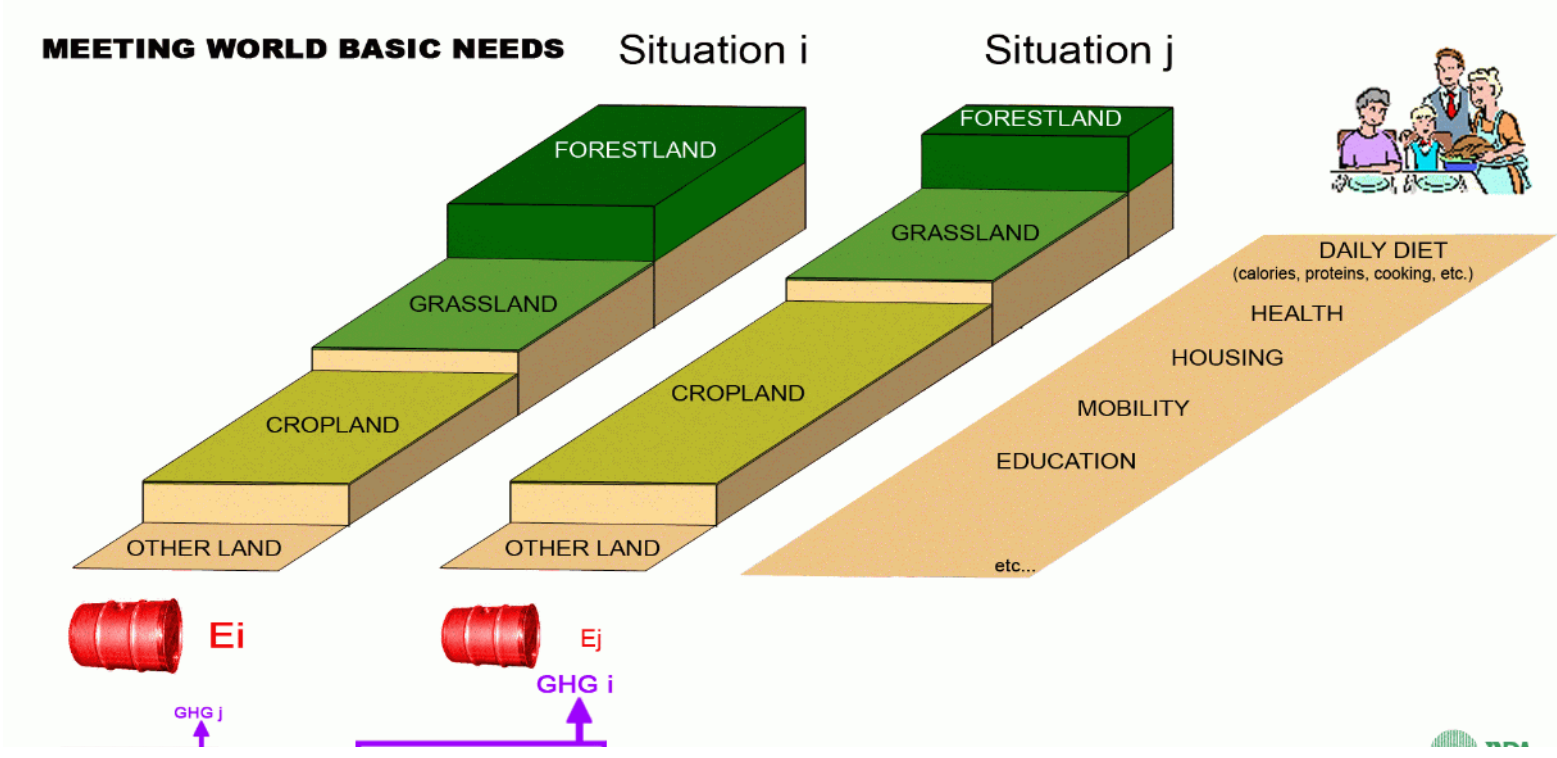
⇒2 d conclusion

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

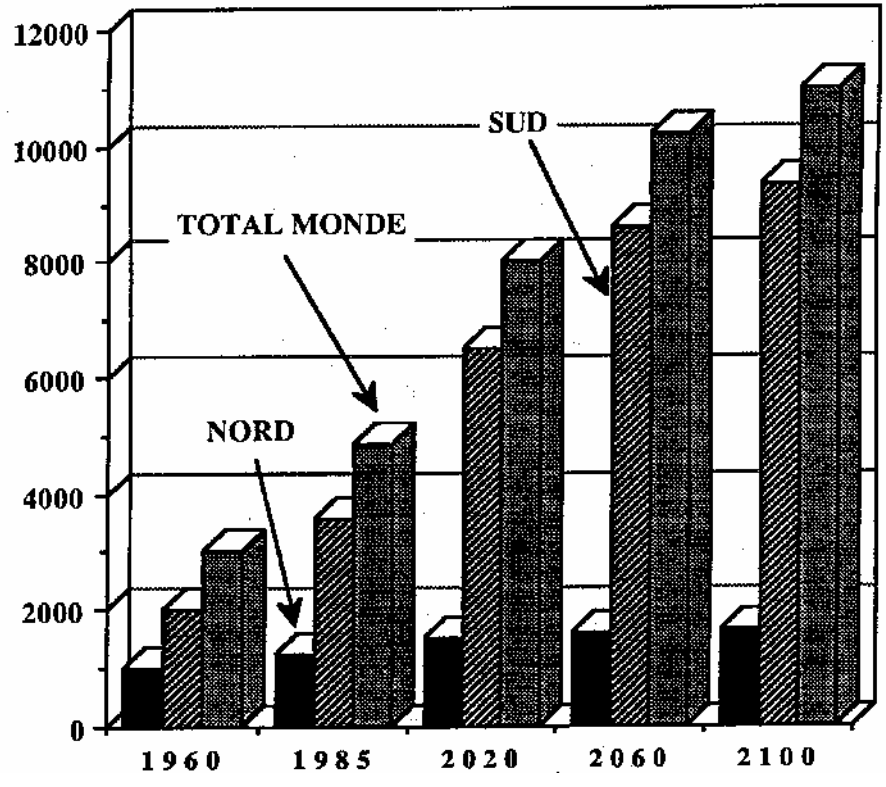
To morrow + 3 Billion people (+50%)!

And +100% in Sub-Saharan Africa

Increase of Population

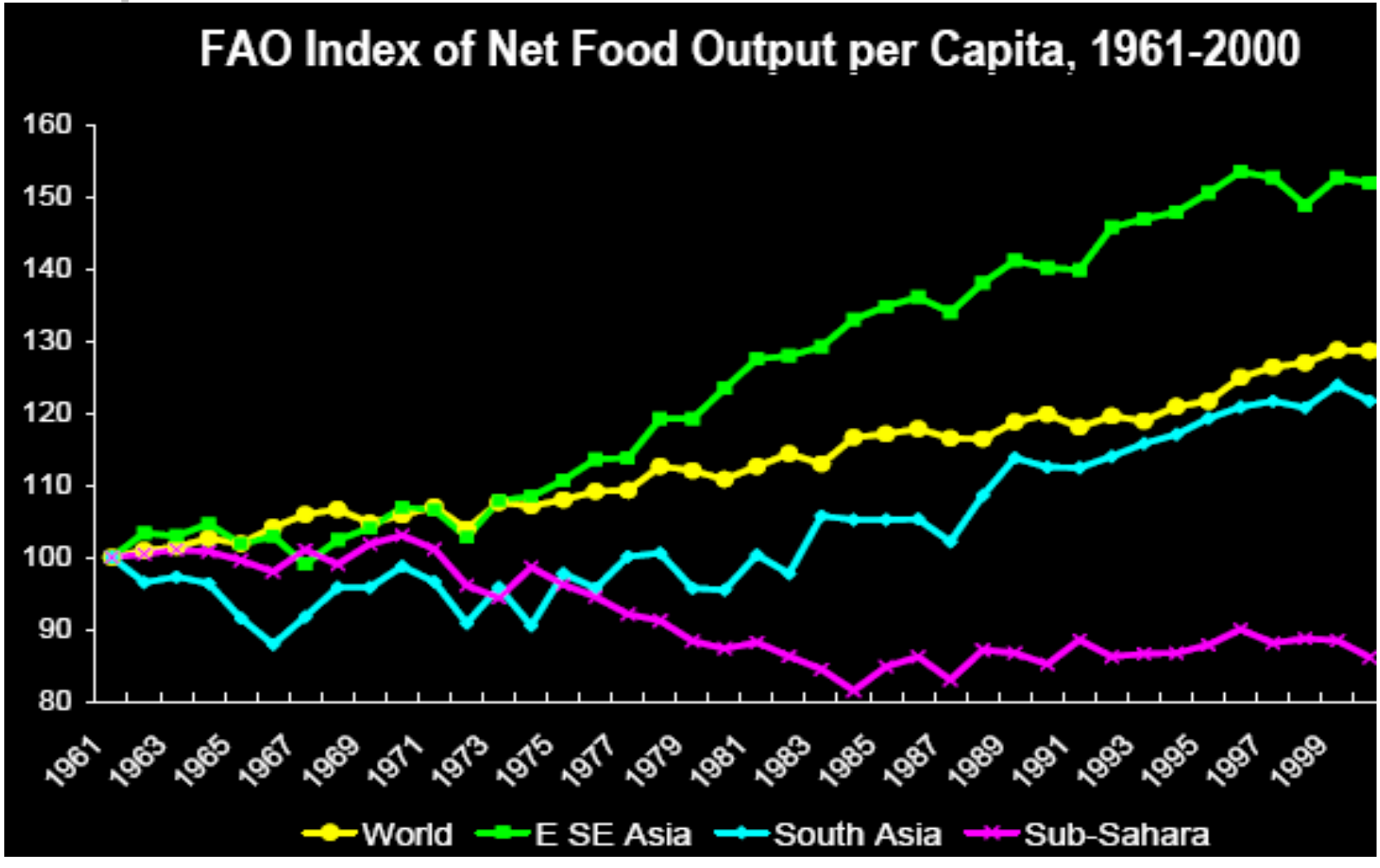
and some

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



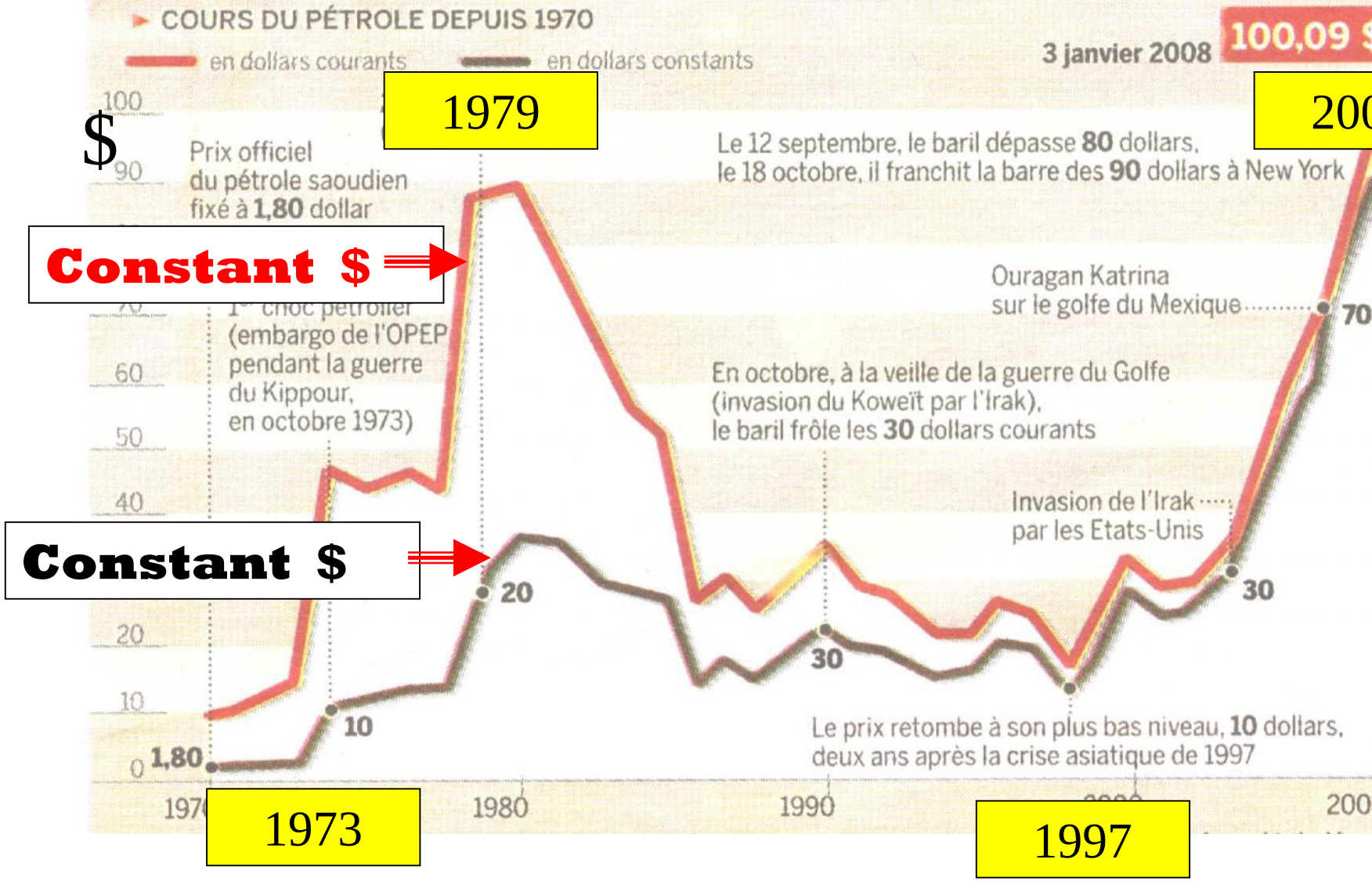
1/ Food

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



Sub-Saharan Africa

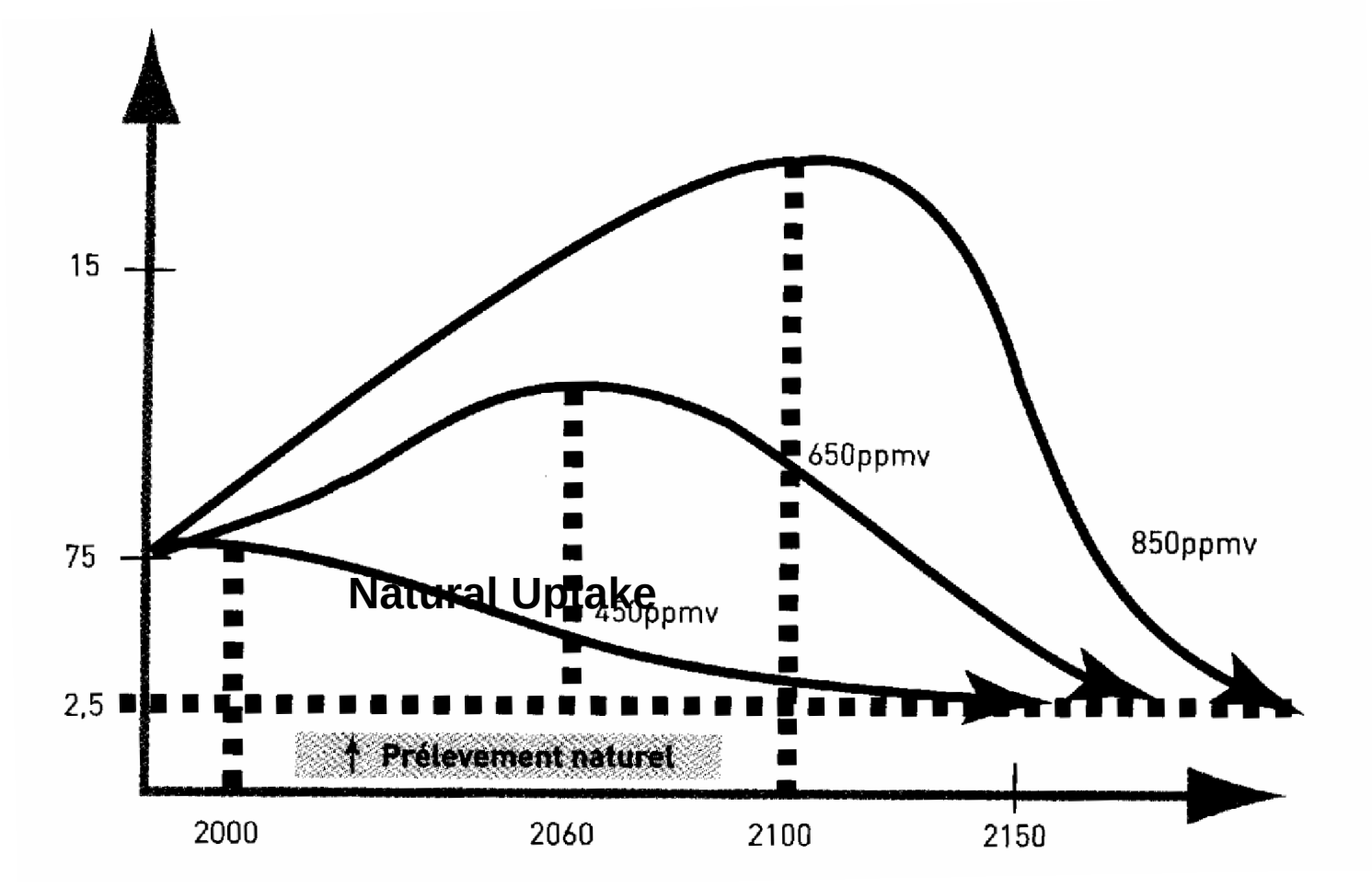
End of cheap oil …..?

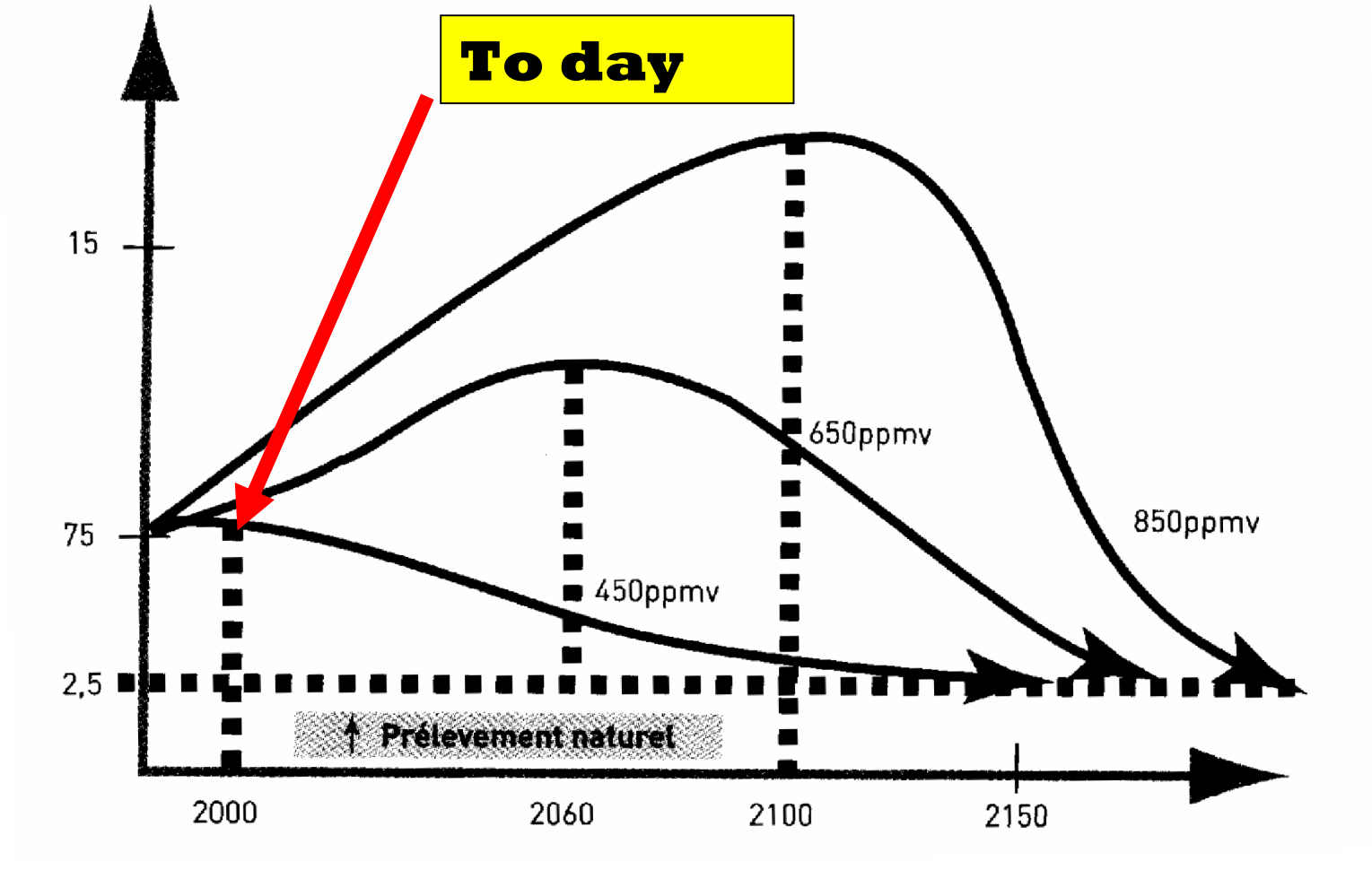


Climate Change ?

