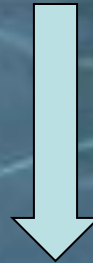


# Virtual Water and Global Food Security towards 2050


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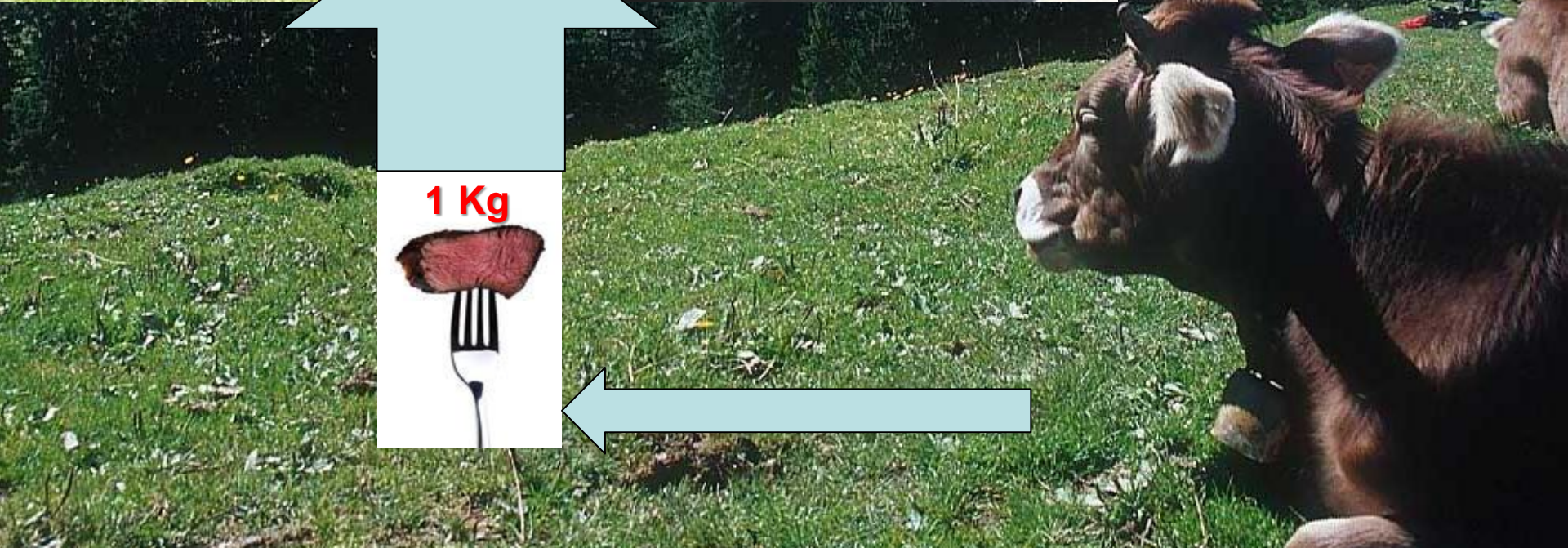


  
0,125 L

0,125 L

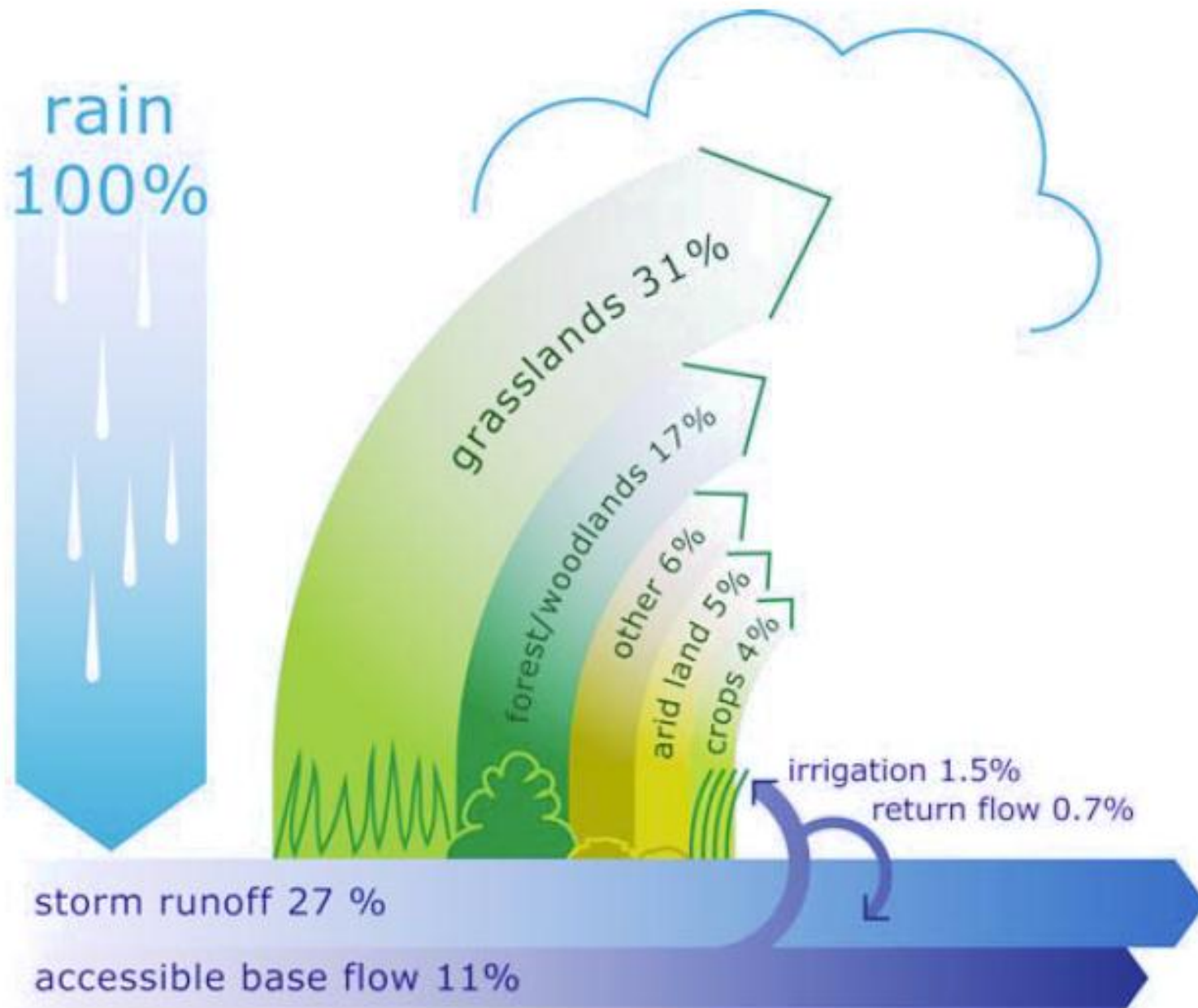


0,125 L



# **Drinking tea instead of coffee would save a lot of water**

**Chapagain A.K. and Hoekstra A.Y - The water needed to have the Dutch drink tea.  
Value of Water Research Report Series No. 15. 2003. UNESCO-IHE, Delft, the Netherlands**



