

# Ten Commandments For Global Agriculture



**Ismail Serageldin**

**World Food Prize Meetings**

**19 October 2006**

# Outline

## I. Prologue

## II. Revisiting Some Main Themes:

- Globalization, Trade And Policy
- Food Security And Production
- The Role Of Science

## III. The Ten Commandments For Global Agriculture

# I. Prologue

**Why Agriculture?  
Why Global?**

**“We are all on this earth as guests  
of the green plants and those who  
tend them.”**

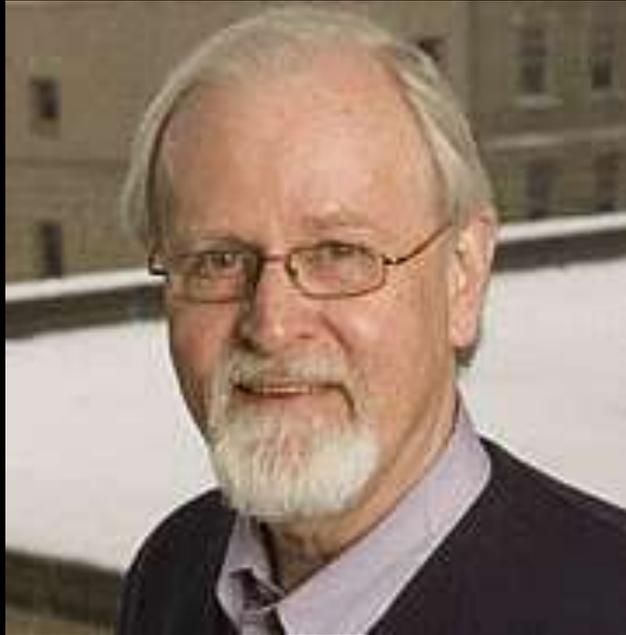


**-- M.S. Swaminathan**

**Agriculture  
is the key to  
Poverty reduction,  
environmental stewardship, and  
food security.**

**The single biggest issue blocking  
a new Trade Agreement**

# Acknowledgement



**Some of this material was kindly provided by Gurdev Khush from his BioVision Lecture and By Per Pinstrup-Anderson from His Wageningen Lectures**

## **II. Revisiting Some Key Themes**

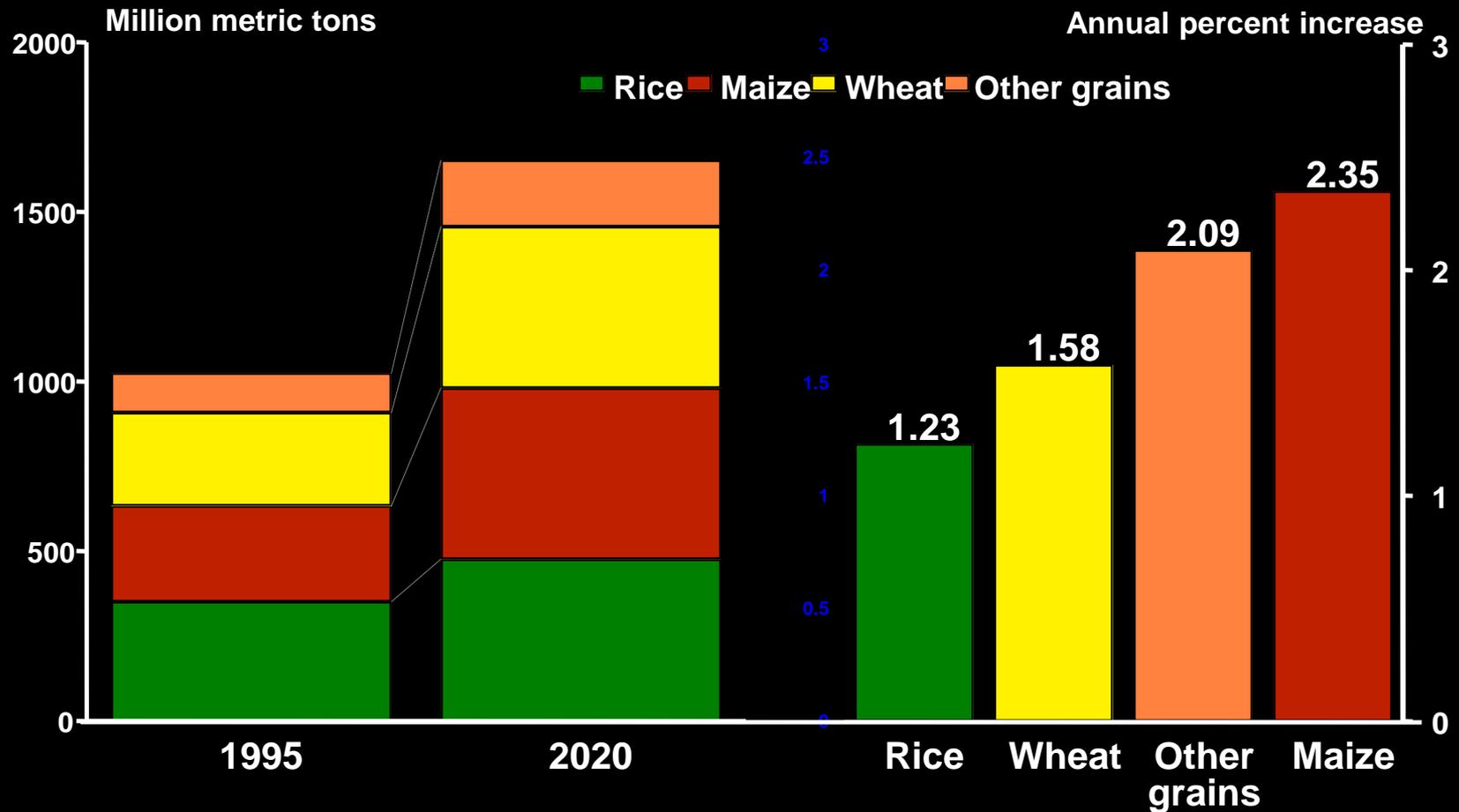
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- Globalization And Trade**
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# Increased Demand for Major Cereals (Developing Countries, 1995-2020)

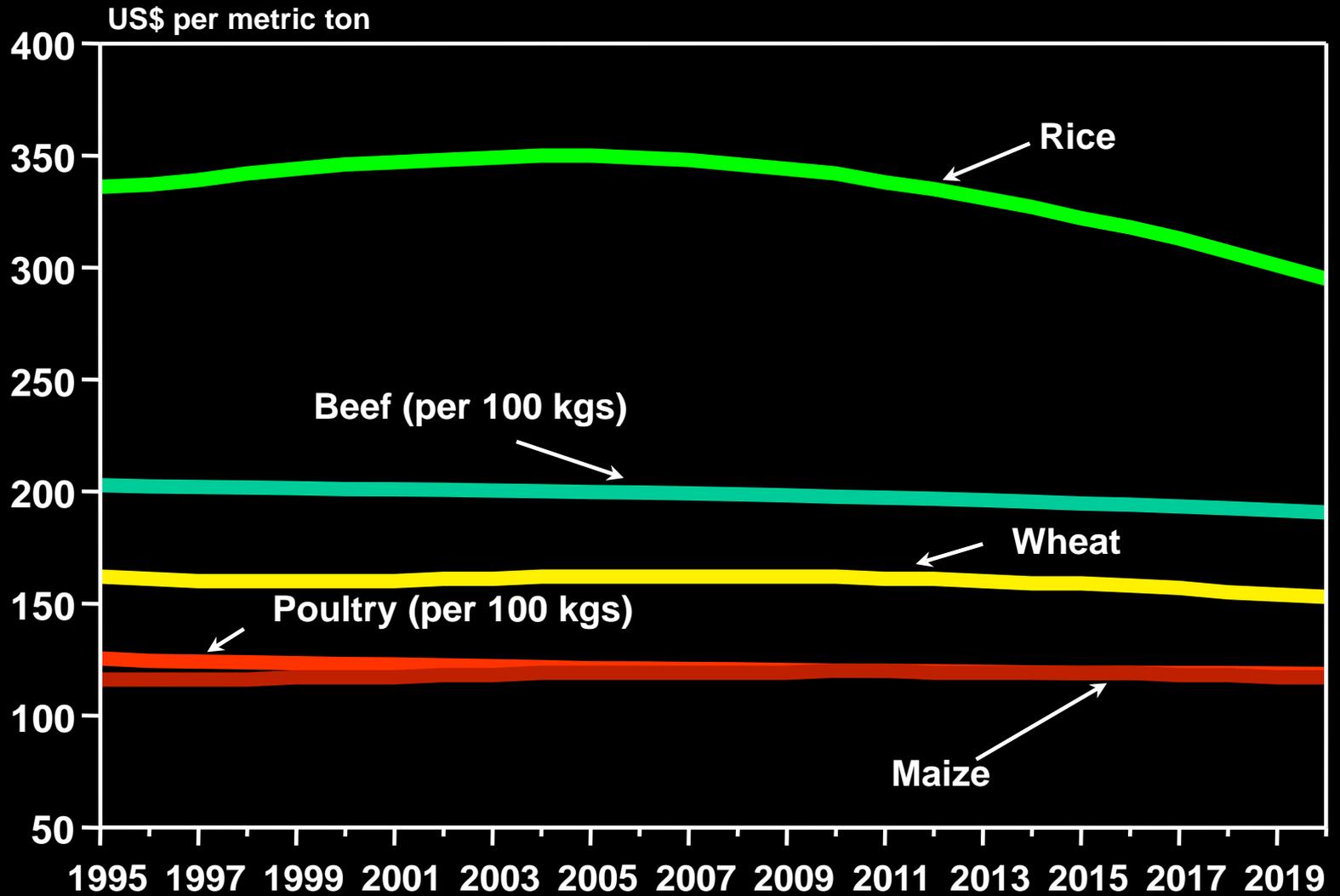


Source: IFPRI IMPACT simulations, July 1999.

**Despite Major Production  
Increases in the Developing  
Countries, Their Net Cereal  
Imports Will Double by 2020**

**Food Prices Will Remain Fairly  
Stable or Decline Slightly...**

# World Prices for Major Commodities



Source: IFPRI IMPACT simulations, July 1999.

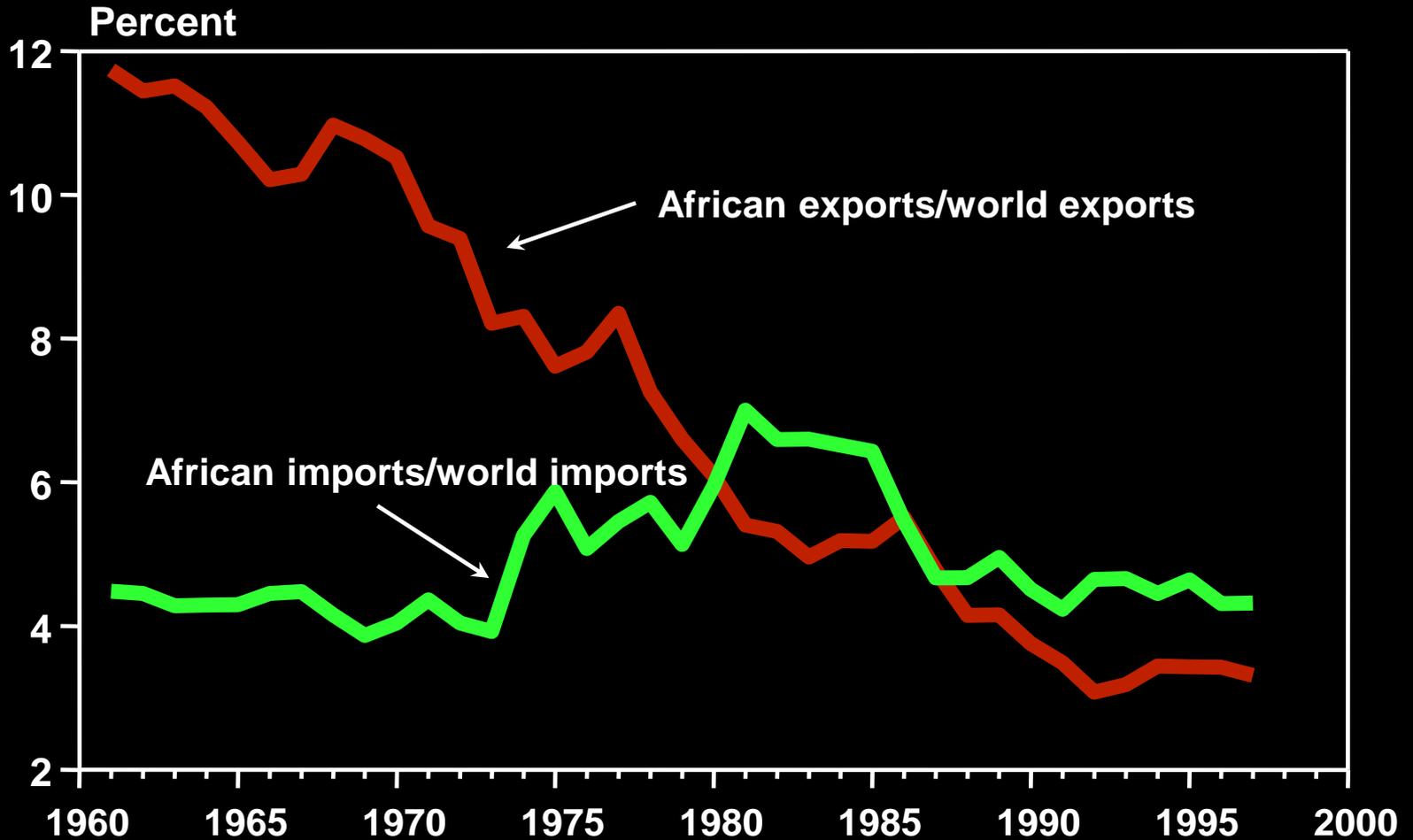
**Except ...**

**If India and/or China Tip From Net  
Exporter to Net Importer**

**Chinese Imports of 10% of Rice Needs, Would Amount to About 30% of Total World Rice Trade**

**Sub-Saharan Africa Will Remain  
Net Importer for Many Years, and  
Vulnerability Will Remain High**

# African Share of International Agricultural Trade



Source: Mukherjee and Harris (1999)

## **II. Revisiting Some Key Themes**

- **Globalization And Trade**
- **Food Security And Production**
- **The Role Of Science**

# **Food Security and Production**

- **Production is a necessary but not sufficient condition for food security**
- **Focusing on the small-holder farmer in developing countries is key to environmental protection, poverty reduction and food security**

# Responding to the Production Challenge:

- **Increasing area under cultivation**
- **Increasing yields**

# Meeting the Production Challenge

- **Increasing biological yields**
- **Improving nutrient content**
- **Intensifying agriculture**
- **Managing natural resources sustainably**

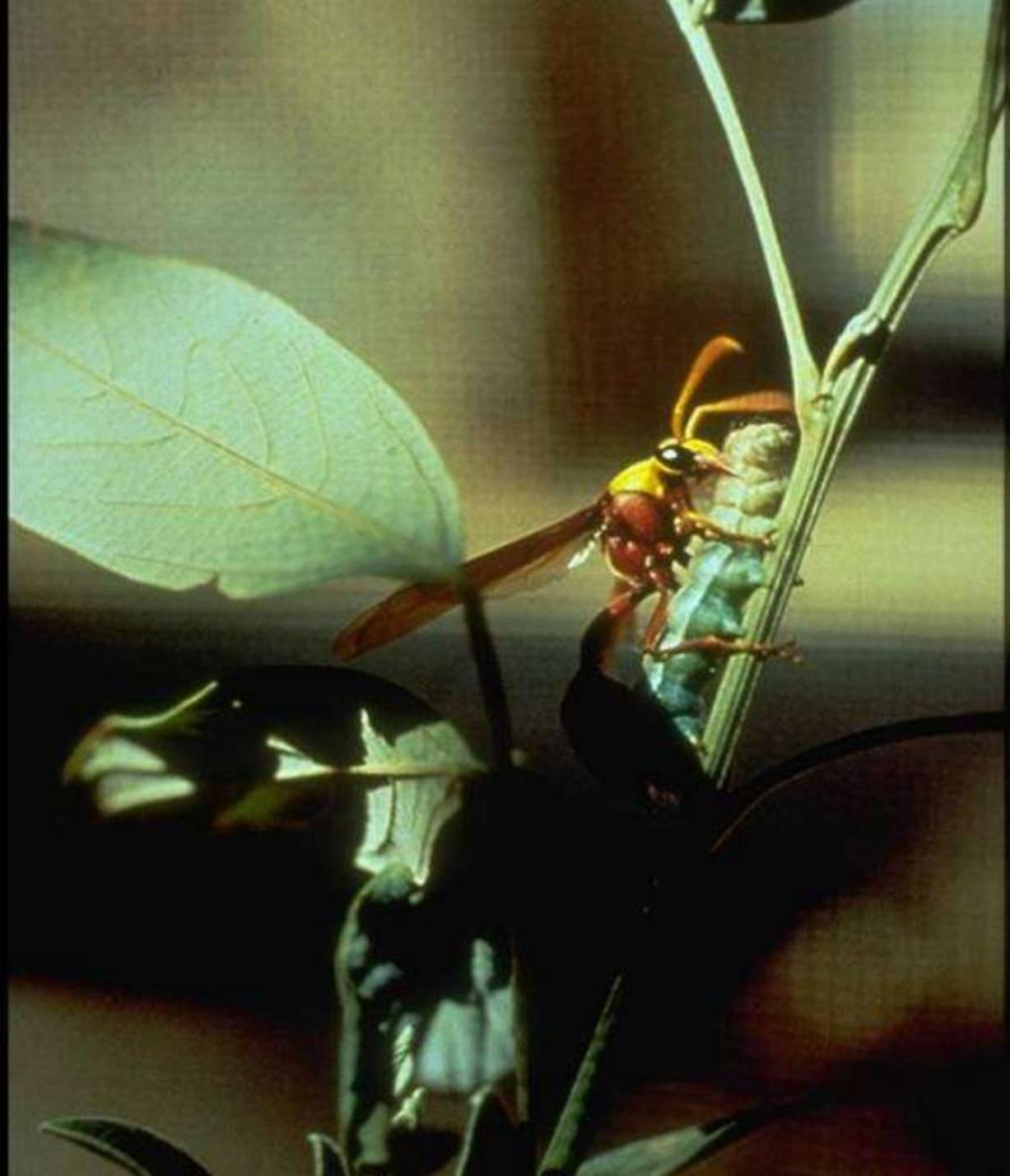
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**From the Green Revolution to  
the Doubly Green Revolution  
to the  
Ever Green Revolution**









**Integrated Soil, Water & Nutrient Management**

**Recognize  
The Gender  
Dimension**



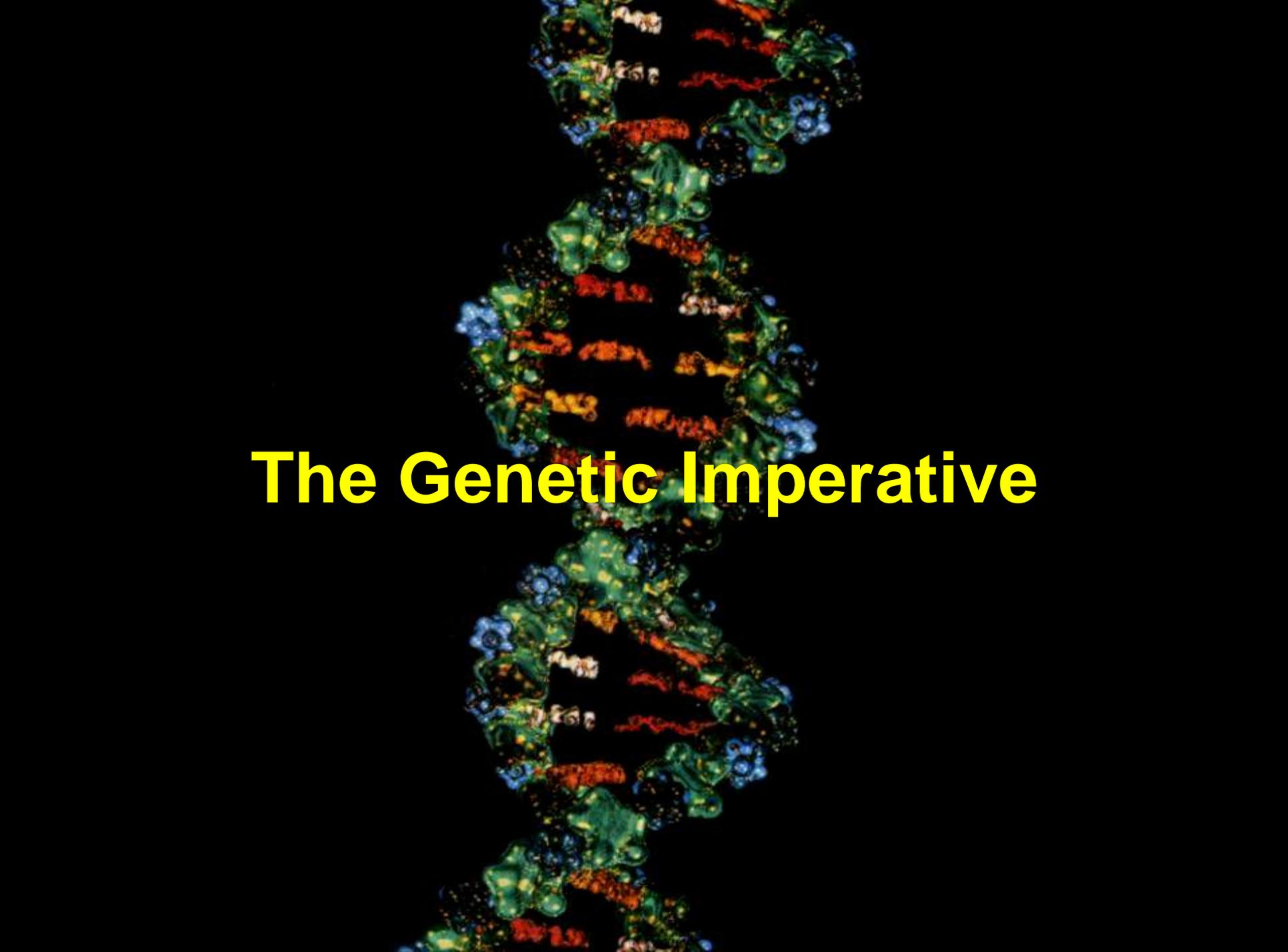
A photograph showing a person from behind, carrying a large, tall bundle of harvested crops (possibly rice or wheat) on their shoulder. They are walking through a field of green grass. In the background, a large fire is burning, consuming dry vegetation. The scene is set in a rural, hilly area with trees and a hazy sky. The overall tone is somber, highlighting the environmental impact of slash-and-burn agriculture.