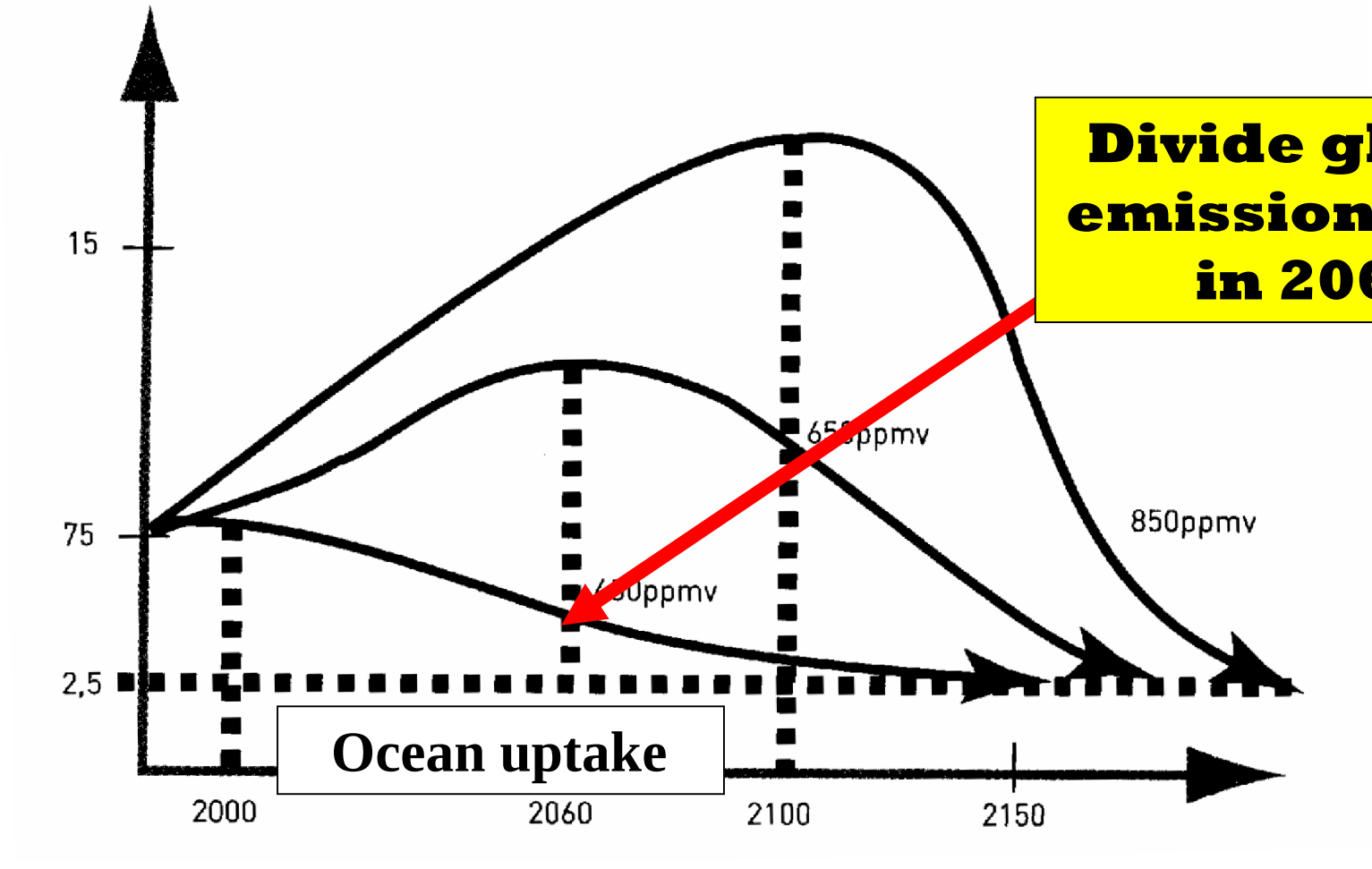
Most important negative impact is on agriculture in most densely populated regions

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

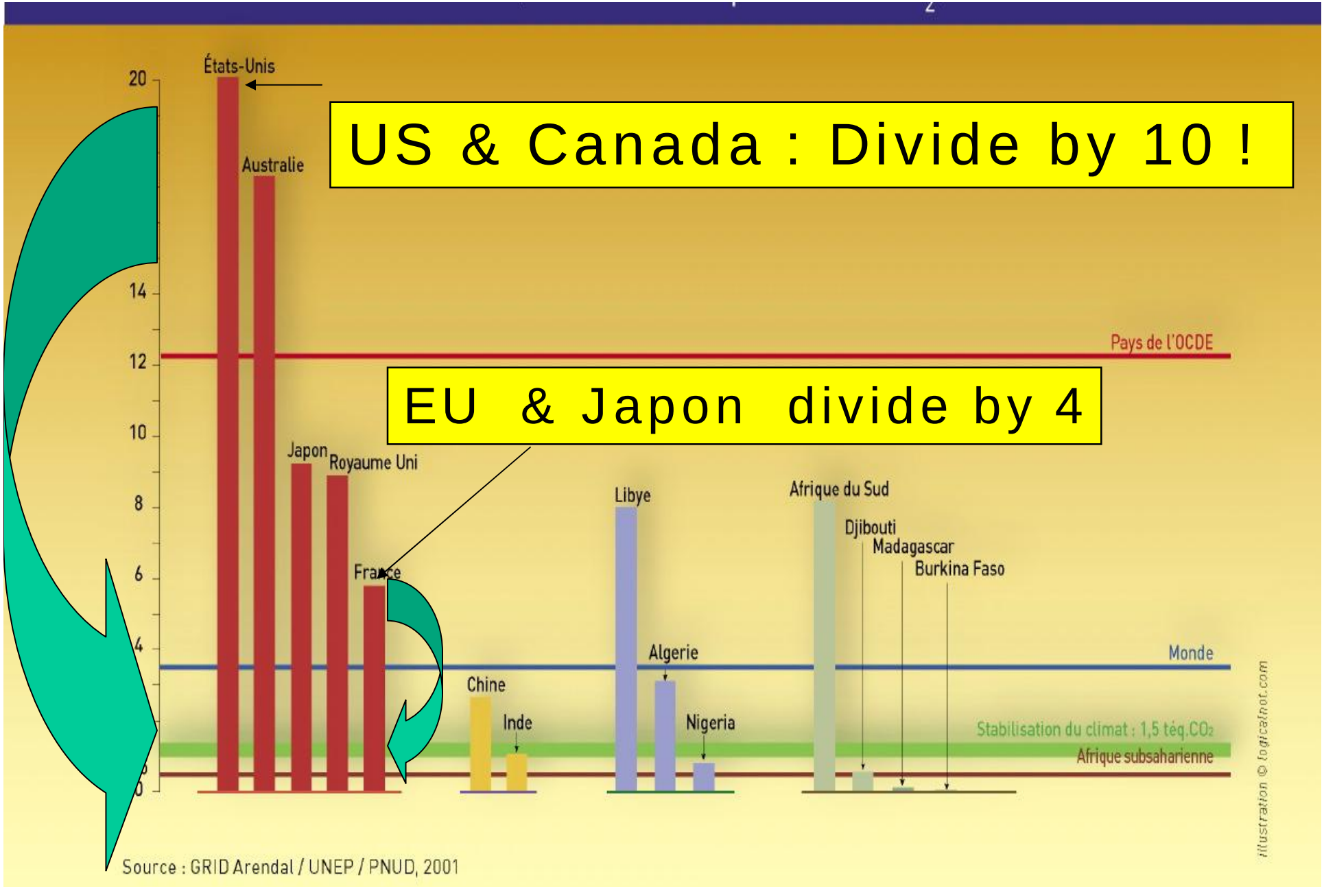



To day
15
75
2,5
650ppmv
850ppmv
450ppmv
Prélevement naturel
2000
2060
2100
2150

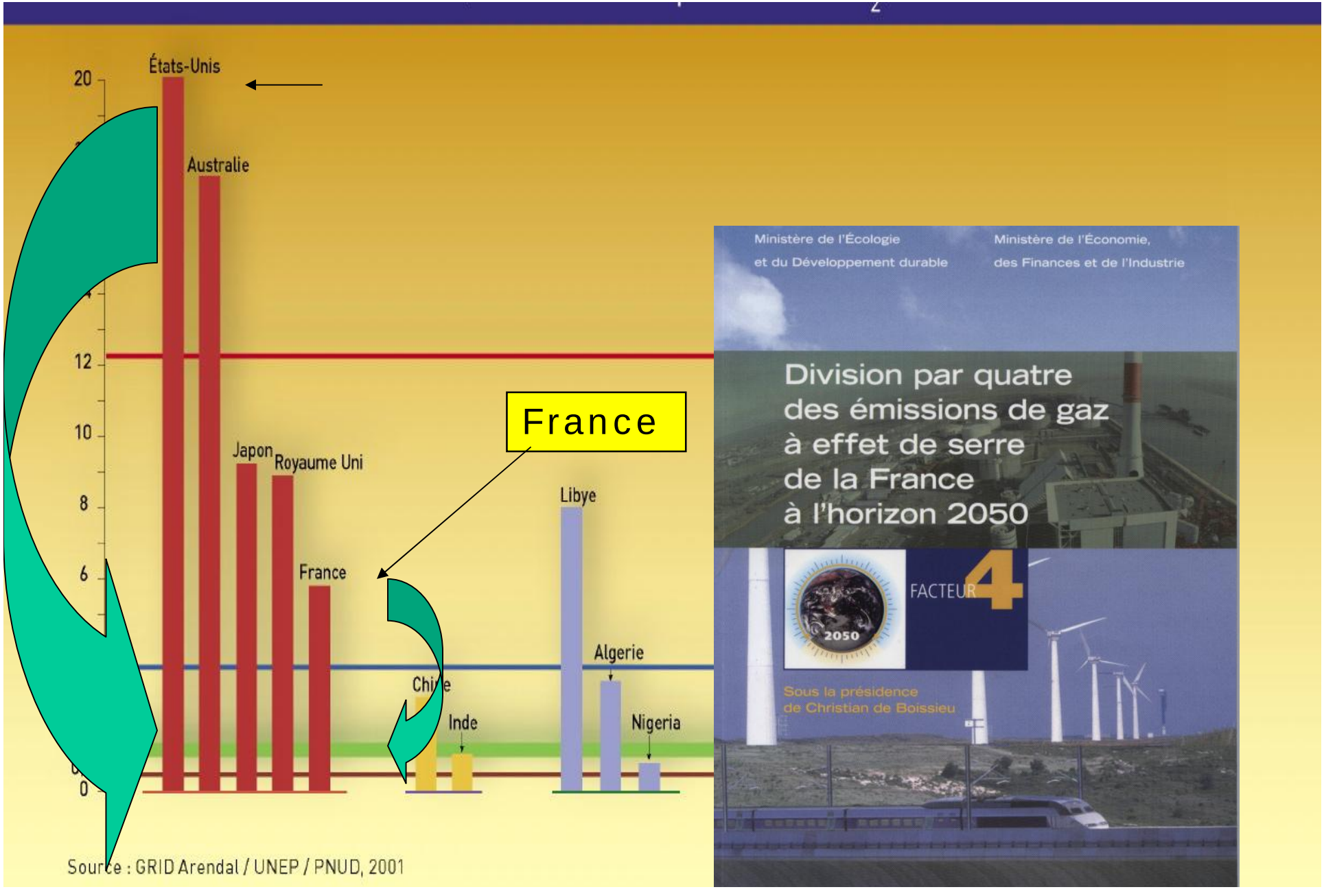
Curve to stabilize at 450 ppm



Developed countries are to show the way…

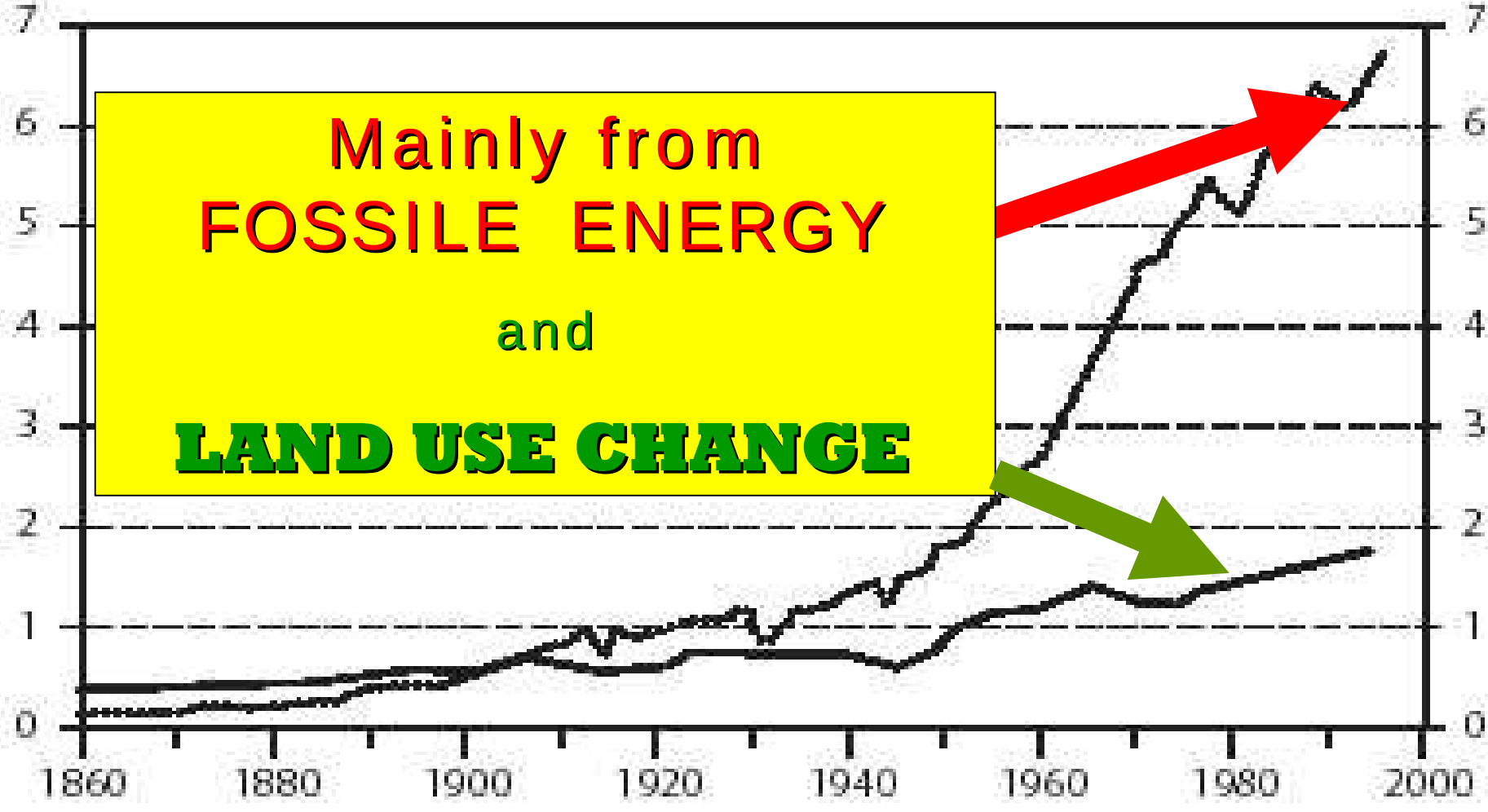


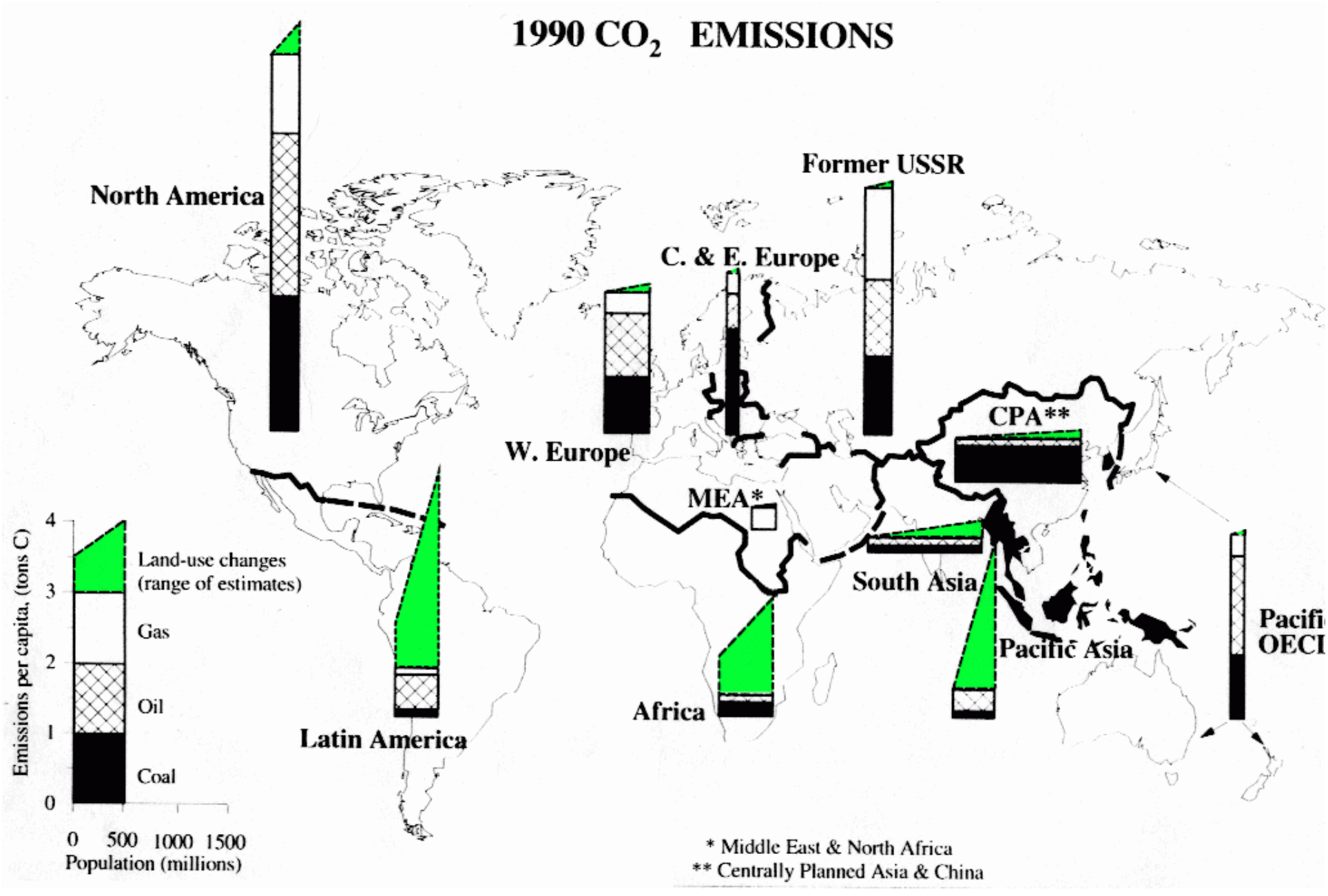
Developed countries are to show the way…



That will not be easy

Net CO_2 emissions in (GtC) since the industrial revolution

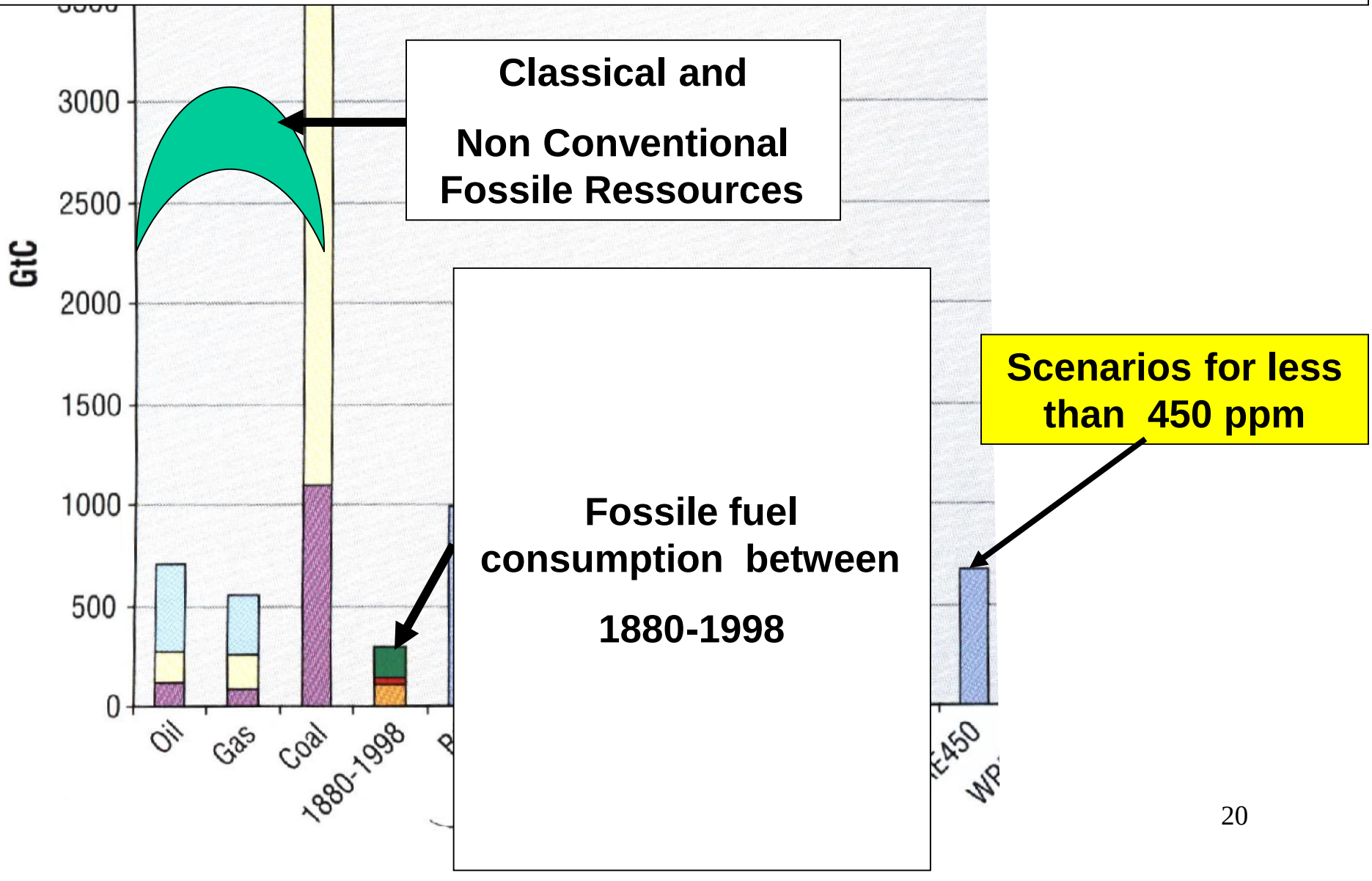



1990 CO_2 EMISSIONS
North America
Former USSR
C. & E. Europe
W. Europe
CPA**
MEA*
South Asia
Pacific Asia
Africa
Latin America
Pacifi
OECI
Emissions per capita, (tons C)
4
3
2
1
0
Land-use changes
(range of estimates)
Gas
Oil
Coal
0 500 1000 1500
Population (millions)
* Middle East & North Africa
**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