# Estimates of virtual water content of a selected products (m<sup>3</sup>/ton or liter/kg)

(from Hoekstra, 2003 – last column from Mekonnen & Hoekstra, 2012))

<b>Product</b>	<b>Hoekstra &amp; Hung (2003)*</b>	<b>Chapagain &amp; Hoekstra (2003)*</b>	<b>Zimmer &amp; Renault (2003)**</b>	<b>Mekonnen &amp; Hoekstra (2012)</b>
<b>Wheat</b>	<b>1 150</b>		<b>1 160</b>	<b>1827</b>
<b>Rice</b>	<b>2 656</b>		<b>1 400</b>	<b>1673</b>
<b>Maize</b>	<b>450</b>		<b>710</b>	<b>1222</b>
<b>Potatoes</b>	<b>160</b>		<b>105</b>	<b>287</b>
<b>Soybean</b>	<b>2 300</b>		<b>2 750</b>	<b>2145</b>
<b>Beef</b>		<b>15 977</b>	<b>13 500</b>	<b>15 415</b>
<b>Pork</b>		<b>5 906</b>	<b>4 600</b>	<b>5 988</b>
<b>Poultry</b>		<b>2 828</b>	<b>4 100</b>	<b>4 325</b>
<b>Eggs</b>		<b>4 657</b>	<b>2 700</b>	<b>3 265</b>
<b>Milk</b>		<b>865</b>	<b>790</b>	<b>1 020</b>
<b>Cheese</b>		<b>5 288</b>		<b>5 060</b>

\* : Global averages

\*\* :California. Egypt for soybean

# Annual Water Footprint of Humanity (period 1996-2005)

Mekonnen & Hoekstra (2011)

**9 087 Gm<sup>3</sup>**

of which

- **92 % agriculture and livestock : 8 362 Gm<sup>3</sup>**
- **4,4 % for industrial goods (including hydropower) : 401 Gm<sup>3</sup>**
- **3,6 % for domestic supply : 324 Gm<sup>3</sup>**



# GLOBAL WATER FOOTPRINT (1996-2005)

	Agriculture	Industry	Domestic	Total
<b>Green</b>	<b>6 684</b>	<b>-</b>	<b>-</b>	<b>6 684</b>
<b>Blue</b>	<b>945</b>	<b>38</b>	<b>42</b>	<b>1 025</b>
<b>Gray</b>	<b>733</b>	<b>362</b>	<b>282</b>	<b>1 378</b>
<b>TOTAL</b>	<b>8 363</b>	<b>400</b>	<b>324</b>	<b>9 087</b>

# Annual Water Footprint per capita (period 1996-2005)

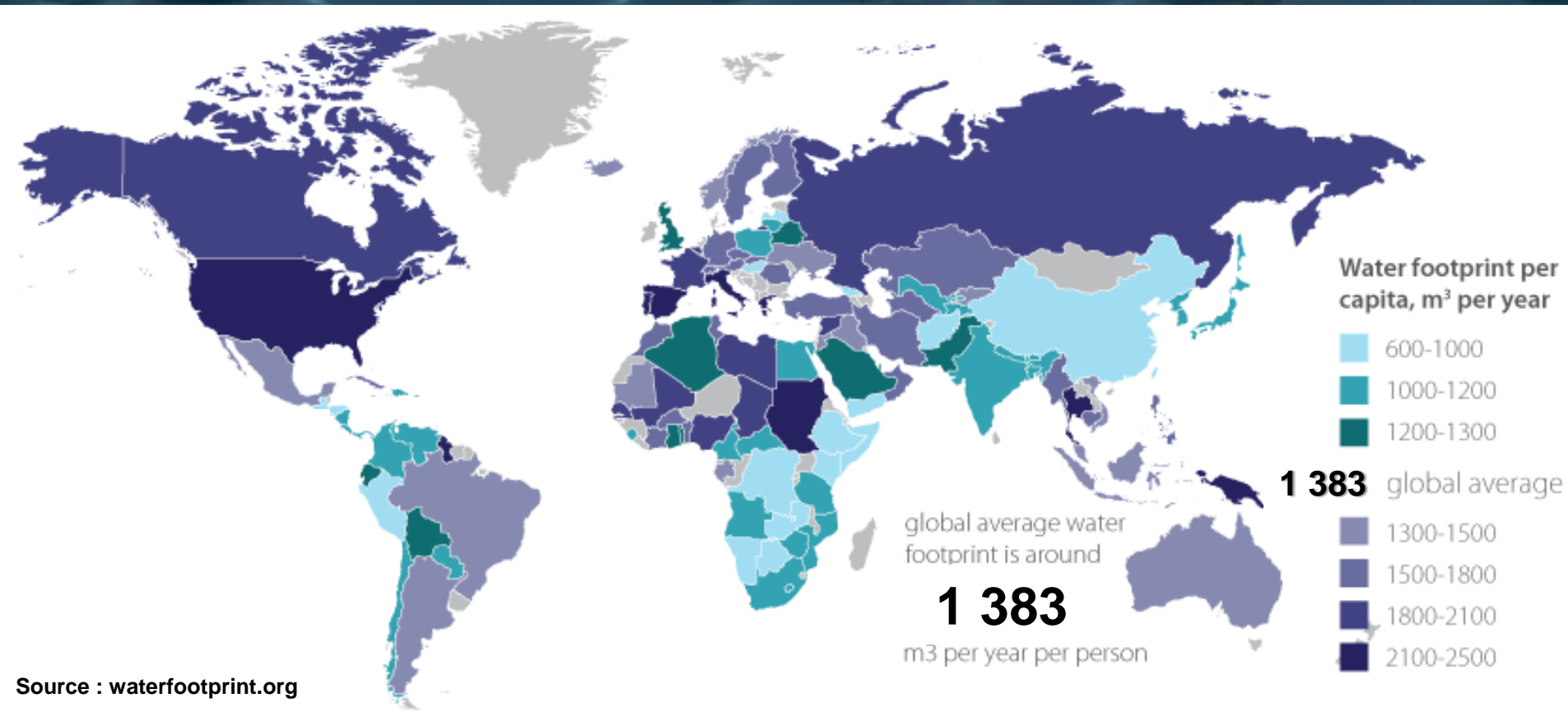
Mekonnen & Hoekstra (2011)

