Fertilizer, Pulp and Paper Technology

ChE 441

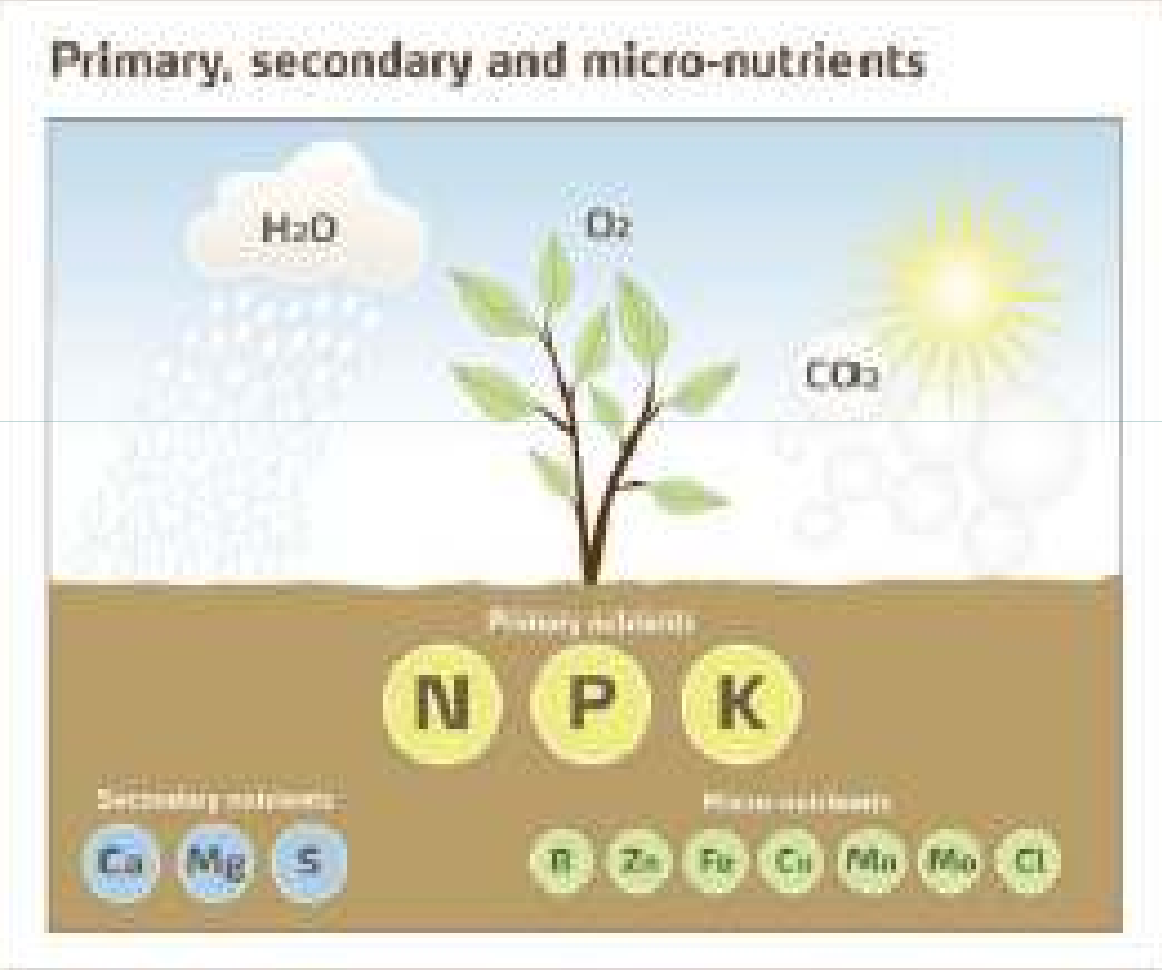
"It is the chemist who must come to the rescue of the threatened communities. It is through the laboratory that starvation may ultimately be turned into plenty. Before we are in the grip of actual dearth the chemist will step in and postpone the days of famine to so distant a period that we, our sons and grandsons may live without undue solicitude for the future."

SIR WILLIAM CROOK (1898)