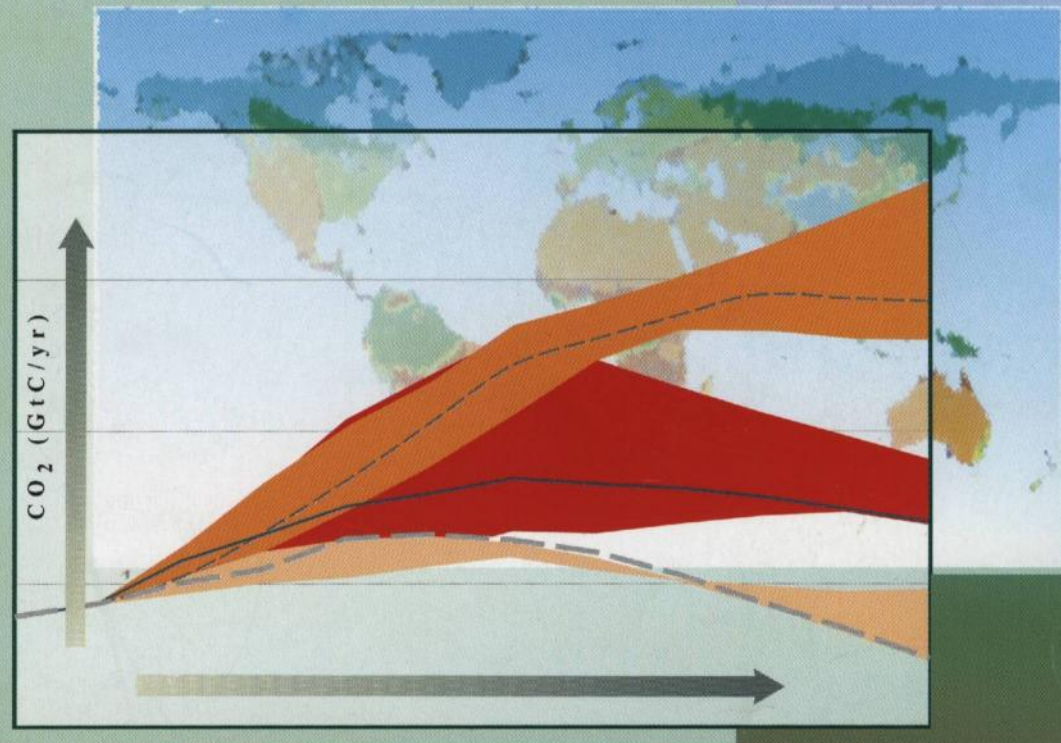
[(Σ of Fossil Energy)/GDP] *

[(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 …

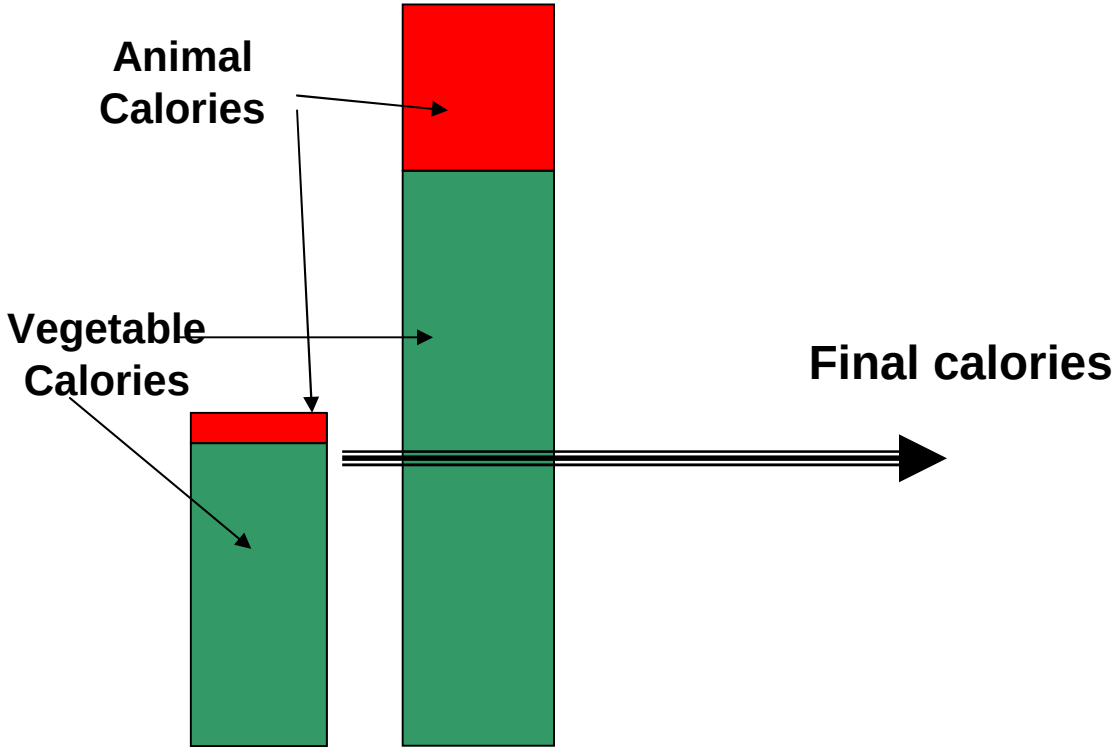
FOOTPRINT PER CAPITA DEPENDS
ON THE DIET
AND
ON LAND USE EFFICIENCY (YIELD)

DIET

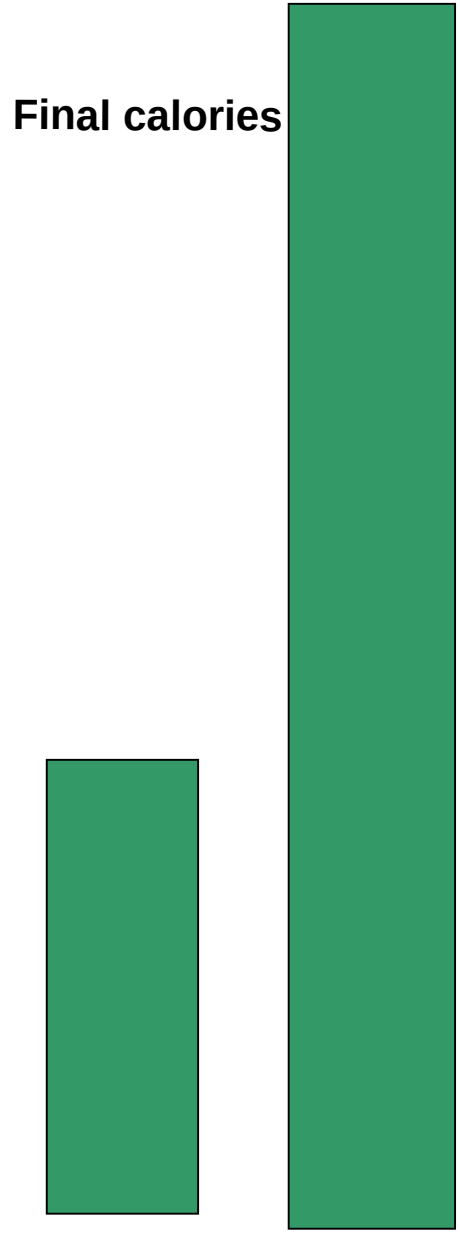
Final calories = VC + 7 AC

7 Vegetable Calories =1 Animal Calorie

1 kg of cereal equivalent = 3500VC



Bengladesh - France



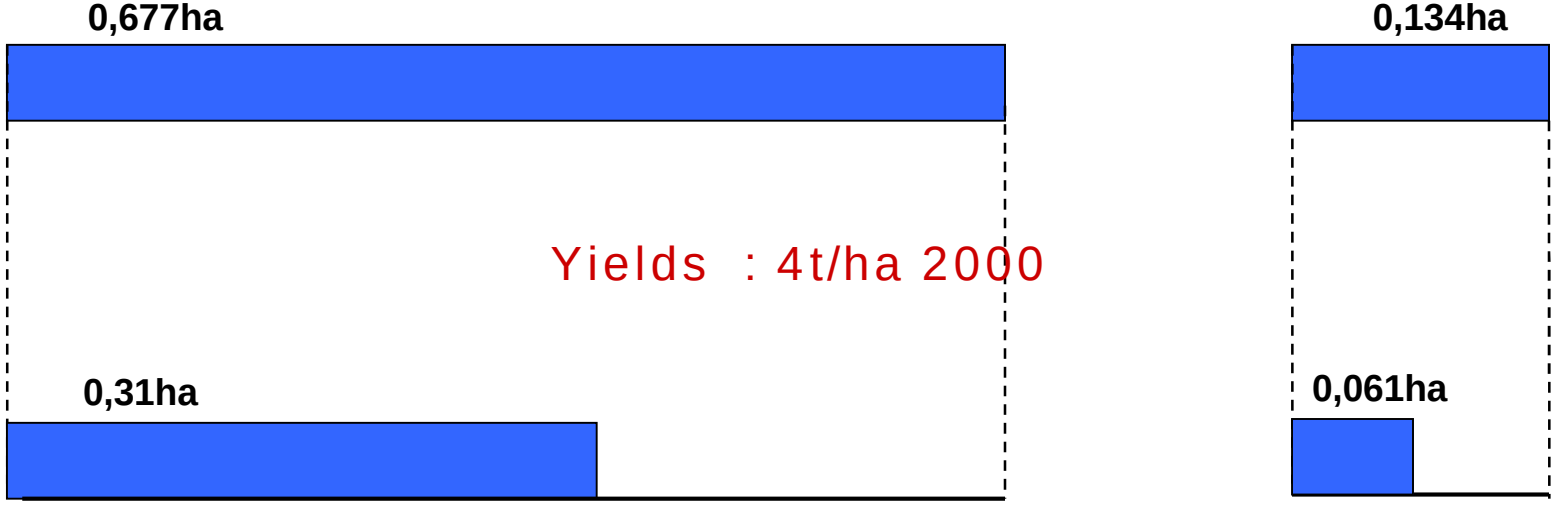
Bengladesh - France

Comparison of France and Bangladesh with different yields

FRANCE

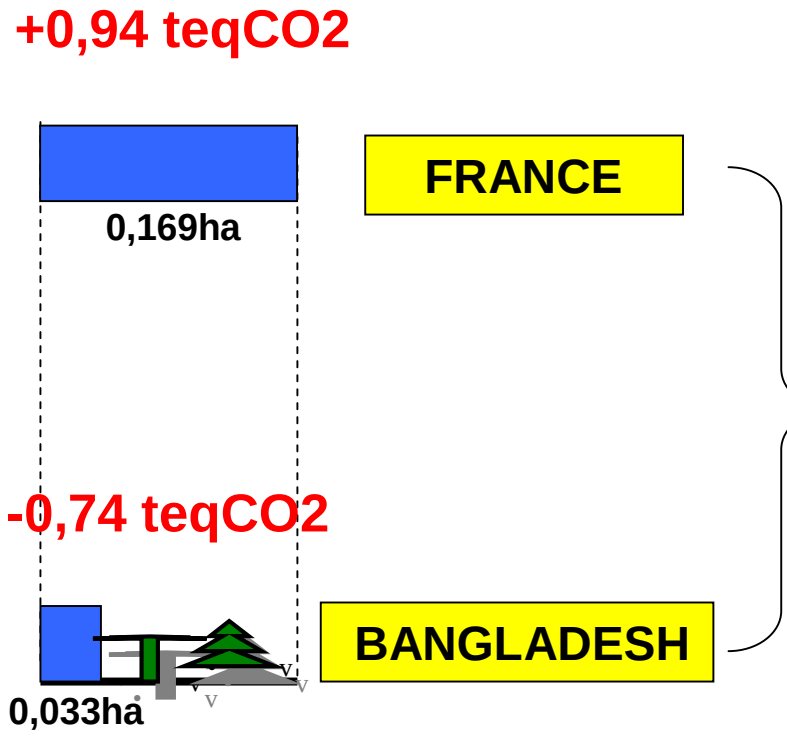
BANGLADESH

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

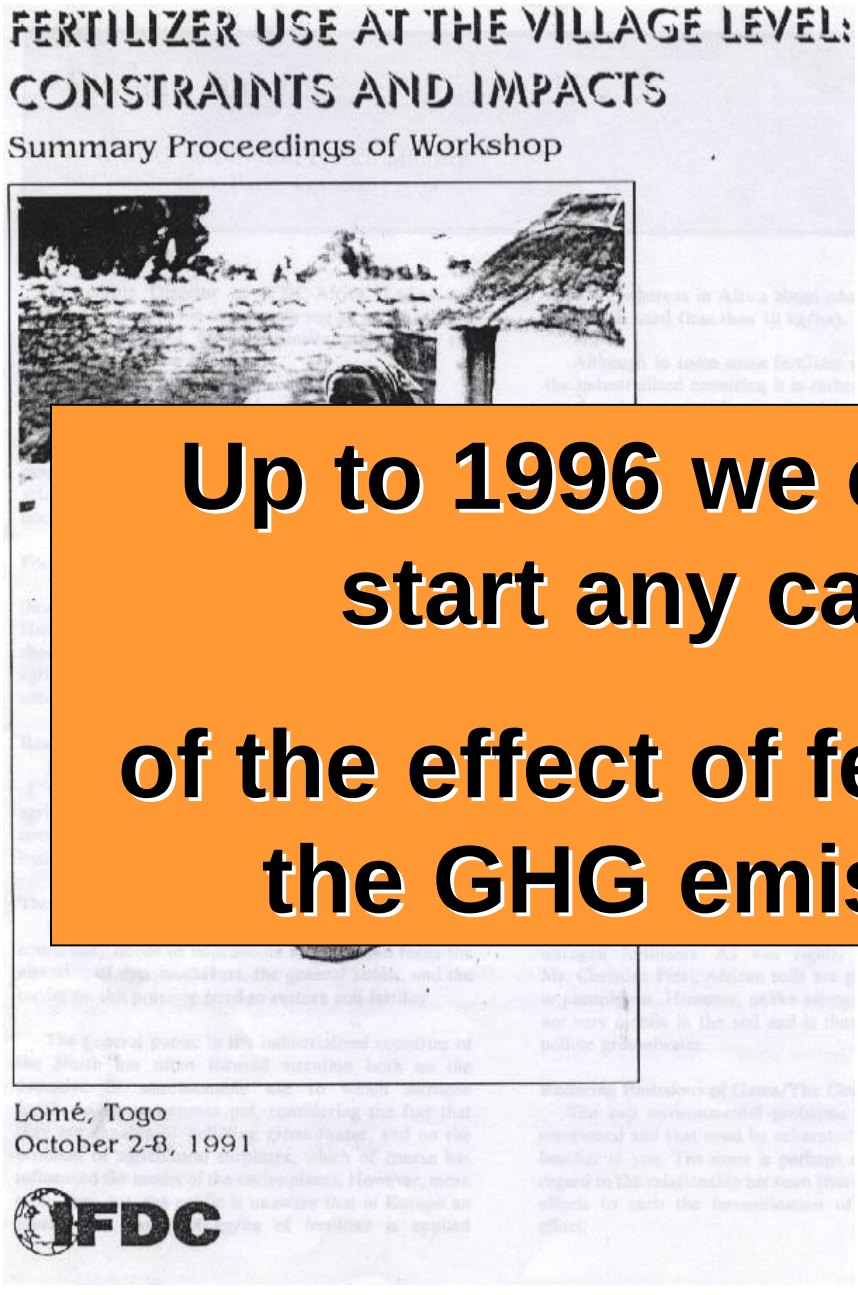
For Phytomass

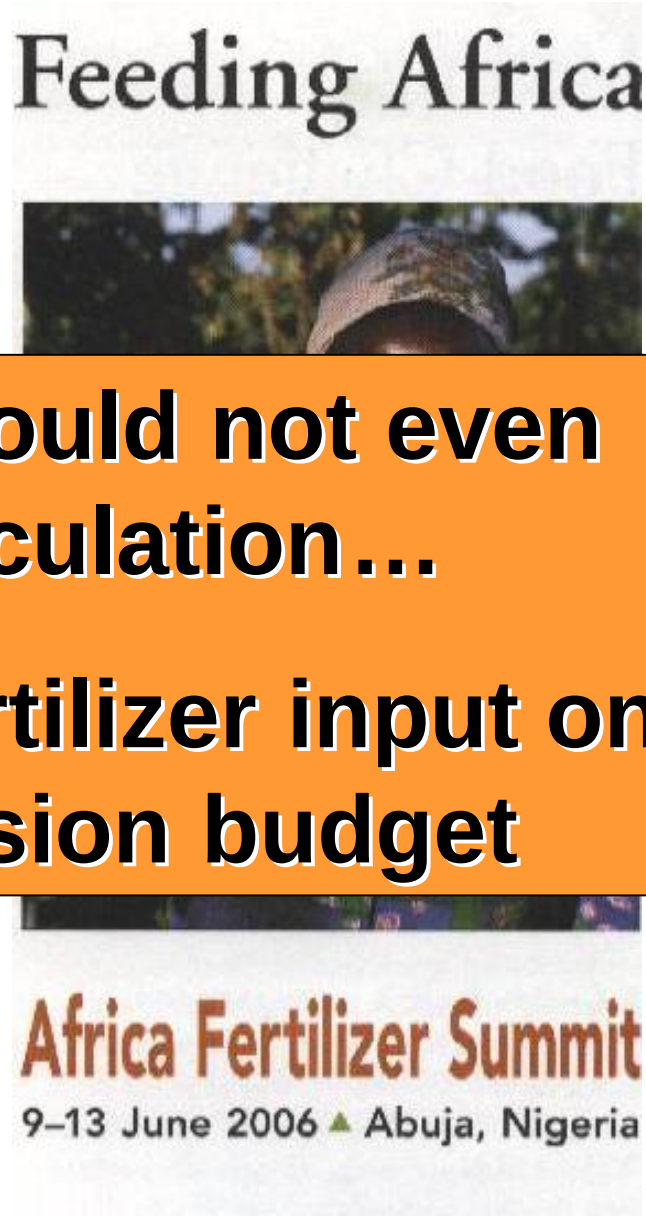
(including food and non food production and use)

it is a little more complicated than for fossil fuel

In spite of IPCC special Report on LULUCF in 2000

IFDC 1991 and 2006

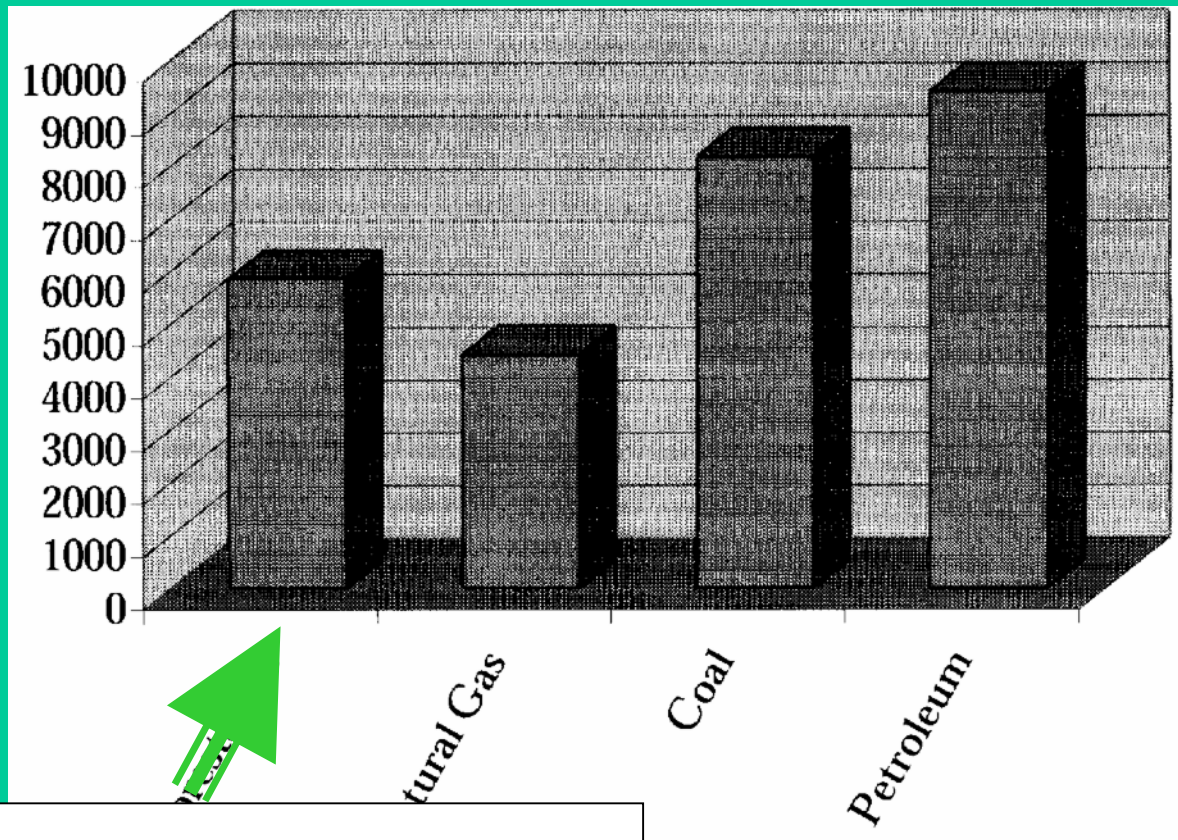




Up to 1996 we could not even start any calculation…

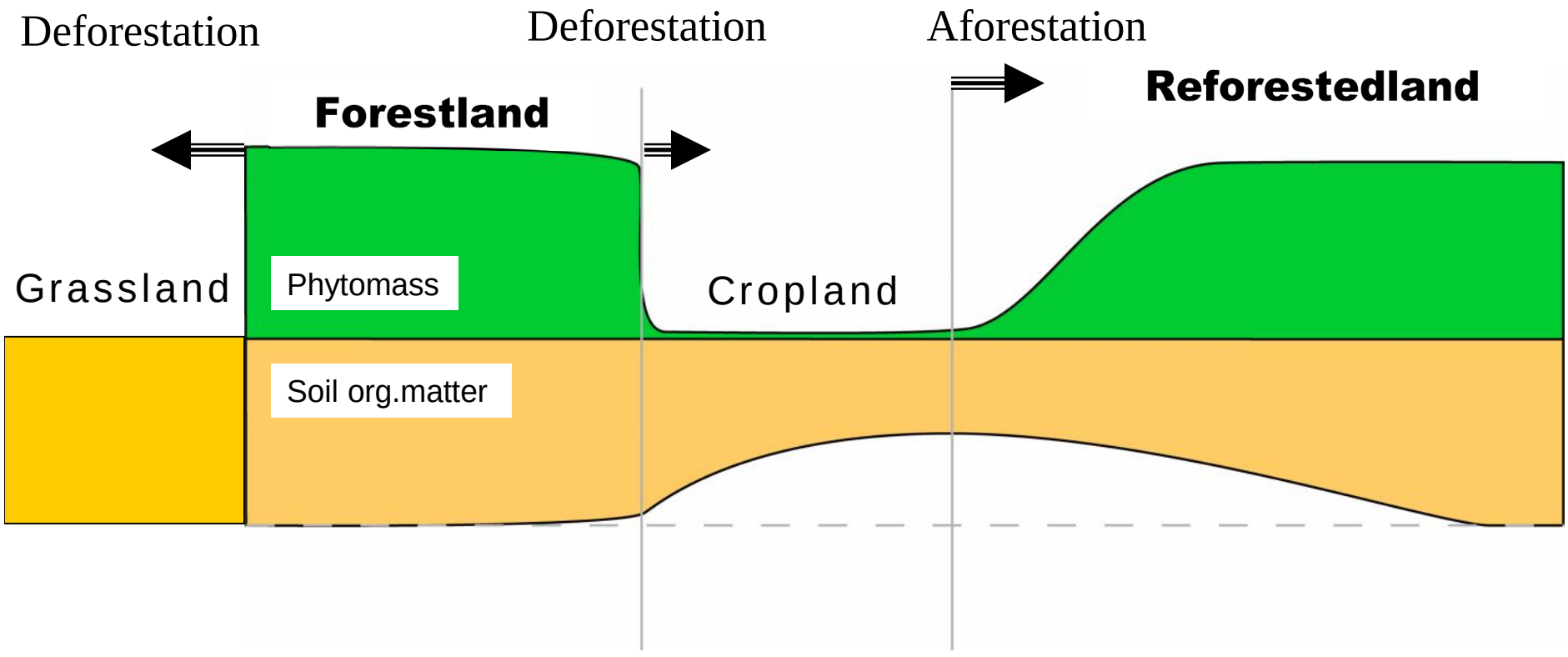
of the effect of fertilizer input on the GHG emission budget