Assuming 6.085 billion people on the Earth in year 2000

**1 383 m<sup>3</sup>**

of which

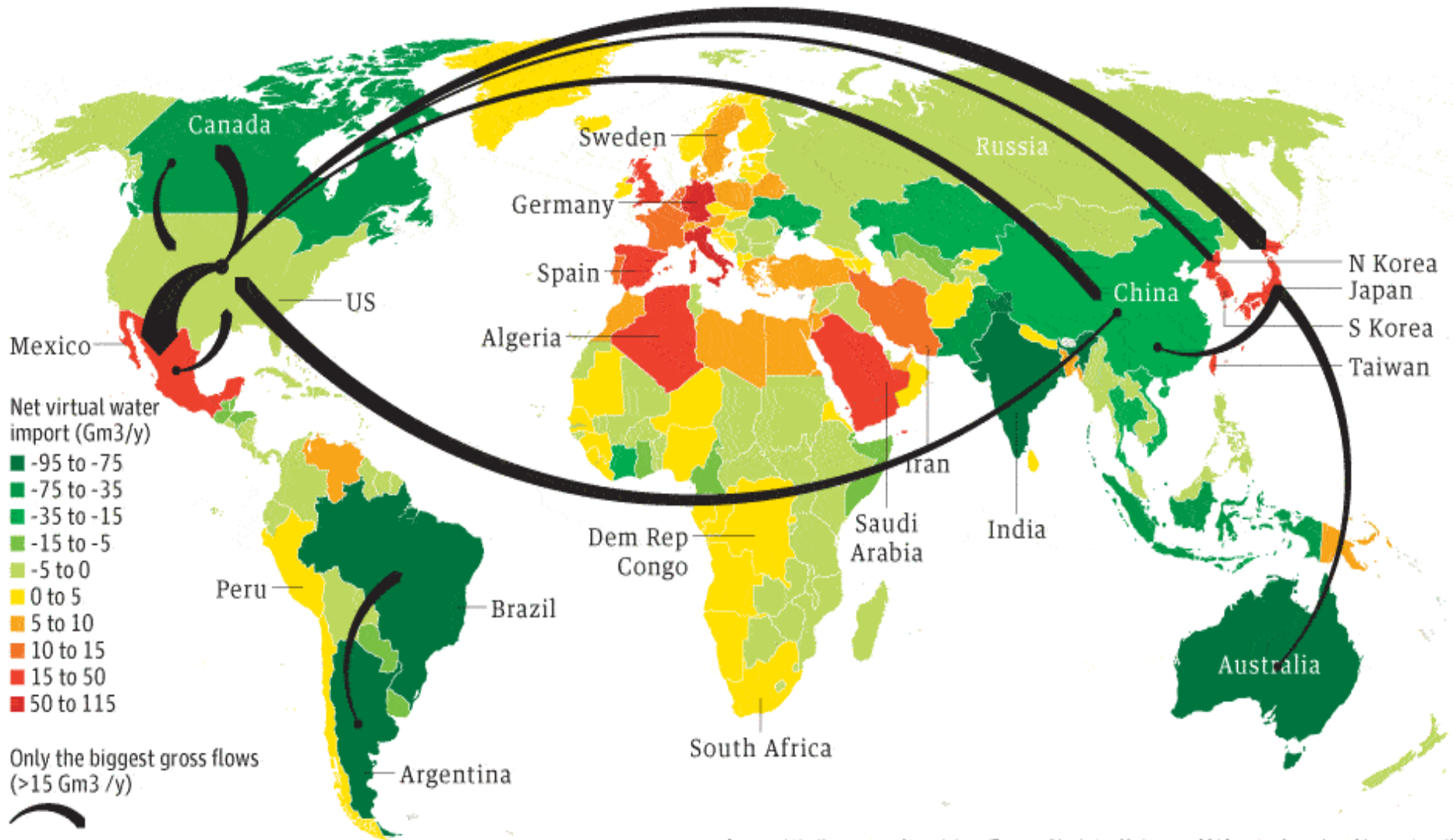
- **92% agriculture and livestock : 1 374 m<sup>3</sup>**
- **5% for industrial goods (including hydropower) : 66 m<sup>3</sup>**
- **4% for domestic supply : 53 m<sup>3</sup>**



# TRADE OF VIRTUAL WATER

Source : Waterfootprint.org

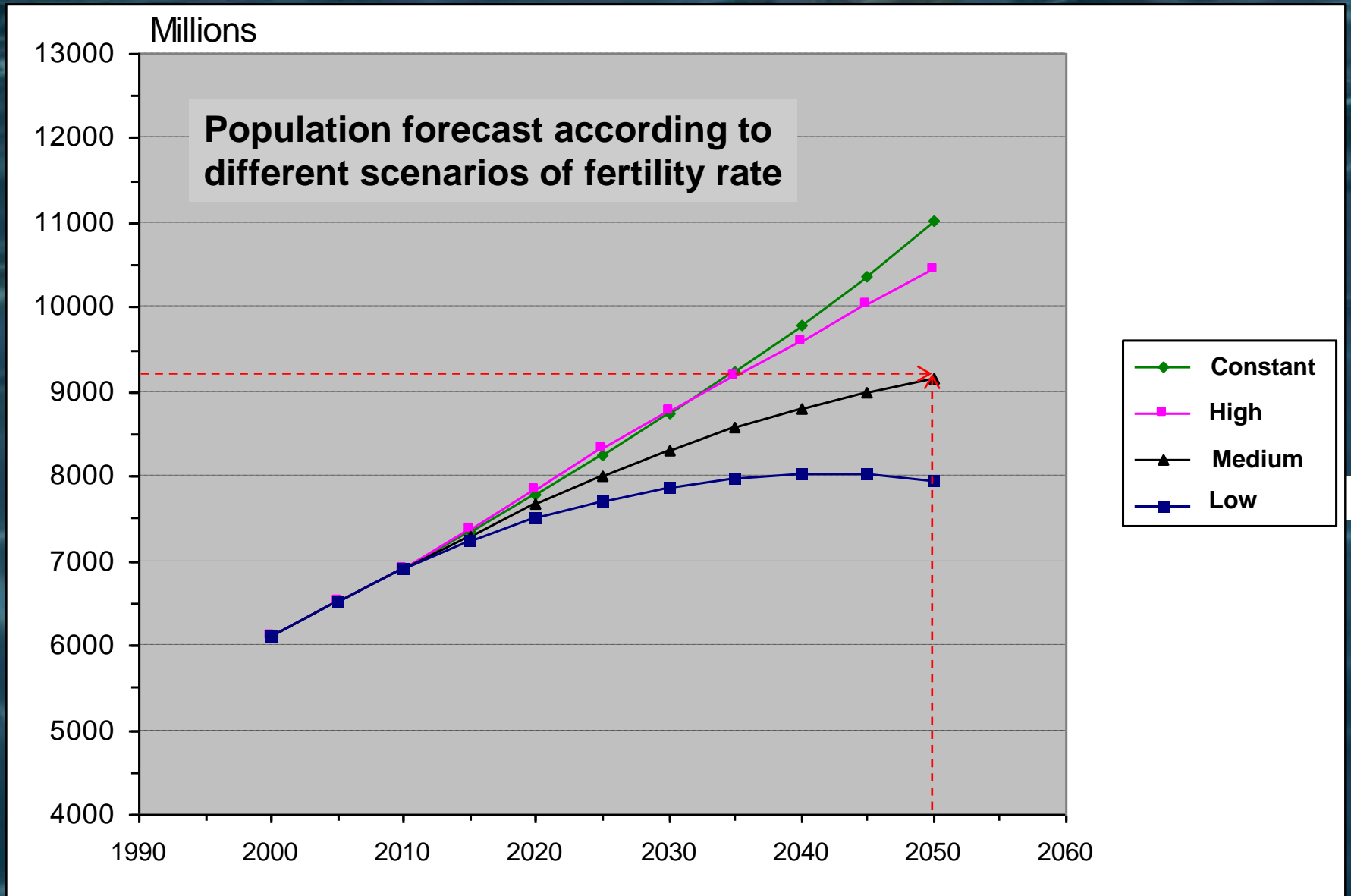
The exports and imports of water through food and commodities, 1996-2005