**Promoting  
Alternatives to  
Slash and Burn**



**Reduce  
Post-Harvest Losses**

**Always**  
**Pro-Poor**  
**Pro-Women**  
**Pro-Environment**



# The Genetic Imperative

# **Traditional Wisdom and Modern Science**

**Different Regions Will Need to  
Address Different Problems...  
But All Will Require the Best of  
Science!**



**Focusing on the problems of  
the poor**

**Whole new avenues are opening  
up at a very fast pace...**

**It is a wonderful time to be  
working in the biological sciences.**

# **III. The Ten Commandments For Global Agriculture**

# **The Ten Commandments For Transforming Global Agriculture**

- 1. Reform Policies And Markets**
- 2. Focus On Small-holder Farmers**
- 3. Husband Natural Resources**
- 4. Raise Agricultural Productivity**
- 5. Improve Nutritional Content**
- 6. Address Short-term Vulnerability**
- 7. Empower Women**
- 8. Reach Out To The Ultra-poor**
- 9. Support Science**
- 10. Translate Rhetoric Into Action**

# **The Ten Commandments For Transforming Global Agriculture**

## **1. Reform Policies And Markets**

# 1. Reform Policies And Markets

- **Globally:** Fair trade

# Farm Subsidies

- The developed world funnels nearly **\$1 billion a day** in subsidies to its farmers
- That is about **six times total amount of ODA !**

# Cows Vs. People

- **A typical cow in the European Union receives a government subsidy of \$2.20 a day –**
- **more than what 2.5 billion of the world's poorest people live on every day.**
- **Twice what 1.2 billion of the world's poorest people live on every day.**

**\$2.20 / day**



**\$0.90 / day**



CAIRO  
SOCIETY 11-9-03

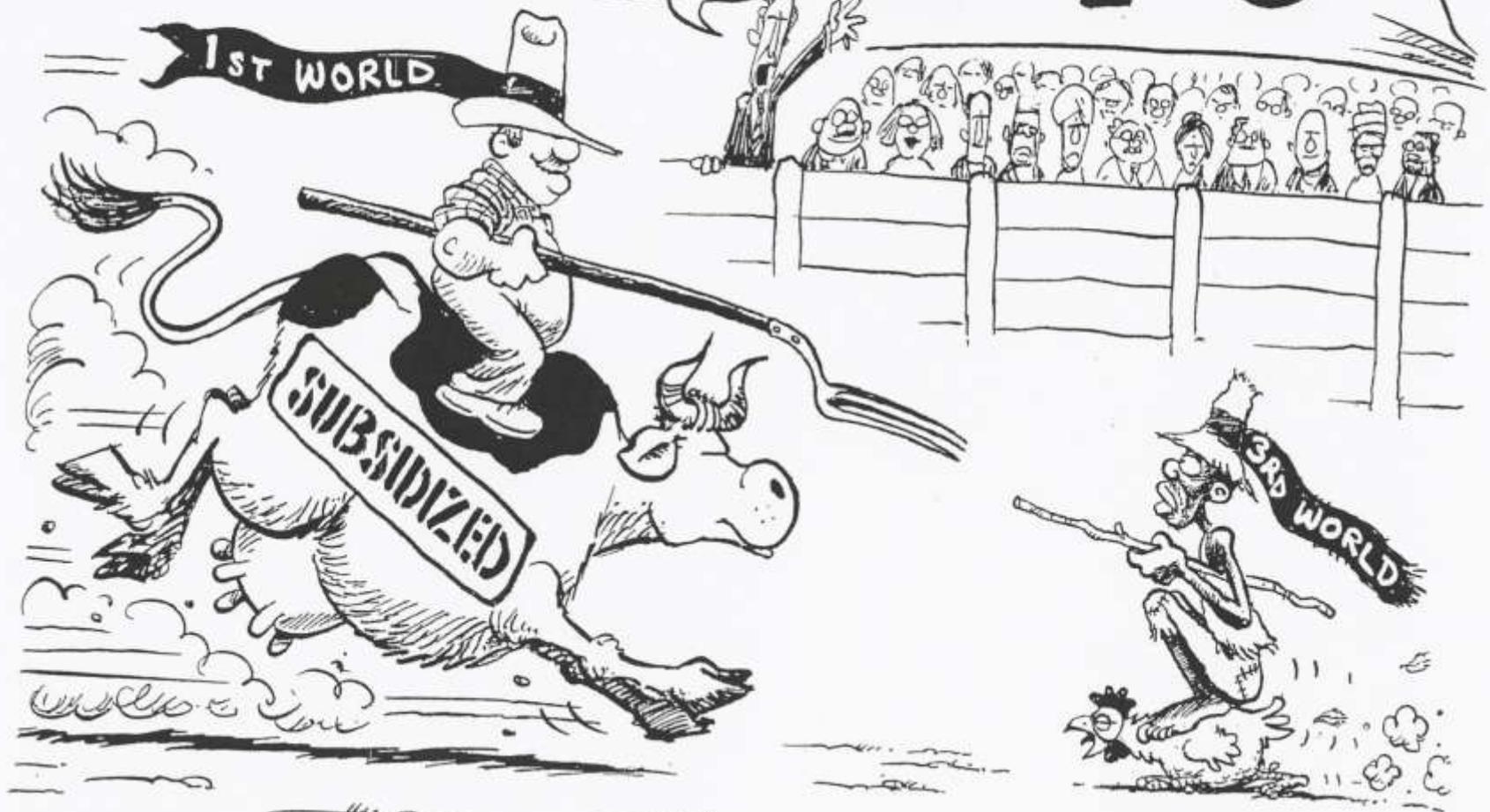
LET THE  
COMPETITION  
BEGIN!...

WTO

1ST WORLD

SUBSIDIZED

3RD WORLD



# 1. Reform Policies And Markets

- **Globally: Fair trade**
- **Locally:**
  - Remove urban bias (educ., health, etc.)
  - Improve access to markets
  - reduce post harvest losses





*thea the thi tho thea*  
*pa pe pi po pu*



T. AIDS  
CARDS

CLASS  
11/1/2011

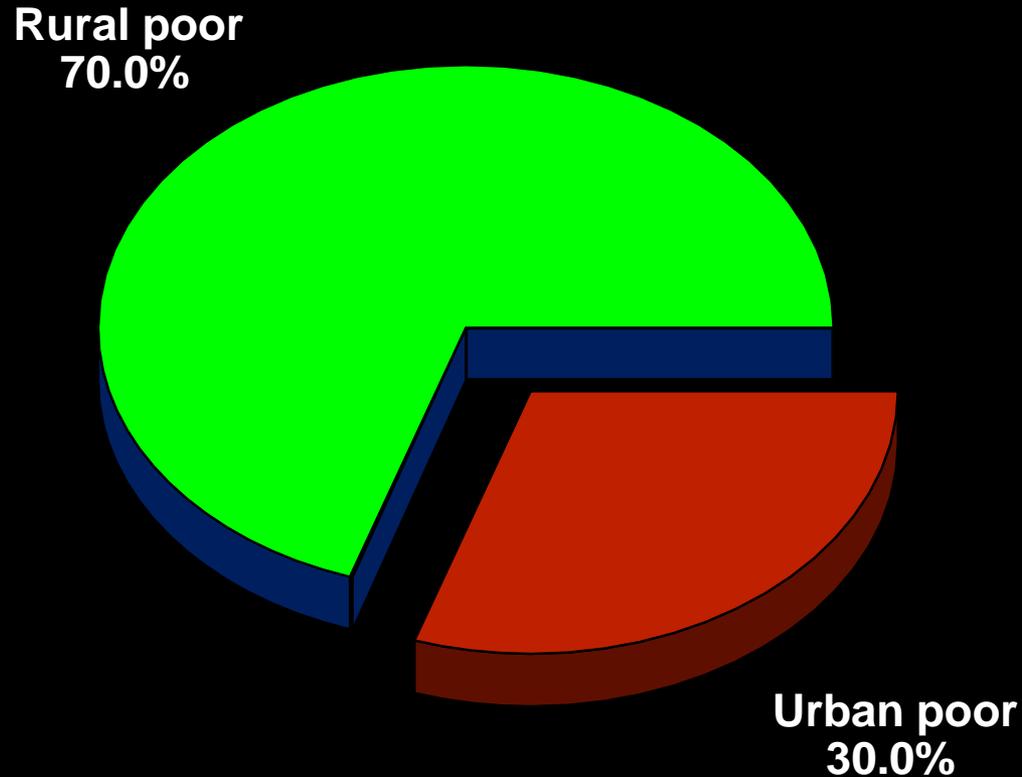
# **The Ten Commandments For Transforming Global Agriculture**

- 1. Reform Policies And Markets**
- 2. Focus On Small-holder Farmers**

## **2. Focus on Small-holder Farmers**

- **They are the majority of all farmers in the world**
- **They are disproportionately poor**
- **The returns in terms of growth, poverty reduction and improved environmental management is substantial**

# Rural and Urban Poverty in Developing Countries



Source: IFPRI estimate from World Bank data.

# Why Small-Holders?

In 2004, they contained

**over 92 percent of the world's  
1.2 billion "dollar-poor"**

(Dollar-poor = households consuming less than one U.S. dollar's worth of a world average consumption bundle, per person per day, at 1993 purchasing-power-parity values).

# Challenges Facing Small Farms

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- **No political voice.**

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- **Climate change.**
- **HIV/AIDS**
- **Continuing population growth that is making small farms smaller.**
- **No political voice.**

**So, dealing with global poverty  
requires that we address rural  
poverty...**

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**AND**

**So, dealing with global poverty  
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poverty...**

**AND**

**A special focus on small-holder  
farmers in developing countries in  
particular to address the problem  
of food security**

# The Ten Commandments For Transforming Global Agriculture

1. Reform Policies And Markets
2. Focus On Small-holder Farmers
3. Husband Natural Resources

# **3. Husband Natural Resources**

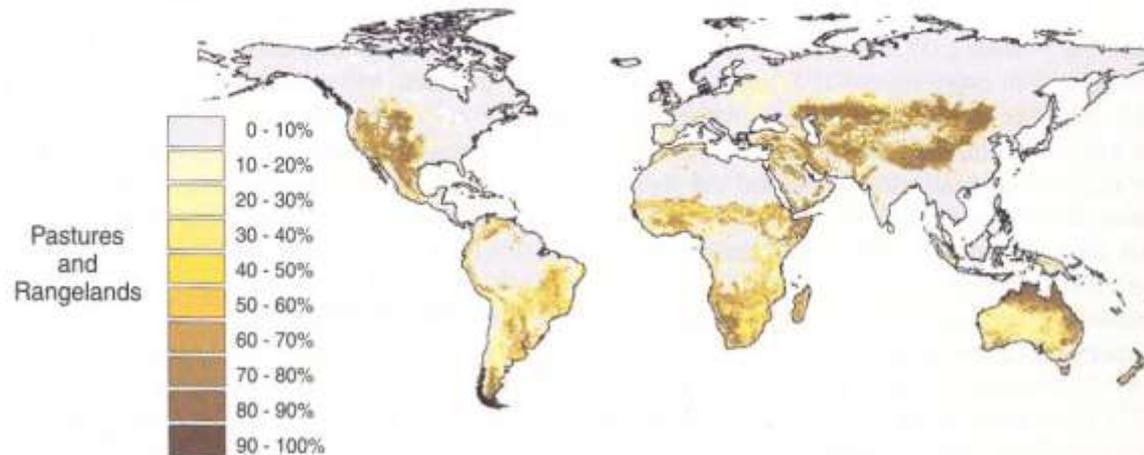
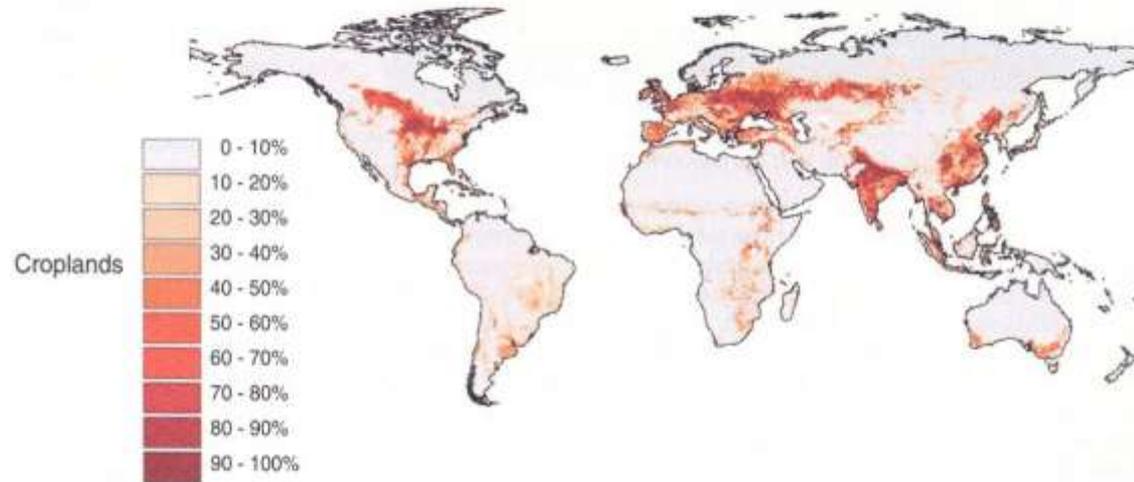
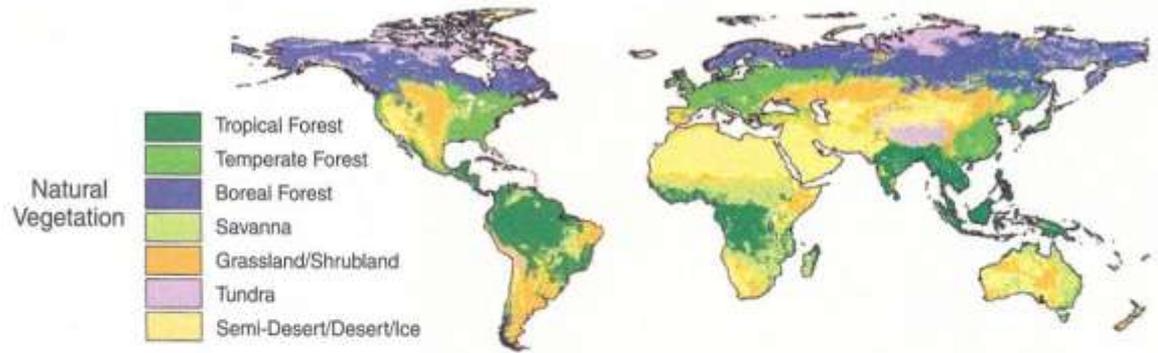
- **Agriculture is the major interface between people and nature**
- **Sustainable development is beneficial for all**
- **Resource degradation hits the poor worst**





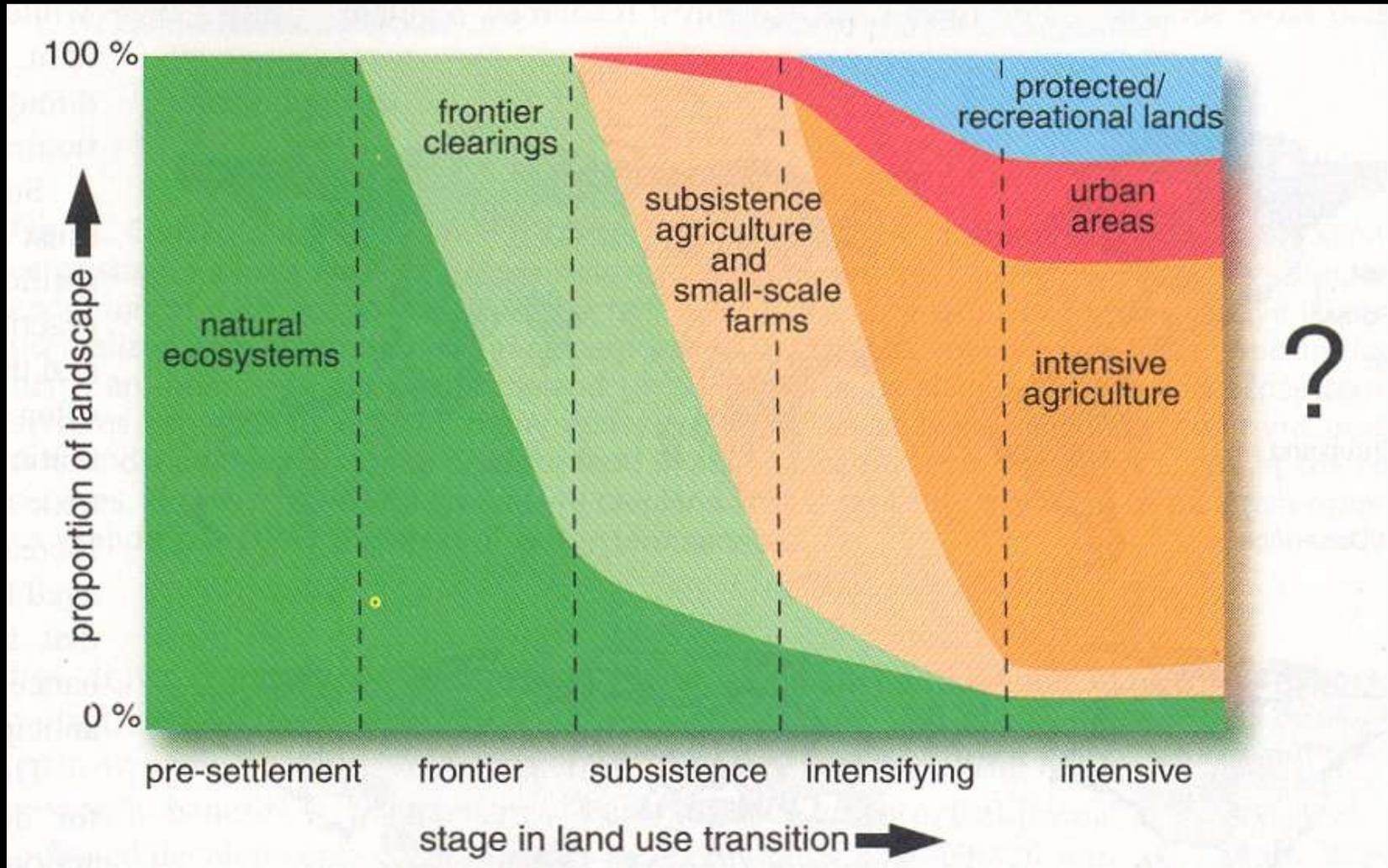
# Global Land Use

- World-Wide Natural Vegetation, Croplands And Rangeland



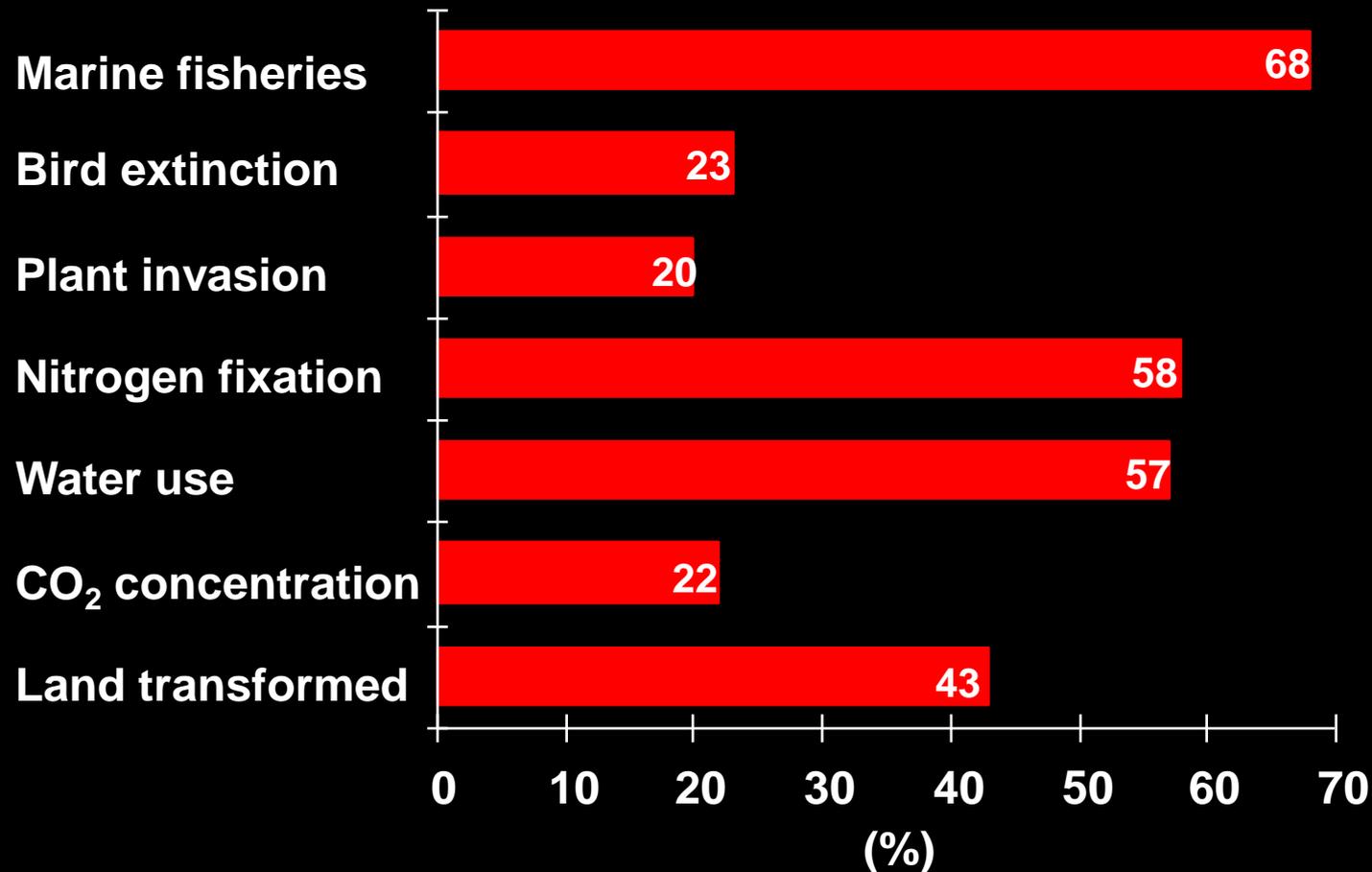
Source: J.A. Foley, et.al.,  
Global Consequences of  
Land Use, in *Science*, 22 July  
2005, v.309, pp.570-574

# Land Use Transitions



Source: J.A. Foley, et.al., Global Consequences of Land Use, in *Science*, 22 July 2005, v.309, pp.570-574

# Human Alteration of Major Components of Earth System

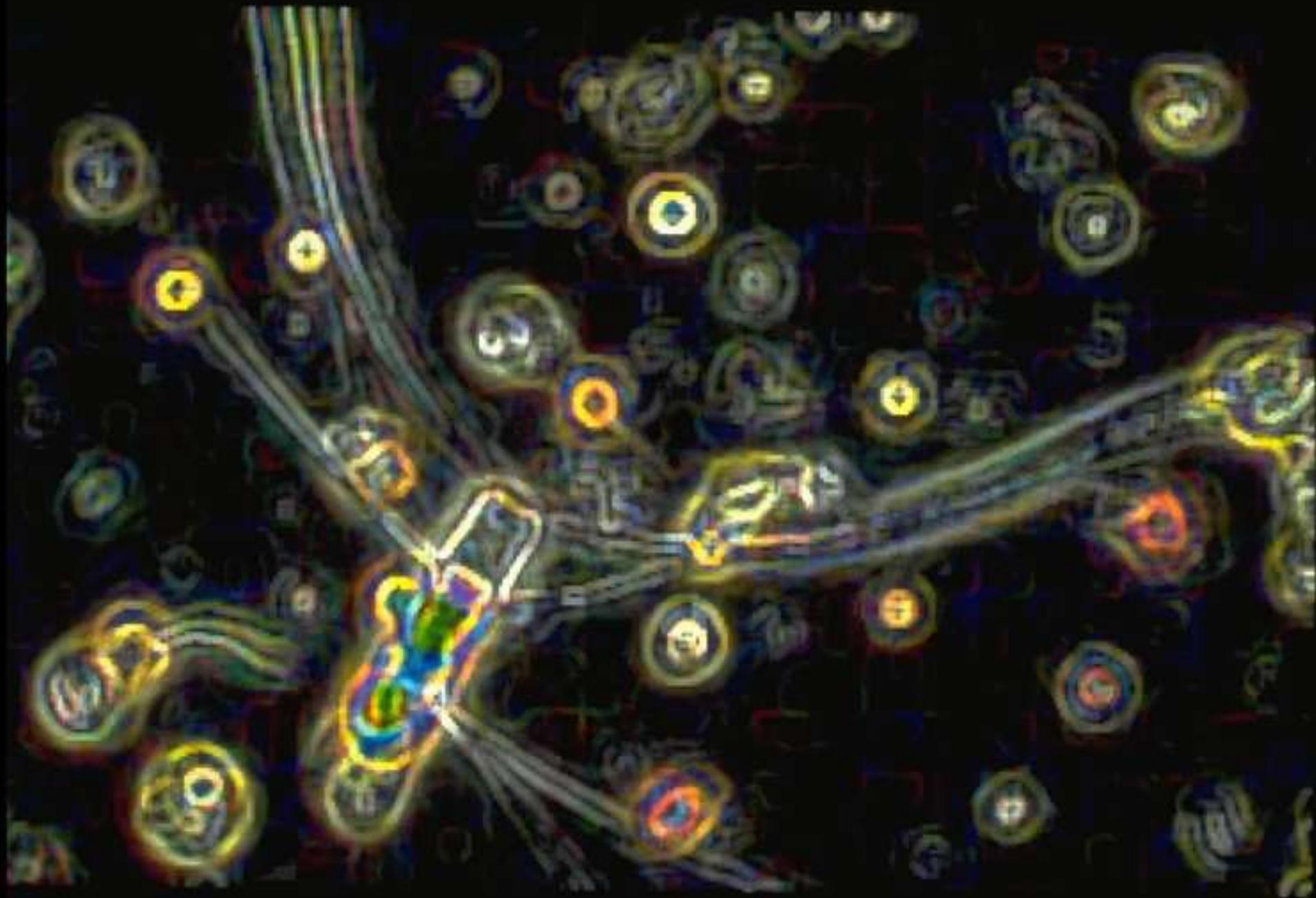


A wide-angle photograph of a lush green field, likely a rice paddy, under a dramatic, cloudy sky. In the distance, a range of mountains is visible. A person and a black cow are standing in the field on the left side. The text is overlaid in the center in a large, white, bold font.