FOR CLIMATE CHANGE MITIGATION



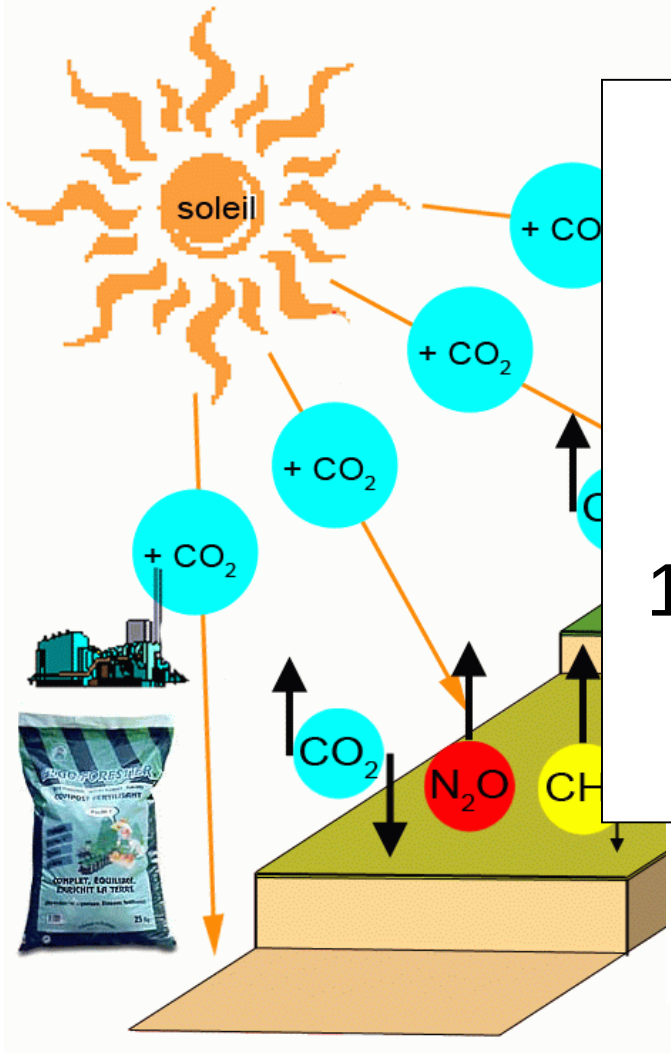
Land Use and Land Use Change

Carbon stock change not only in soils but also in phytomass



Land Use Change

CO2 and non CO2 GHG



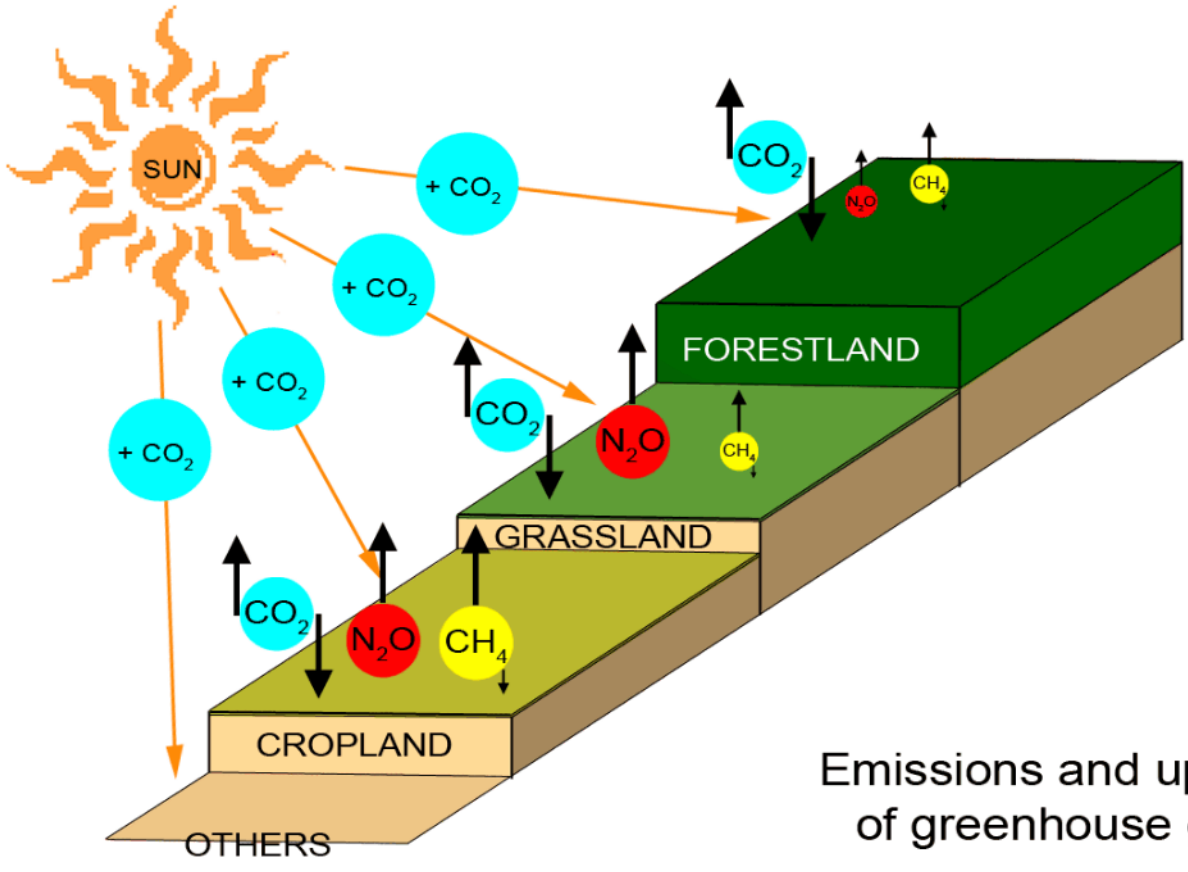
1 t of **CH_4= 23 teqCO2**

But ~ 45 teqCO2

for 50 years

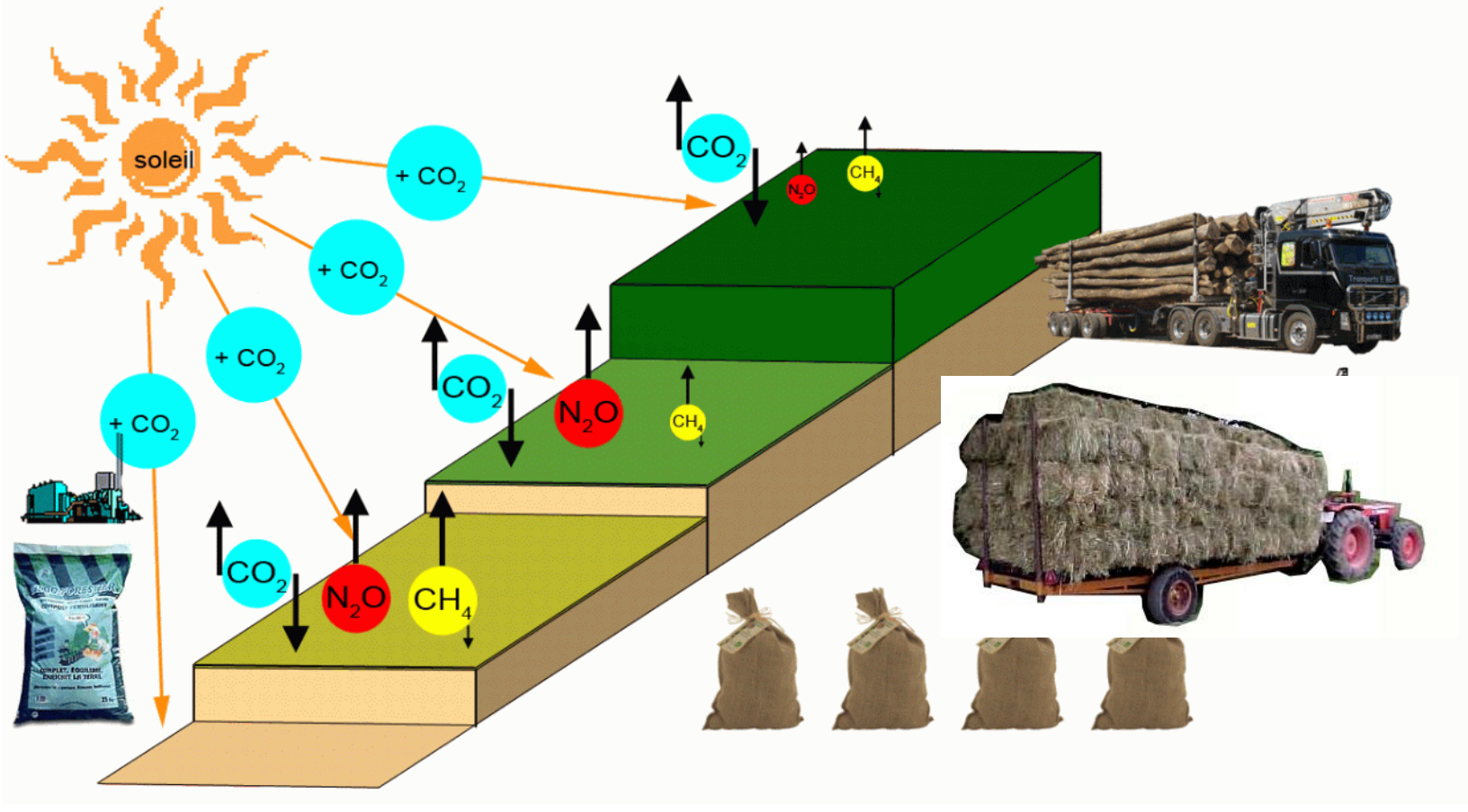
1 tonne of **N_20** = 296 t de CO_2

Gross Emissions

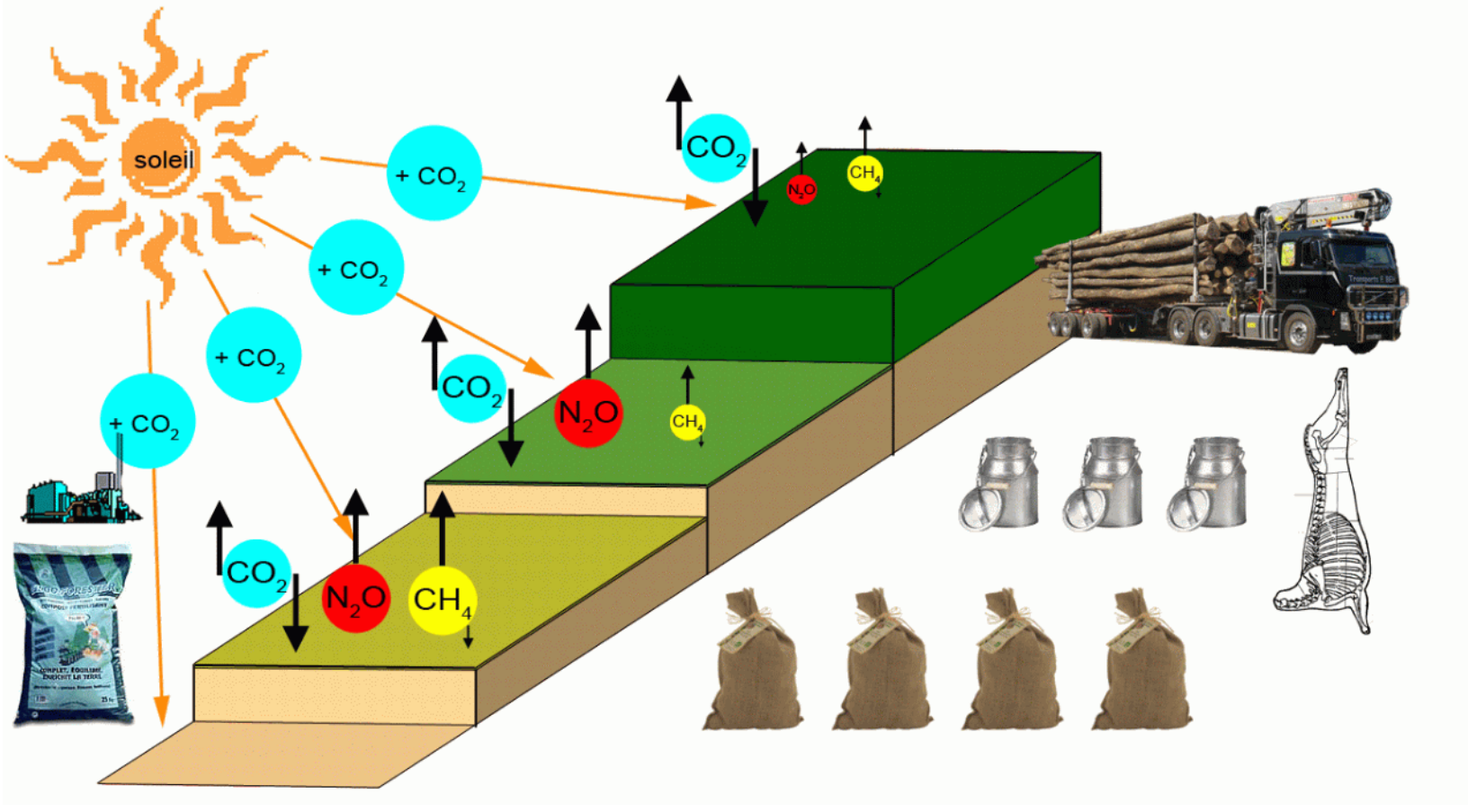


Emissions and uptake of greenhouse gas

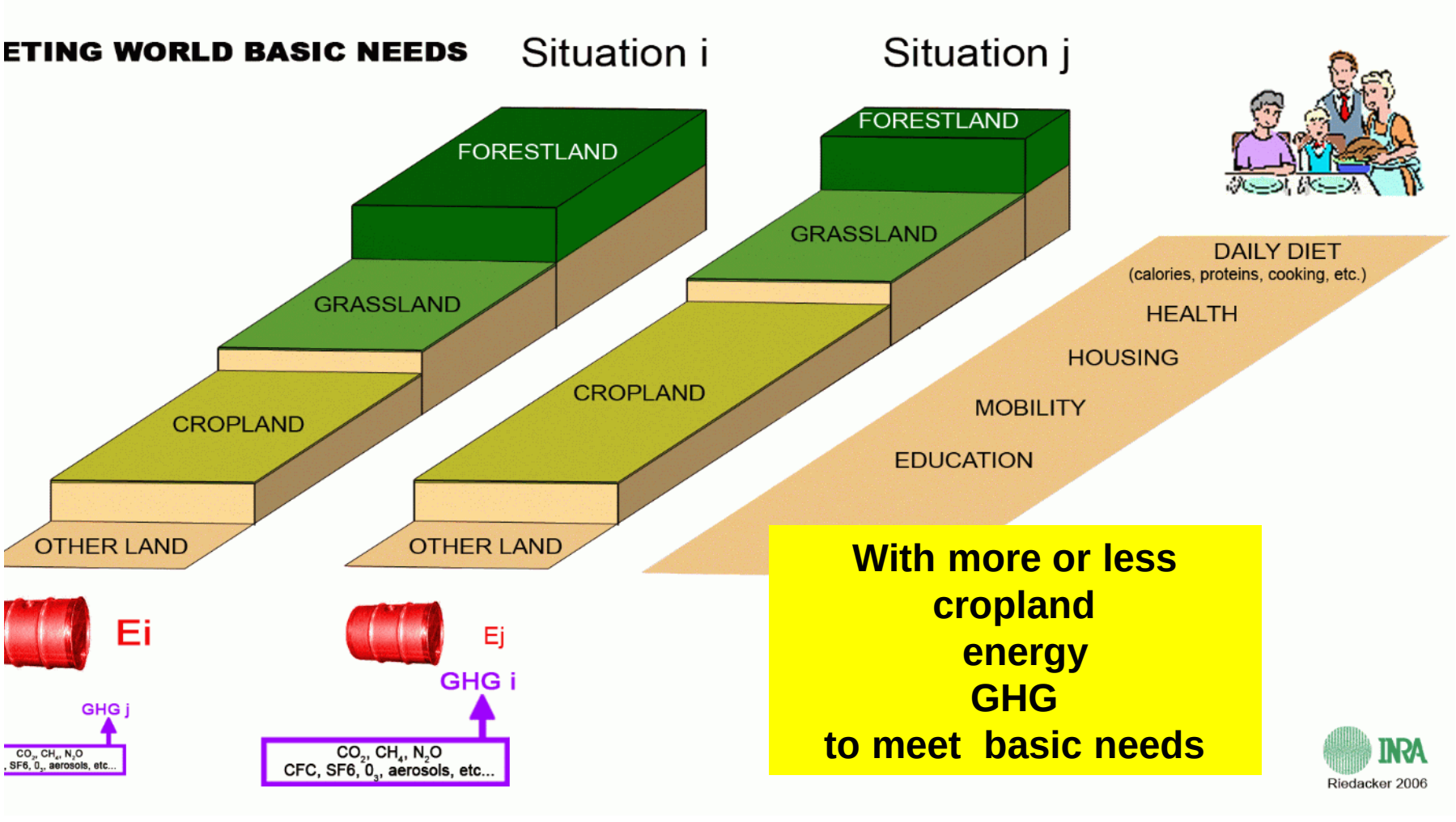
Net emissions at stage I

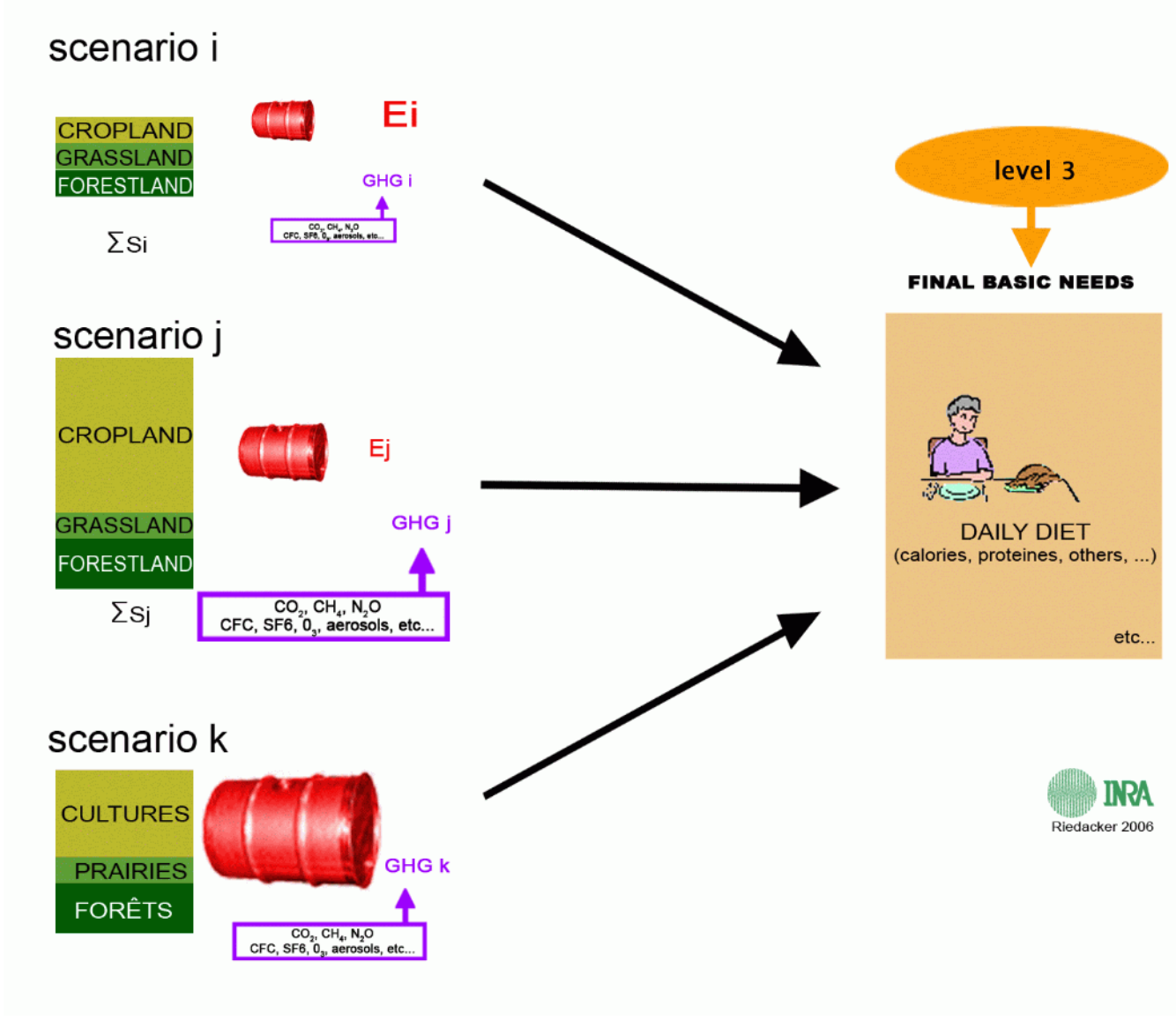


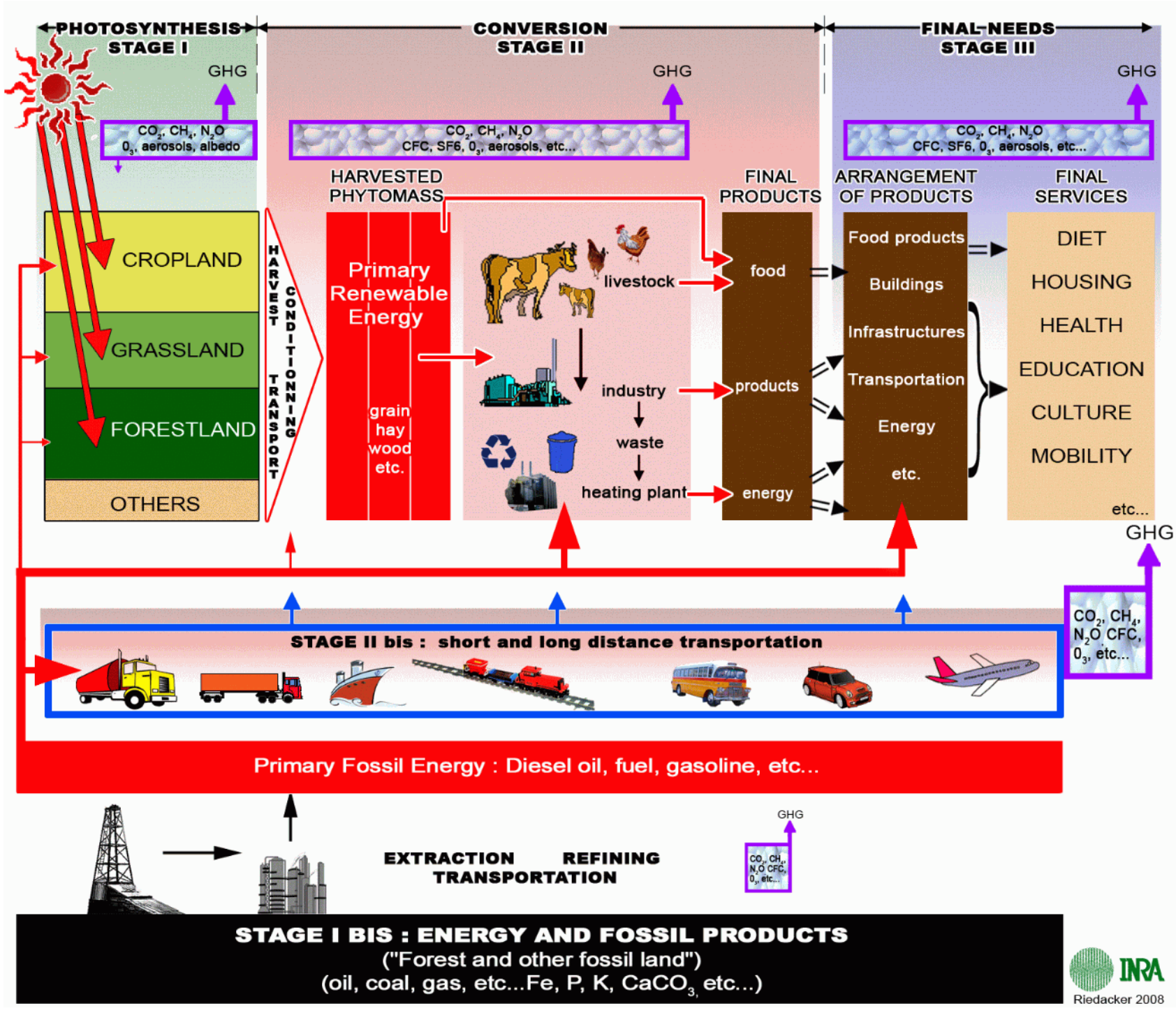
Net emissions at stage II



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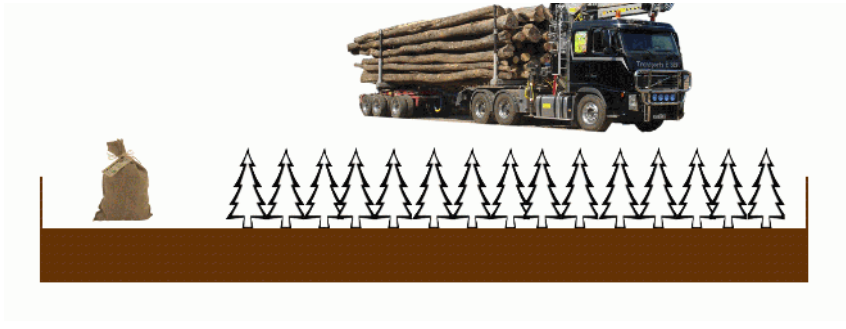