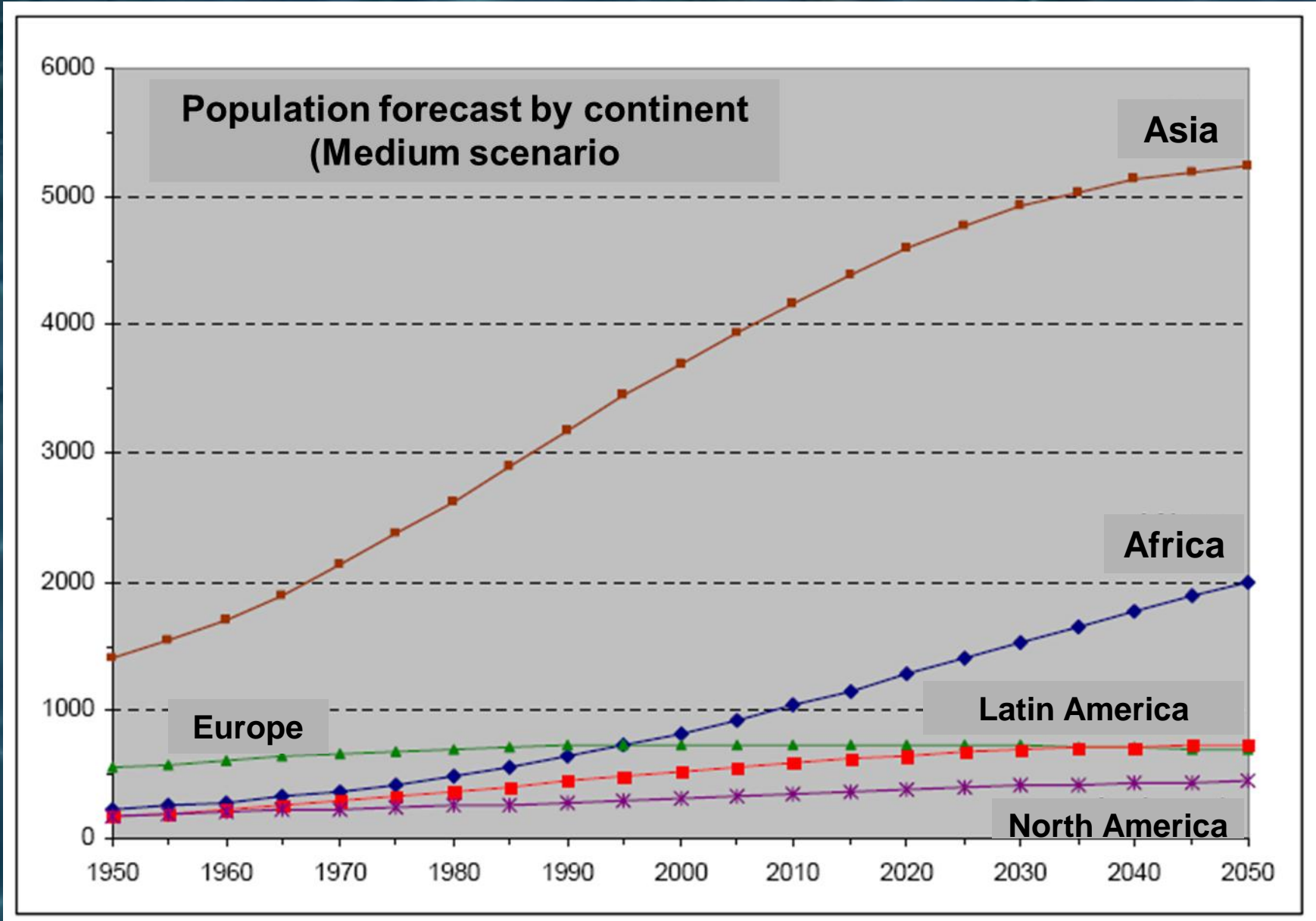


# **The Future Towards 2050**

# Demographic forecast 2000-2050 (United Nations, 2008)



# Demographic forecast 2000-2050 (United Nations, 2008)



# Apparent food consumption (2006-2008).

Source : FAO\_Stat

<b>Food consumption (period 2006-2008)</b>		
<b>Country groups</b> <i>MDG/UN regional classification</i>	<b>(kcal/person/day)</b>	<b>% of undernourished</b>
<b>WORLD</b>	<b>2 790</b>	<b>13</b>
<b>Developed regions</b>	<b>3 430</b>	<b>—</b>
<b>Developing Regions</b>	<b>2 640</b>	<b>15</b>
<b>Least Developed Countries</b>	<b>2 120</b>	<b>33</b>
<b>Landlocked Developing Countries</b>	<b>2 280</b>	<b>26</b>
<b>Small Island Developing States</b>	<b>2 550</b>	<b>21</b>



# Meat versus vegetarian diet

Source : [waterfootprint.org](http://waterfootprint.org)

	Meat diet	kcal/day	litre/kcal	litre/day	Vegetarian diet	kcal/day	litre/kcal	litre/day
Industrial countries	Animal origin	950	2.5	2375	Animal origin	300	2.5	750
	Vegetable origin	2450	0.5	1225	Vegetable origin	3100	0.5	1550
	<b>Total</b>	<b>3400</b>		<b>3600</b>	<b>Total</b>	<b>3400</b>		<b>2300</b>

# Meat versus vegetarian diet

Source : [waterfootprint.org](http://waterfootprint.org)

	Meat diet	kcal/day	litre/kcal	litre/day	Vegetarian diet	kcal/day	litre/kcal	litre/day
Industrial countries	Animal origin	950	2.5	2 375	Animal origin	300	2.5	750
	Vegetable origin	2 450	0.5	1 225	Vegetable origin	3100	0.5	1550
	<b>Total</b>	<b>3 400</b>		<b>3 600</b>	<b>Total</b>	<b>3400</b>		<b>2300</b>
Developing countries	Animal origin	350	2.5	875	Animal origin	200	2.5	500
	Vegetable origin	2 350	0.5	1175	Vegetable origin	2500	0.5	1250
	<b>Total</b>	<b>2 700</b>		<b>2050</b>	<b>Total</b>	<b>2700</b>		<b>1750</b>