**The Most Important  
Environmental Action Is to  
Reduce the Need for More  
Land Under Cultivation**

**It Saves Habitats and  
Biodiversity**







**Water Is Also a Constraint**





**10% of World Grain Production  
Depends on Unsustainable  
Underground Water  
Withdrawals.**





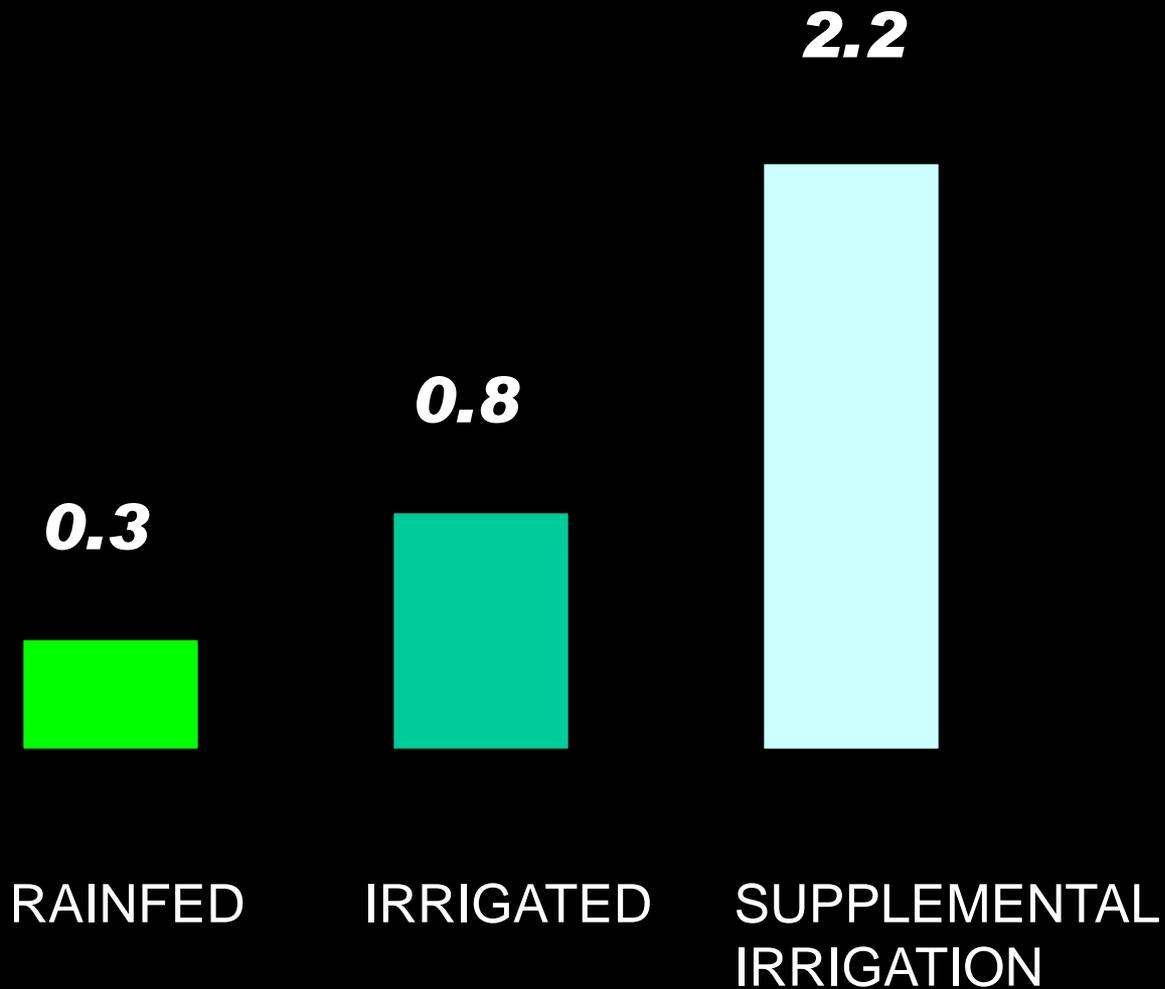
**One Calorie = One Liter**





**More Crop Per Drop!**

# Crop yield per unit of water wheat kg/cu.m





# New Water Sources

(US cents /cu.m)

- **Reduce demand** = **10 - 70**
- **leakage repair** = **10 - 70**
- **Desalination** = **20 - 40**
  - (brackish water)
- **Wastewater reuse** = **10 – 50**
  - (Only for irrig. & some industry)
- **Desalination** = **50 – 90**
  - (sea water)

# Using Treated Wastewater



**Sorghum and Topinambur irrigated with Treated Wastewater in Sorbulak area, Kazakhstan – Courtesy ICARDA**

**And So Much More...**

**2000 to 4000 tons of water to  
produce 1 ton of rice**

# Differences in Growth Duration



# Levees for Water Management in Uneven Field



# Laser Land Leveling



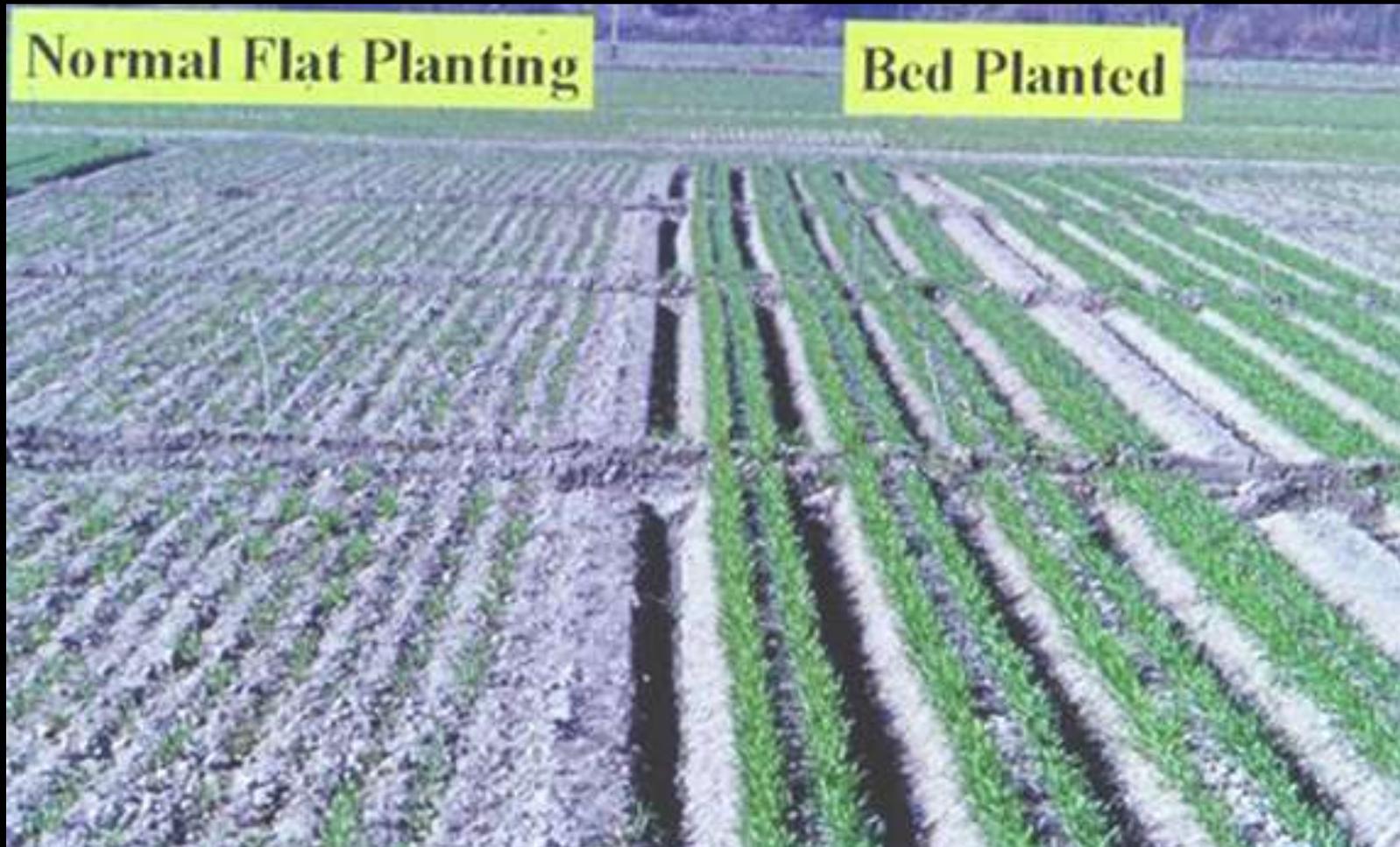
# Laser Levelled Fields



# Soil Puddling for Transplanted Rice



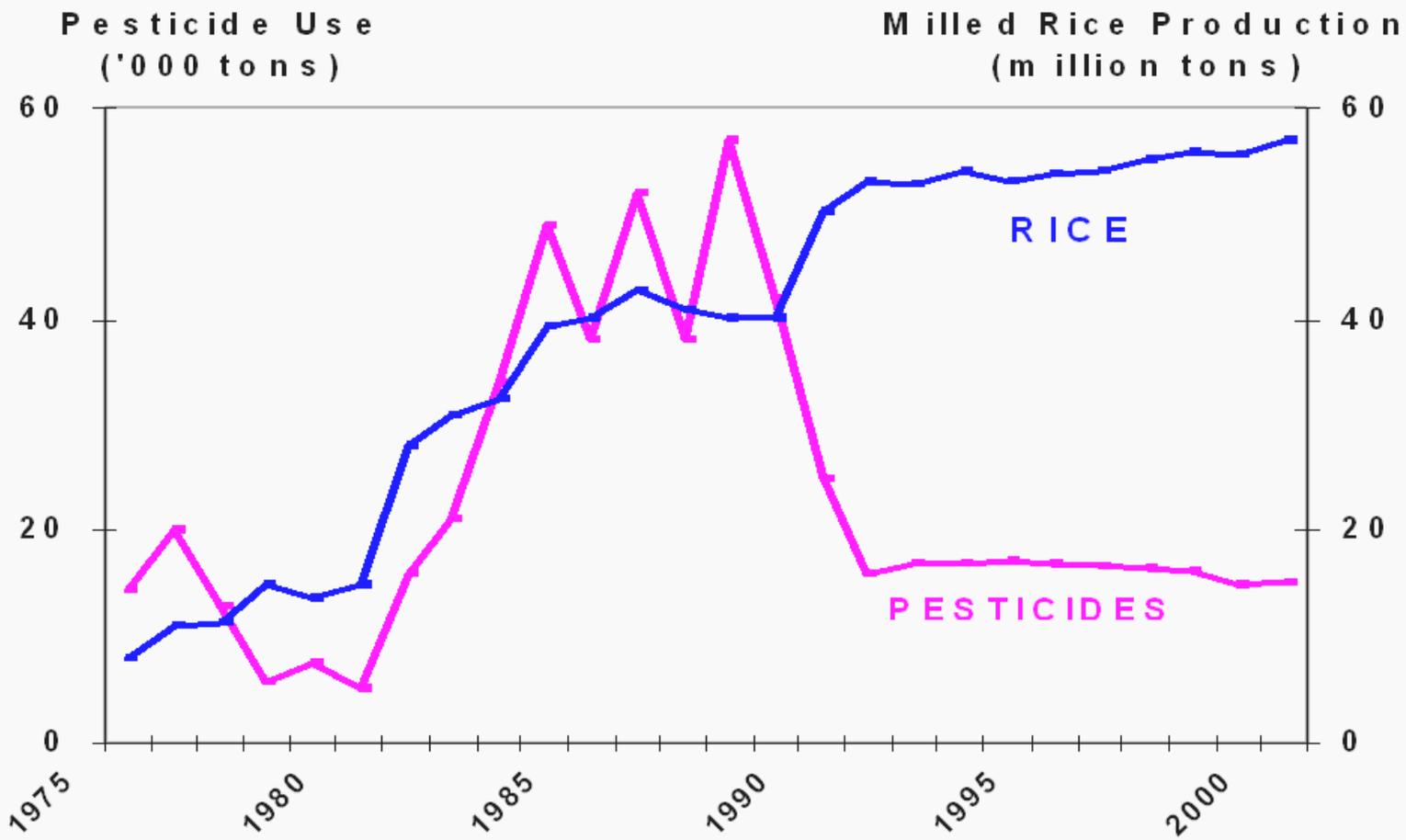
# Dry Sowing of Rice





**Reducing Pollution Is Essential.**

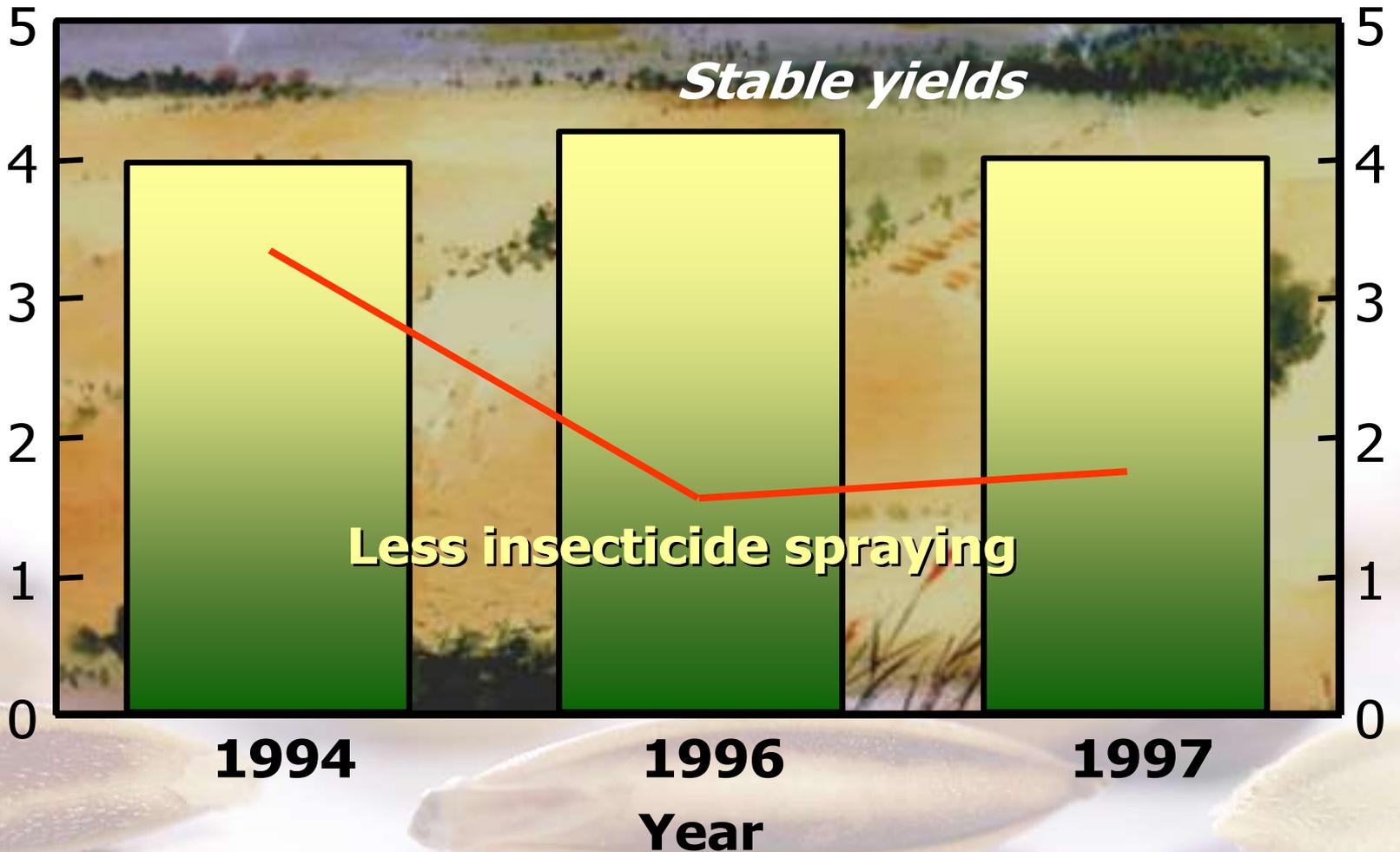
# Reduction in Pesticide Use but Continued Increase in Rice Production in Indonesia



# Long An Province, Vietnam.

Av. insecticide sprays/season

Av. yields (t/ha)



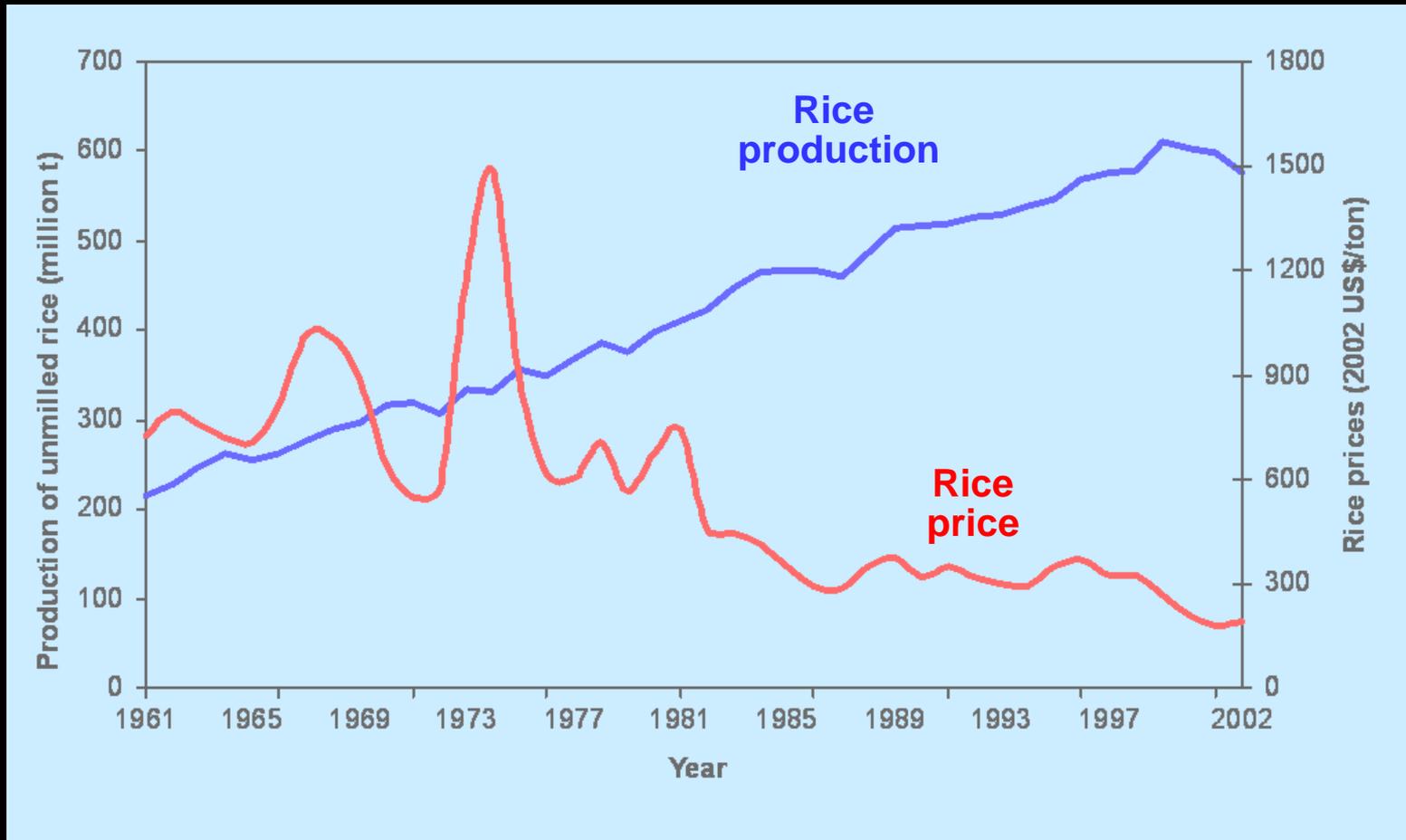
# The Ten Commandments For Transforming Global Agriculture

1. Reform Policies And Markets
2. Focus On Small-holder Farmers
3. Husband Natural Resources
4. **Raise Agricultural Productivity**

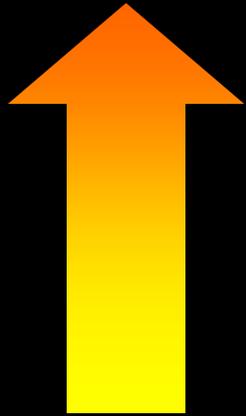
## **4. Raise Agricultural Productivity**

- **Productivity must rise faster than price declines to generate surpluses for the small-holder farmers and reduce their poverty as their cheaper products help reduce the poverty in the cities**
- **Measure in terms of Total Factor Productivity (land, water, labor, energy and chemical inputs)**