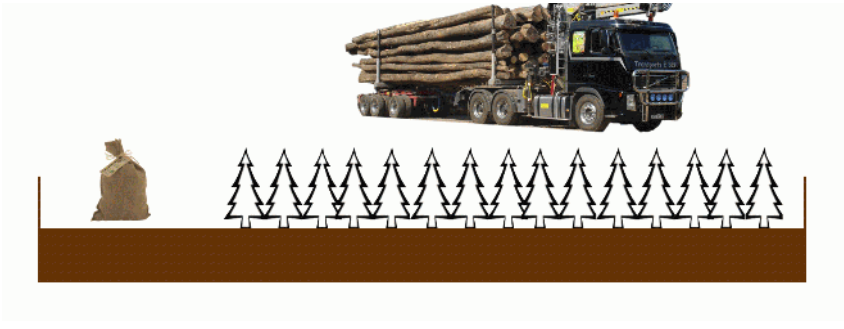
See also Global Land Use and Biomass Approch to Reduce GHG Emissions, Fossil Fuel Use and to Preserve Biodiversity. Triest e 2006
Down load from www.bepress.com/feem/paper12 12

To feed more people => Double crop production

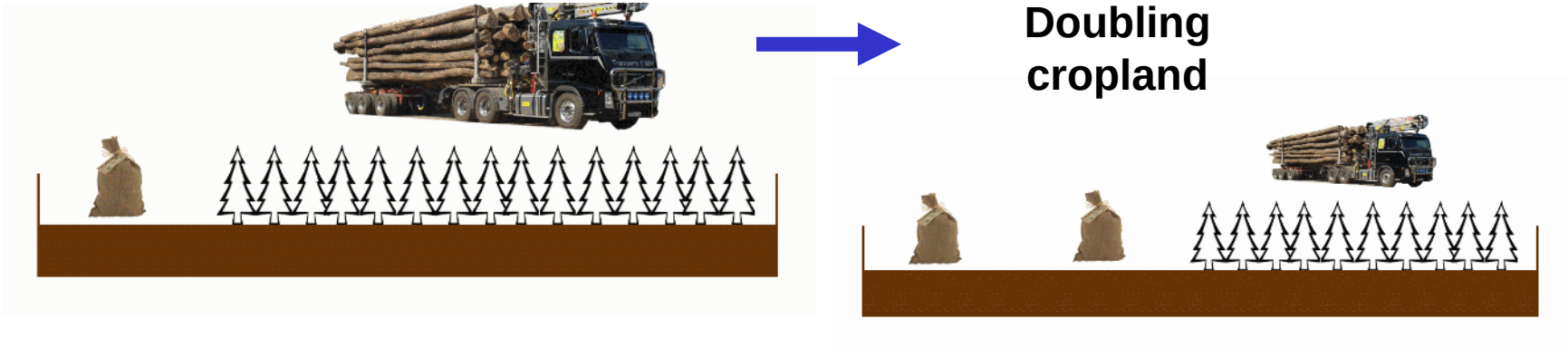


doubling land cultivated ?

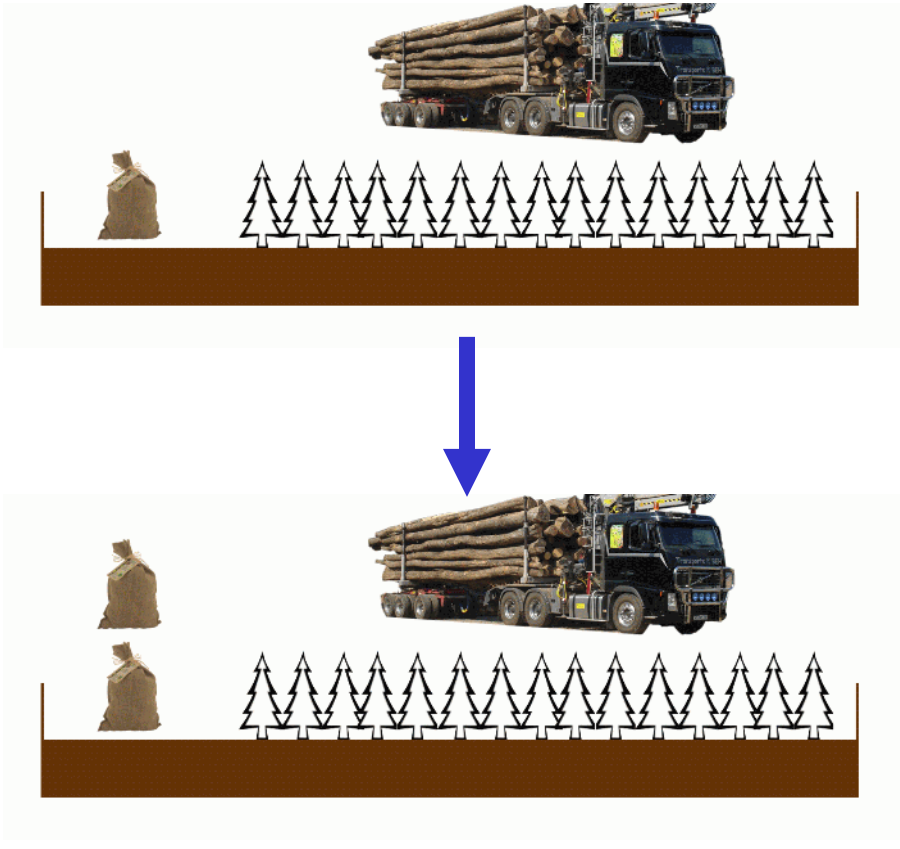
doubling yields?



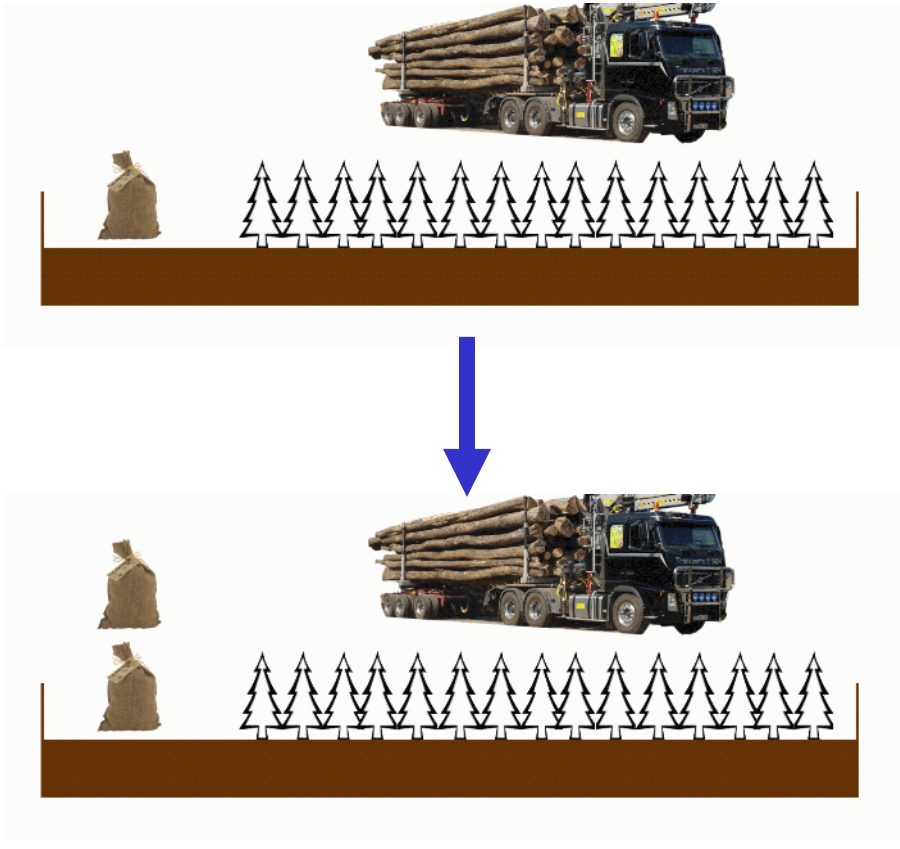
Doubling cropland



Doubling Yields?



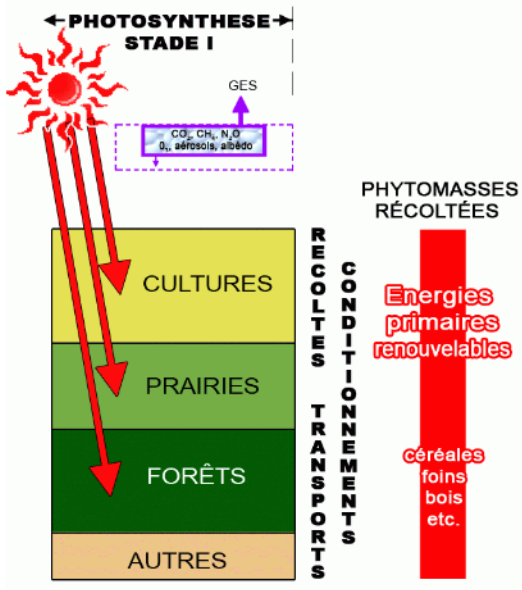
Doubling Yields?



By increasing inputs

and /or

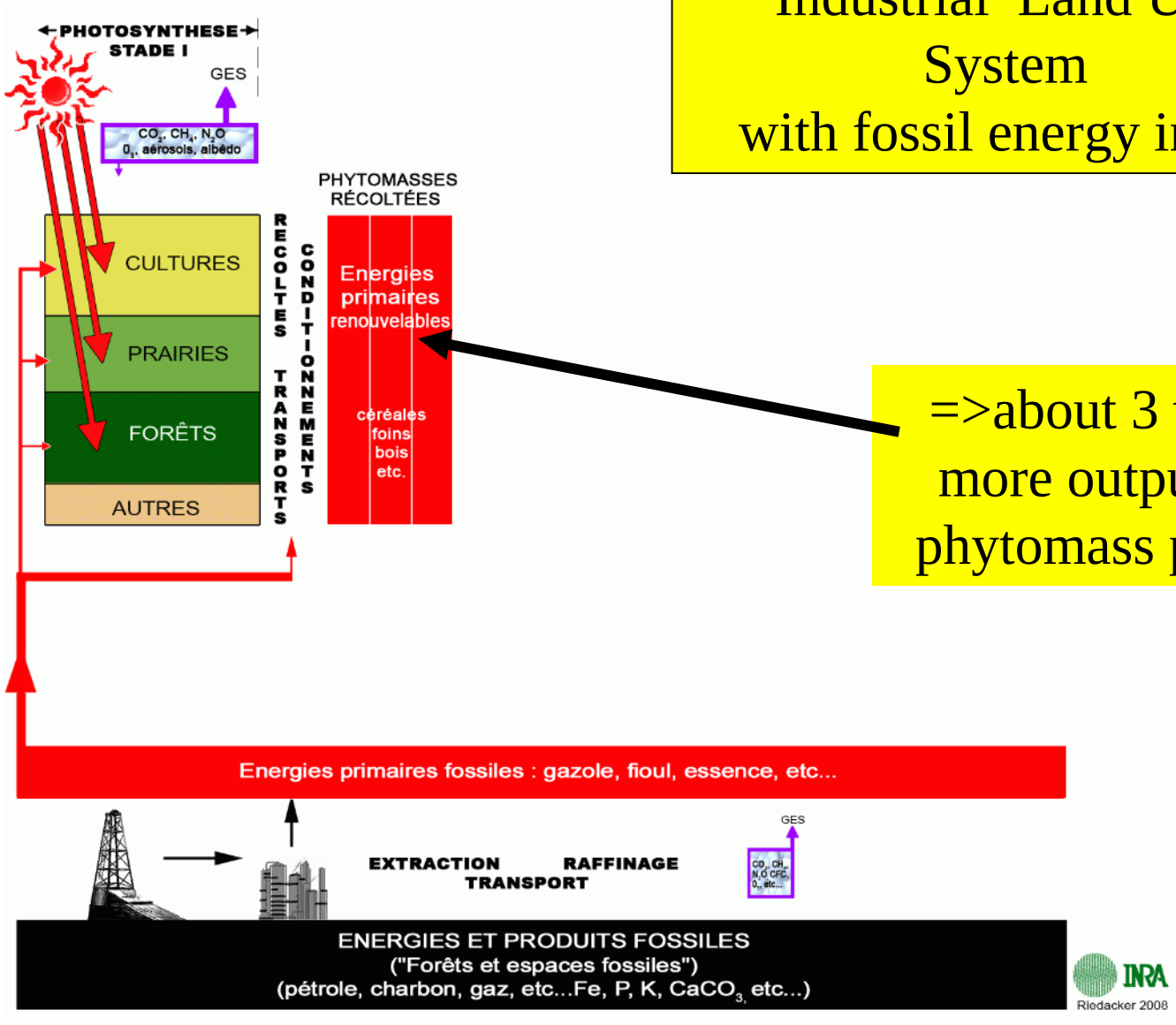
by choosing more productive plants (per ha)



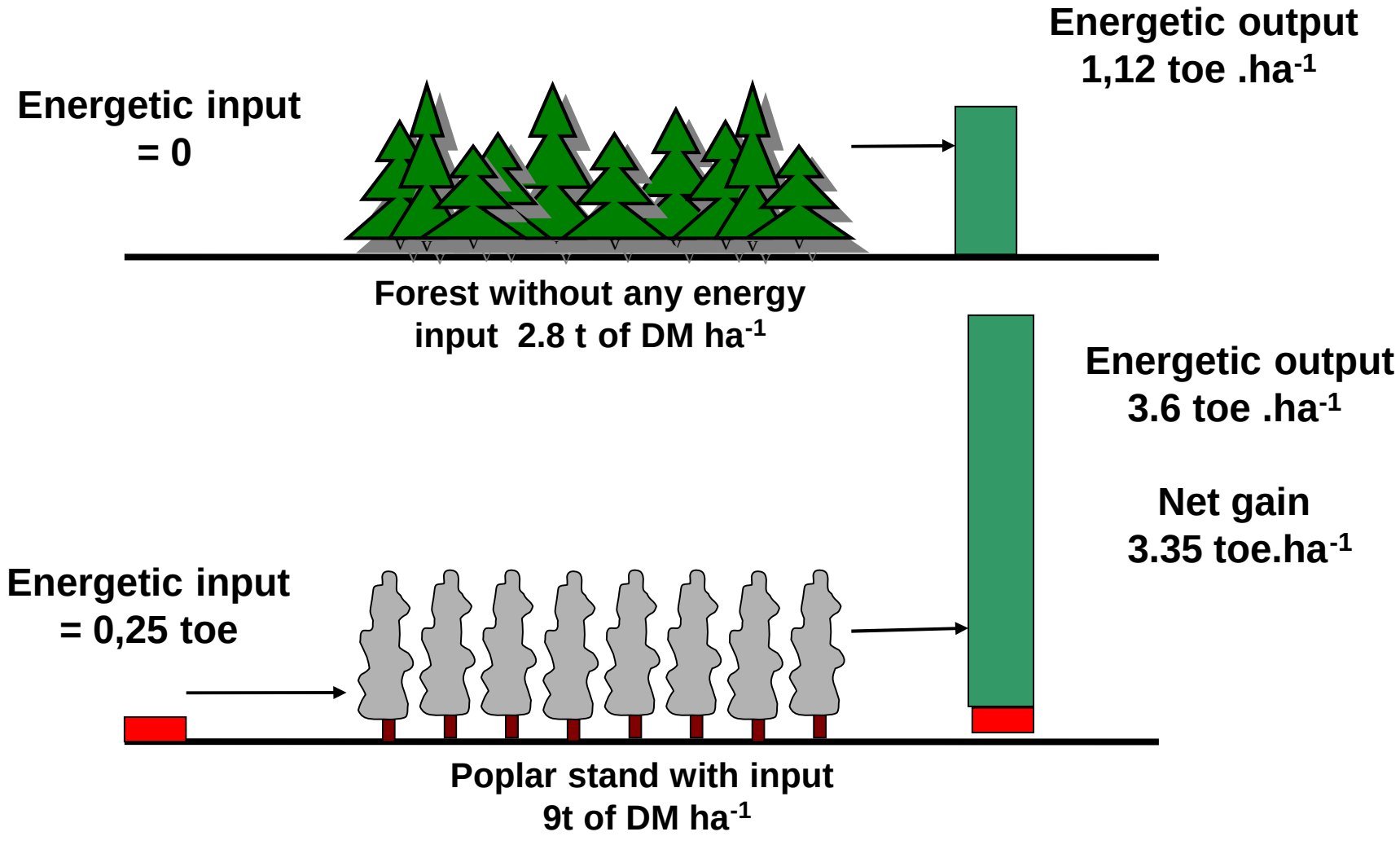
Pre- Industrial Land Use System
without any fossil energy input