TOPICS

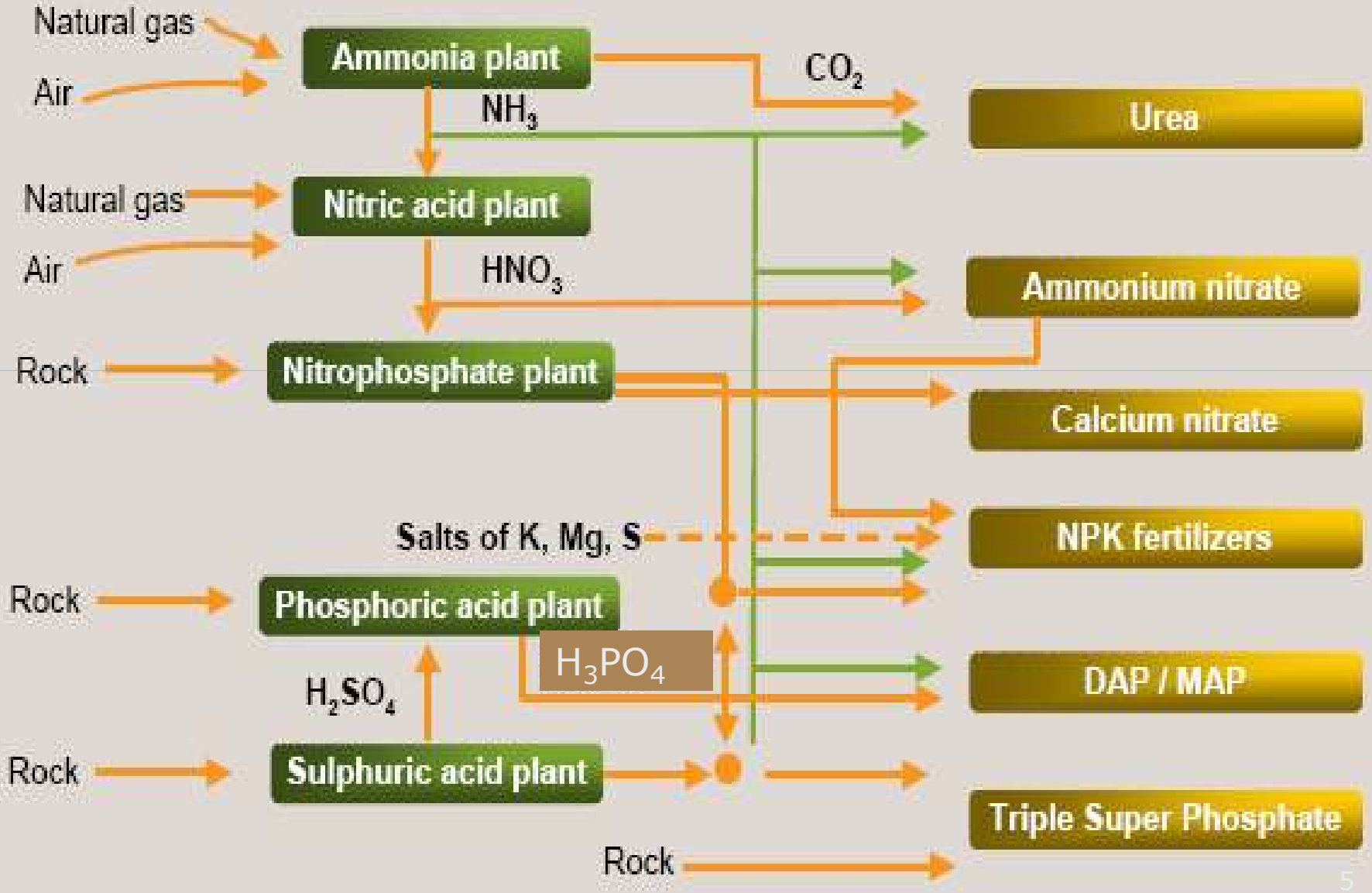
- Fertilizer Effects on Human Beings
- Fertilizer Production, Demand, and Supply in Bangladesh and Worldwide
- Pollution and its Control from Urea Complex

What is fertilizer?



Nitrogen is the main driver of yield

Fertilizer production routes



Fertilizer Effects on Human Beings

Fertilizer Effects on Human Beings

Healthy food for plants ...

... yields healthy food for people ...

Fertilizer Effects on Human Beings

Fertilizer Effects on Human Beings

There is no life without plant, there is no plant without nutrients

Fertilizer Effects on Human Beings

without fertilizer **with fertilizer**

- Continuous cropping without replacement of nutrients leads to decreasing soil fertility, increasing erosion and declining yields.
- Production without plant nutrition is mining the soil
- Fertilizer application increases yield by 3-4 times

Fertilizer Effects on Human Beings

Fertilizers increase yield substantially and enable food production without depleting valuable soil nutrients

Trials conducted without replacing nutrients show that the productivity of the land is dramatically reduced. This not only leads to low farmer income and food shortages, but also contributes to erosion and destruction of agricultural land.

Effects of soil mining are
- reduced soil fertility
- poor yield
- soil compaction
- reduced humus content
- increased erosion

Fertilizer Effects on Human Beings

Applying nitrogen mineral fertilizer produces energy and fixes CO_2

Plants supply energy to mankind. The energy benefit is 7 times higher than the cost of fertilizer.