# Trends in world rice production and price adjusted for inflation, 1961-2002



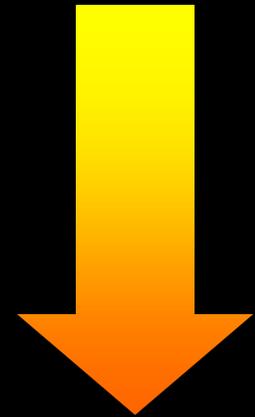
# Future Challenges



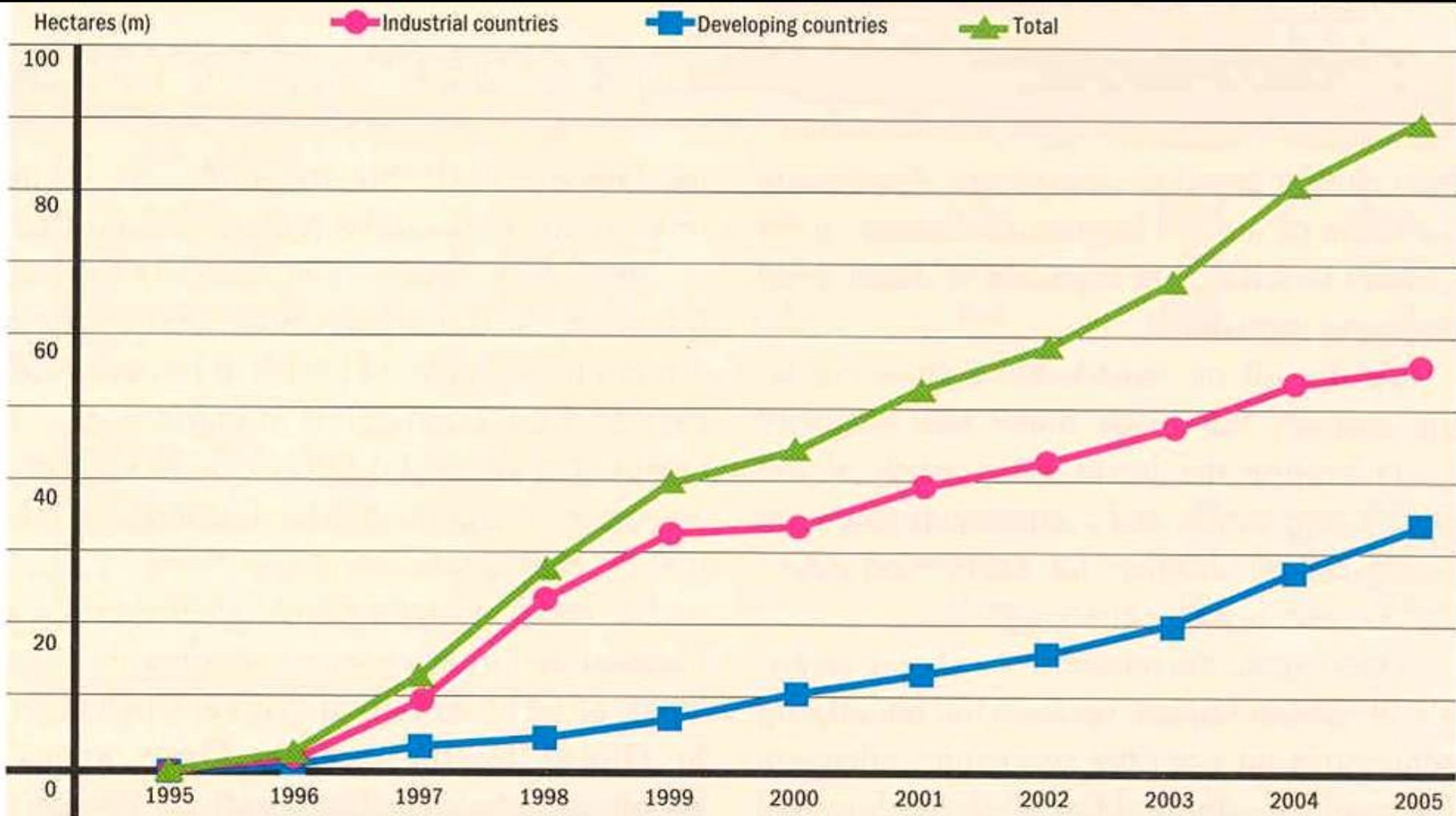
To Produce  
More Food

Less Water  
Less Land  
Less Labor  
Less Chemicals

Increasing  
Population



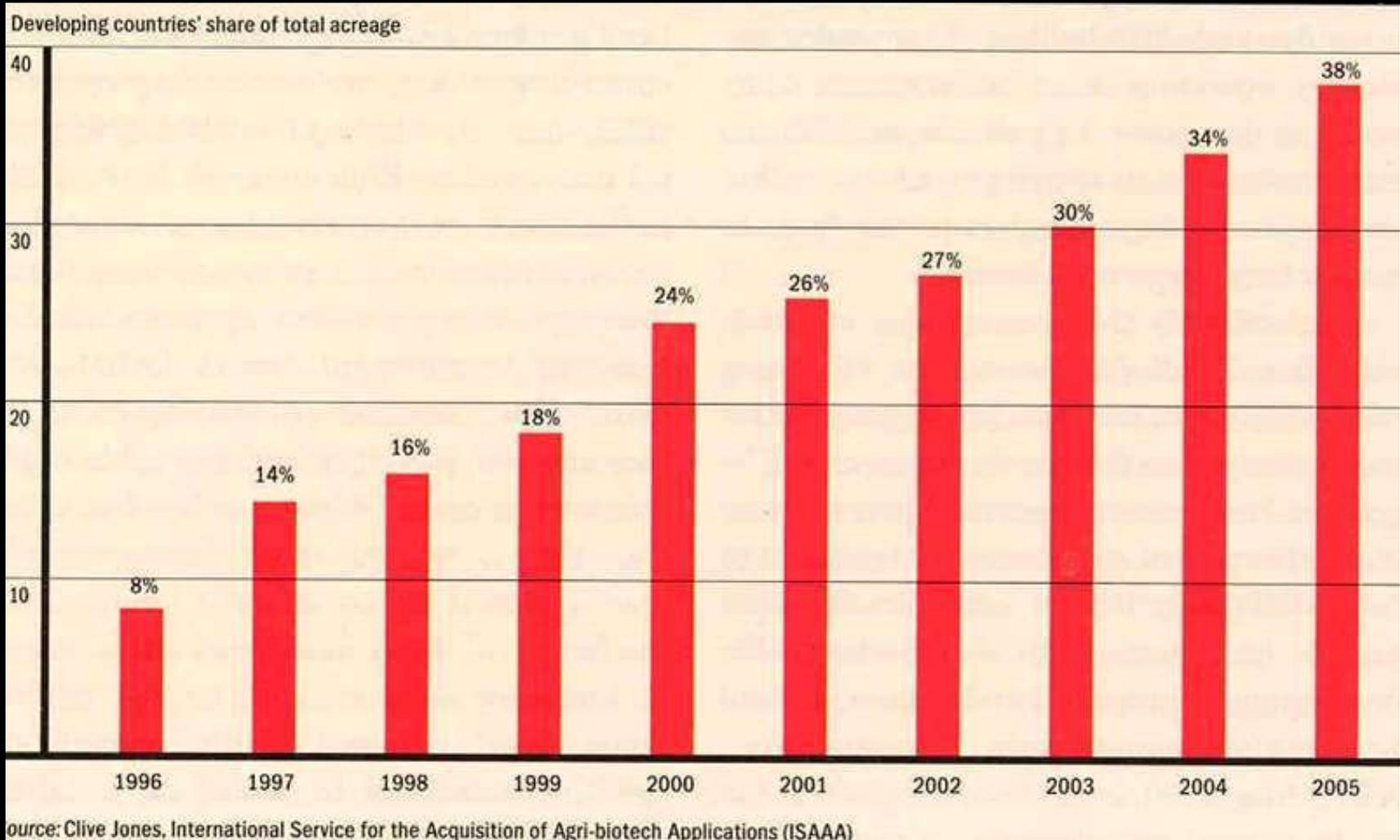
# Transgenic Crop Acreage Growing



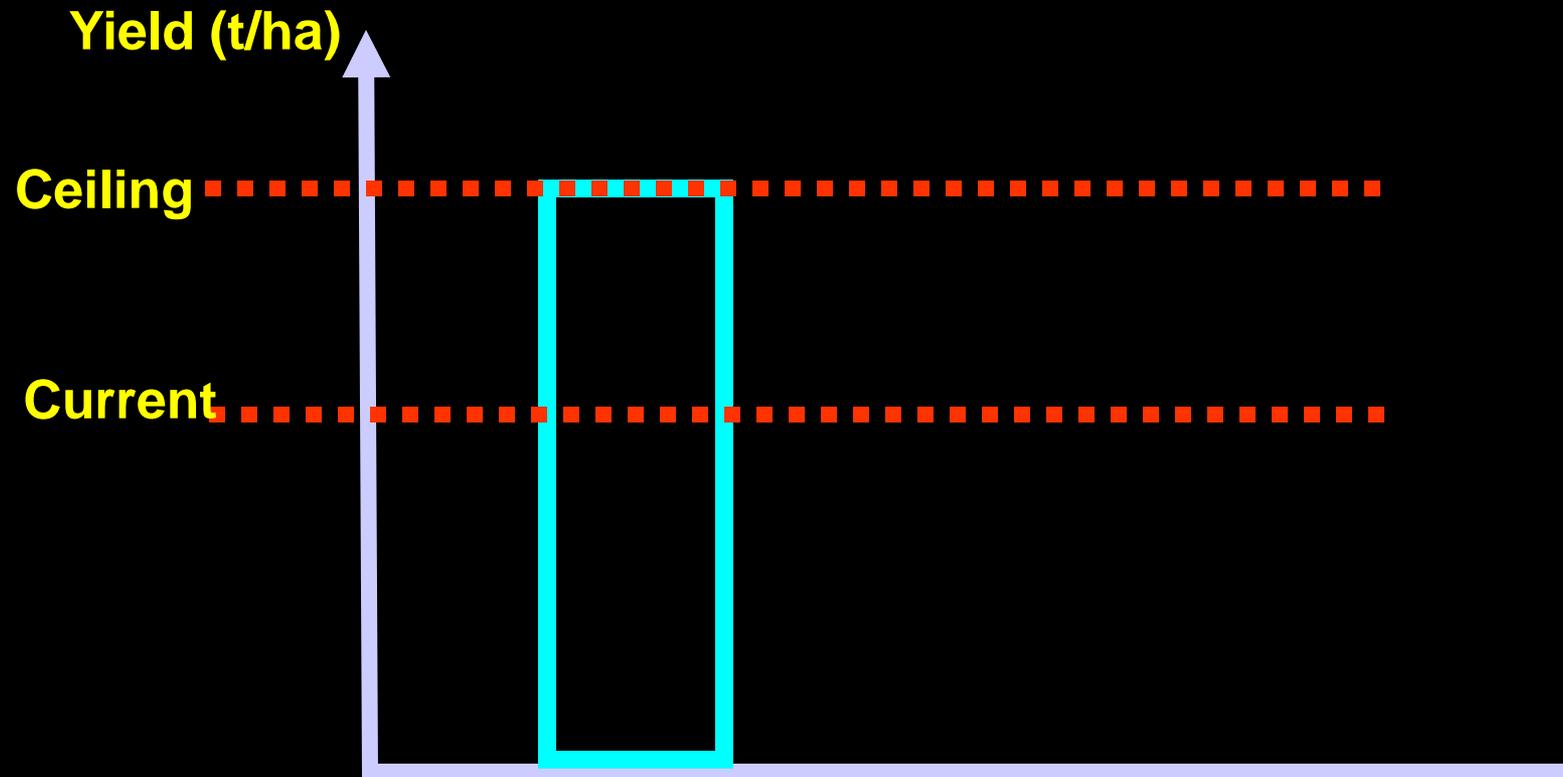
Source: Clive Jones, International Service for the Acquisition of Agri-biotech Applications (ISAAA)

Source: Ernst & Young, Beyond Borders, Global Biotechnology Report 2006

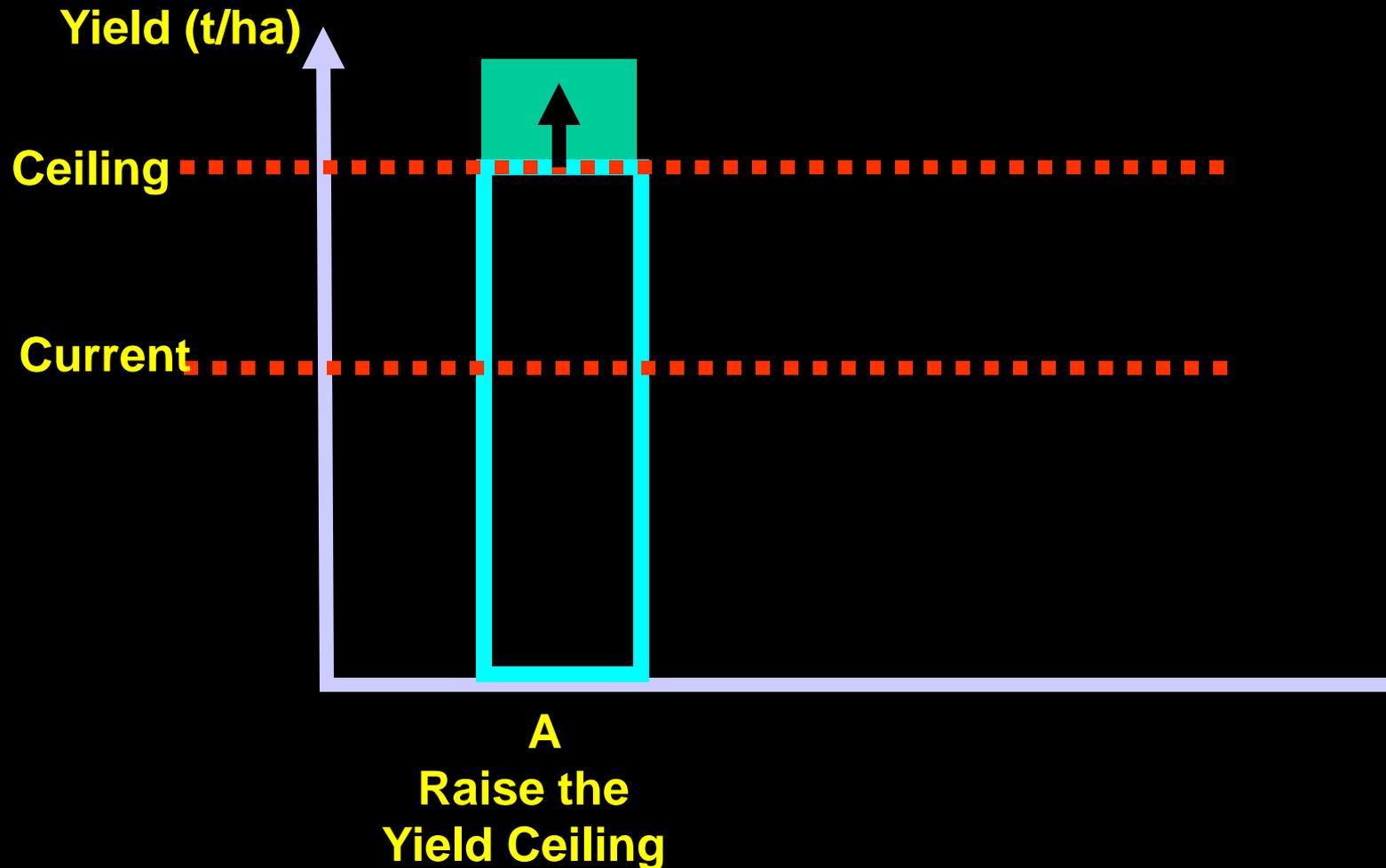
# Developing Countries Share Of Transgenic Crop Area Growing Fast



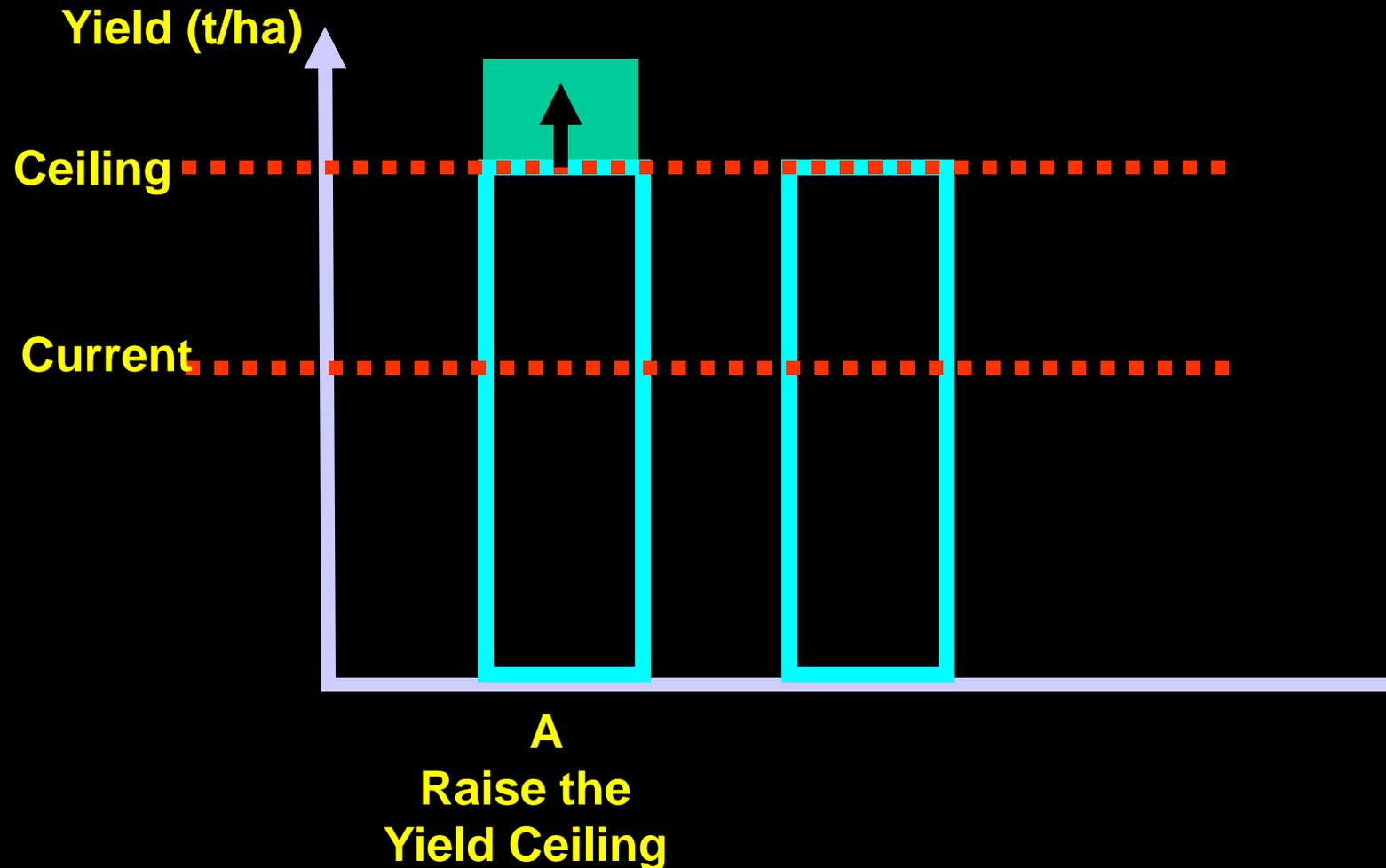
# Three Themes in Rice Research for Increased Production