INRA
Riedacker 2008

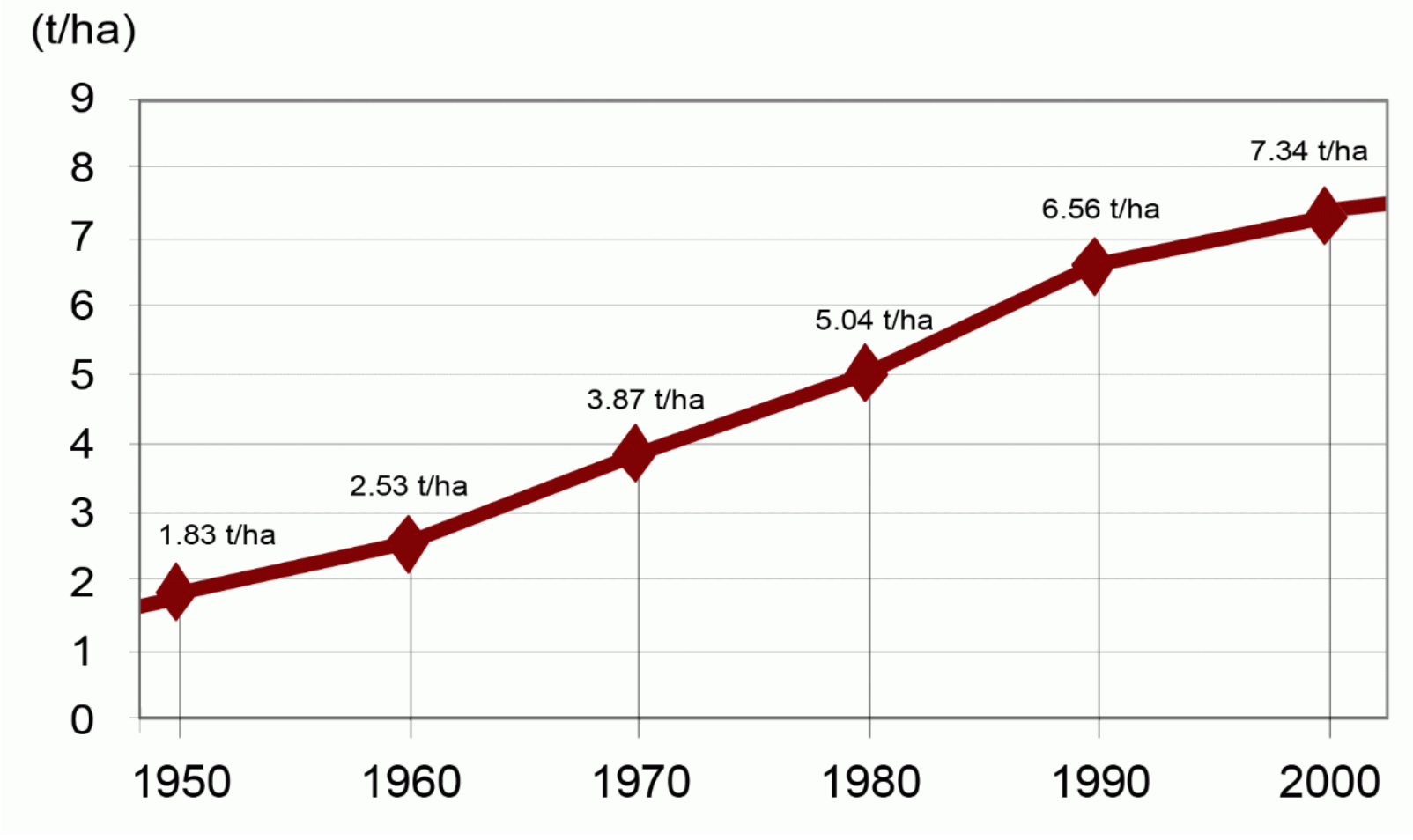
Industrial Land Use System with fossil energy input