CO_2 is removed from the atmosphere by plants

Fertilizer Effects on Human Beings

Energy consumption in Agriculture

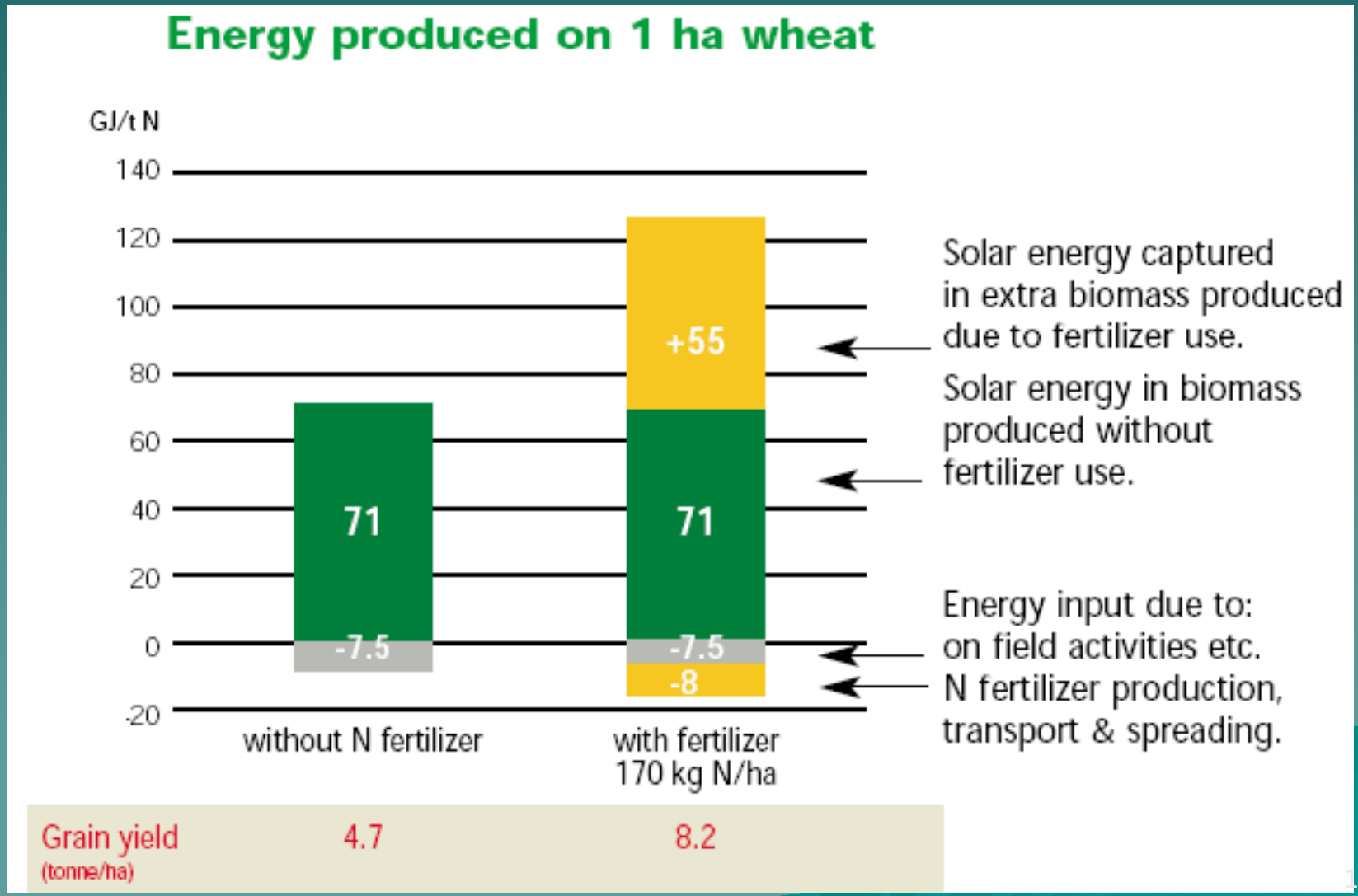
Production of mineral fertilizers
Transportation of raw materials
Supply of fertilizer
Spreading of fertilizer
Ploughing of land

Energy production by Agriculture

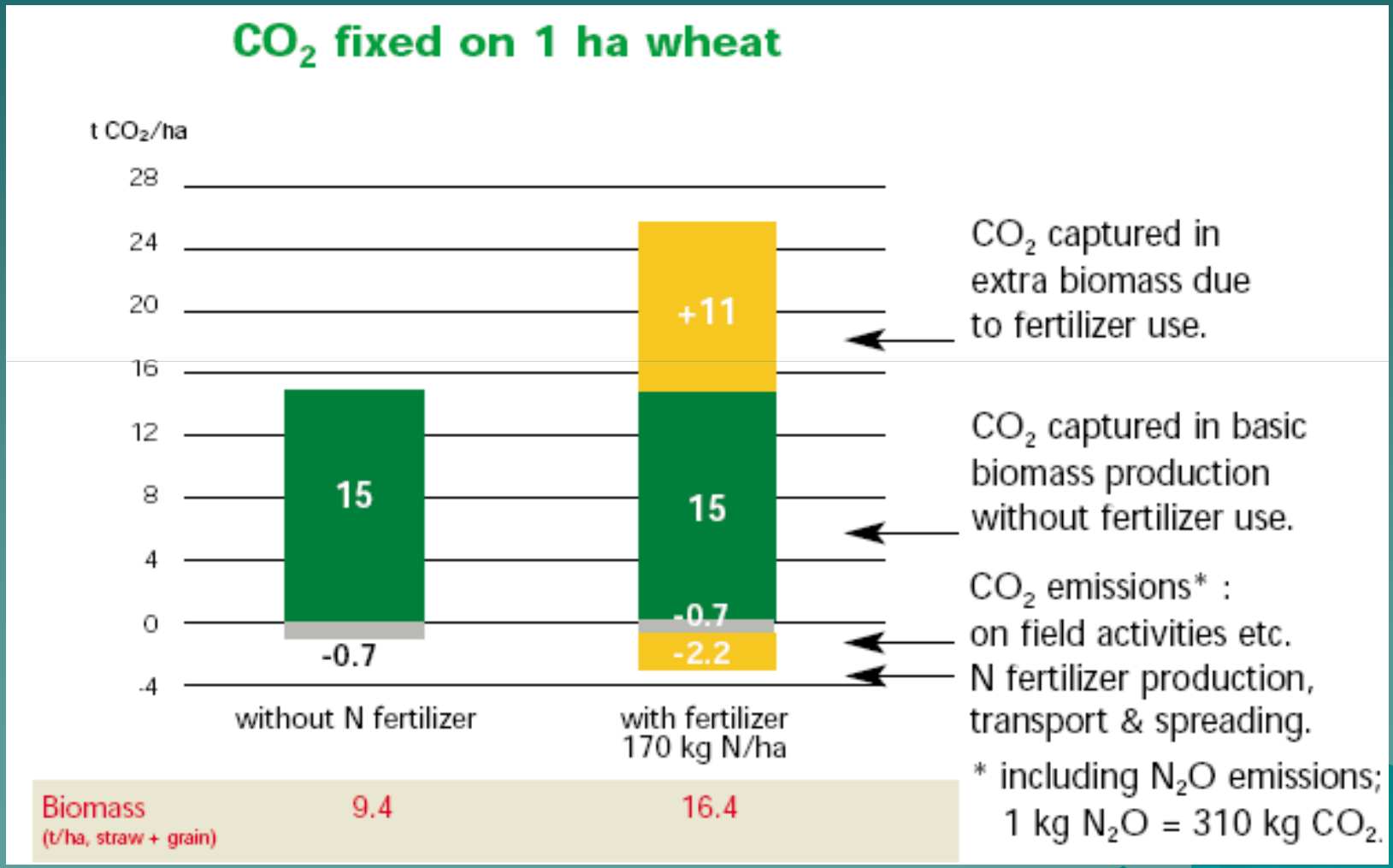
Agriculture converts solar energy into biomass, which in turn provides energy for human beings and animals in the form of food and feed