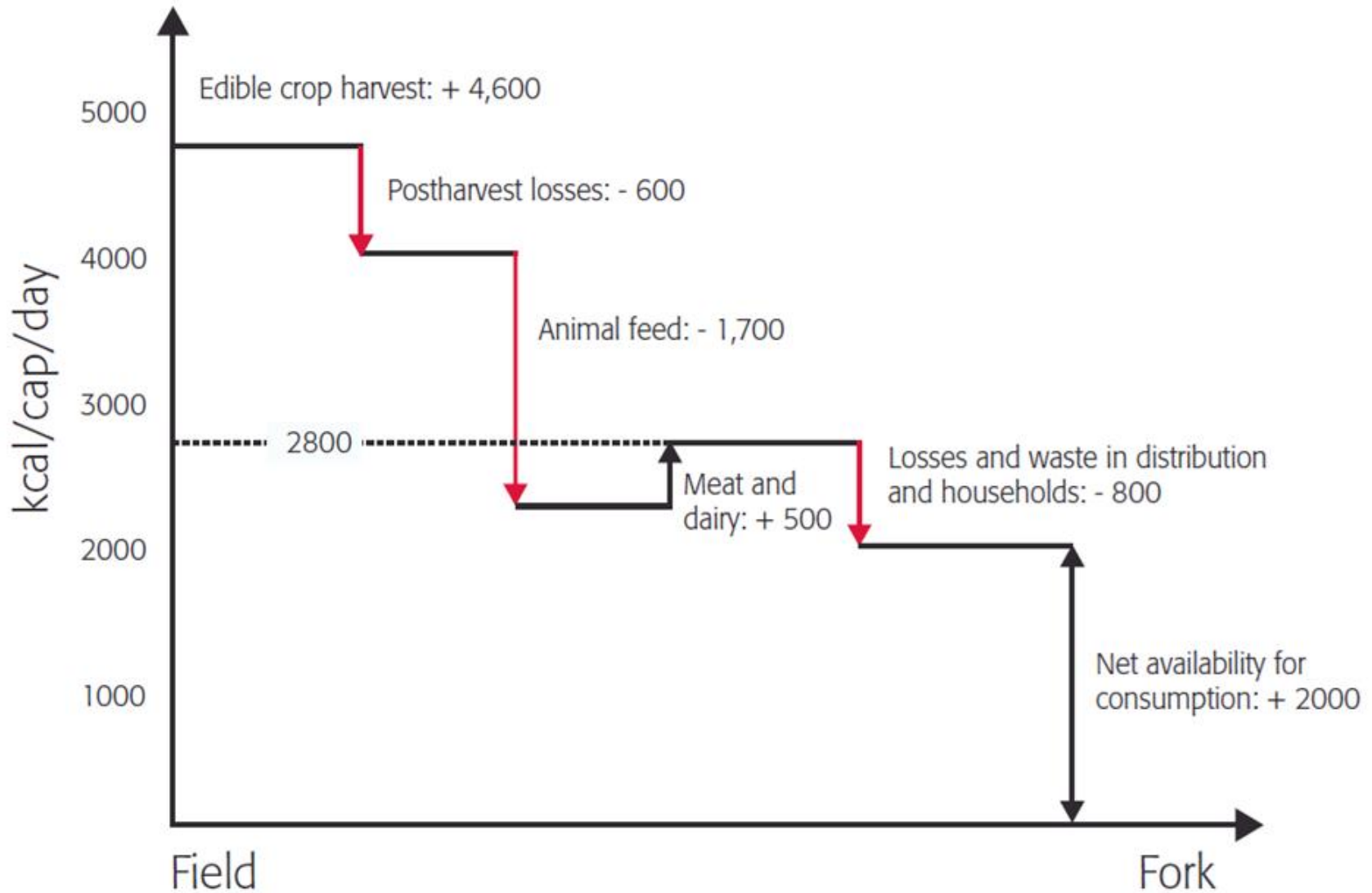
**4,500 km<sup>3</sup>/y additional water is needed**

## **Solutions ?**

- **Reduce food losses : ~30% of production**

# Losses and wastage in the food chain

Source : Smil (2000). Graph in Lundqvist et al. (2008)



**4,500 km<sup>3</sup>/y additional water is needed**

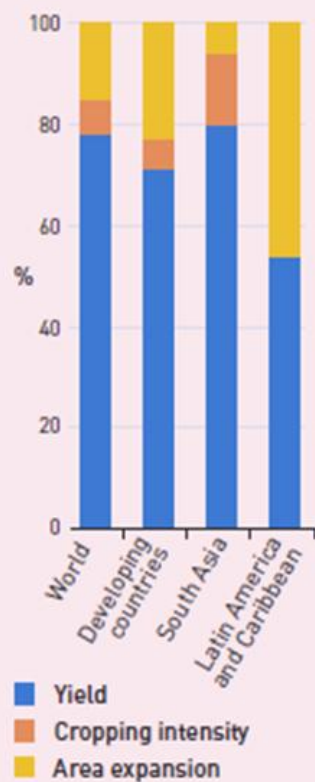
## **Solutions ?**

- **Reduce food losses : ~30% of production**
- **Improve crop efficiency**

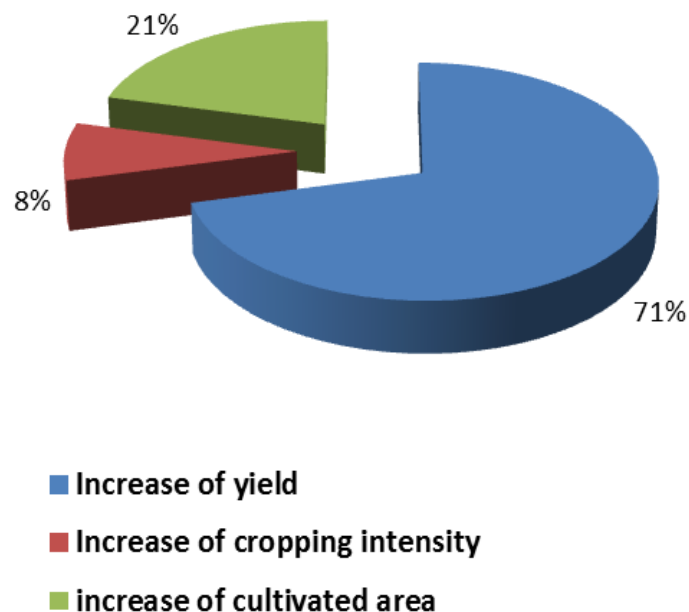
**Increase of population (2002-2050) : 1.47 (UN)**