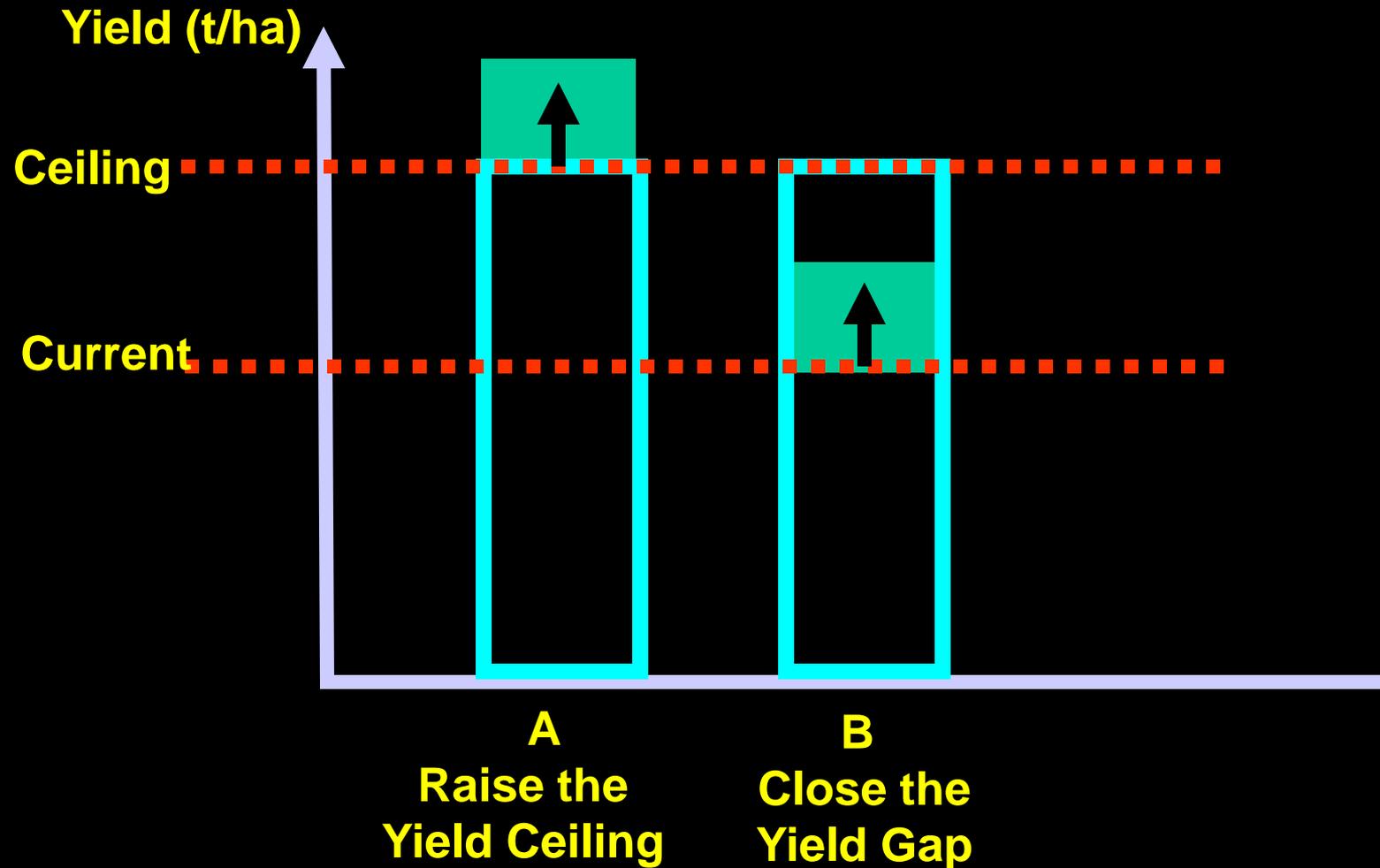
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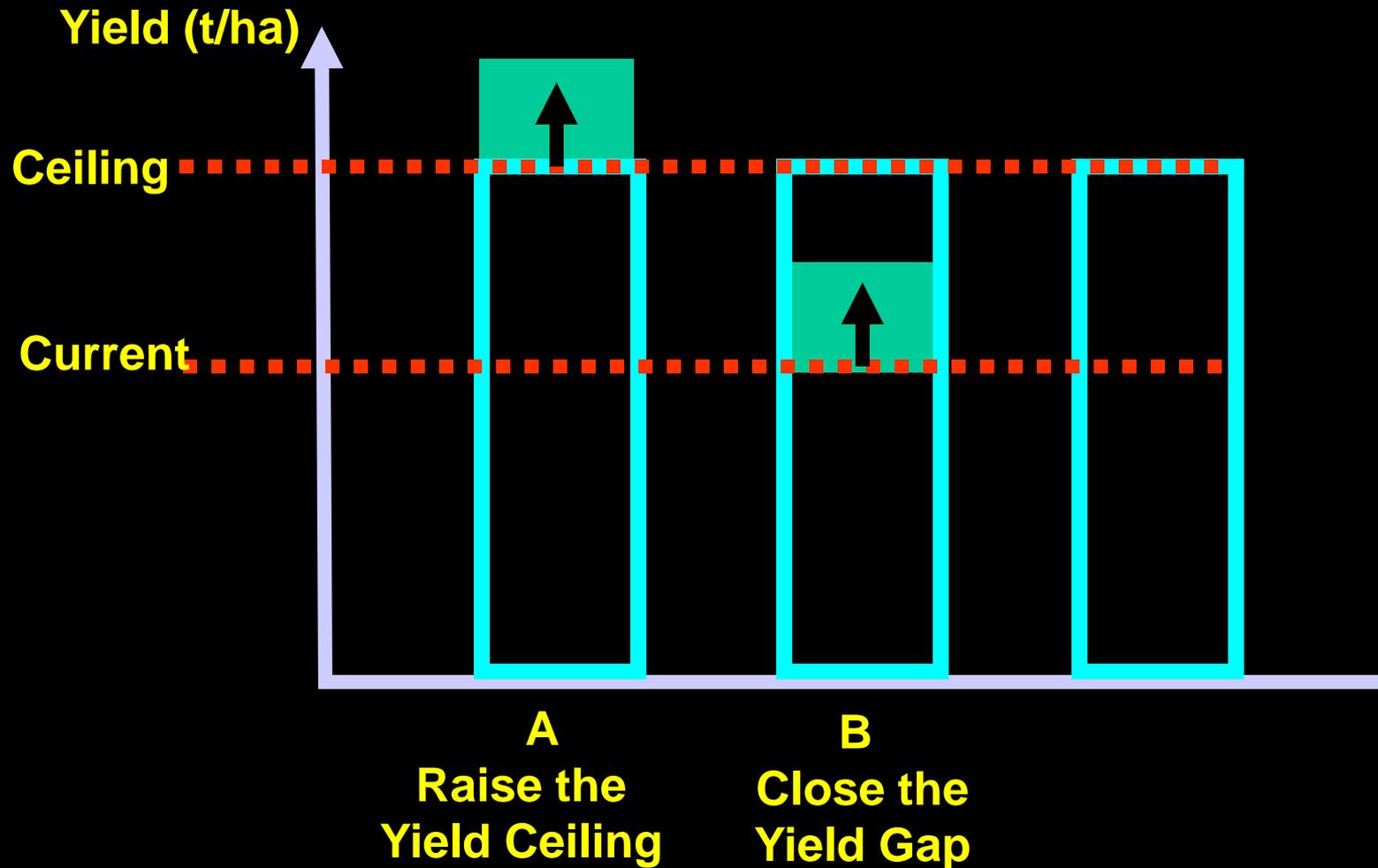
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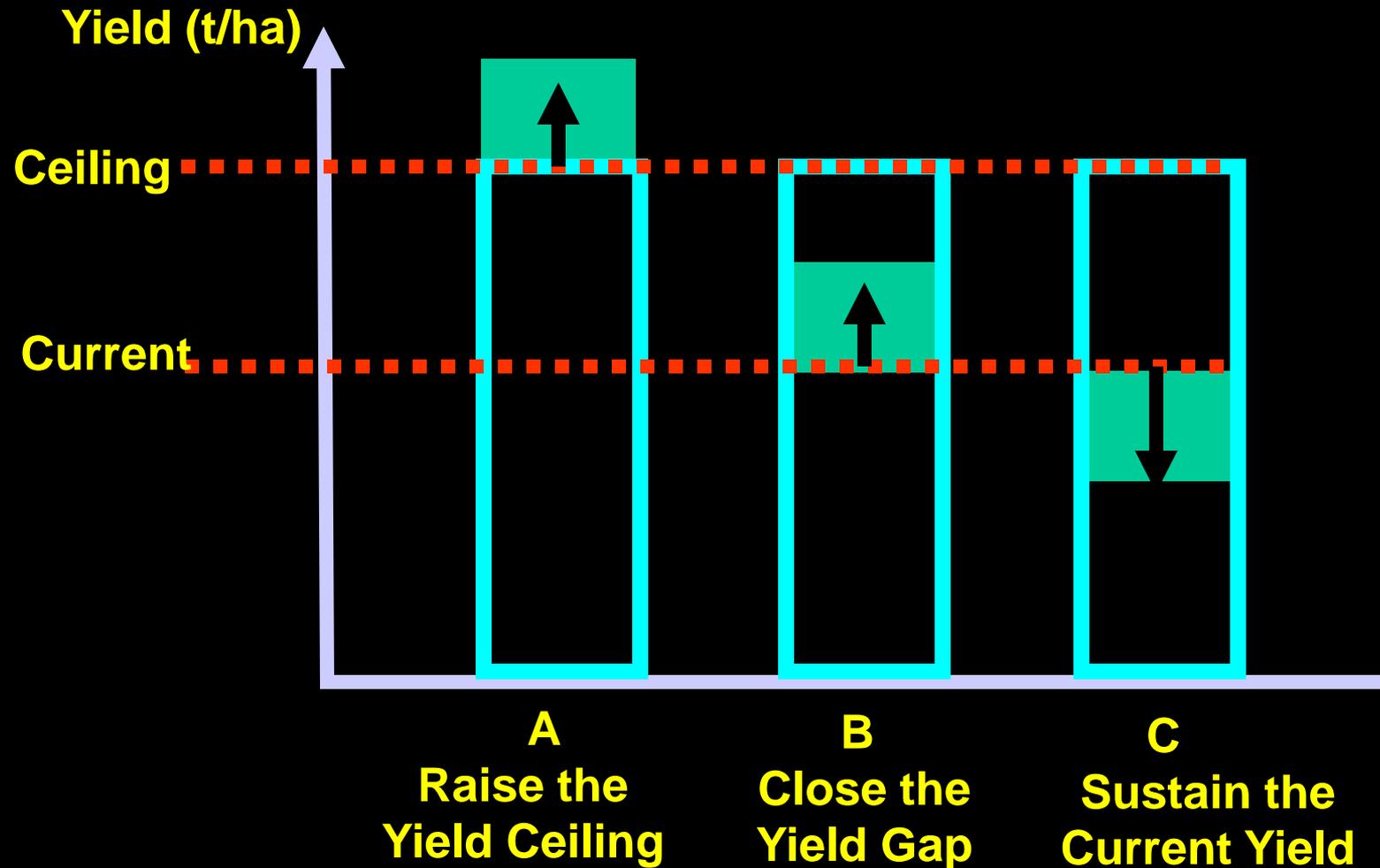
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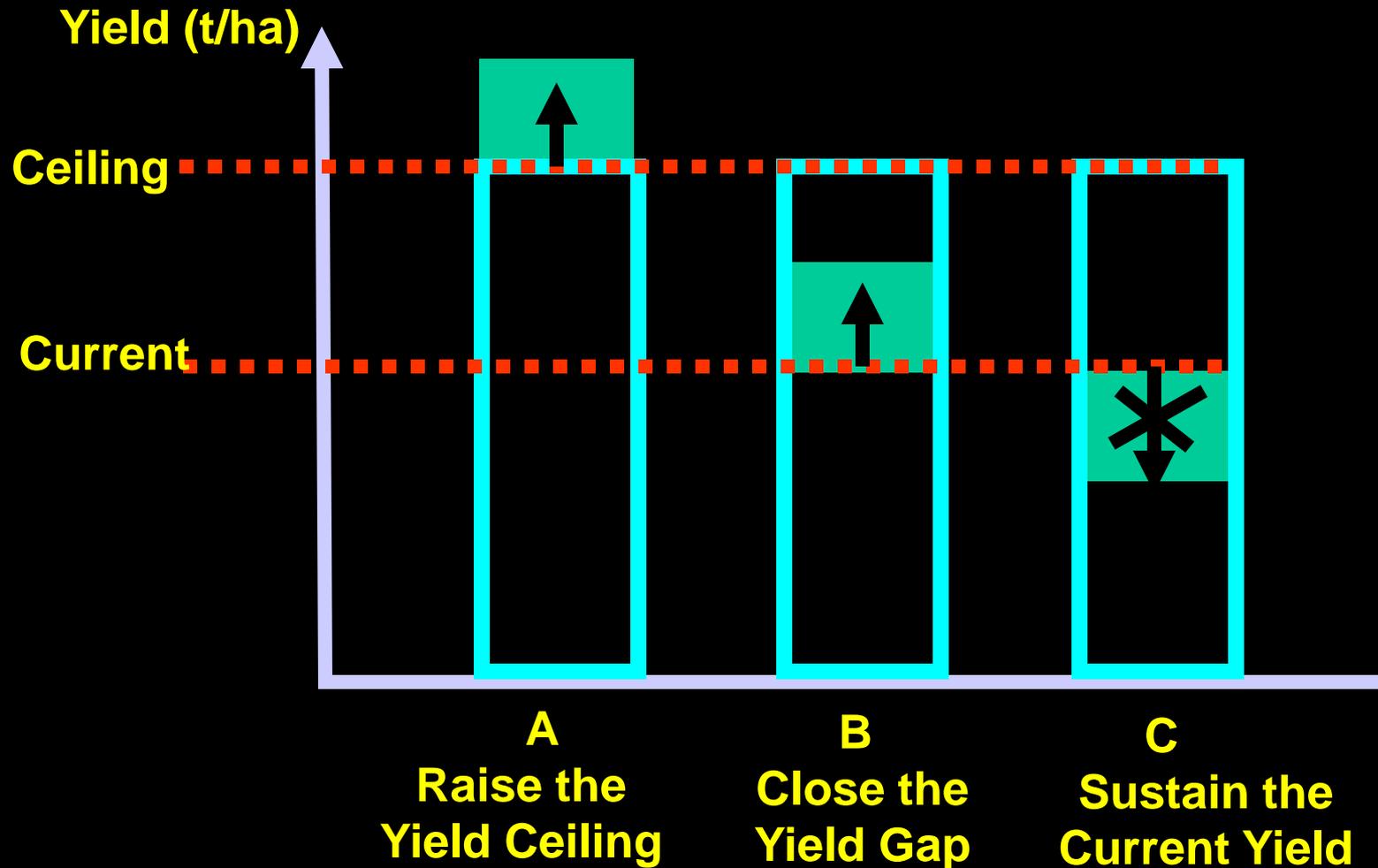
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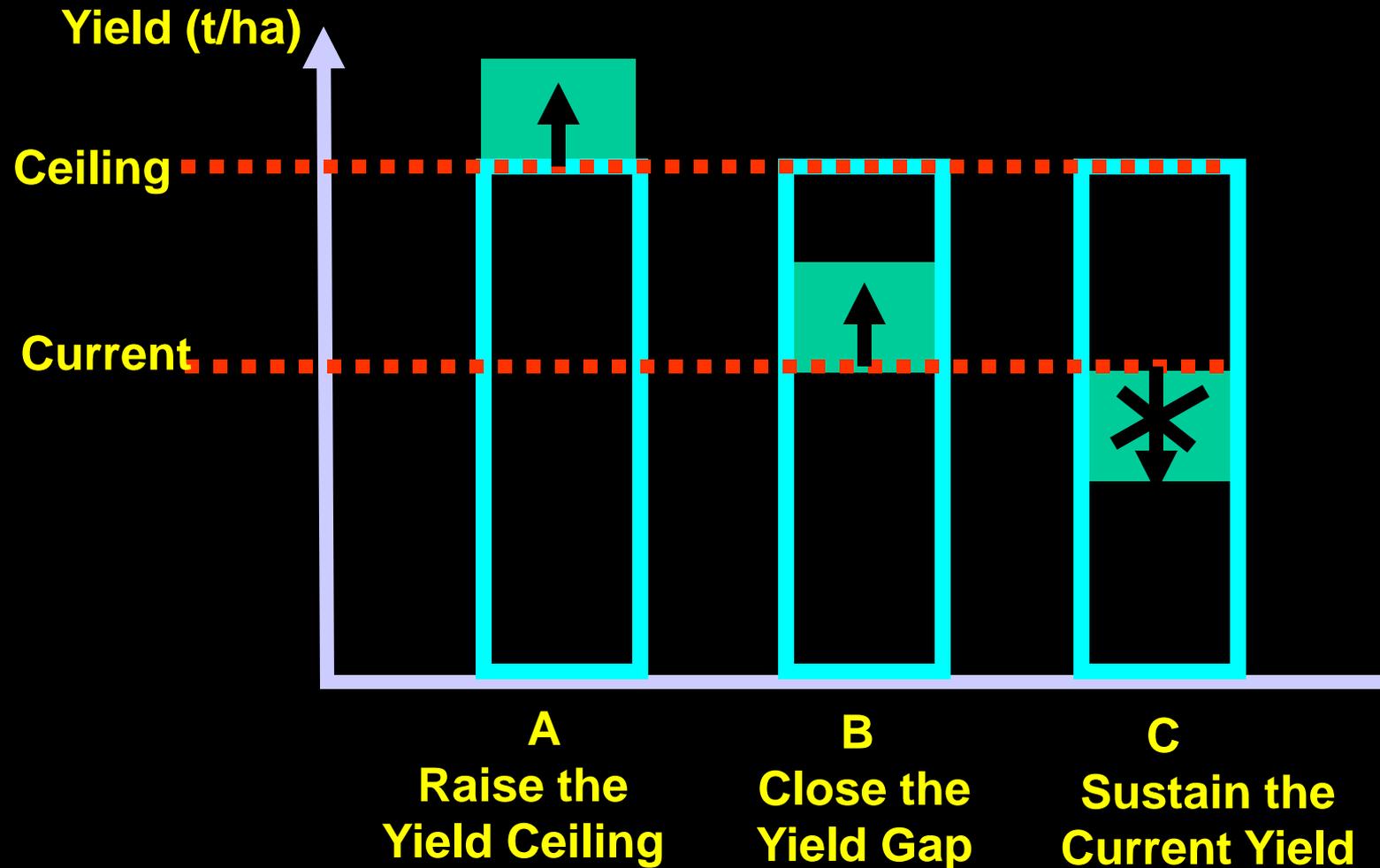
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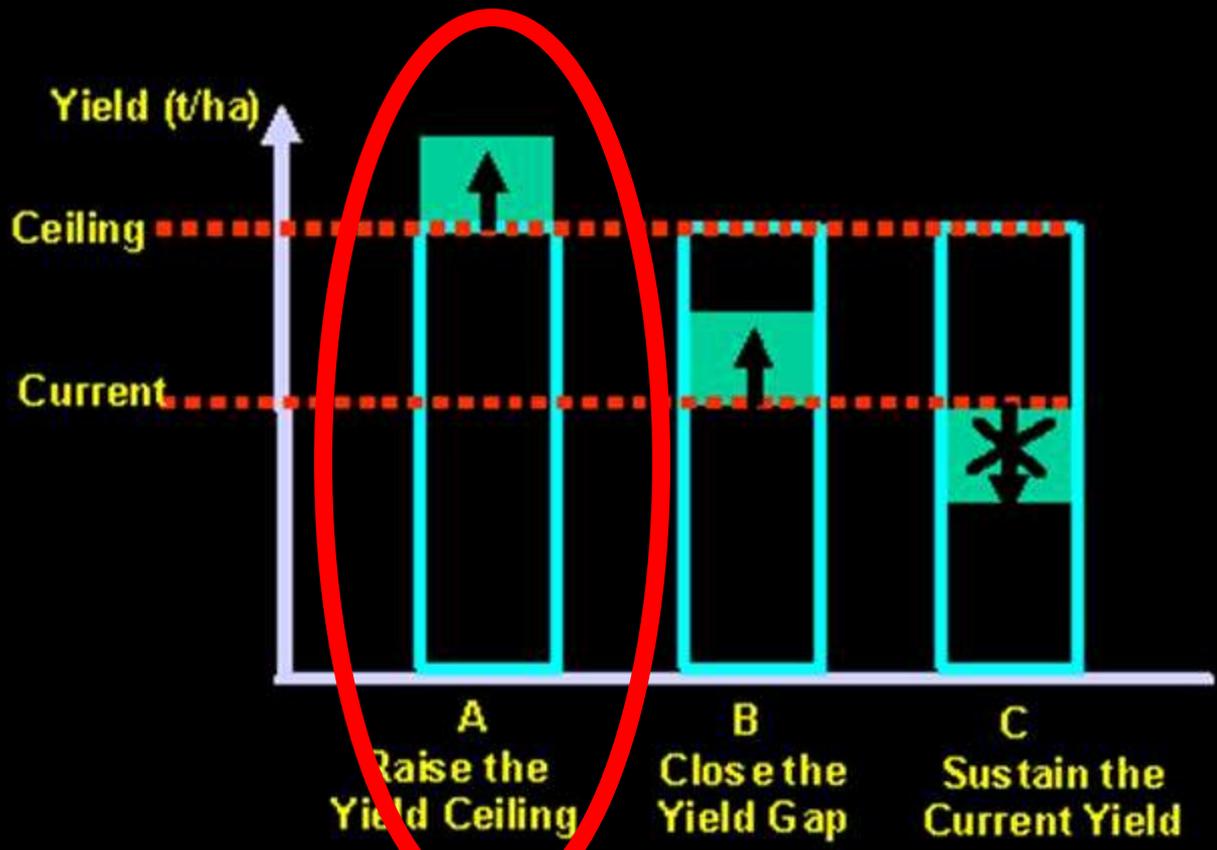


# Three Themes in Rice Research for Increased Production



**Let's take them by turn**

# Technologies for Increasing the Yield Potential



Source: G. U. Khush, Lecture at BioVision Lyon 2005

# Different Plant Types of Rice

Conventional

Improved

NPT



# New Plant Type Rice



# **New Plant Type**

**Three of the NPT lines have been released in Yunnan Province of China, with a yield of more than 13 tons/ha in farmers' fields.**

**IR64446-7-10-5 'Dianchao 1' (2002)**

**IR69097-AC2-1 'Dianchao 2' (2003)**

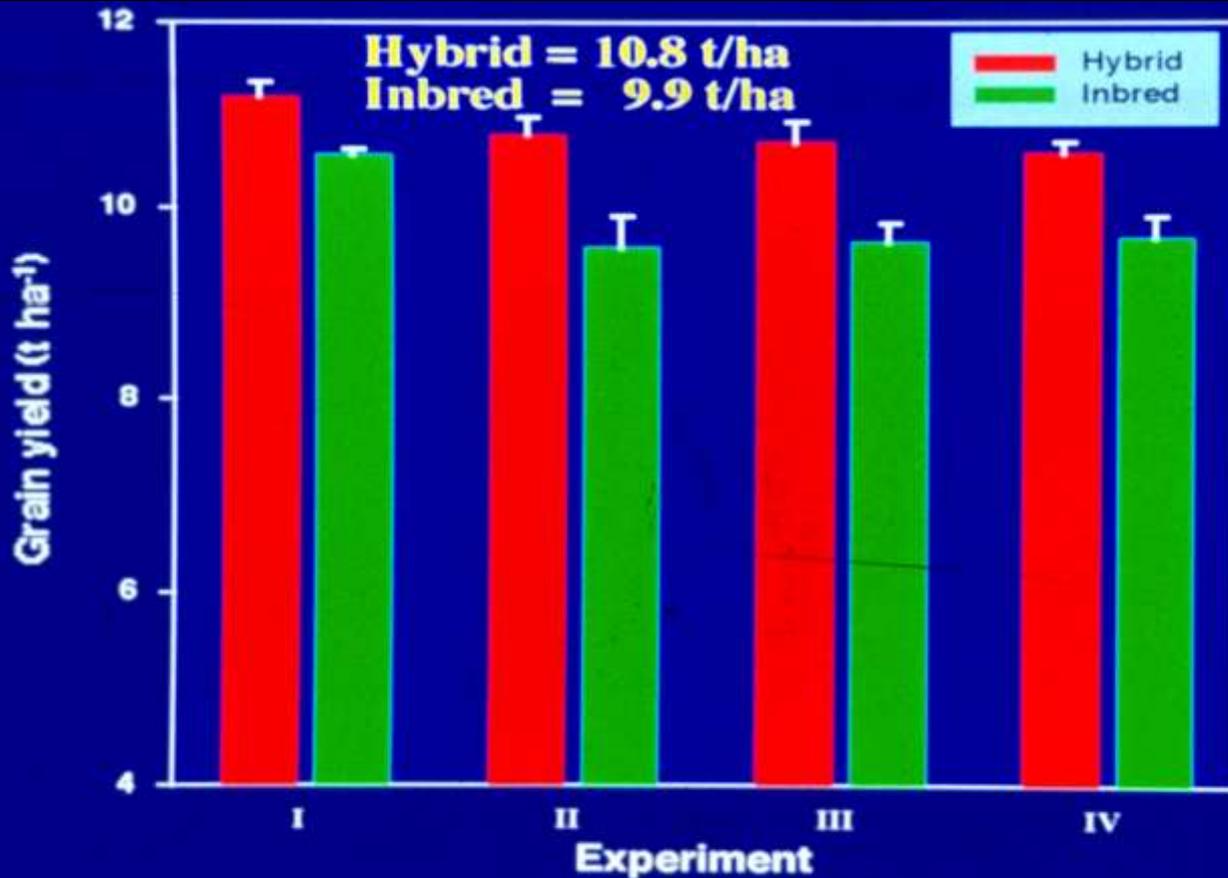
**IR64446-7-10-5 'Dianchao 3' (2000)**

**Best yield 15.2 t/ha**

# An Experimental Rice Hybrid



# Comparison of Yield of Hybrid and Inbred Rice



**Exp I = PhilRice, 96DS**

**Exp III = IRRI, 97DS**

**Exp II = PhilRice, 97DS**

**Exp IV = IRRI, 97DS**

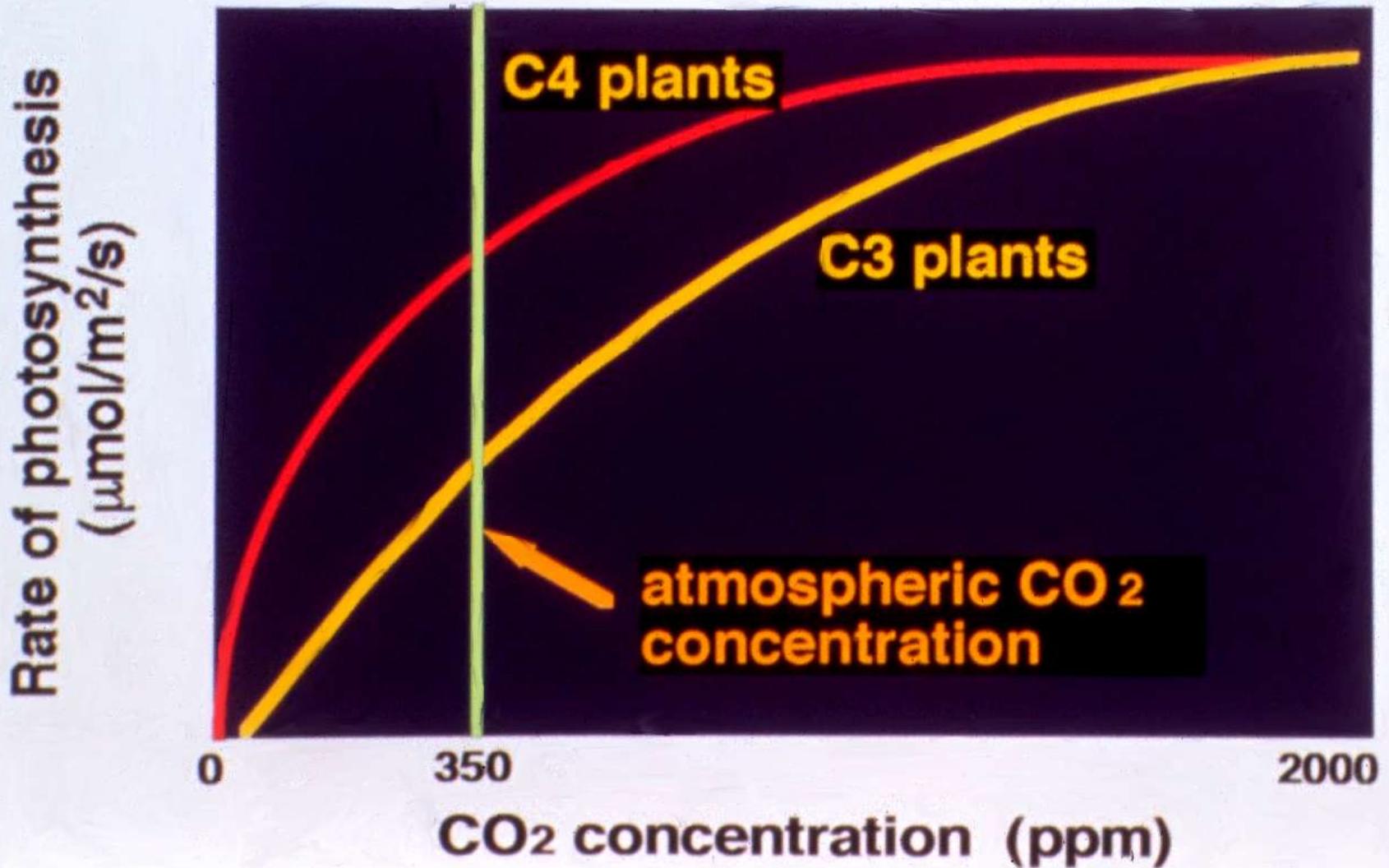
# C3 and C4

- The Calvin Cycle, discovered in 1958 by Melville Calvin (1911-1997), explains how plants convert CO<sub>2</sub> and H<sub>2</sub>O into sugar during photosynthesis, producing a compound with 3 carbon atoms in its molecule, hence the **C3 plants**.
- Another pathway, discovered by Australians Slack and Hatch in 1966, shows that plants like Sorghum, sugar cane, and maize, have 4 carbon atoms, hence **C4 plants**.