Fertilizer Effects on Human Beings

Fertilizers greatly increase the positive energy balance of agriculture



Fertilizer Effects on Human Beings



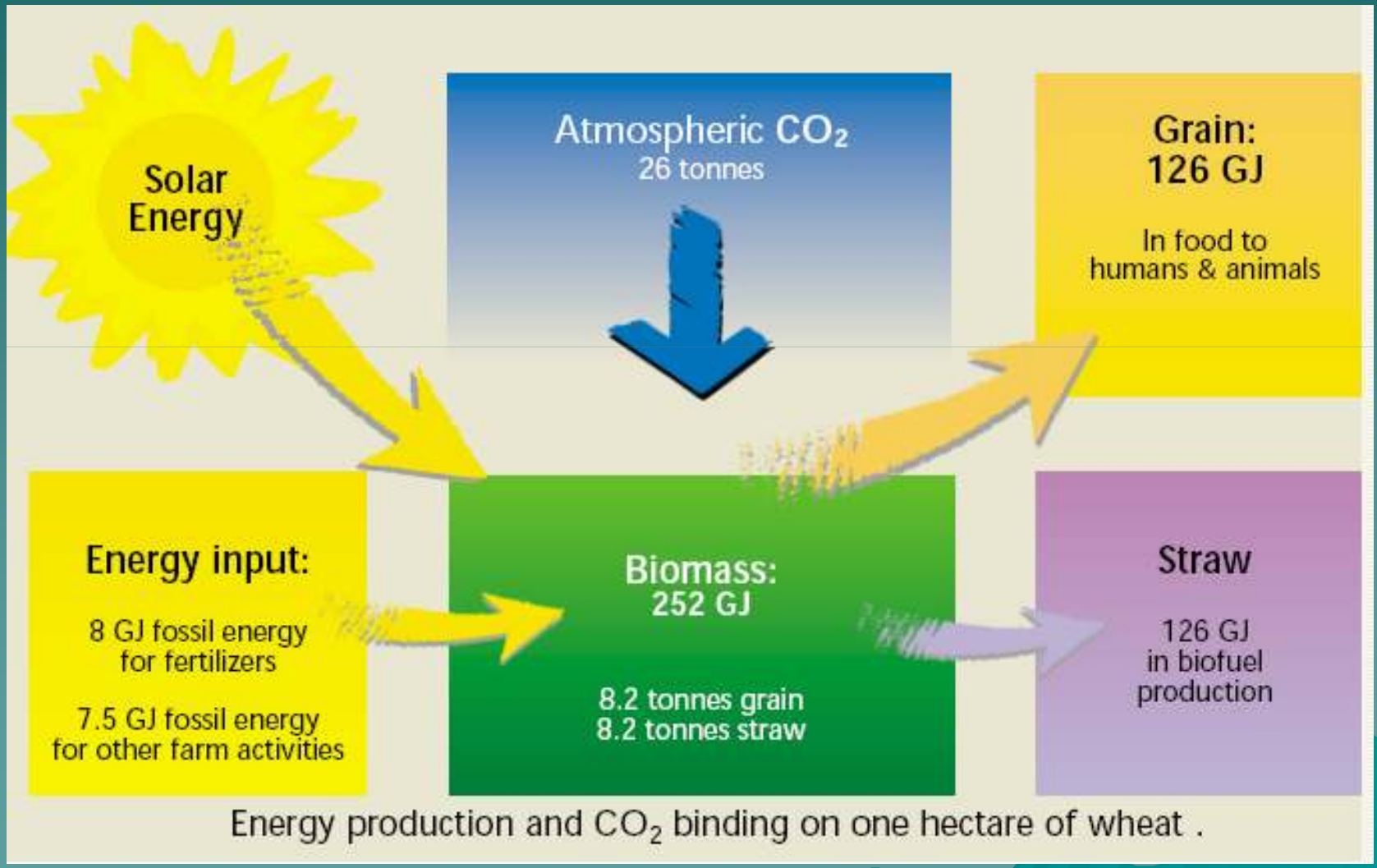
Fertilizer Effects on Human Beings

Biomass as a direct energy source:

Recycling crop wastes can have an added benefit since part of the biomass produced can be used as a direct energy source in the form of biofuels :
Unlike oil, straw is neutral in terms of greenhouse gas effect : the CO_2 released when using straw as a biofuel is equal to the CO_2 captured to produce the same straw.

The potential impact is significant. Assuming that 50% of the straw produced on all (16.8 million) hectares of wheat in West Europe is used as a biofuel, Europe will 'save' 3.5 % of its total CO_2 emission.

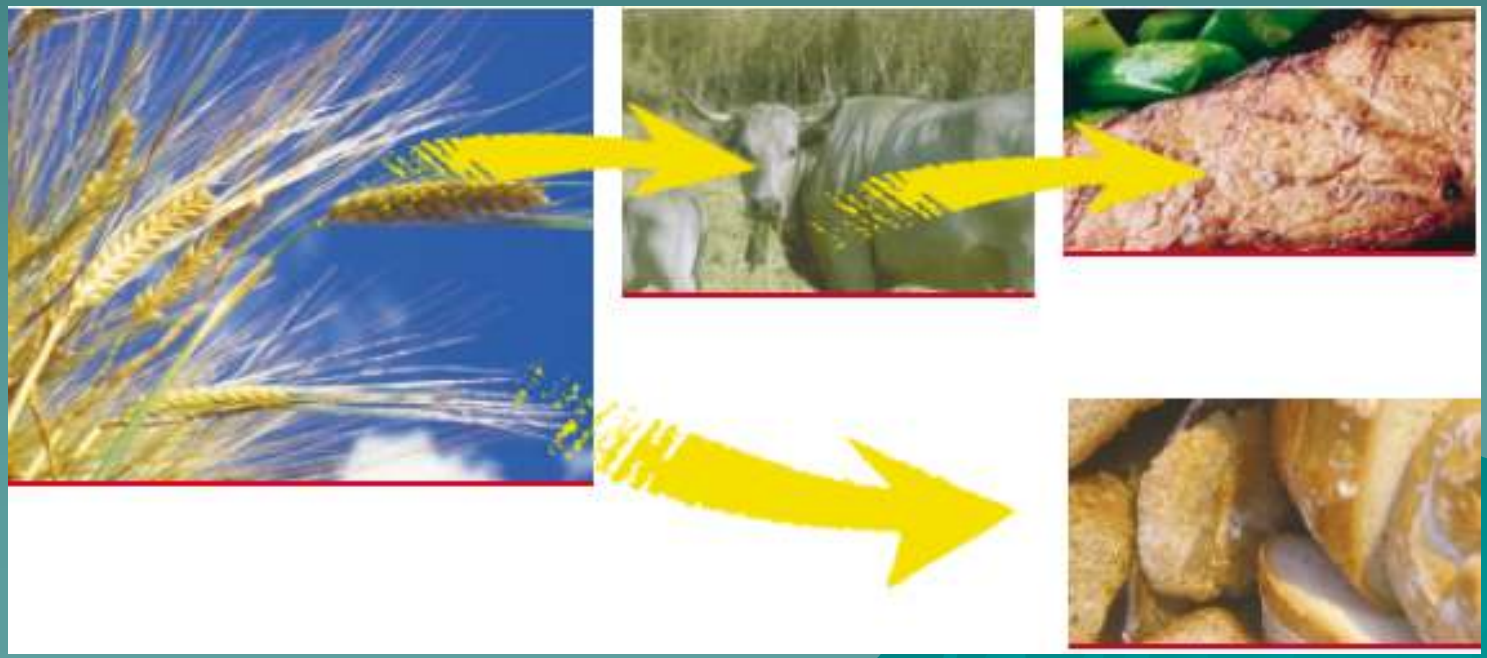
Fertilizer Effects on Human Beings



Energy production and CO_2 binding on one hectare of wheat .