=>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



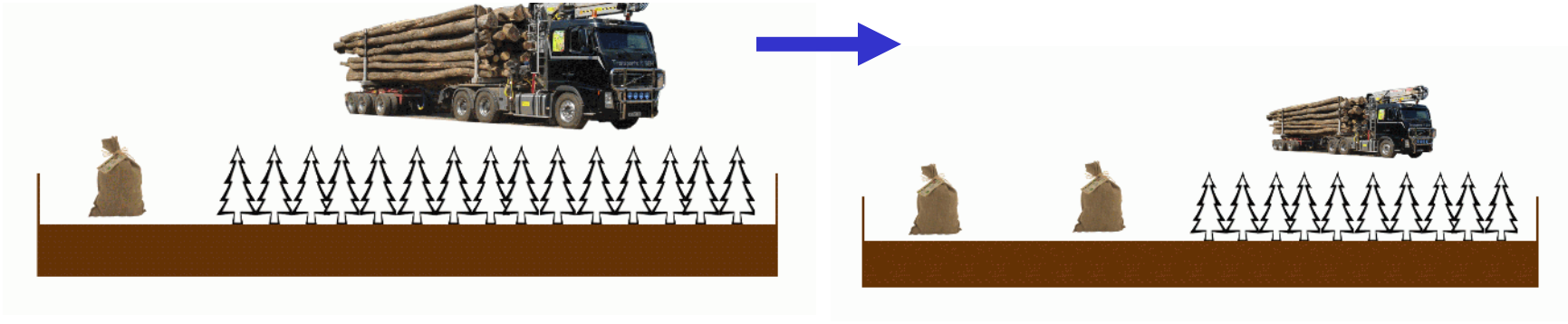
Change in Energy Budget

	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

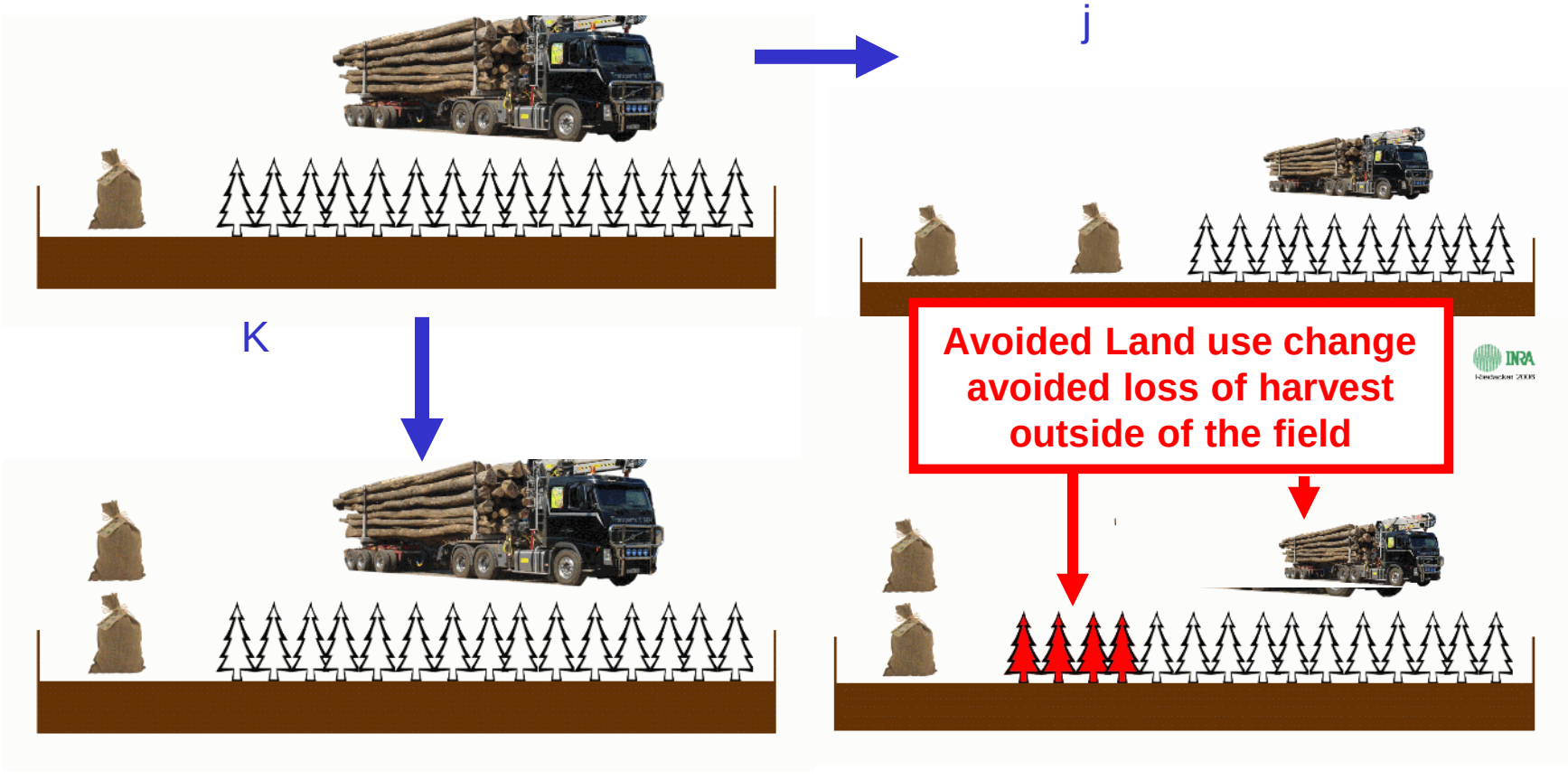
Change in GHG Budget is also positive

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

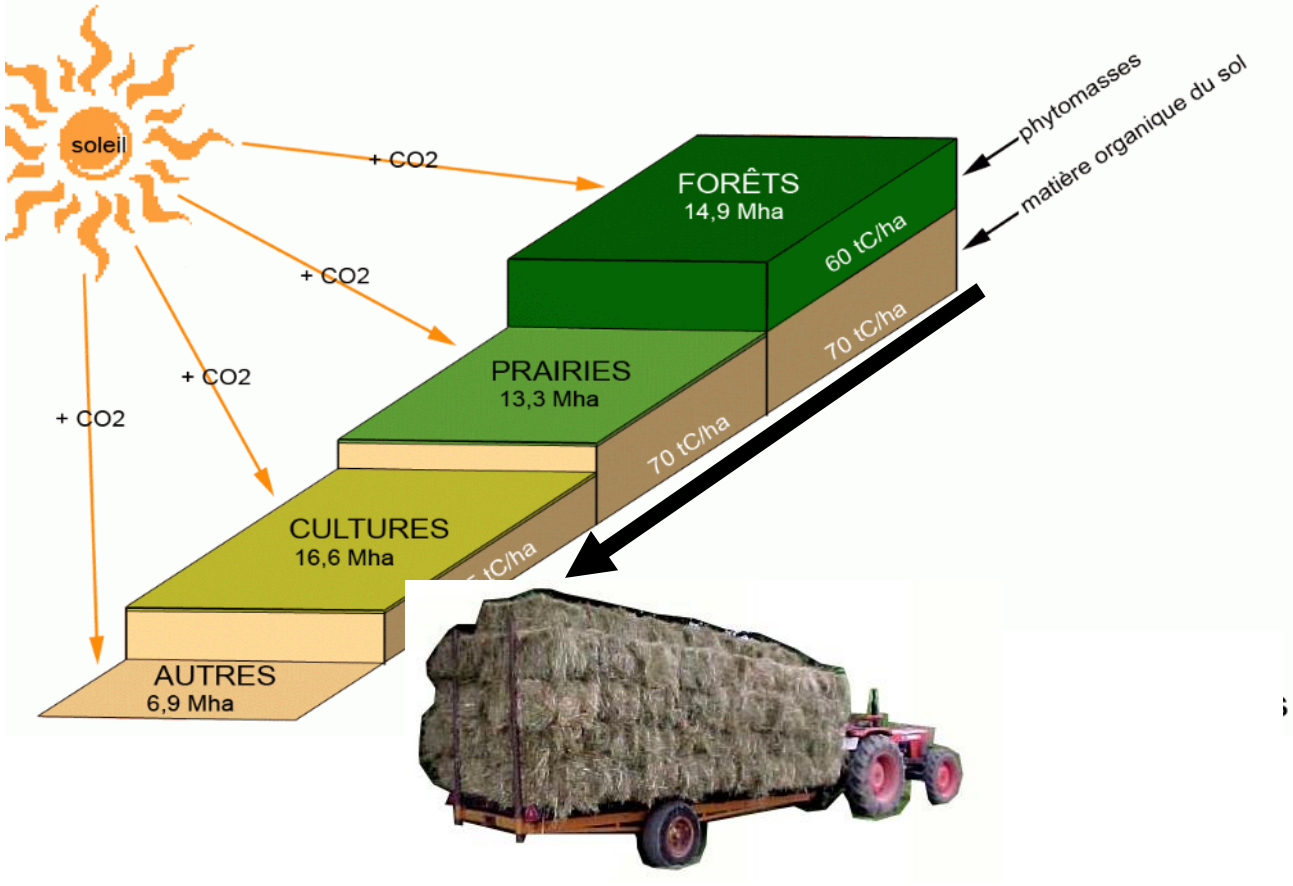


Differences between the two scenarios



LAND USE CHANGE

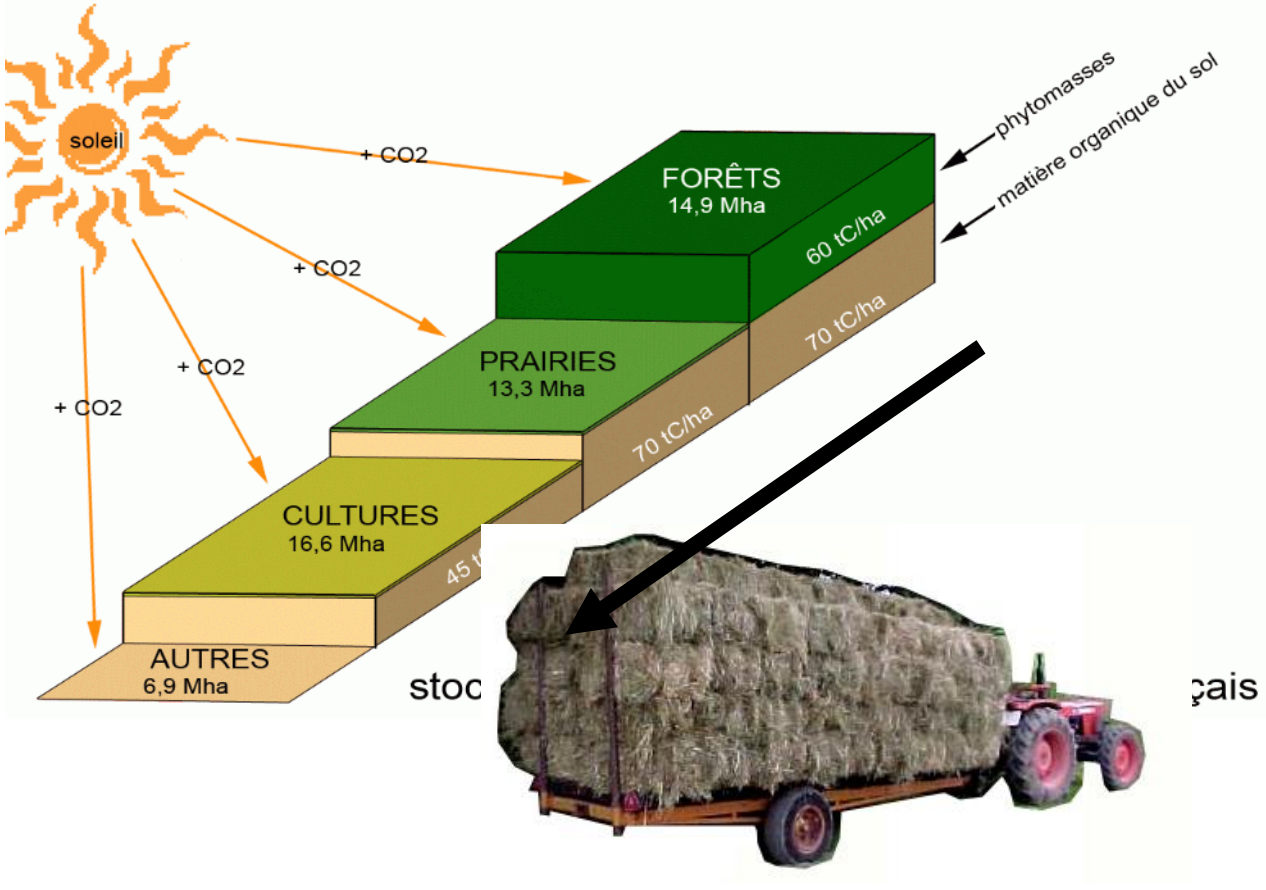
Forest ~312 t CO2 per ha



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

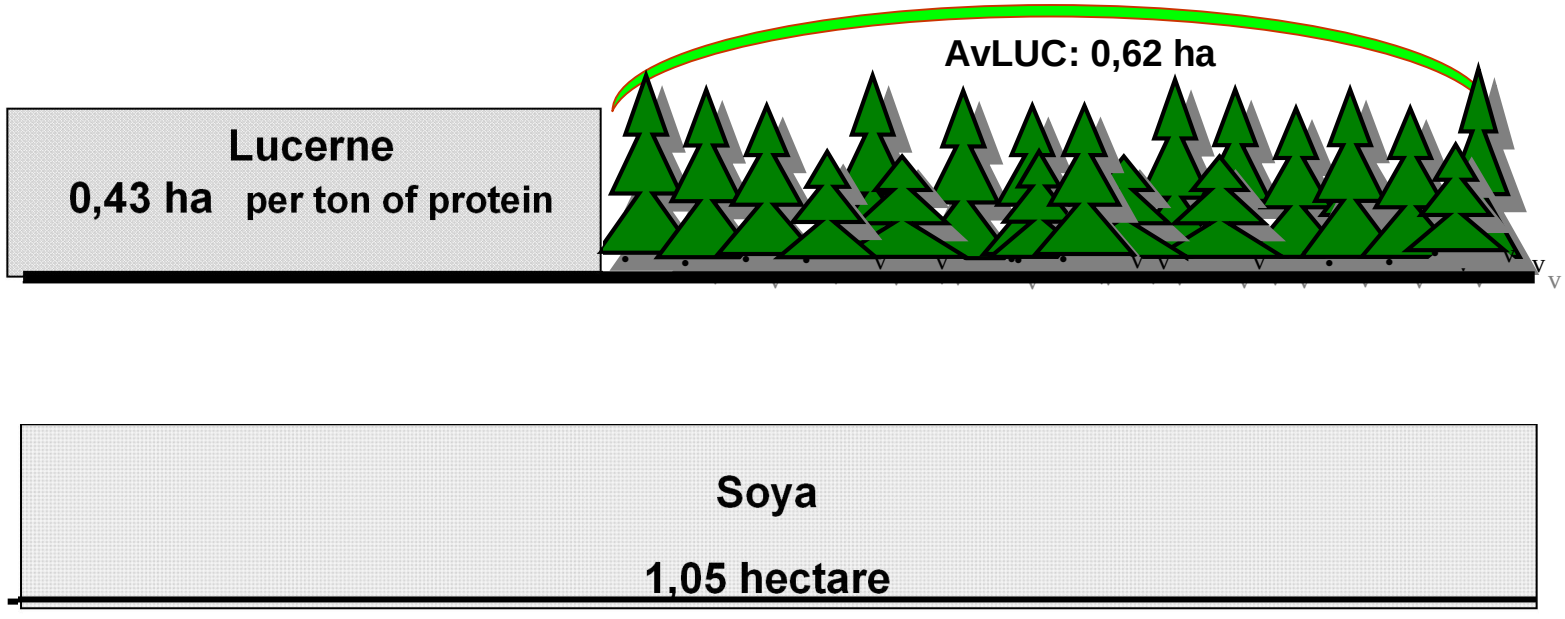


Gross Émissions

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

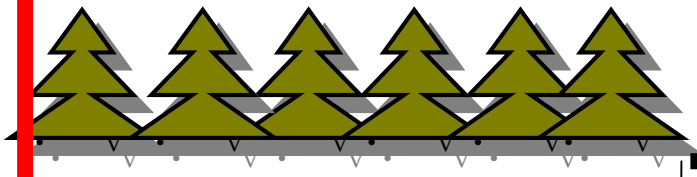


Land required to produce 1 t of protein

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

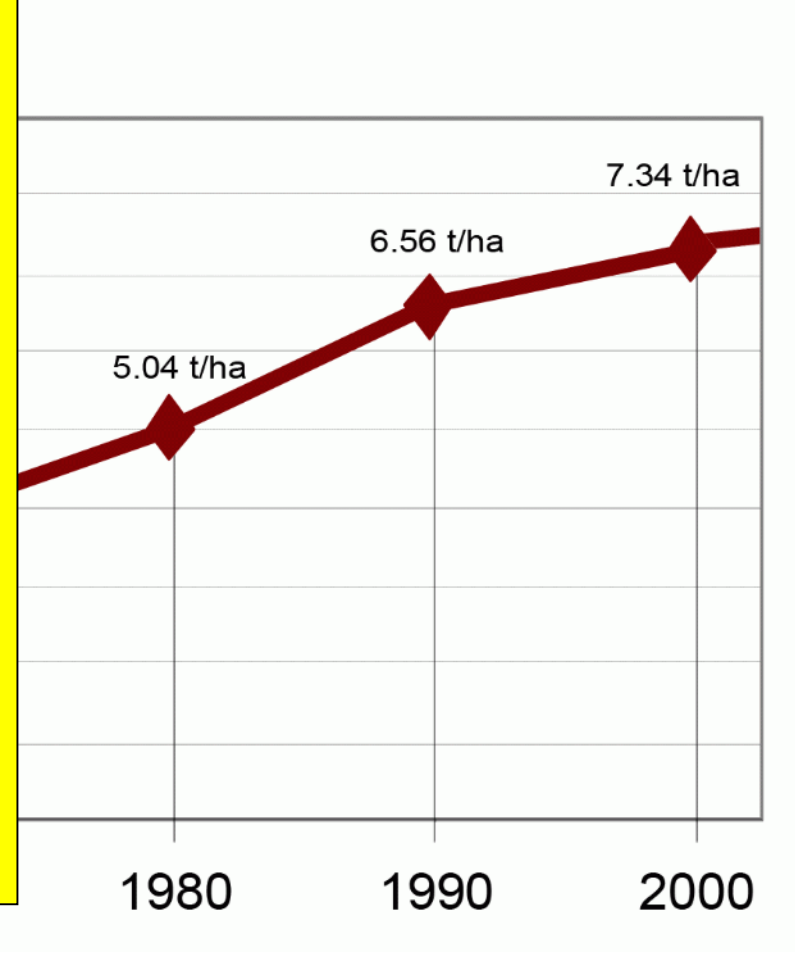
we saved in France

- **27 Mha**

and in spite of

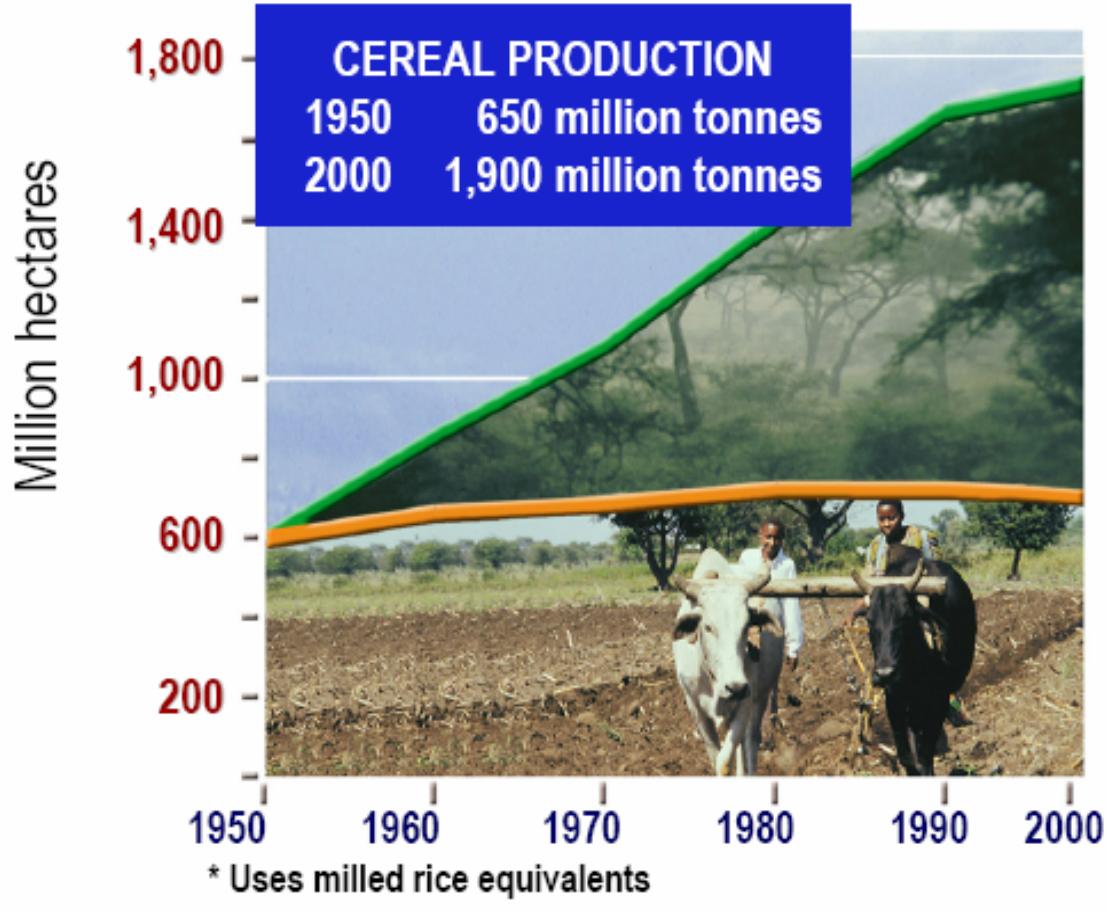
increased inputs

- **60 millions tCO2 equivalent per year**



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

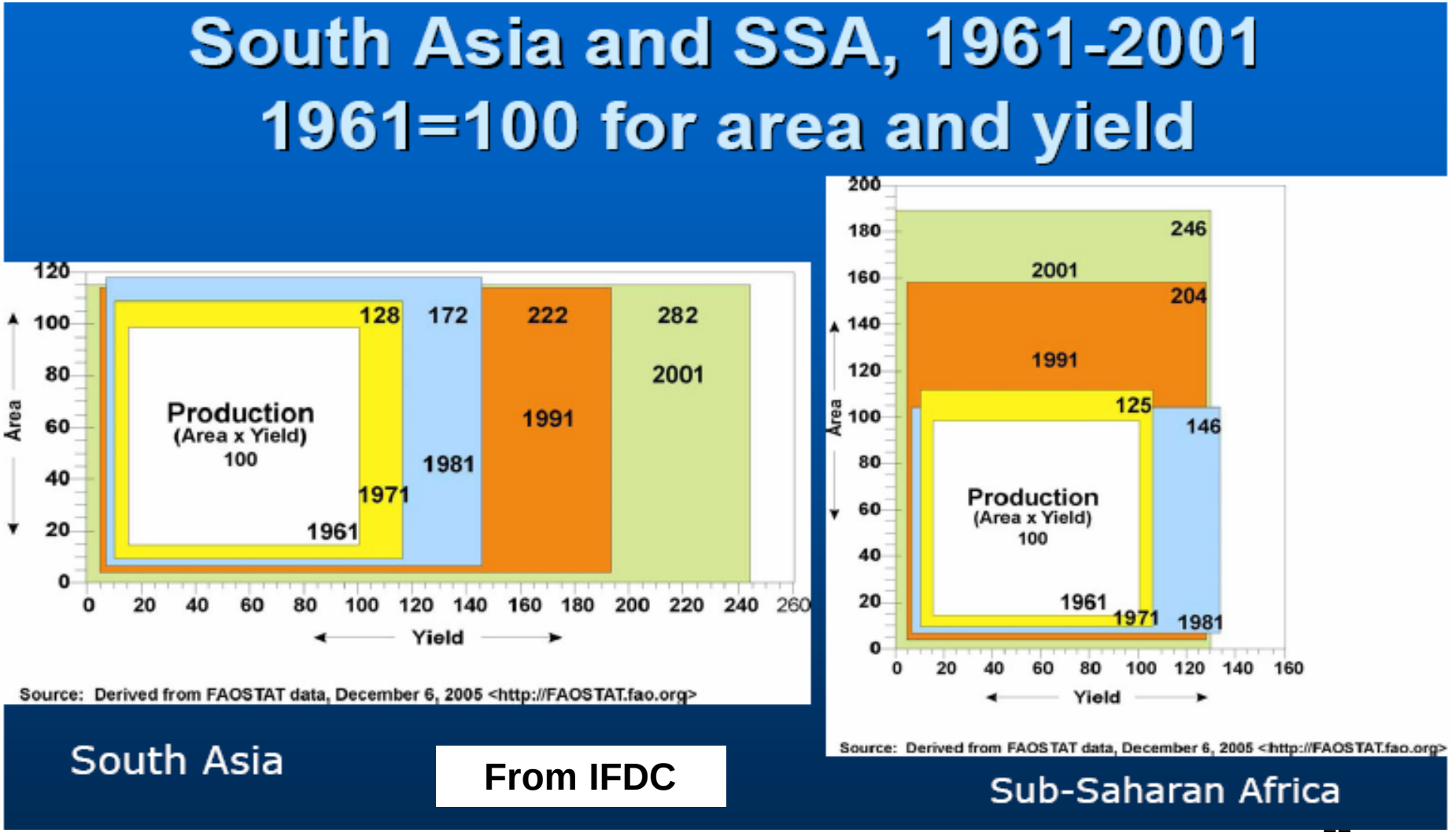
World Cereal* Production–Areas Saved Through Improved Technology, 1950-2000