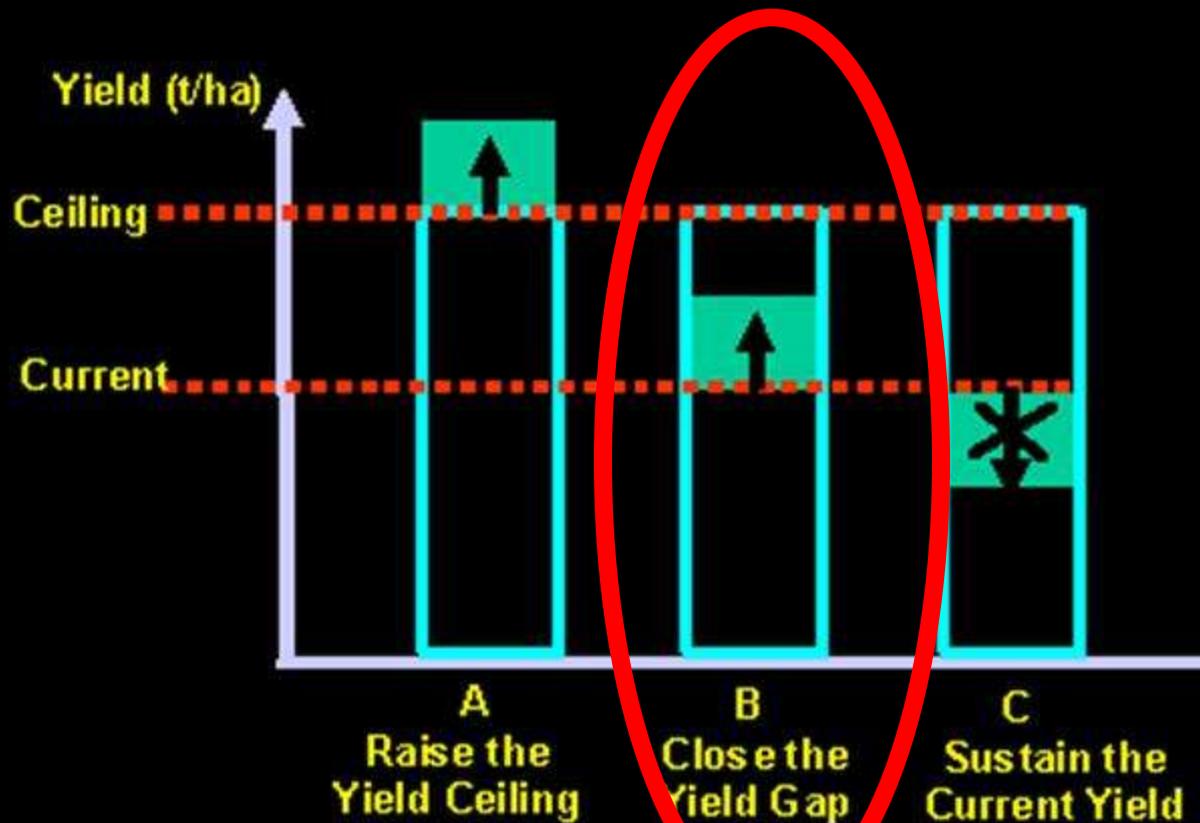
# **C3 and C4**

- **C4 plants assimilate CO<sub>2</sub> at twice or more the rate of C3 plants and grow much faster**
- **If it were possible to transgenically convert C3 to C4 plants it would have dramatic results**

# Differences in the Photosynthesis of C3 and C4 Plants



# Technologies for Closing the Yield Gap



Source: Gurdew Khush, Lecture at BioM, Lyon 2005

# Biological cost of weeds, Diseases and Insects

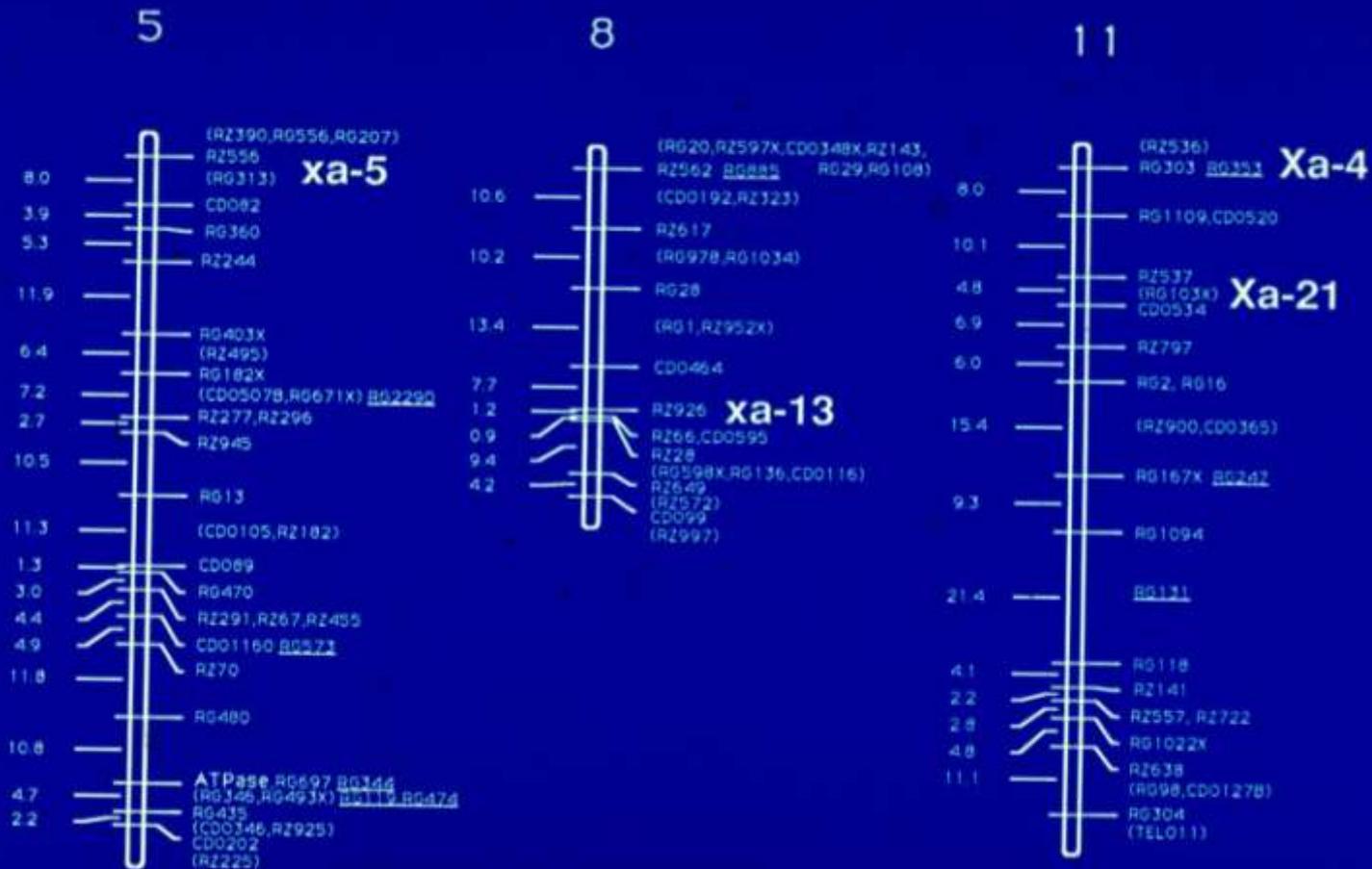
Crop	Percent of Yield Potential		
	Weeds	Disease	Insects
Rice	10.6	9.0	27.3
Wheat	9.8	9.5	5.4
Maize	13.1	9.6	12.9
Millets & Sorghum	17.9	10.3	9.5
Barley	8.8	8.3	3.9

# Reaction to Bacterial Blight

**Resistant**                      **Susceptible**

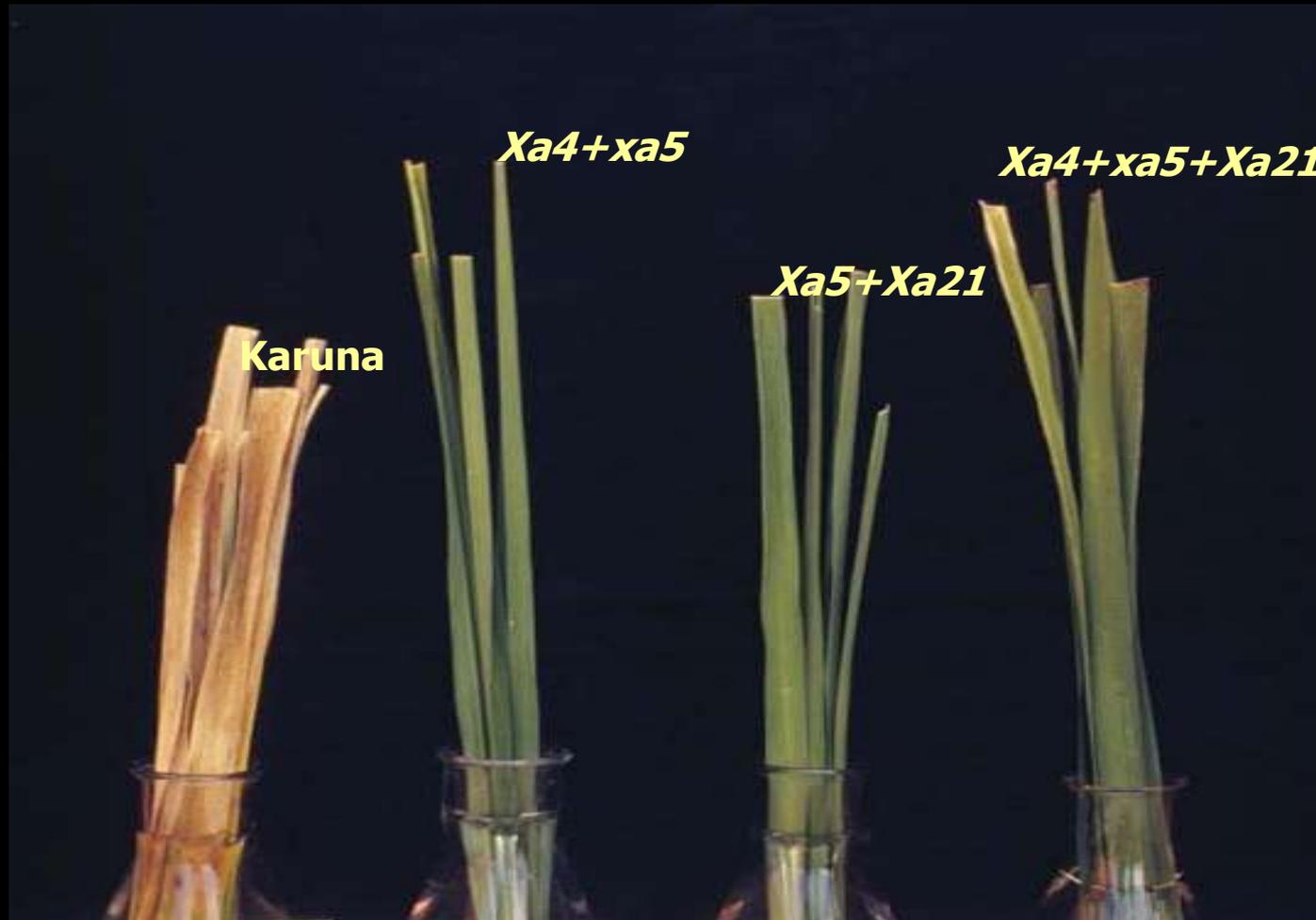


# Bacterial Blight Resistance Genes tagged with molecular markers



# Resistance genes effective against bacterial blight

Reaction to a virulent isolate



# Rice Plants with White Heads caused by Stem-Borer damage



# Stem-Borer Larvae from Transgenic Rice (top) and Control (bottom)





Bio-Control



Pheromone Trap

Latest Trend in IPM is to maximize the use of eco-friendly strategies and minimize the use of toxic chemicals for longer lasting benefits to famers



Need based Chemical Control



Host Plant Resistance

# Biological Control

The rich and diverse wealth of biological agents such as predators, parasitoids, insect pathogens and their natural *in situ* interactions can be exploited as key components of IPM



## 4. Raise Agricultural Productivity

- Productivity must rise faster than price declines to generate surpluses for the small-holder farmers and reduce their poverty as their cheaper products help reduce the poverty in the cities
- **Measure in terms of Total Factor Productivity (land, water, labor, energy and chemical inputs)**

# **Technologies Needed For:**

- **increasing the yield potential**
- **closing the yield gap, including pest management**
- **Soil, water & nutrient management**
- **Labor & capital input management**
- **developing nutritious crops (more later)**

# The Ten Commandments For Transforming Global Agriculture

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2. Focus On Small-holder Farmers
3. Husband Natural Resources
4. Raise Agricultural Productivity
5. Improve Nutritional Content

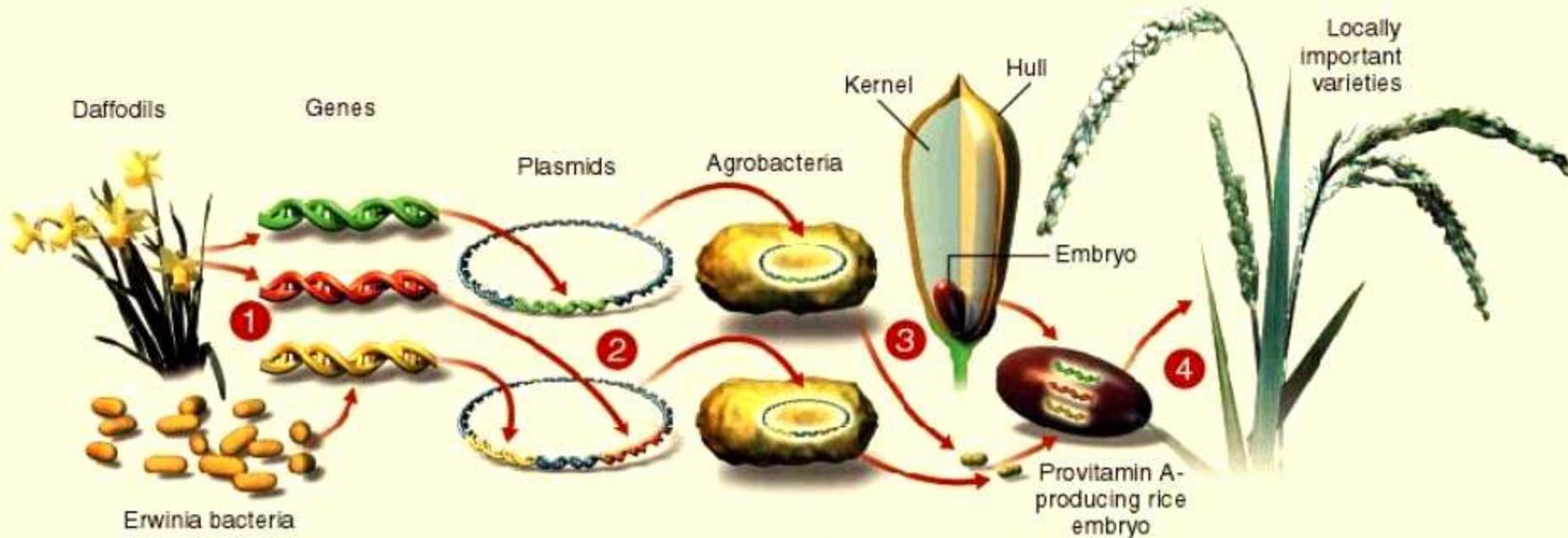
# **5. Improve Nutritional Content**

- **Enormous health benefits**
- **Bio-fortification is just the beginning**
- **Edible vaccines?**

**Better Nutrition**



# Golden Rice



**1** The genes that give golden rice its ability to make beta-carotene in its endosperm (the interior of the kernel) come from daffodils and a bacterium called *Erwinia uredovora*.

**2** These genes, along with promoters (segments of DNA that activate genes), are inserted into plasmids (small loops of DNA) that occur inside a species of bacterium known as *Agrobacterium tumefaciens*.

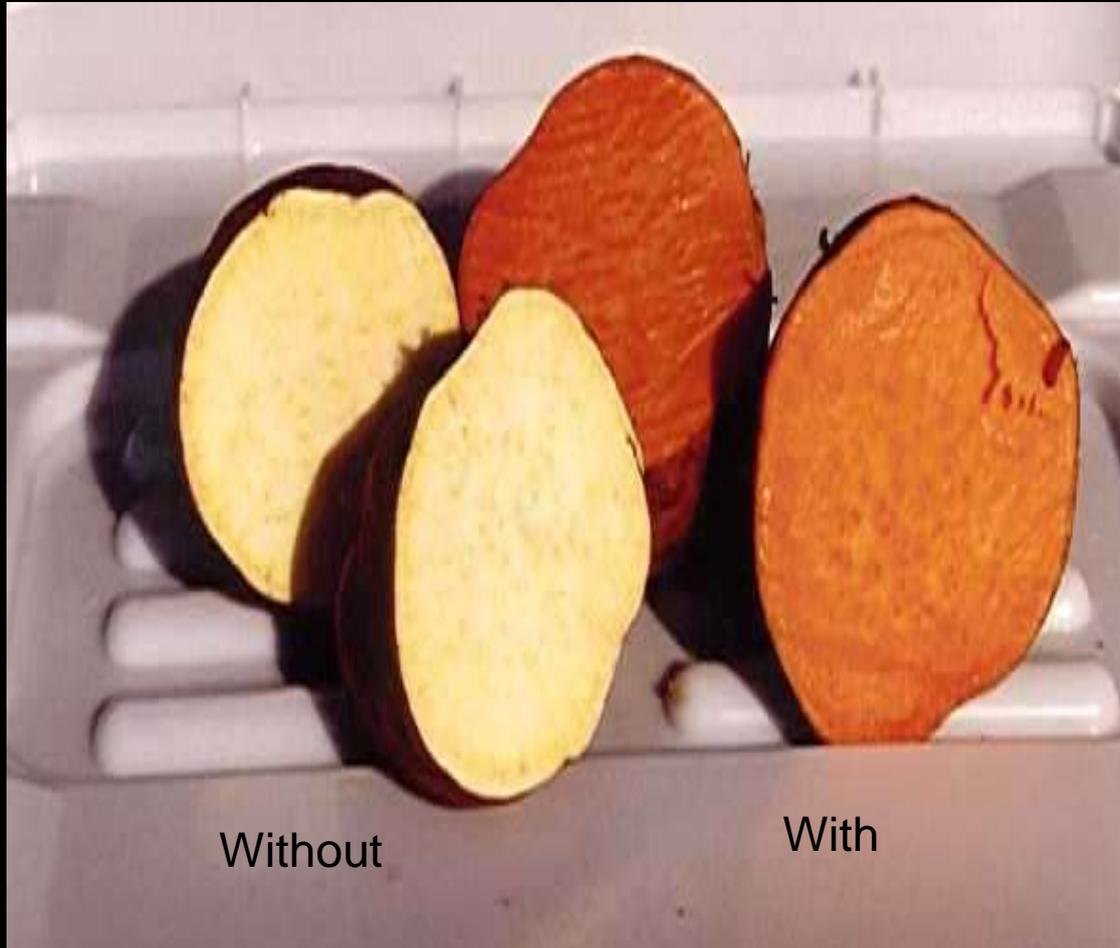
**3** These *agrobacteria* are then added to a Petri dish containing rice embryos. As they "infect" the embryos, they also transfer the genes that encode the instructions for making beta-carotene.

**4** The transgenic rice plants must now be crossed with strains of rice that are grown locally and are suited to a particular region's climate and growing conditions.

# White and Golden Rice



# Sweet Potatoes with and Without Beta-Carotene



Without

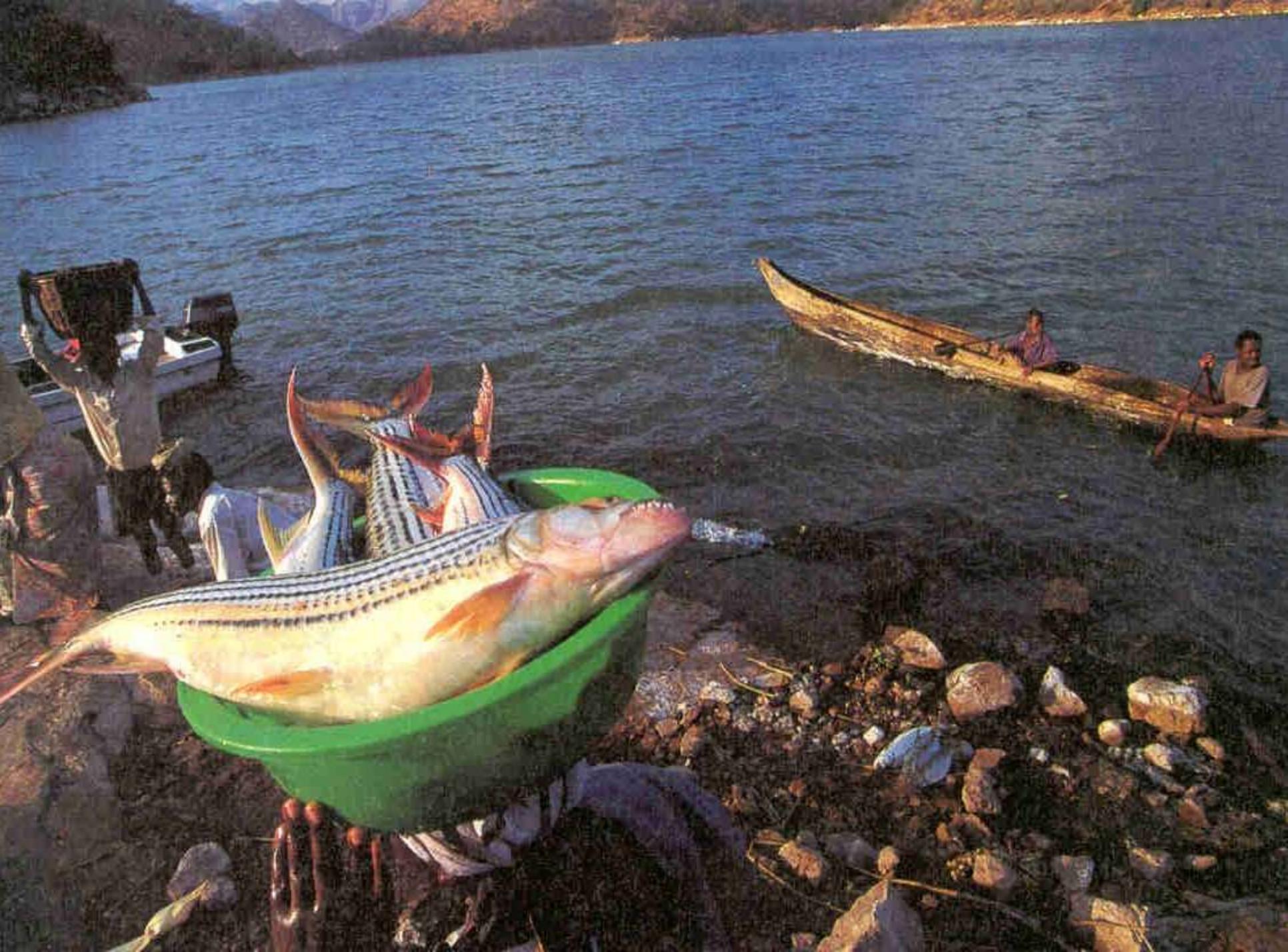
With

# High Iron Rice



**16ha production of the High iron rice in Mindanao**







# Longer, More Productive Lives



# The Ten Commandments For Transforming Global Agriculture

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6. Address Short-term Vulnerability