**Increase of food production (2002-2050) : 1,65 (FAO)**

Sources of growth in production, 1961 to 1999

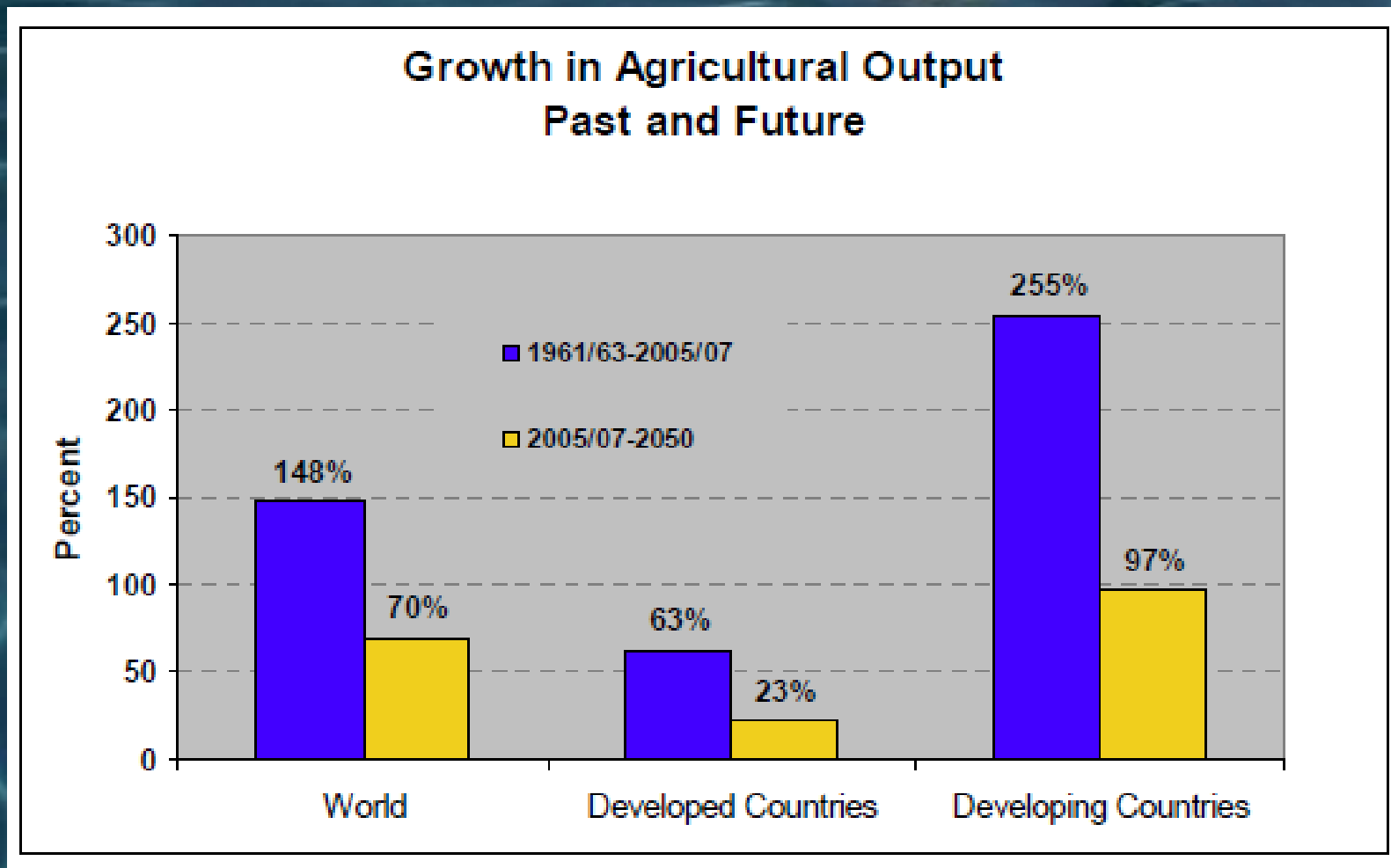


Source of growth in production by 2050



# Past (1960-2005) and future (2005-2050) agricultural production growth

Source: FAO Global Perspectives Studies Unit



**4,500 km<sup>3</sup>/y additional water is needed**

## **Solutions ?**

- **Reduce food losses : ~30% of production**
- **Improve crop efficiency**
- **More irrigated crops**



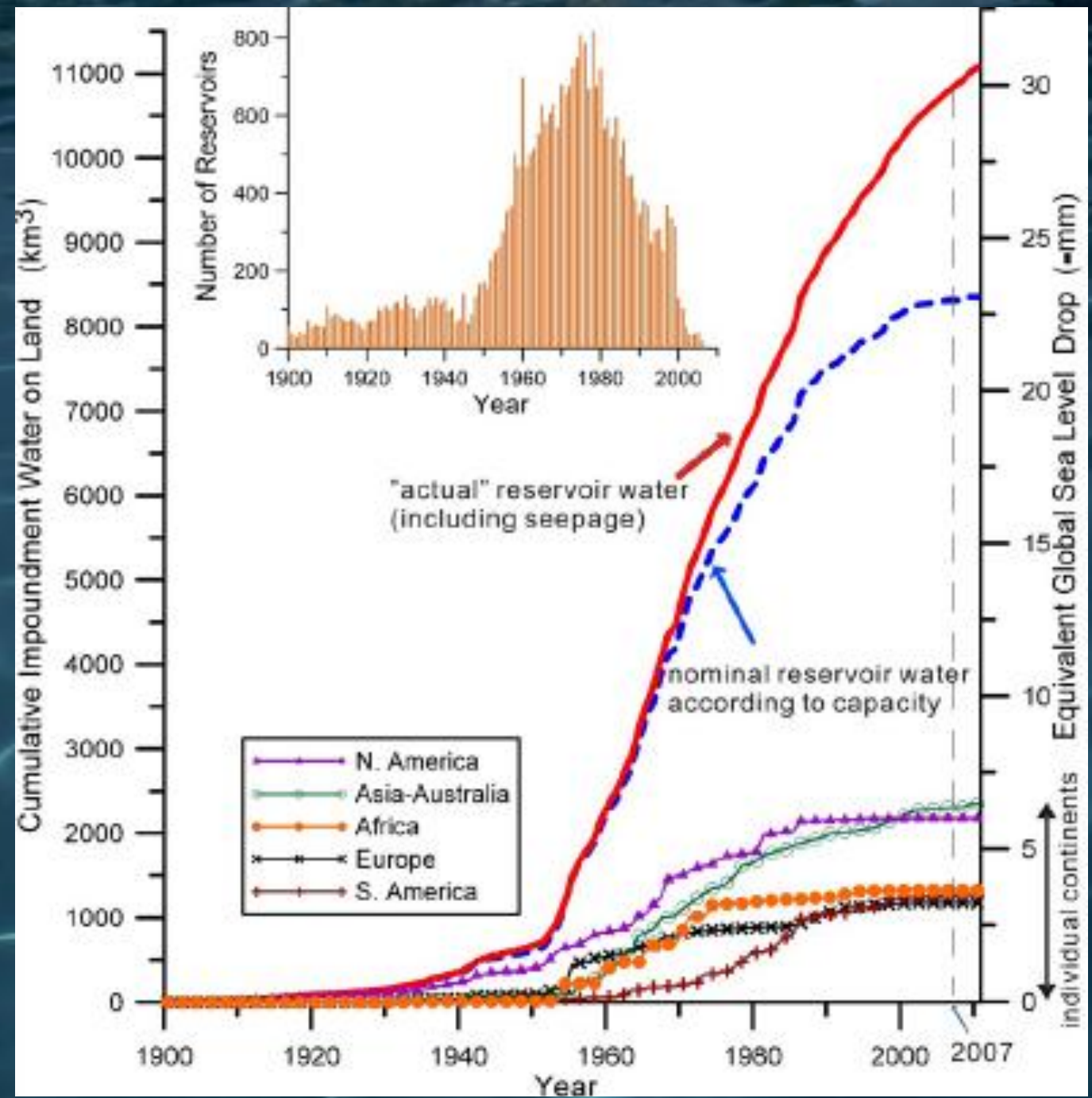
# Water Withdrawals for irrigation by 2050 (FAO forecast)