Fertilizer Effects on Human Beings

Energy input and output in Agriculture



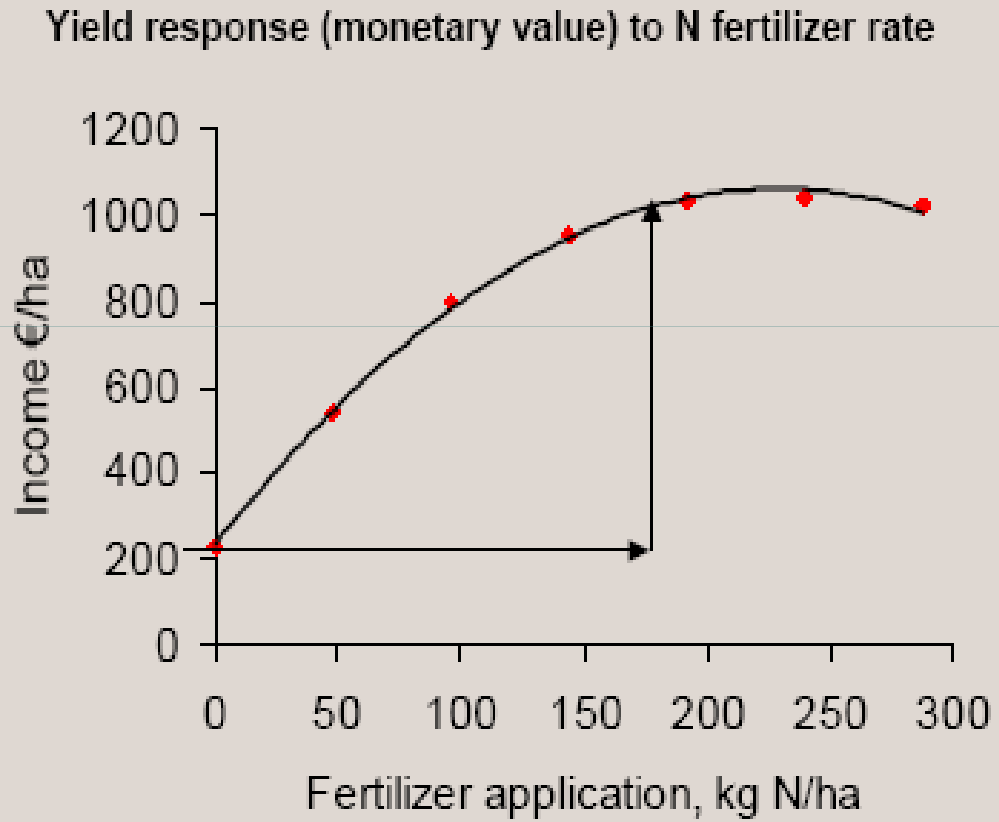
Fertilizer Effects on Human Beings

Profitability of investment in mineral fertilizers

- The investment in nitrogen fertilizer is highly profitable for growers

  => Fertilizer investment: 96 €/ha
  => Net return: 714 €/ha

- Net return is 7x the investment



Fertilizer Effects on Human Beings

Correct use of fertilizers can yield a 700% return on investment

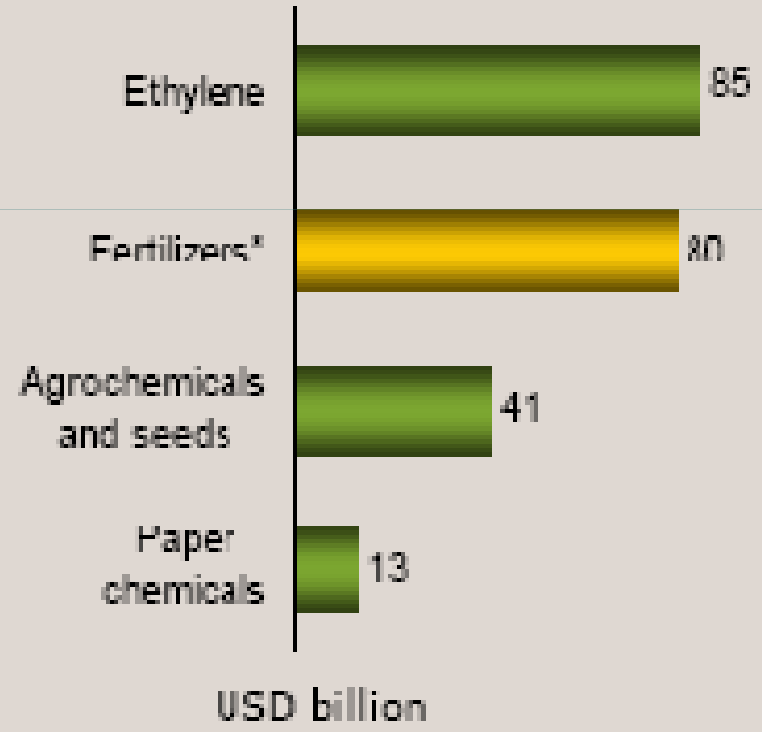
At the optimum nitrogen rate of 192 kg N/ha (winter wheat in Europe), it is possible to produce 9.3 tonnes of grain per hectare. The fertilizer cost at this optimum nitrogen level is approximately 192 kg N/ha * 0.5 €/kg N = 96 €/ha

With wheat prices of 112 €/t, the farmer gets the following alternative revenue scenarios:

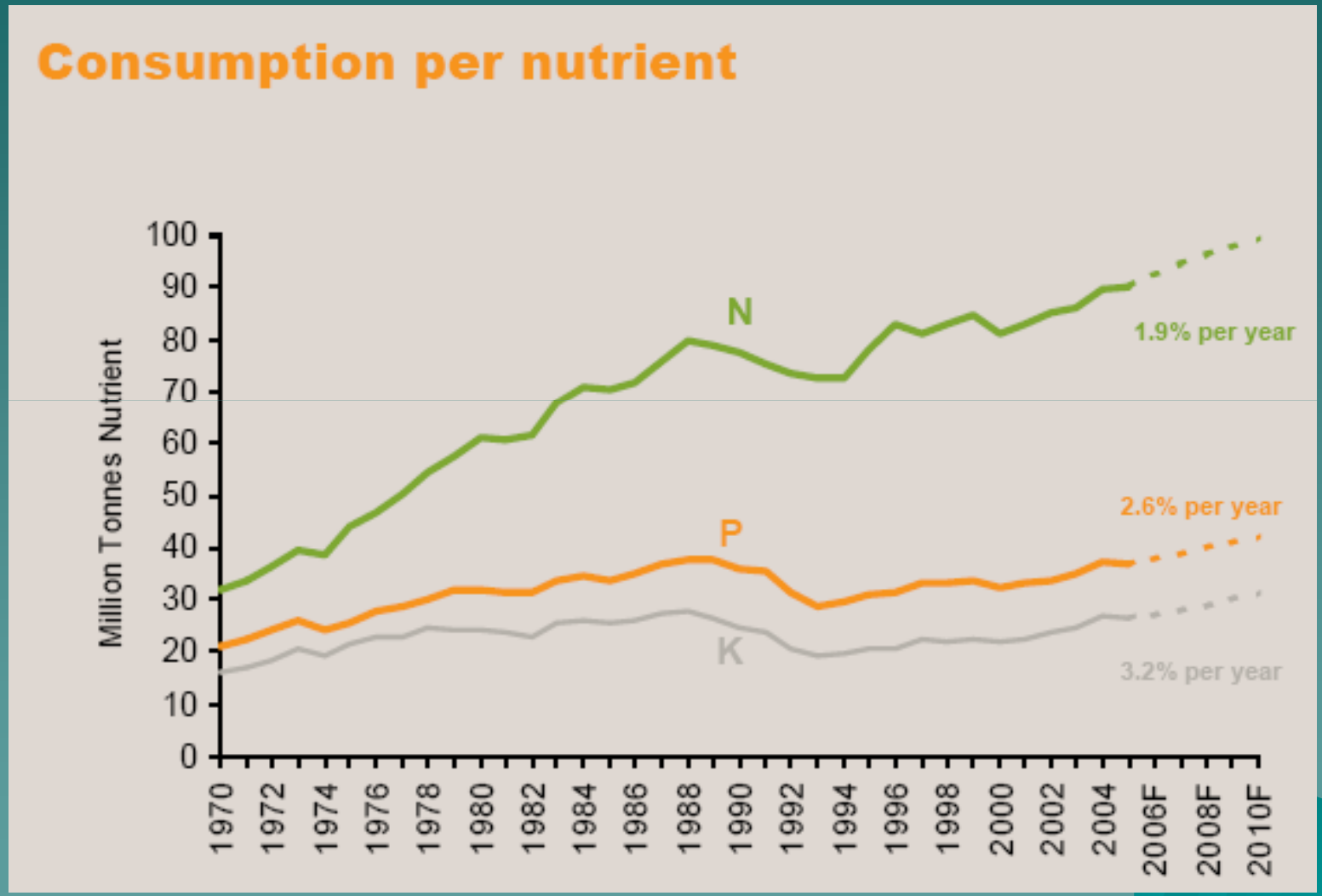
- Optimal nitrogen level: 9.30 t grain/ha * 112 € = 1042 €/ha
- No nitrogen fertilizer added: 2.07 t grain/ha * 112 € = 232 €/ha

The difference in revenues is 810 €/ha resulting from an input cost of 96 €/ha, i.e., a return on investment of more than 700%.