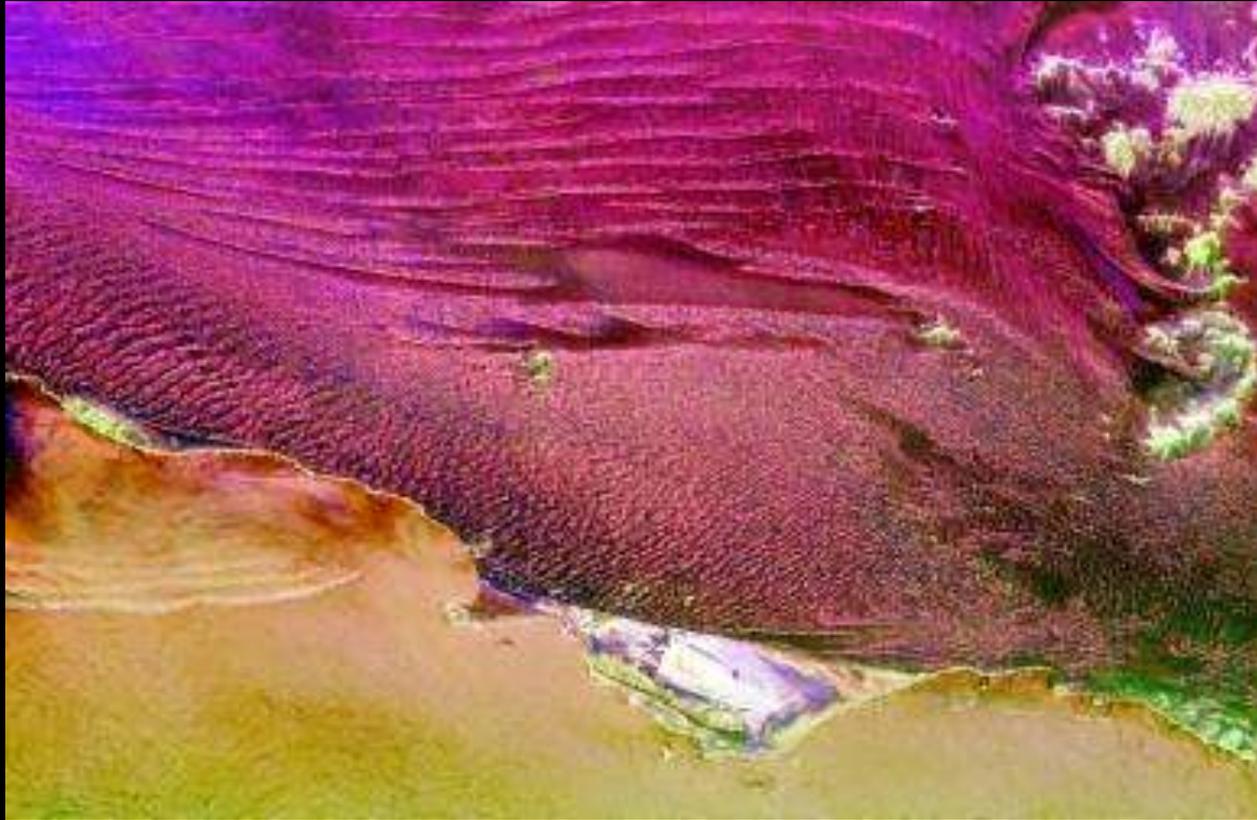
## **6. Address Short-term Vulnerability**

- **Most farmers live precariously**
- **Downside is devastating**
- **Climate change is increasing vulnerability**





# Desertification



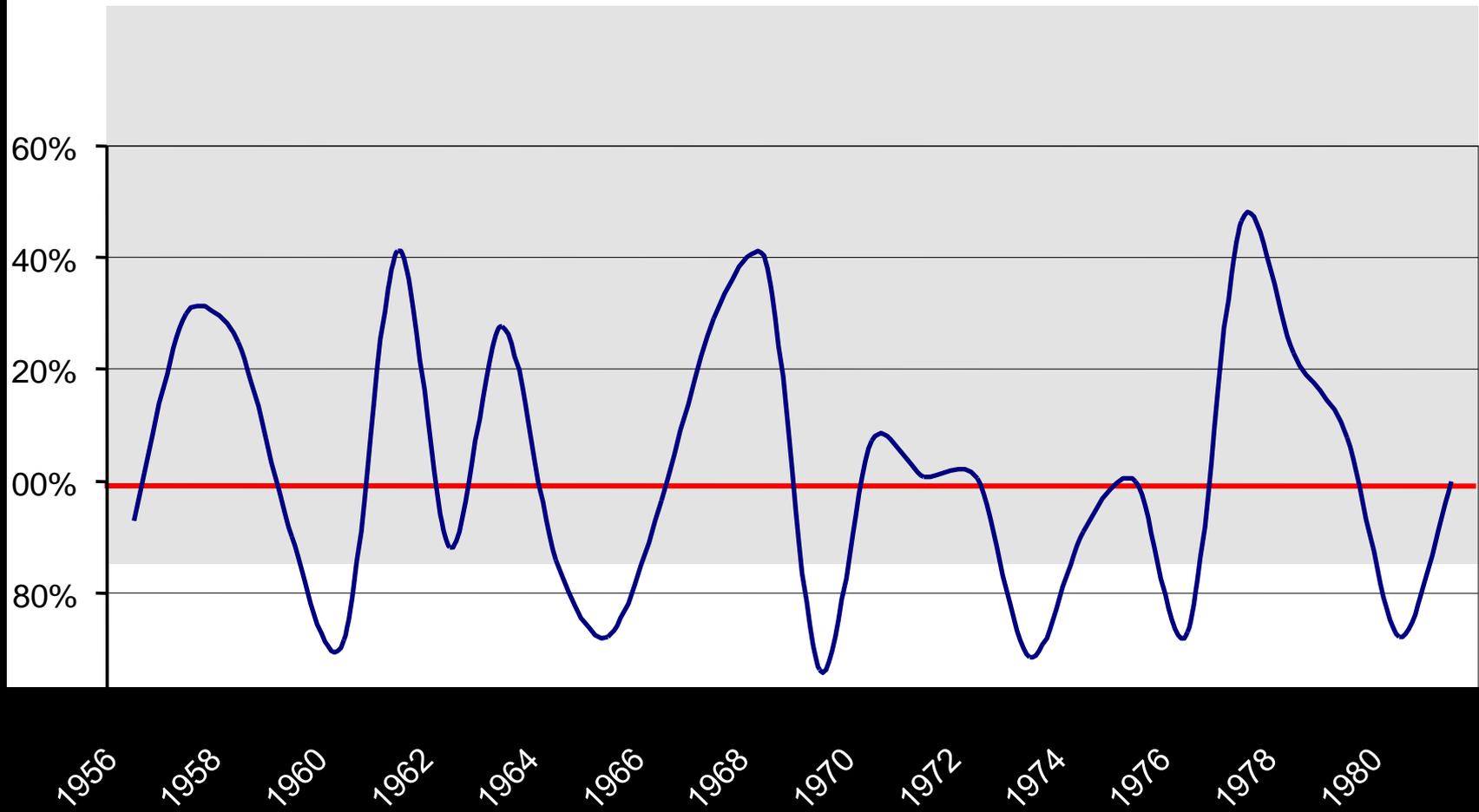
**In one year (1984-1985), Sahara's boundary shifted 110 km decreasing an area 724,000 sq. km (21.3 times the Netherlands)**





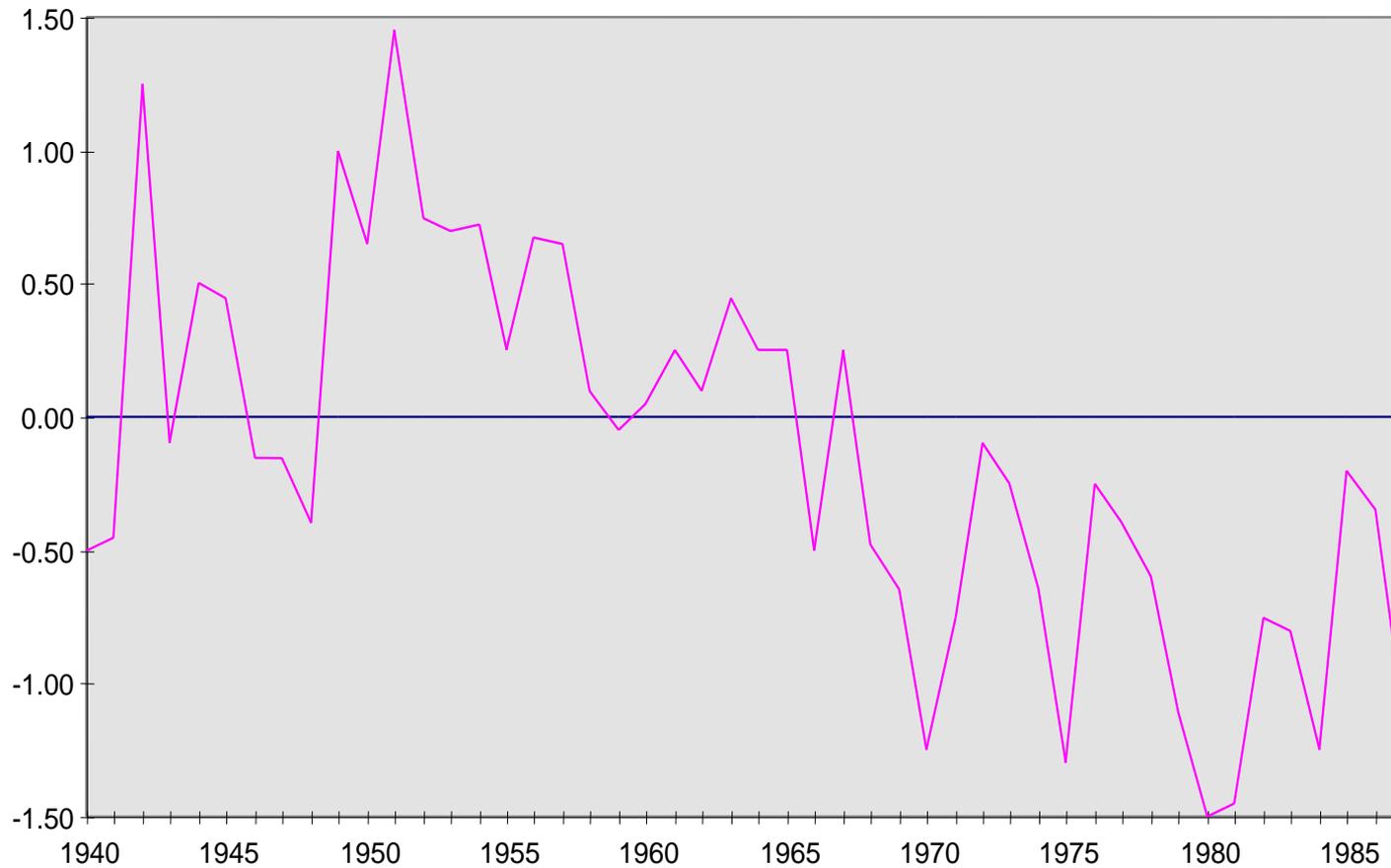
# Extreme Variability : Africa's Burden

Kenya: Annual Rainfall Variation about the Average



# Climate Variability (Change?)

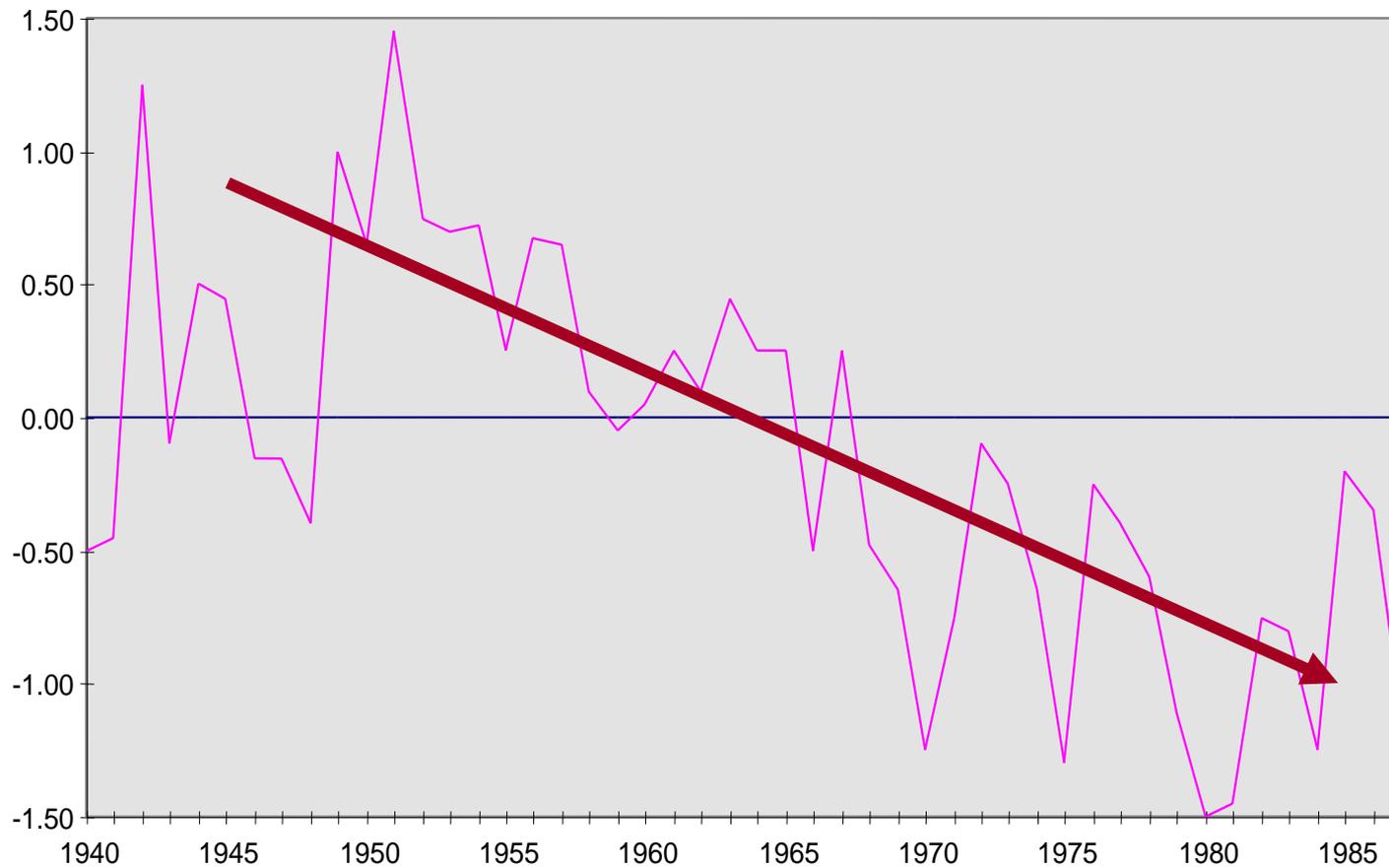
## Index of Rainfall in Sahel 1941-1990



Source: Departure from standard deviation; Climate Prediction Center 1991, Presentation by South Africa at Camdessus Panel meetings.

# Climate Variability (Change?)

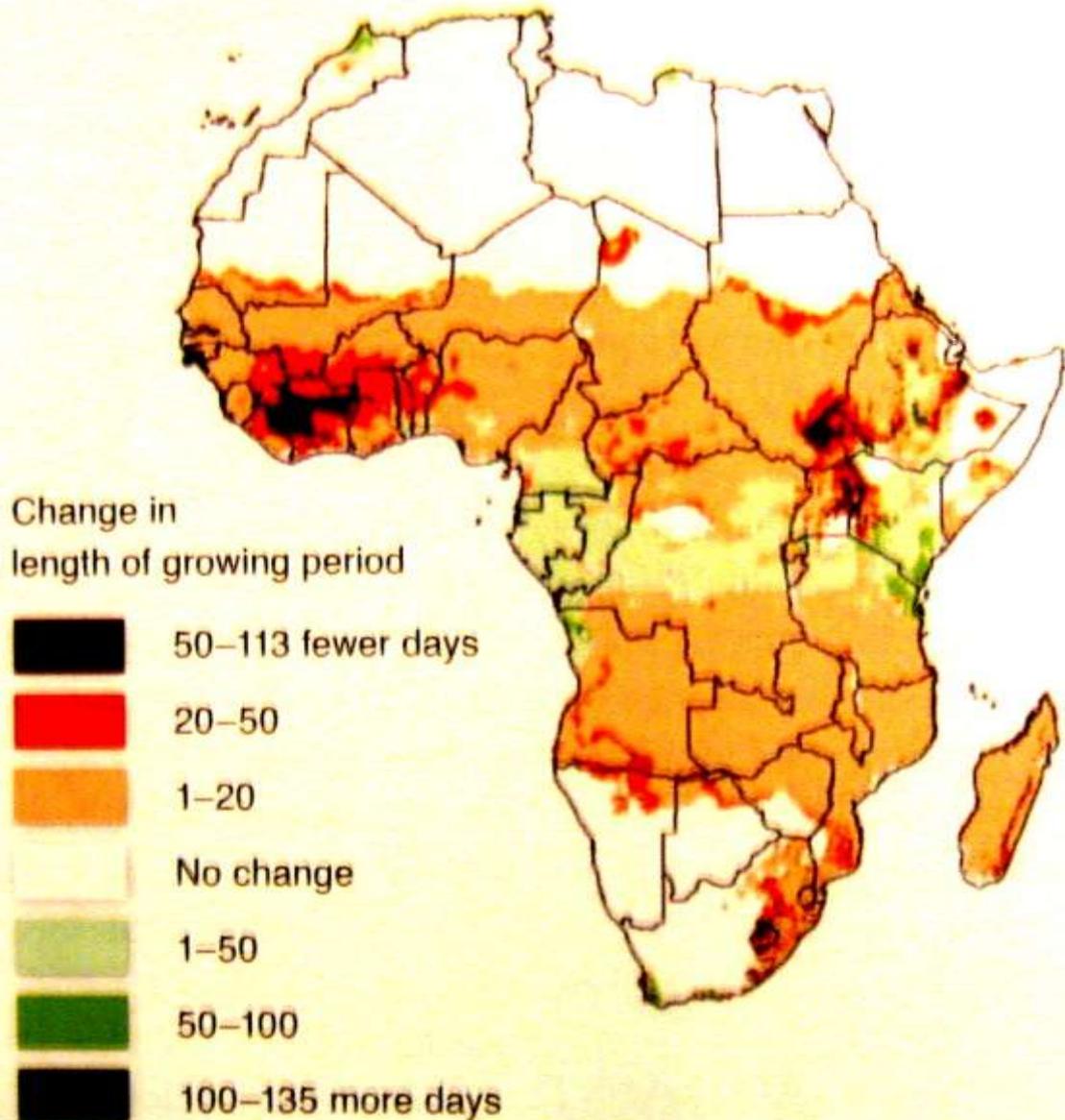
## Index of Rainfall in Sahel 1941-1990



Source: Departure from standard deviation; Climate Prediction Center 1991, Presentation by South Africa at Camdessus Panel meetings.

# Climate Change and Food Security:

## Changes in Length of growing period 2000-2005



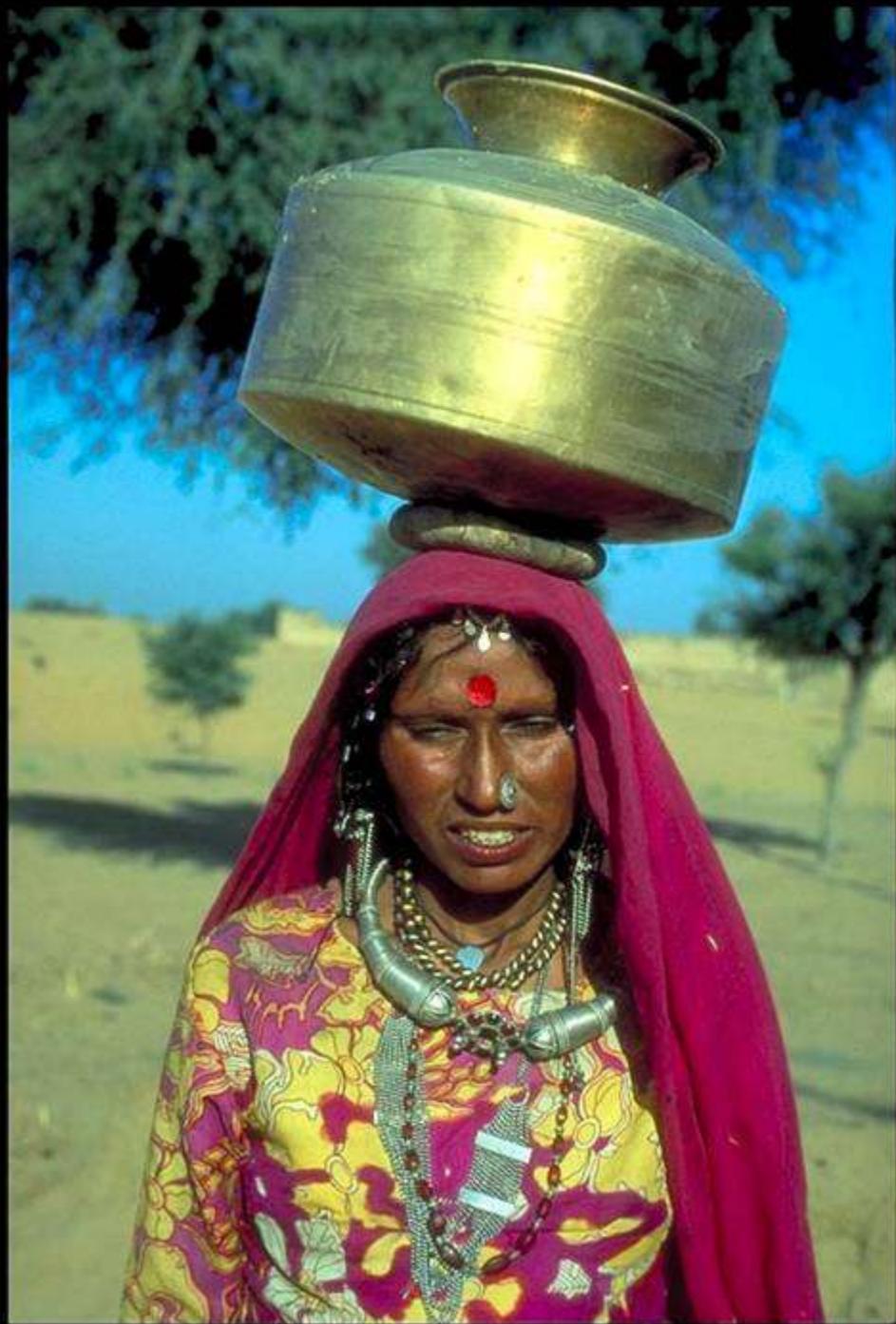
Thronton, et.al., cited in Greg Mock and Paul Steele, "Power to the poor: tapping the wealth of ecosystems", in *Environment*, vol 48: 1; Jan/Feb 2006, p. 15

# **The Ten Commandments For Transforming Global Agriculture**

- 1. Reform Policies And Markets**
- 2. Focus On Small-holder Farmers**
- 3. Husband Natural Resources**
- 4. Raise Agricultural Productivity**
- 5. Improve Nutritional Content**
- 6. Address Short-term Vulnerability**
- 7. Empower Women**

## **7. Empower Women**

- **Essential to recognize the gender dimension of agriculture**
- **Empowering Women results in major improvements in infant mortality, school enrolments, child morbidity**



# 7. Empower Women

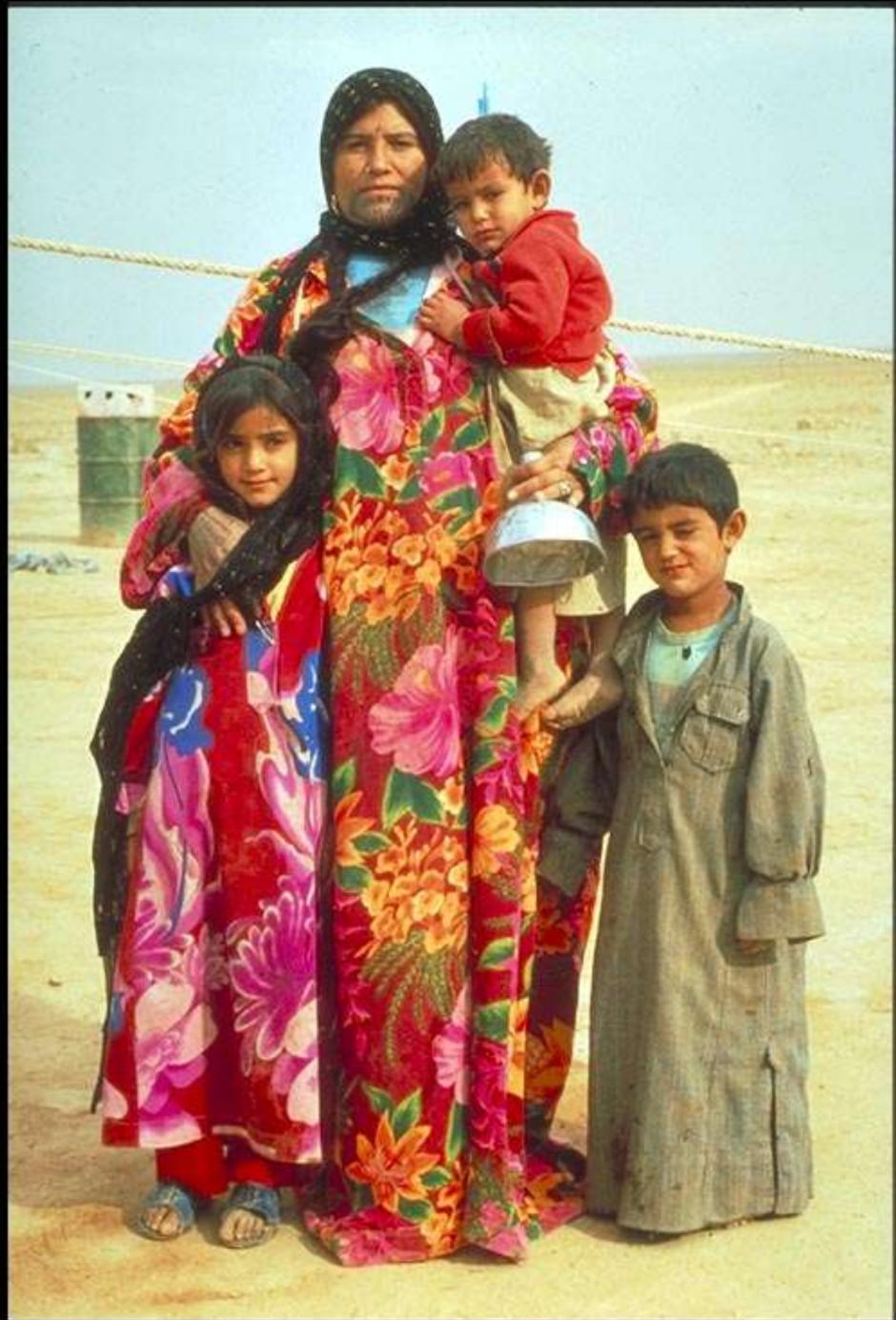
- **Women have unequal opportunity in:**
  - **Education**
  - **Health care**
  - **Income**
  - **Credit**
  - **Employment**
  - **Assets**
  - **Decision-making**

A group of six women, dressed in traditional Indian saris of various colors (yellow, blue, green, purple, red, and beige), are standing in a line at a public water tap. They are filling their pots and containers with water. The water is flowing from the tap into a concrete basin. The background shows a clear blue sky and some distant structures, suggesting an outdoor setting. The text "And We Must Never Forget the Gender Dimension..." is overlaid in yellow on the image.