Source : Bruinsma (2009)

	Blue water withdrawal for irrigation		Increase of Withdrawal 2005 -> 2050
	2005	2050	
	km <sup>3</sup>	km <sup>3</sup>	%
<b>Developing countries</b>	<b>2 115</b>	<b>2 413</b>	<b>14.1</b>
Sub Saharan Africa	55	87	58.2
Latin America/Caribbean	181	253	39.8
Near East / North Africa	347	374	7.8
South Asia	819	906	10.6
East Asia	714	793	11.1
<b>Developed countries</b>	<b>505</b>	<b>493</b>	<b>-2.4</b>
<b>WORLD</b>	<b>2 620</b>	<b>2 906</b>	<b>10.9</b>

# Development of dam construction during the XX century

(Source : Chao et al., 2008)



**4,500 km<sup>3</sup>/y additional water is needed**

## **Solutions ?**

- **Reduce food losses (~30% of food production)**
- **Improve crop efficiency**
- **More irrigated crops**
- **More rain-fed agriculture**

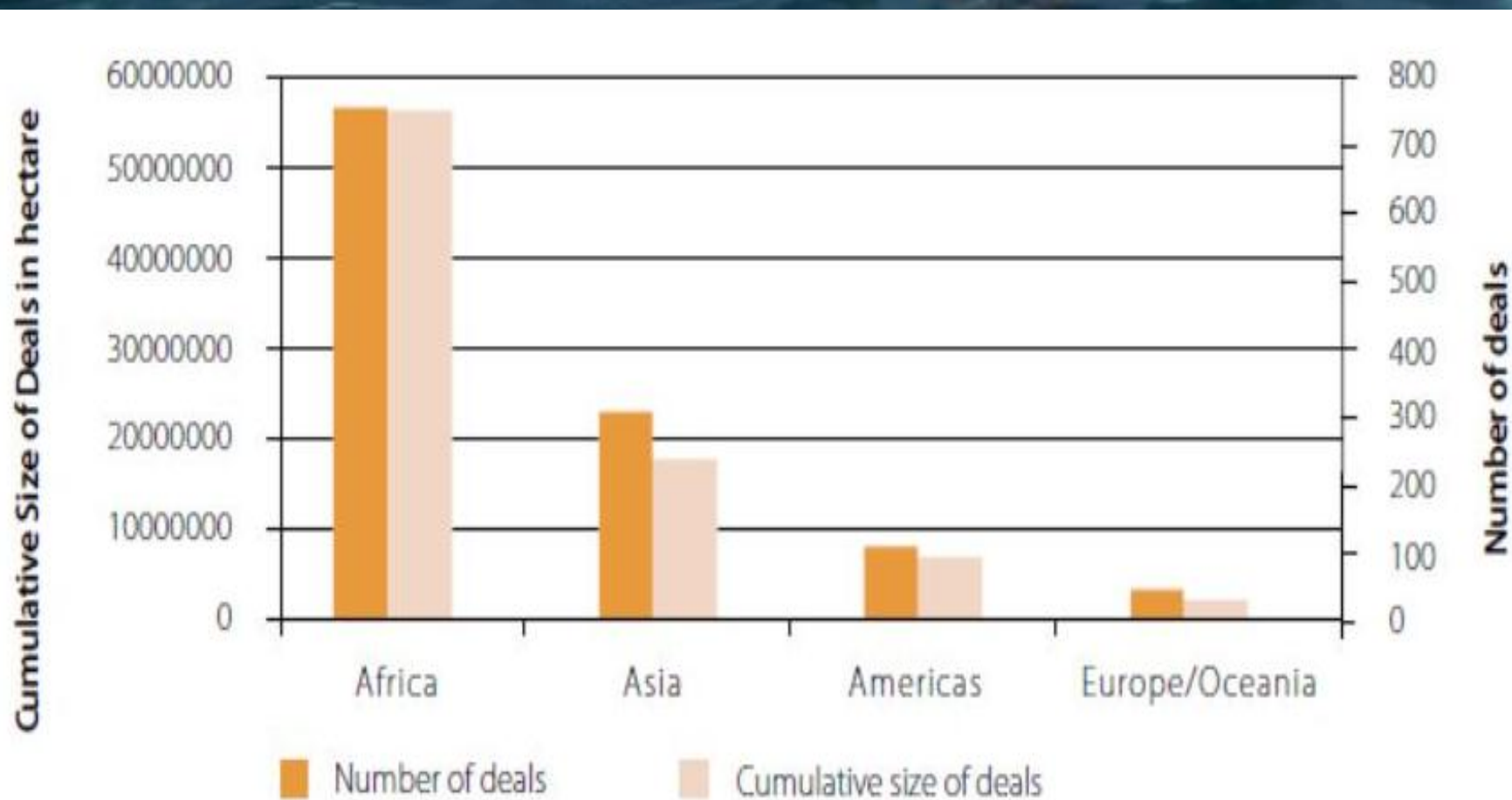
# **Limited opportunities for increasing irrigation according to environmental prescriptions**

## **Remaining option : RAINFED AGRICULTURE**

- ❖ **Where the water-related risk is limited**
- ❖ **Where there is available land**
- **The Humid Tropics**
- **Russia and the former Republics of USSR (climate change)**