LAND SPARED 1.1 billion ha

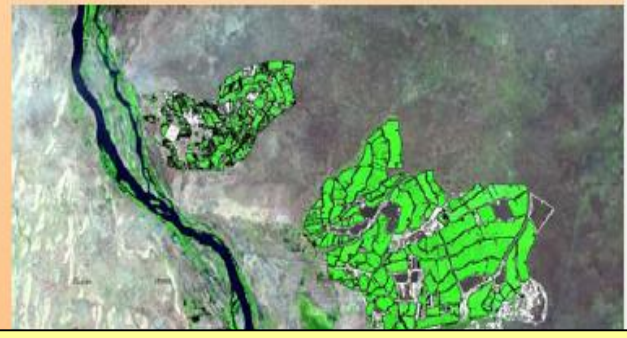
LAND USED 660 million ha

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

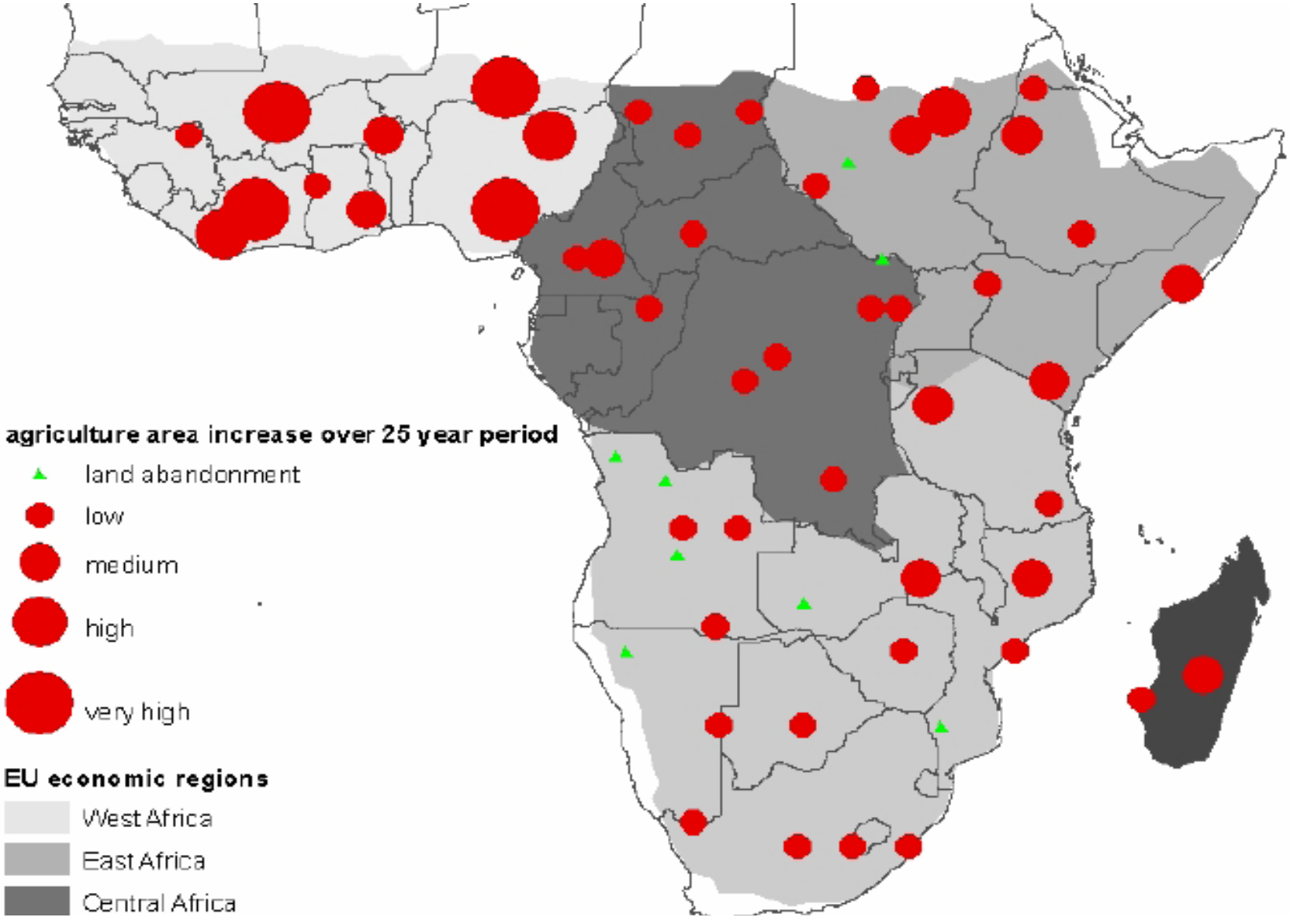
H.D. Eva, A. Brink and D. Simonetti

Between 1975 and 2000

~1 billions ton of CO2 per year

About twice the annual emissions of France

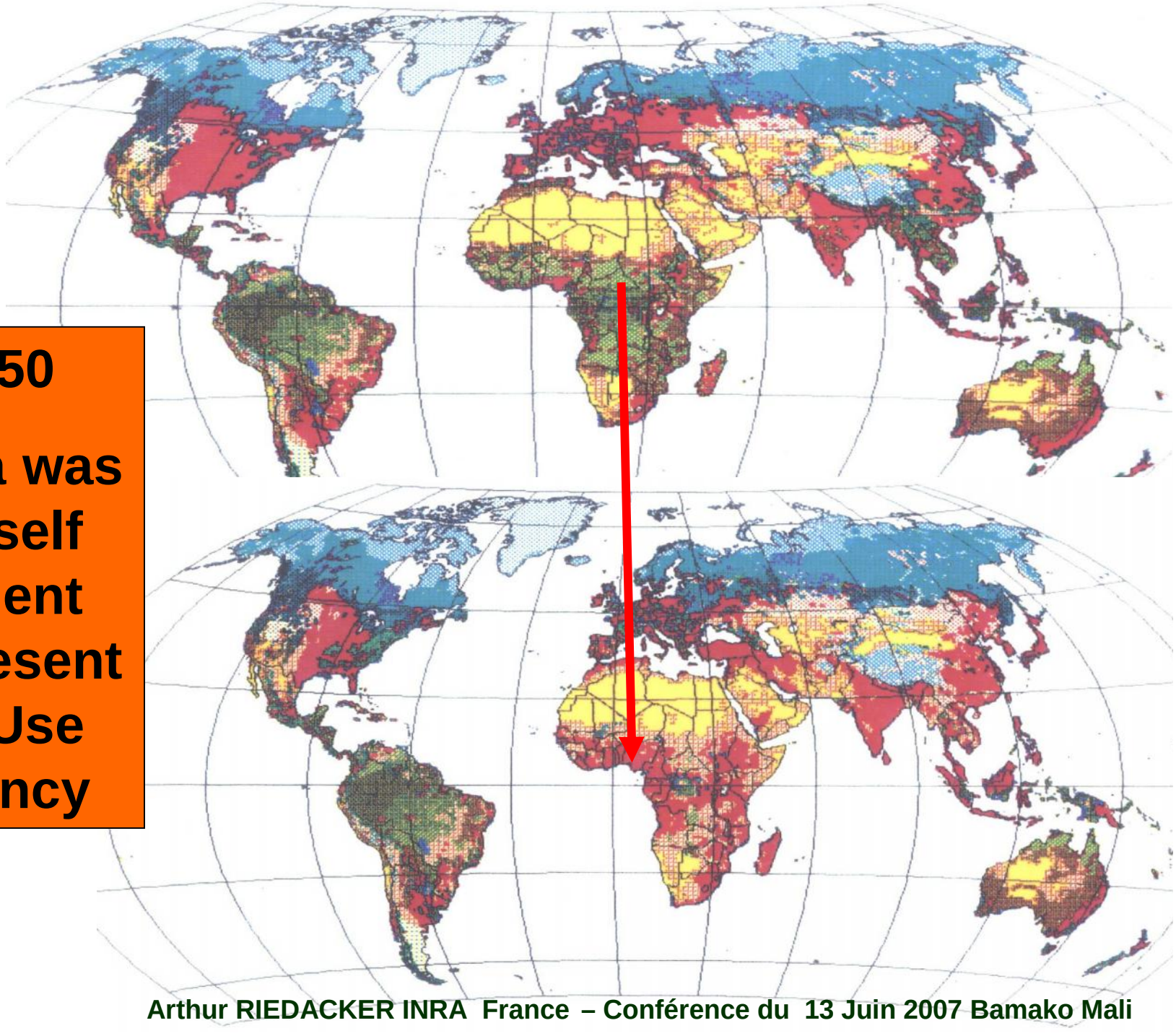
Land Use Change



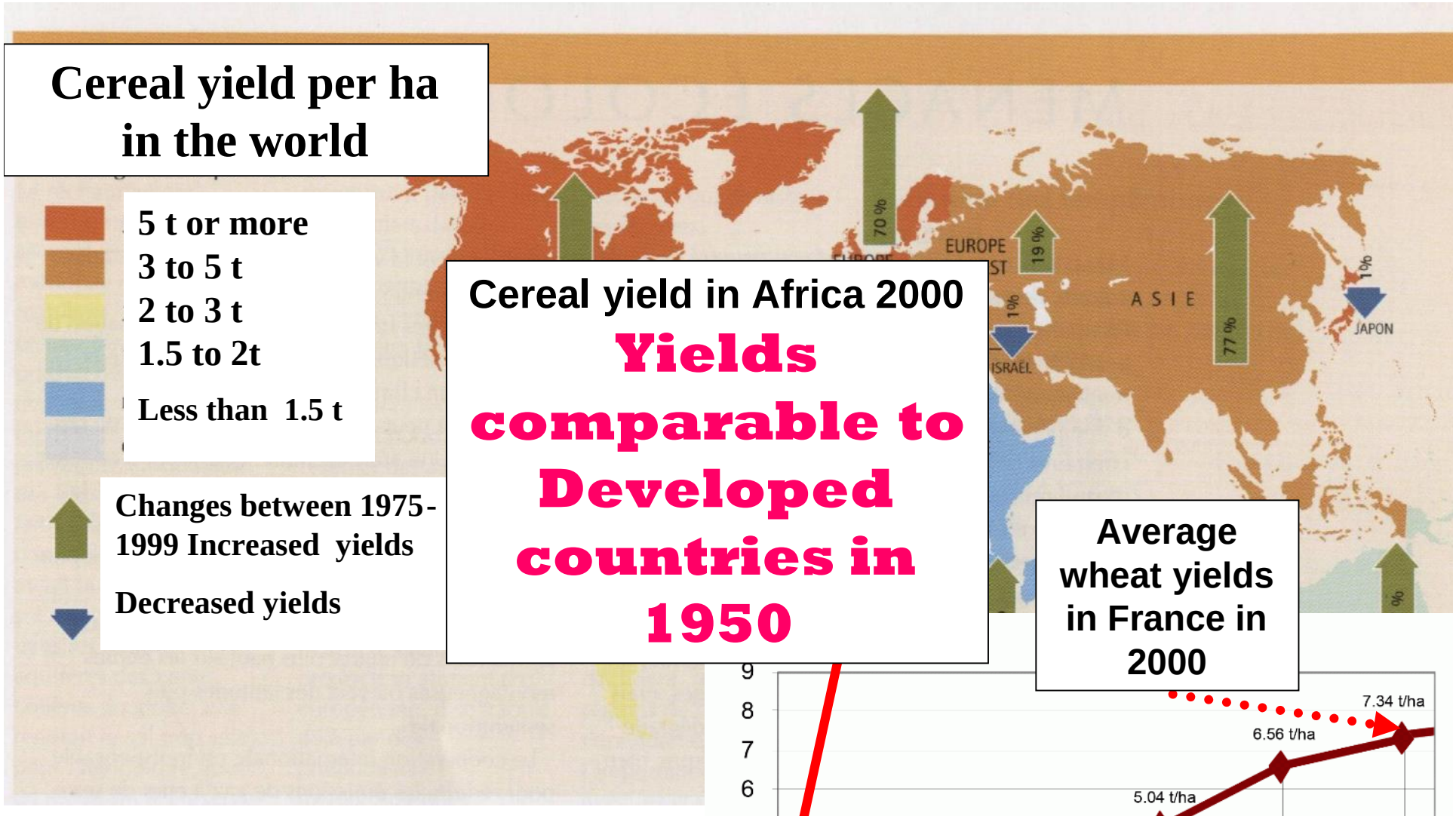
1990

In 2050

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



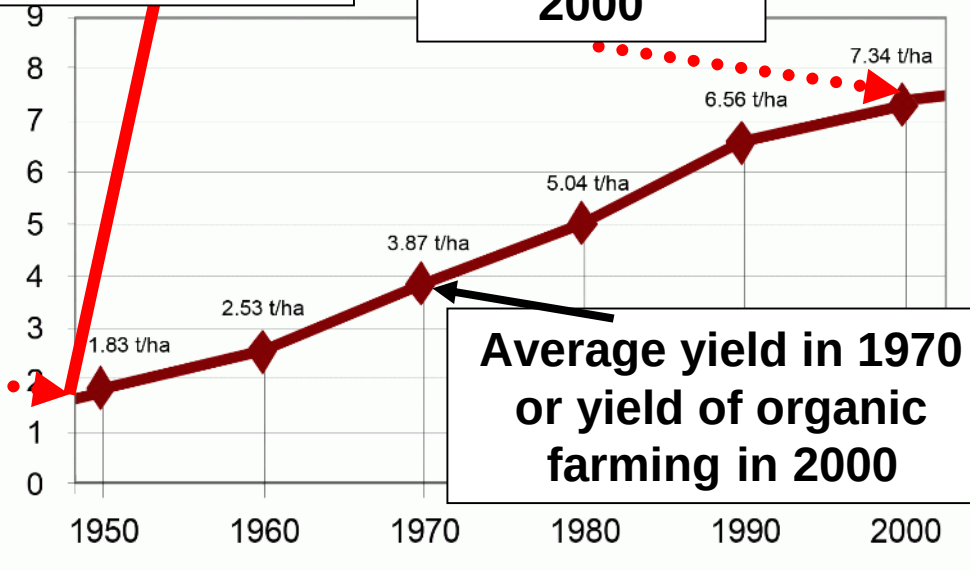
Cereal yield per ha in the world



Cereal yield in Africa 2000

Yields comparable to Developed countries in 1950

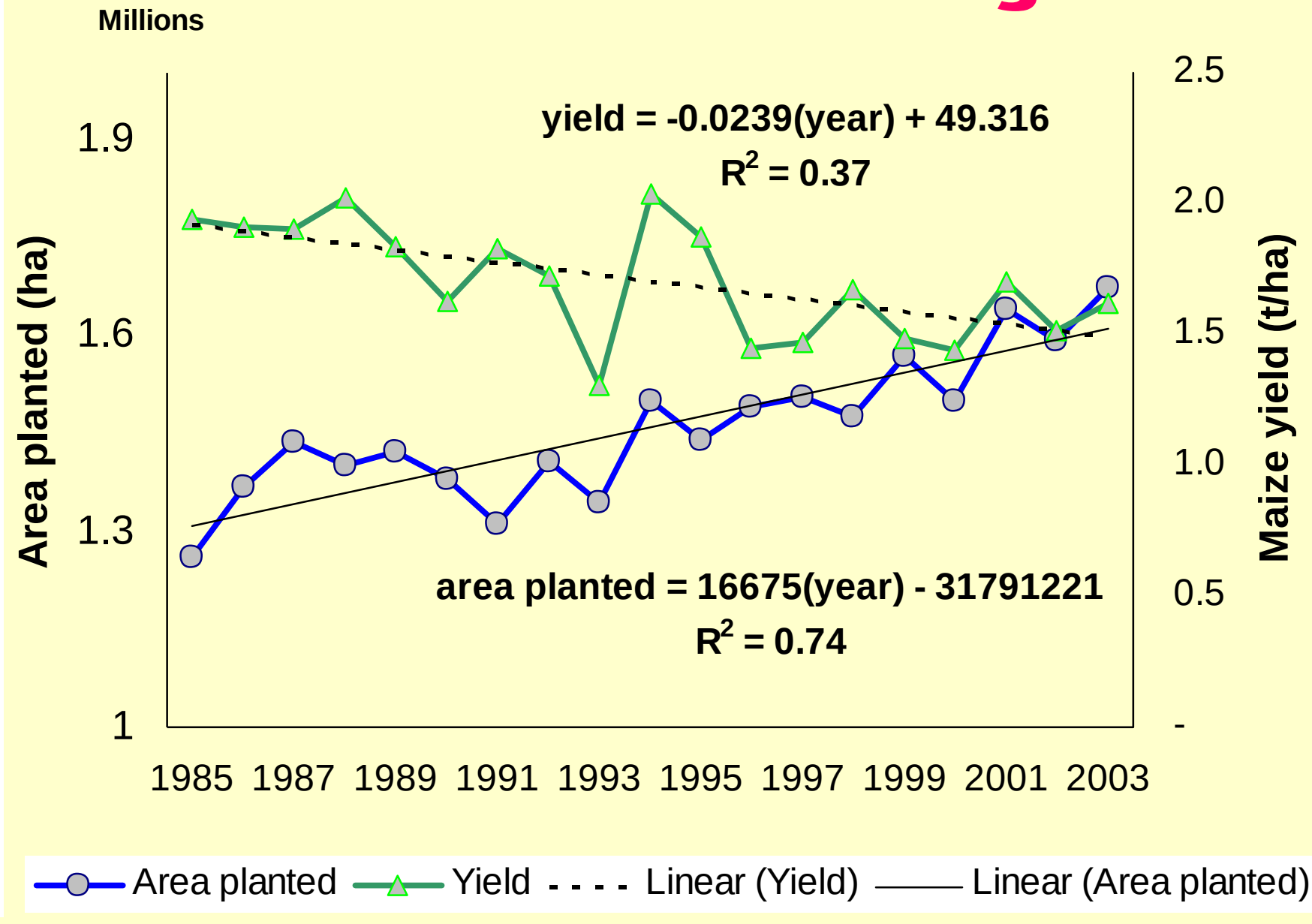
Average wheat yields in France in 1950



Average wheat yields in France in 2000

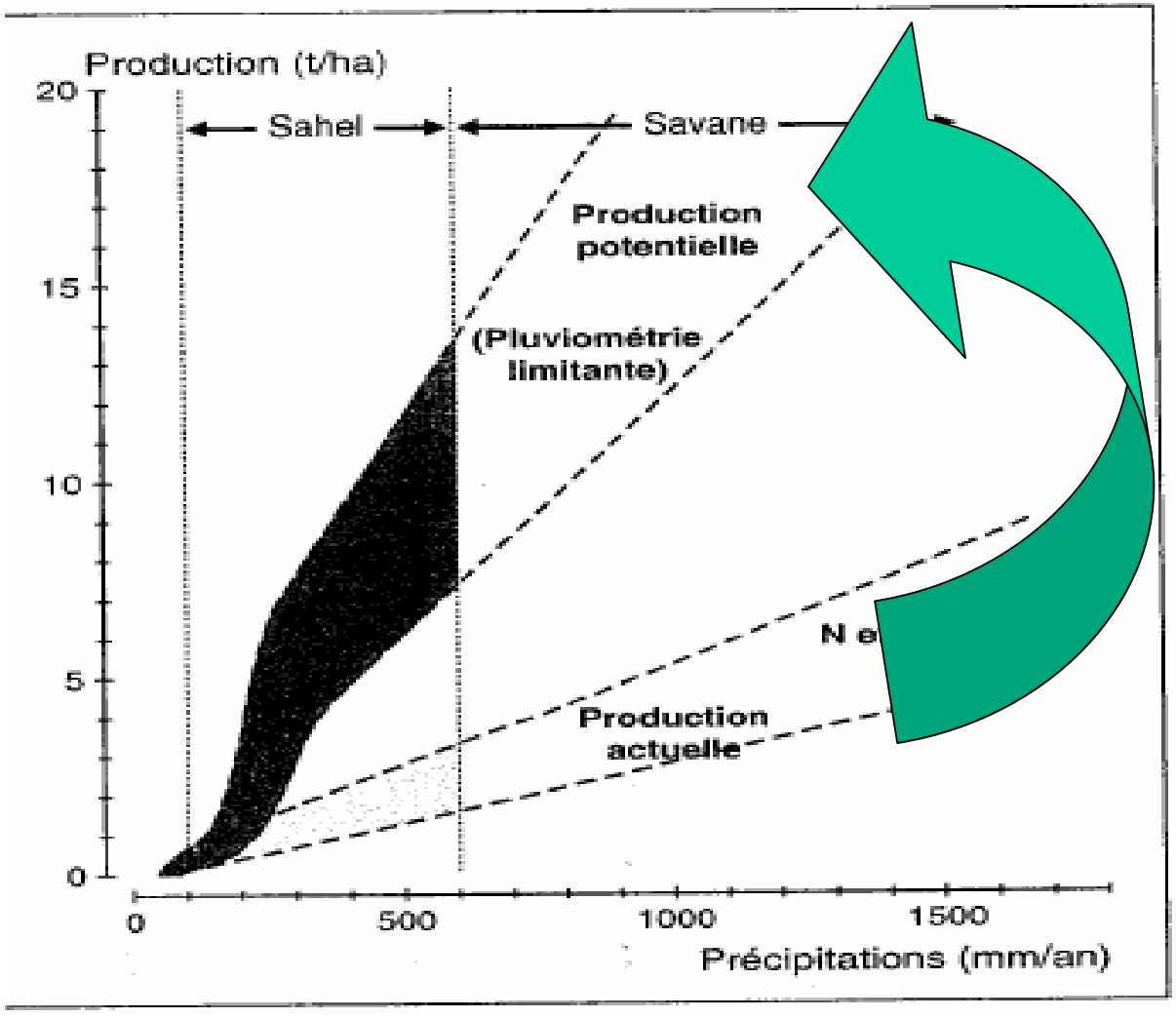
Average yield in 1970 or yield of organic farming in 2000

And even decreasing



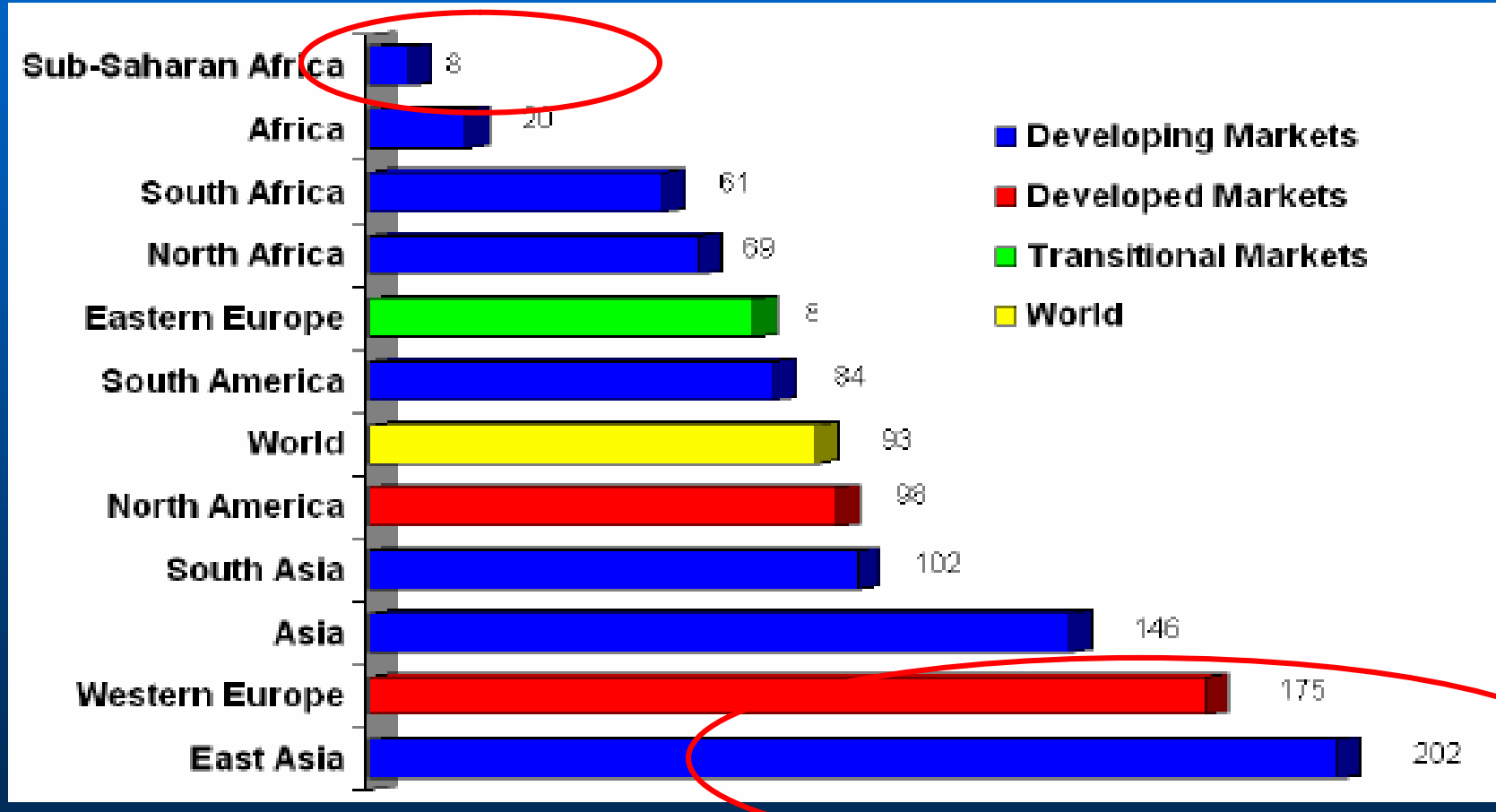
Maize Yield and area trends for Kenya (nat. statistics)

Yields can be increased with some fertilizer



Yields are to low due to mineral deficiency

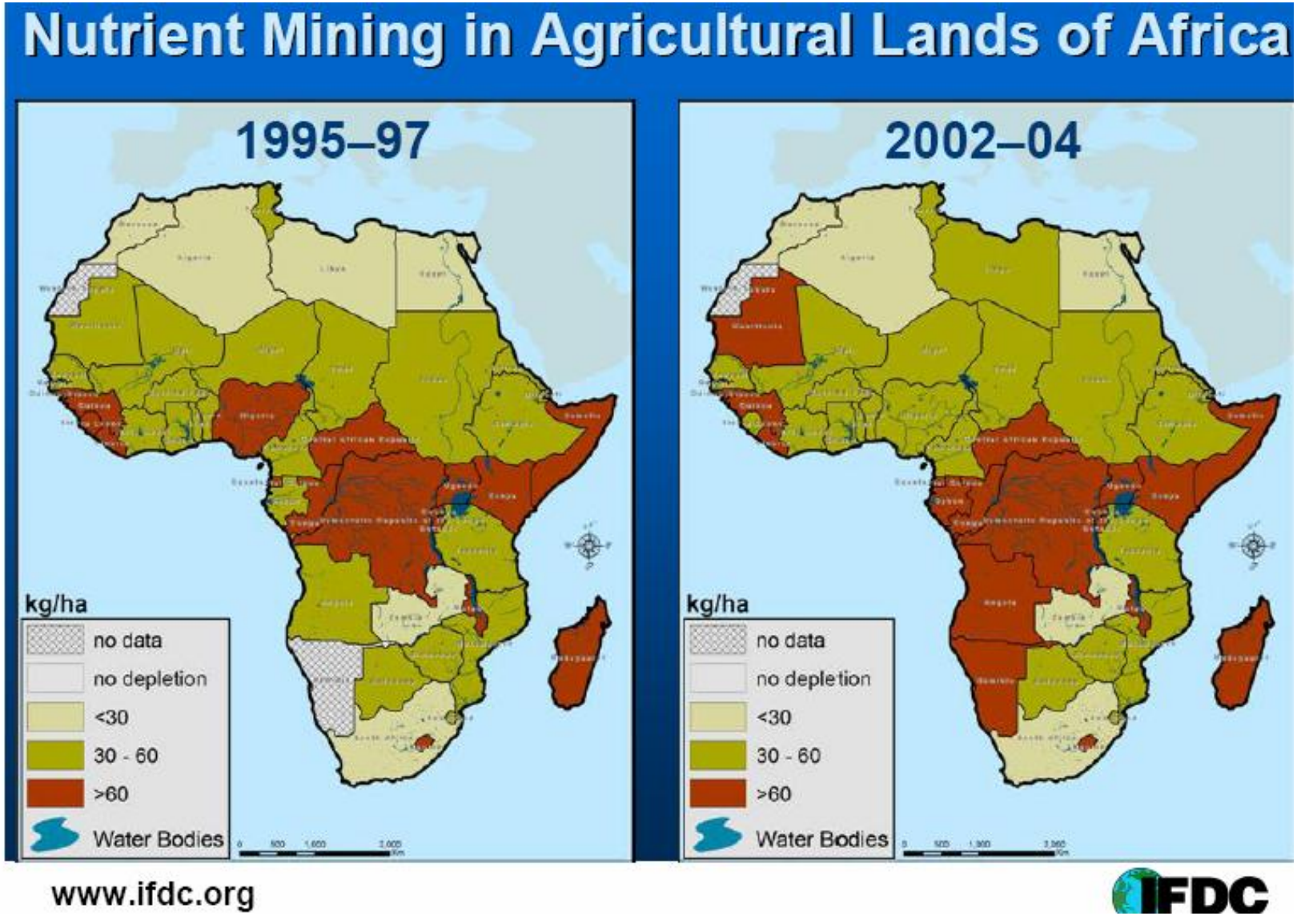
Per Hectare Fertilizer Use by Markets 2002/03 (kg/ha)



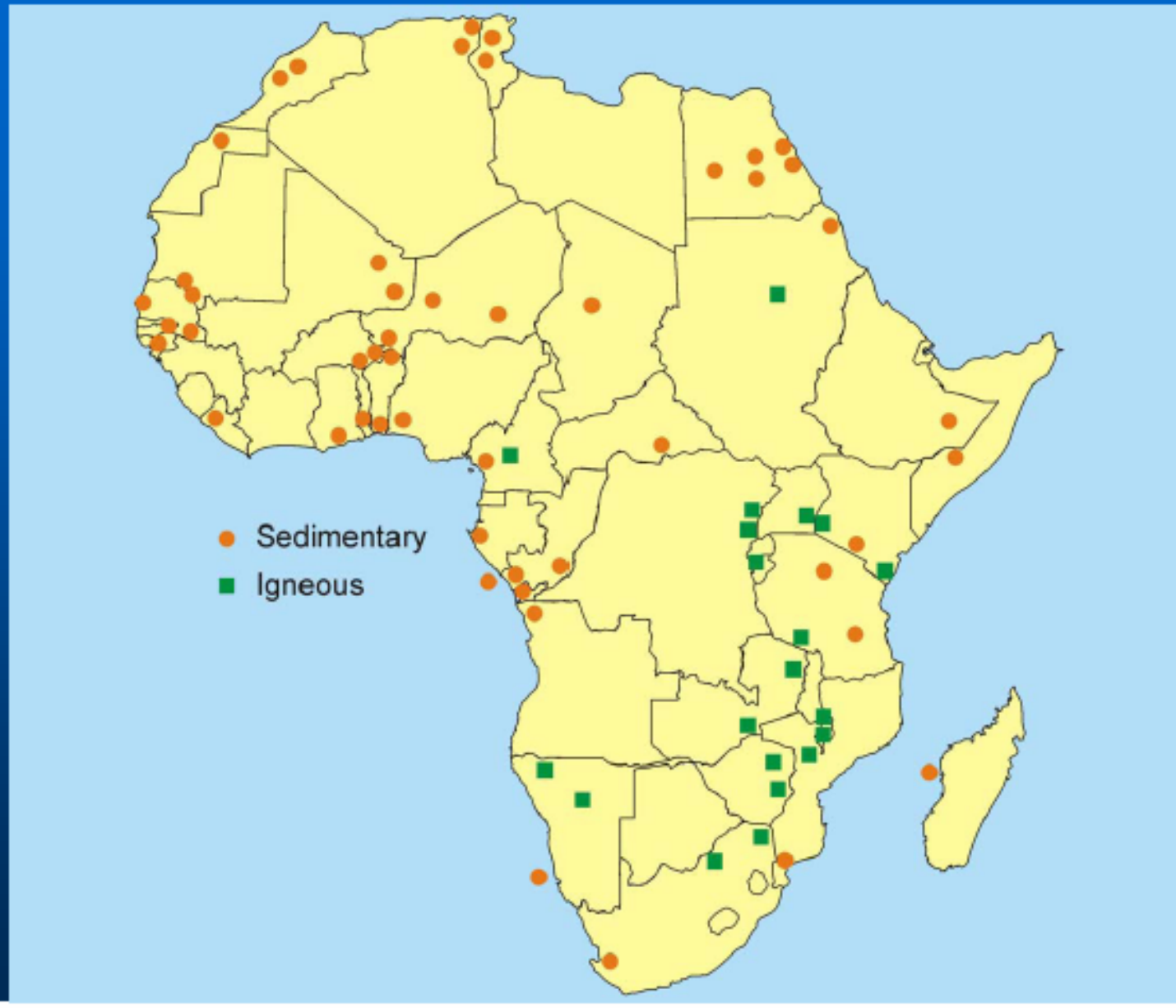
www.ifdc.org

IFDC

Agriculture is not sustainable

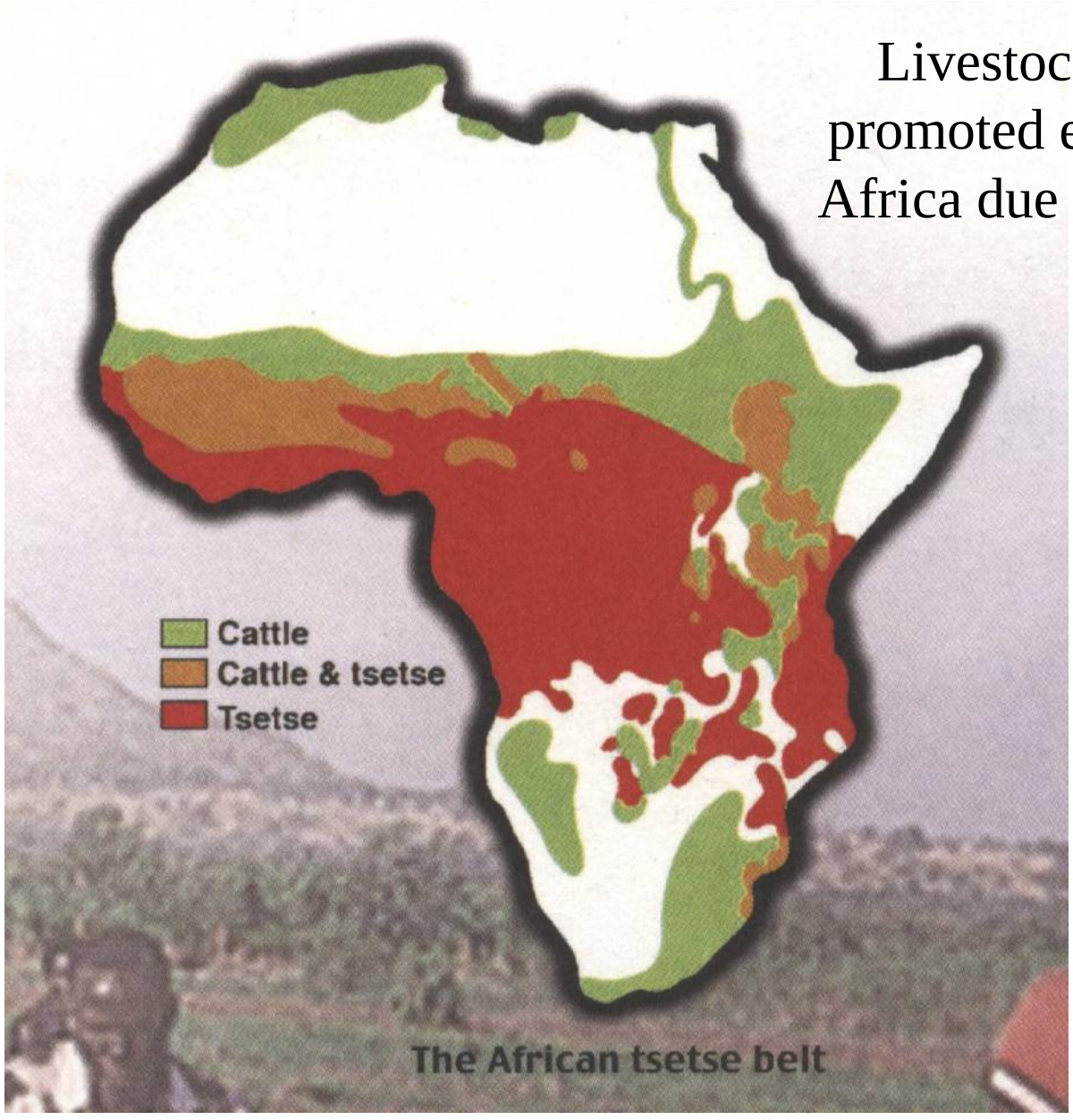


Significant Phosphate Deposits of Africa



www.ifdc.org

IFDC



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**

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and AASF aasf@gwdg.de