**And We Must Never Forget the Gender Dimension...**

# Educate Girls and Empower Women...







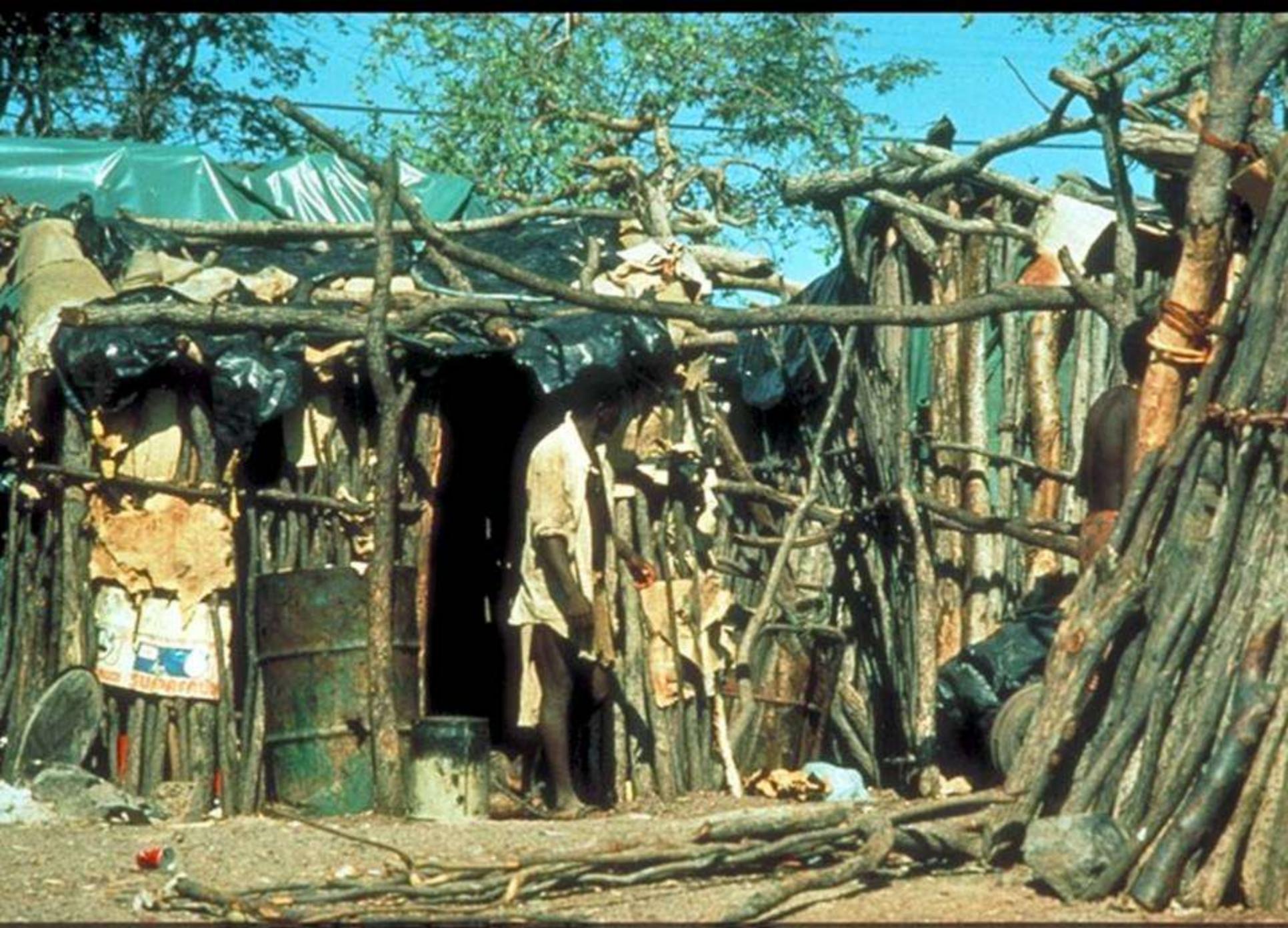
# The Ten Commandments For Transforming Global Agriculture

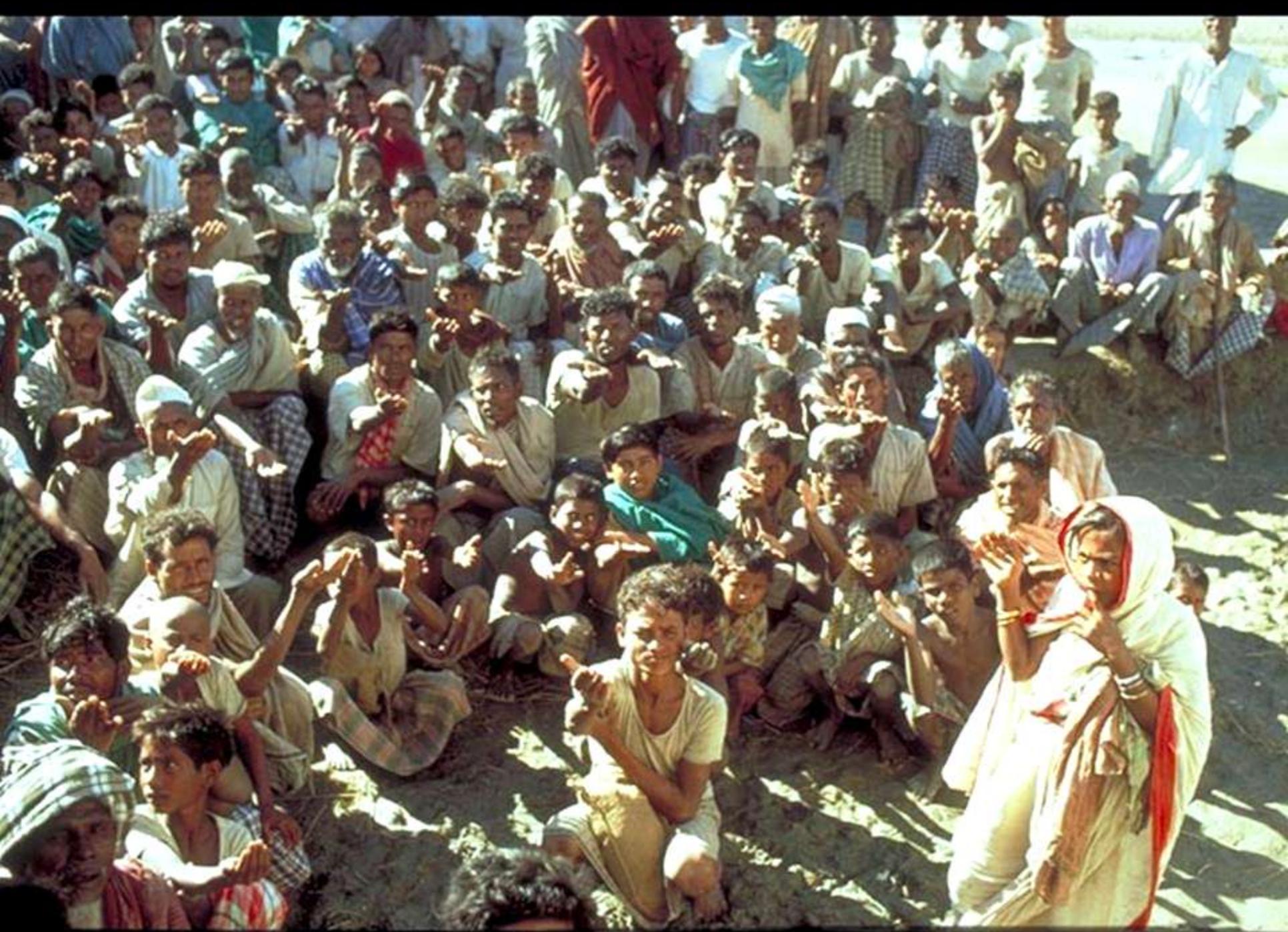
1. Reform Policies And Markets
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7. Empower Women
8. Reach Out To The Ultra-poor

## **8. Reach Out To The Ultra-Poor**

- **Market incentives do not work for the ultra-poor**
- **Trickle-down does not work**
- **Special Programs will be needed**







# The Ten Commandments For Transforming Global Agriculture

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9. **Support Science**

## **9. Support Science**

- **We need more support for science in developing countries**
- **Not just technology**

# Rich Countries Vs. Poor Countries

Income:

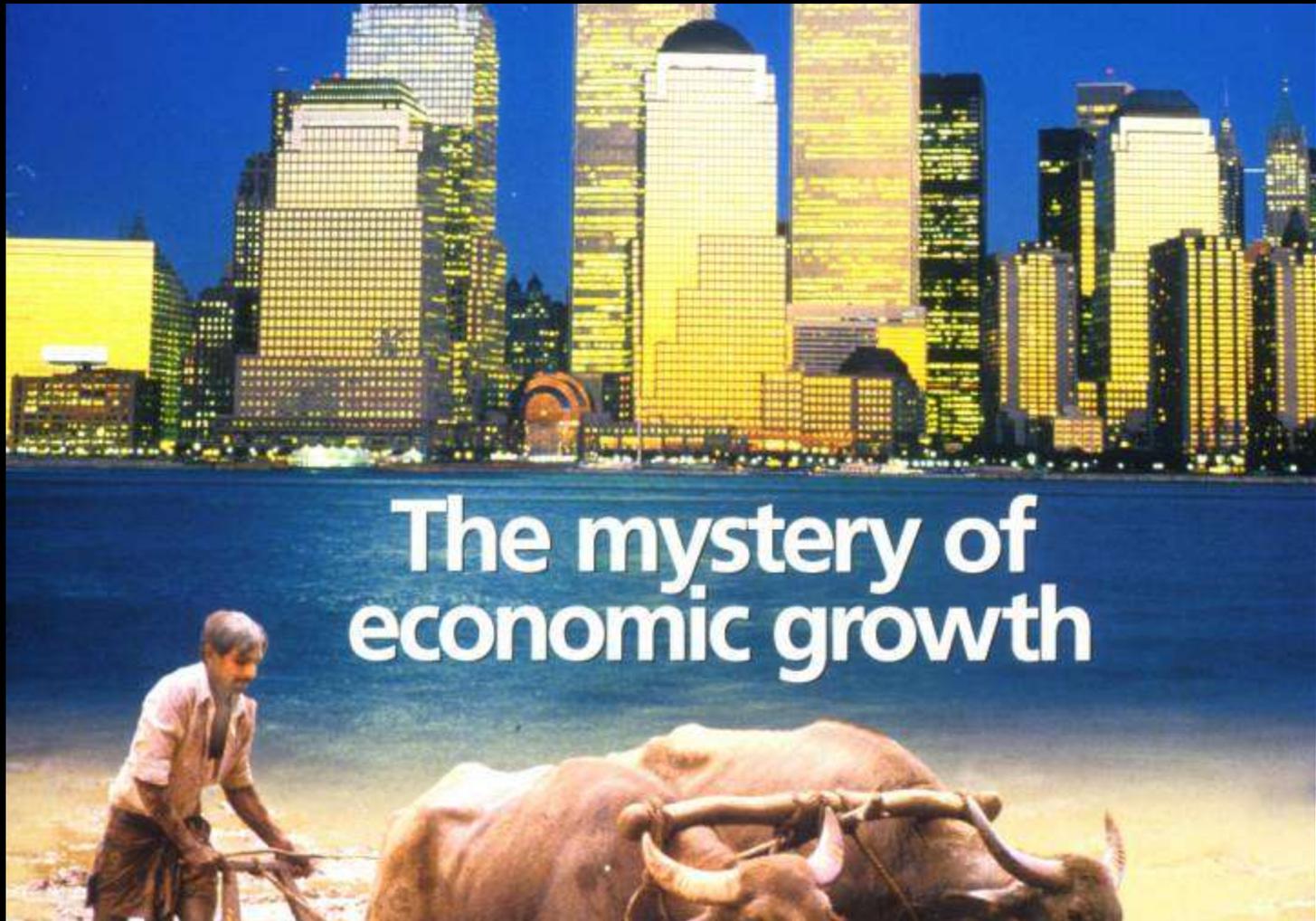
**40** Times

Research:

**220** times

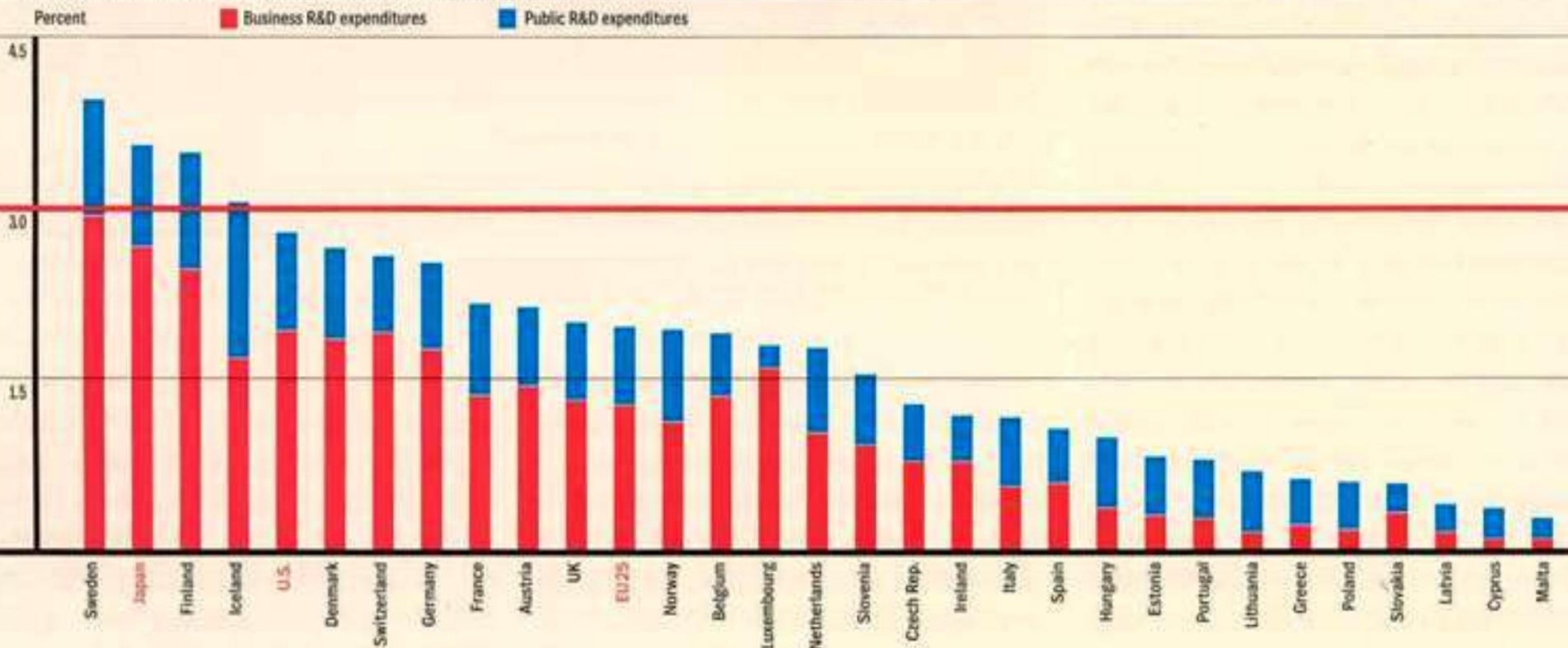


# The Divide in S&T Capacity



# R&D expenditures as percent of GDP

Comparison of R&D expenditures as a percent of GDP



Source: European Commission, European Innovation Scoreboard 2005

January 2004

## **Inventing a better future**

A strategy for building worldwide  
capacities in science and technology



InterAcademy Council

January 2004

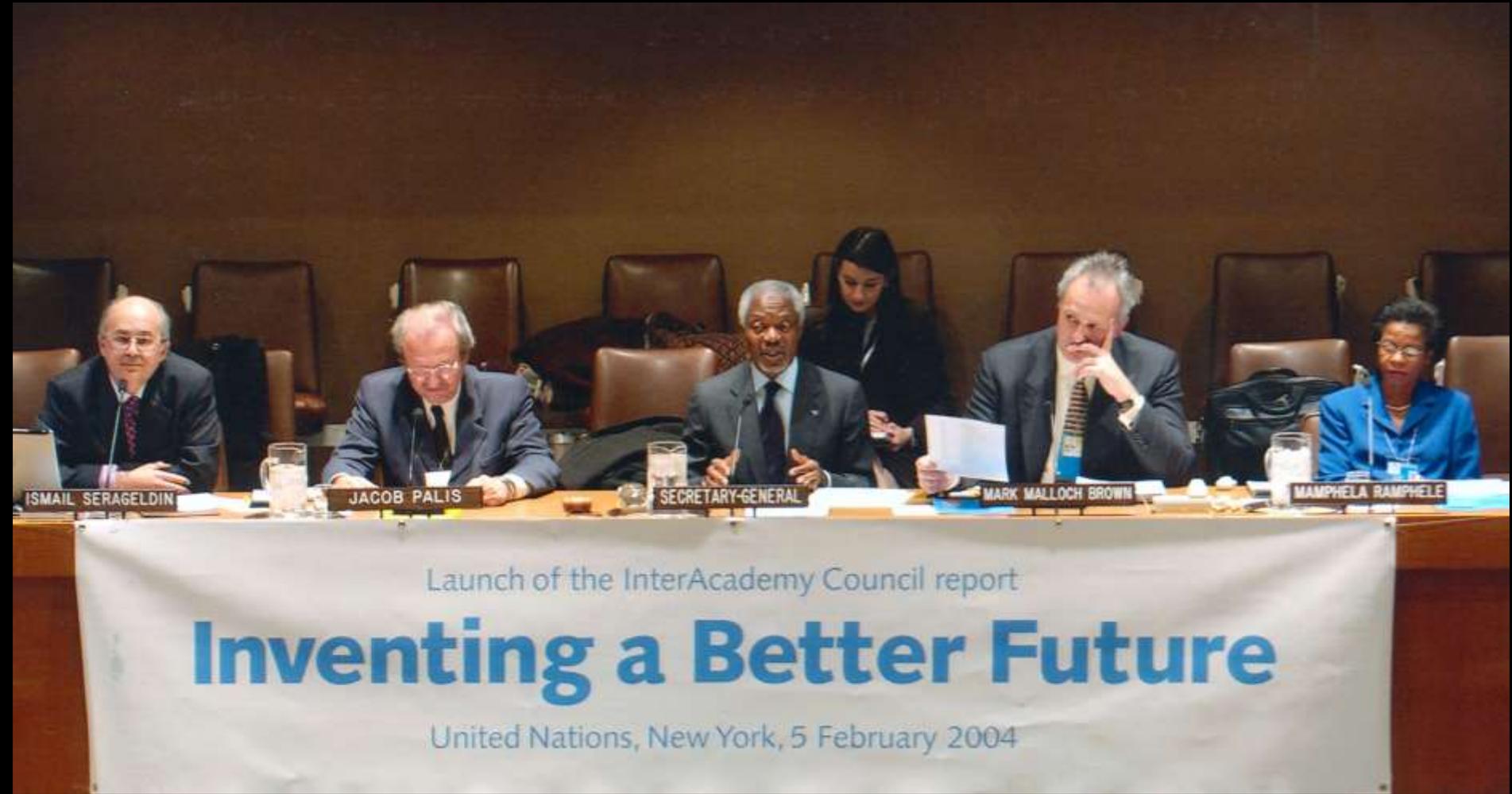
## **Inventing a better future**

A strategy for building worldwide  
capacities in science and technology

[www.interacademycouncil.net/streport](http://www.interacademycouncil.net/streport)



InterAcademy Council



ISMAIL SERAGELDIN

JACOB PALIS

SECRETARY-GENERAL

MARK MALLOCH BROWN

MAMPHELA RAMPHELE

Launch of the InterAcademy Council report

# Inventing a Better Future

United Nations, New York, 5 February 2004

# 9. Support Science

- **Science and Society**
- **Human resources (including Brain drain)**
- **Institutions of excellence**
- **Public/Private interface**
- **Financing mechanisms**

# African Biotechnology Panel



**Presenting our report later this year for consideration by AU summit in early 2007**

# The Ten Commandments For Transforming Global Agriculture

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9. Support Science
- 10. Translate Rhetoric Into Action**

# **10. Translate Rhetoric into Action**

- **Many past declarations**
- **Many government announcements**
- **Will the Millennium Development Goals be different?**

***“We have the capacity to  
eliminate hunger from the  
face of the earth in our  
lifetime.  
We need only the will.”***

**President John F. Kennedy  
World Food Congress 1963**

Rhetoric  
Declarations  
Plans  
Targets



Action

The Per Pinstrup-Andersen Equation (Wageningen Lecture March 2005)

WE'RE STILL MISSING A  
KEY TRANSLATOR...



**A.U.**  
**LAUNCH**

9-7-02  
SQUETAN E.  
**ZAPIRO**

# **The Ten Commandments For Transforming Global Agriculture**

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- 10. Translate Rhetoric Into Action**

**Envoi**

**Working All Together**



**There is  
so much  
we can do  
for a  
whole  
generation**



**For The Whole World...**





**Thank You**

**Thank You**



# **Important notice**

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