# Surface and number of land acquisition deals by region

Source : Anseeuw et al. 2012

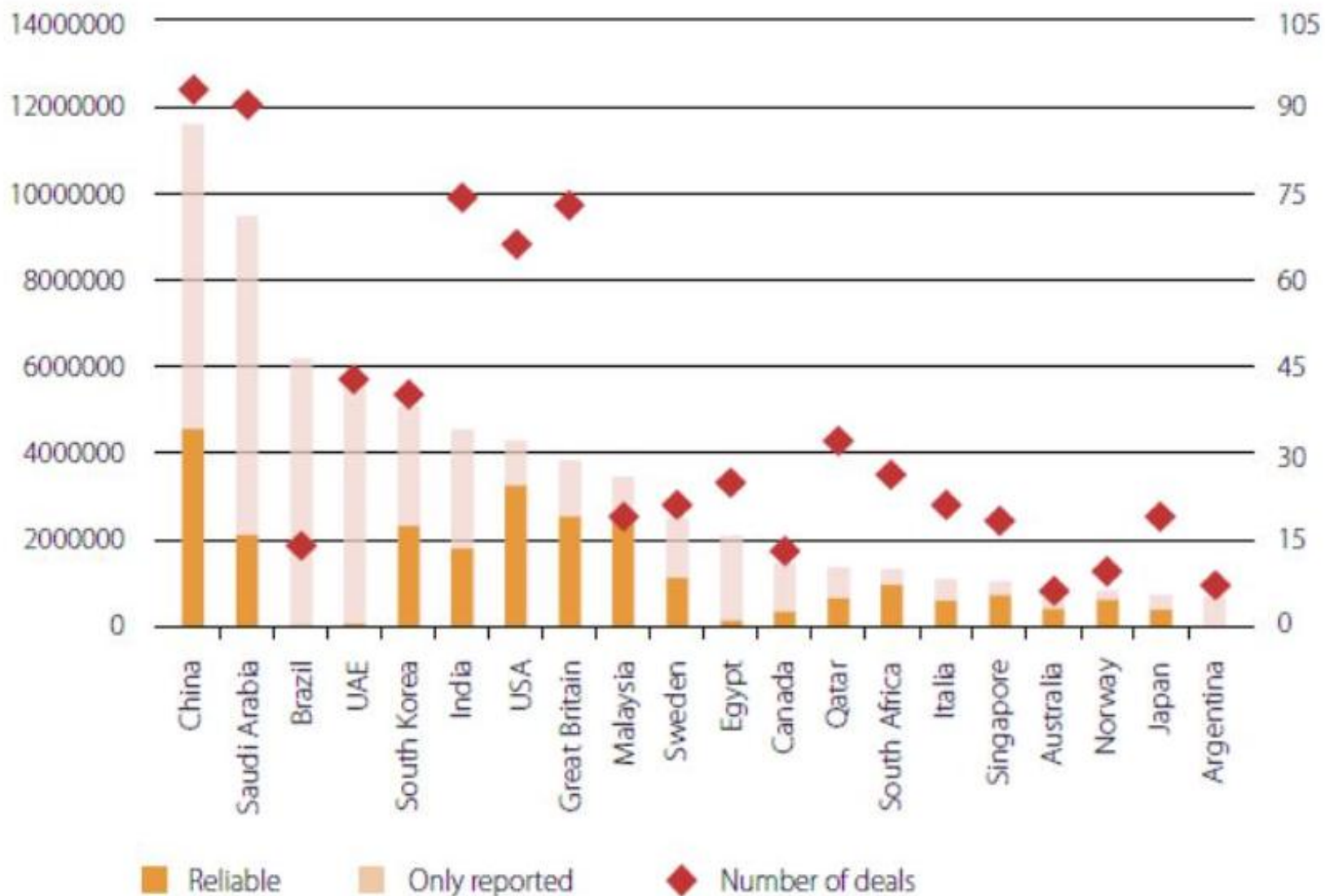


Source: Authors' calculations based on the Land Matrix.

Notes: N = 1217 for number of deals and N = 917 for cumulative size of deals

# Origin of investment for land acquisition (top 20 countries)

Source : Anseeuw and al. 2012



# Deficits & surplus of food production by regions 2003 & 2050

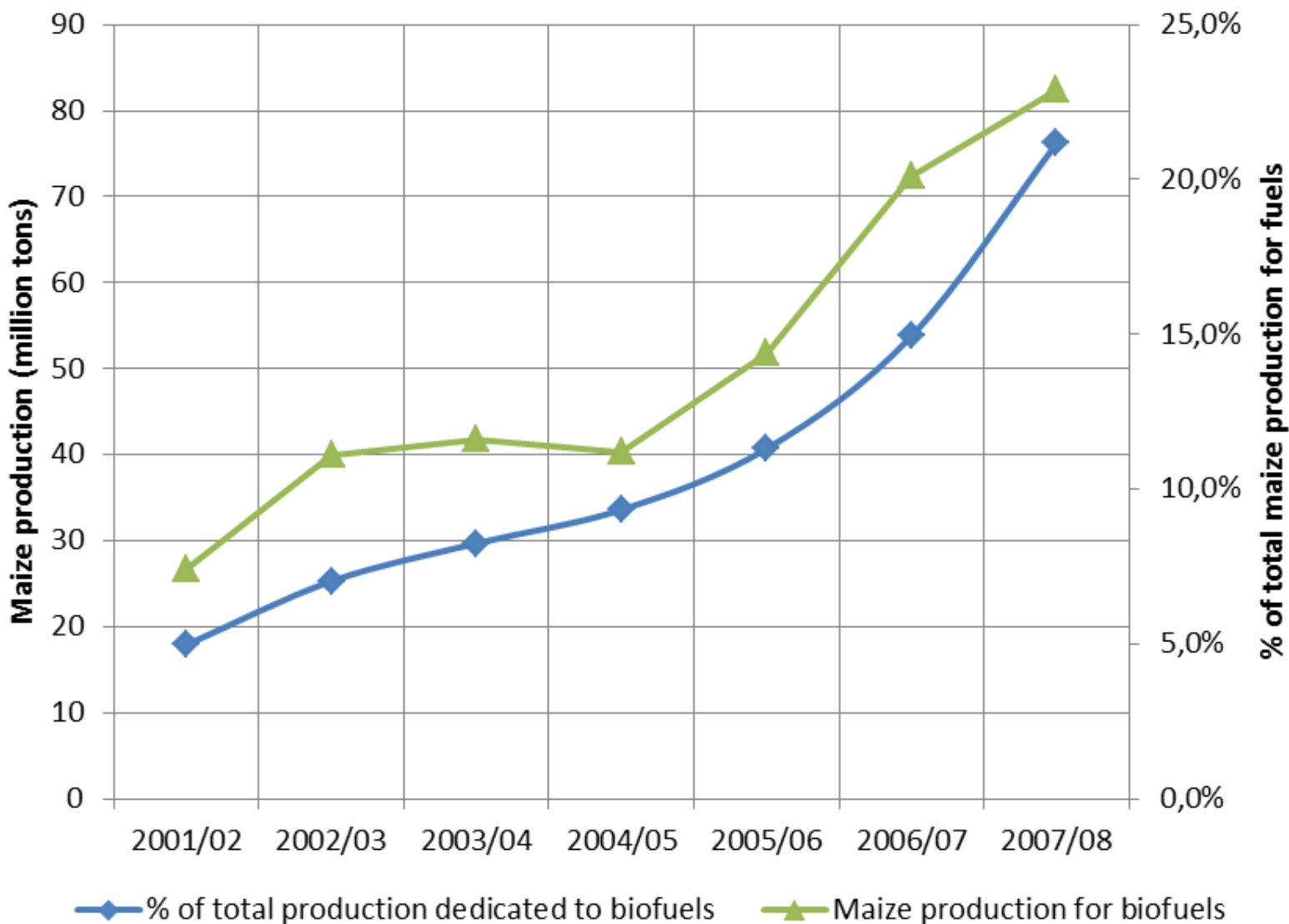
<b>Region</b>	<b>Scenario Agrimonde 2003</b>	<b>Scenario Agrimonde GO, 2050</b>	<b>Scenario Agrimonde 1, 2050</b>
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# Biofuels



# Production of maize for biofuels in the USA

Source : [www.ers.usda.gov](http://www.ers.usda.gov)



# Role of biofuels in the increase of cereals prices

Source : Voituriez (2010)

<b>Authors</b>	<b>Role of biofuels in the price increase</b>
<b>Lipsky (2008)</b>	<b>70% for Maize 40% for Soya</b>
<b>Collins (2008)</b>	<b>60% for Maize</b>
<b>Rosengrant et al. (2008)</b>	<b>47 % for Maize 26% for Wheat 25 % for Rice</b>

# Some references

- **Démographie, Climat et Alimentation Mondiale**  
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Reports of Two Workshops, National Academy Press, (2012)
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G. de Marsily, Dunod (2009)

**Obrigado**