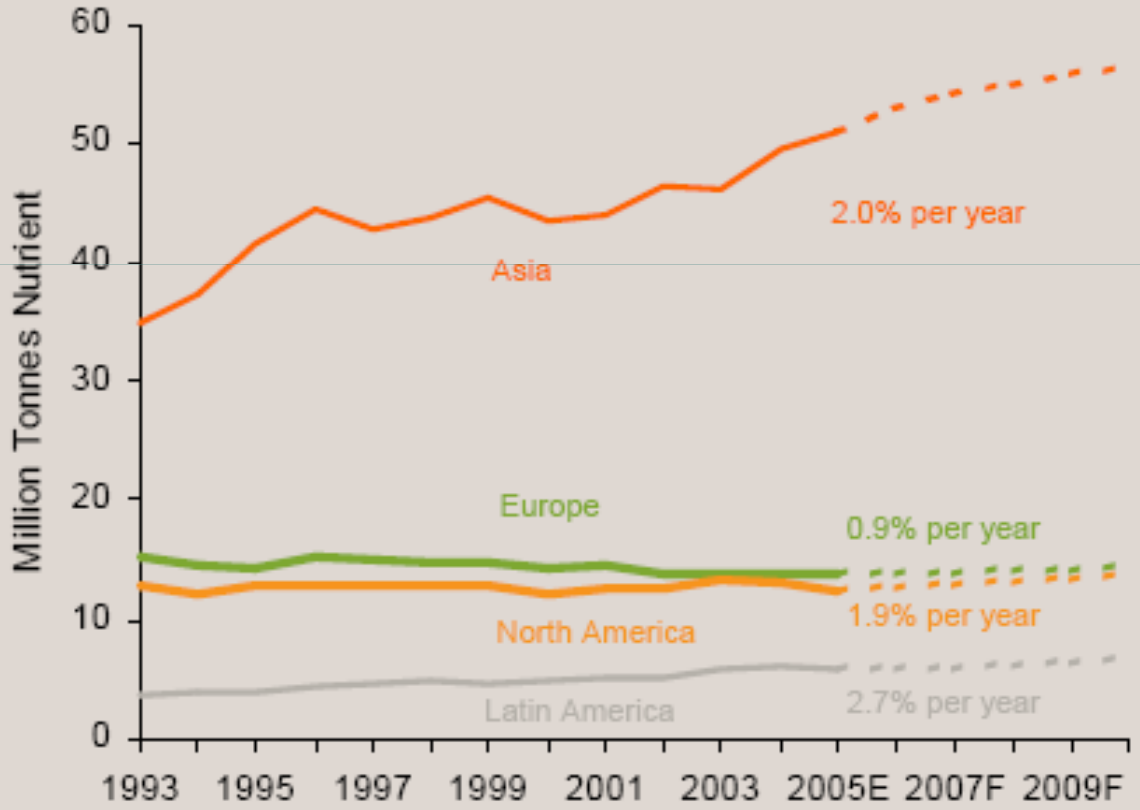
The fertilizer market in comparison



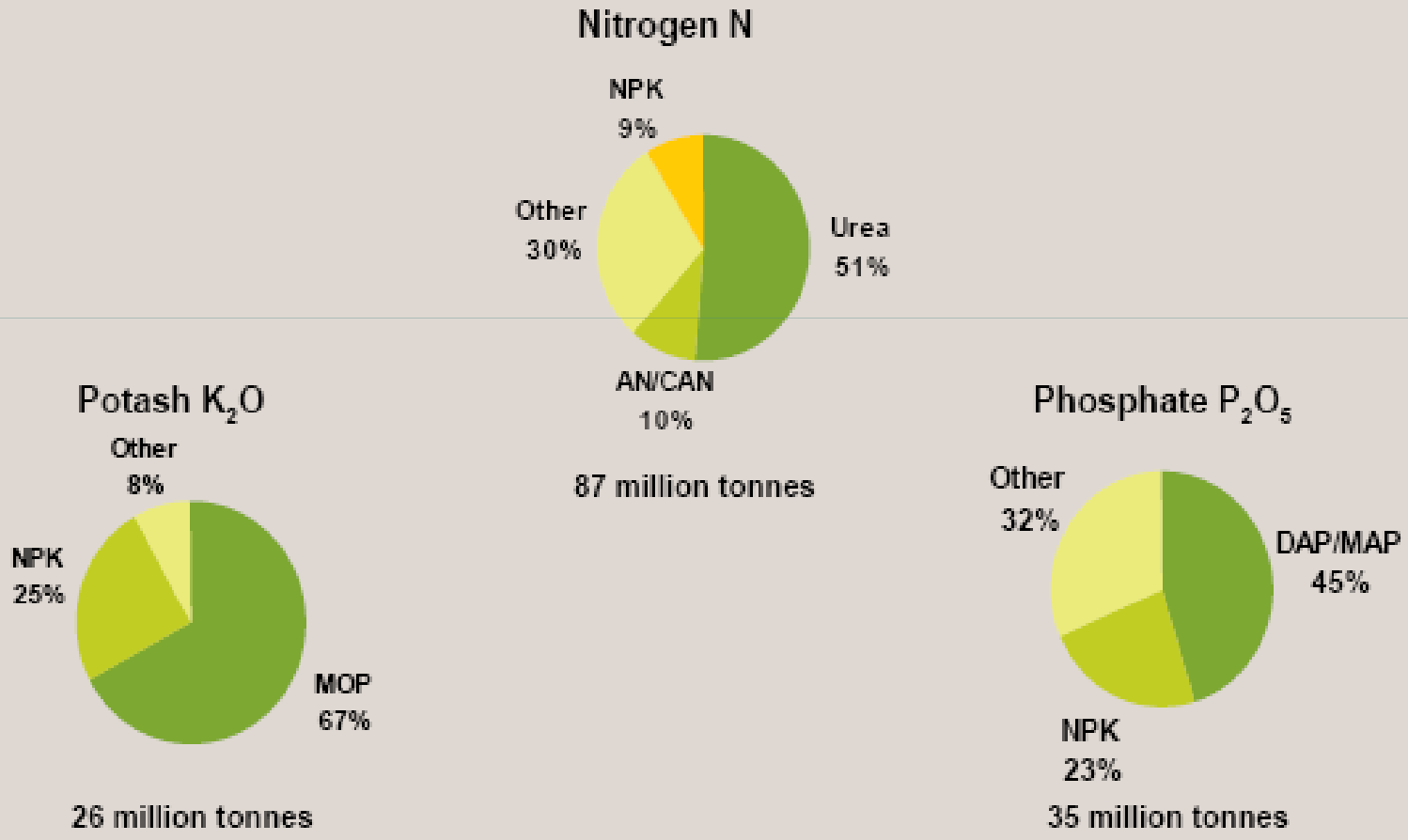
Worldwide Consumption



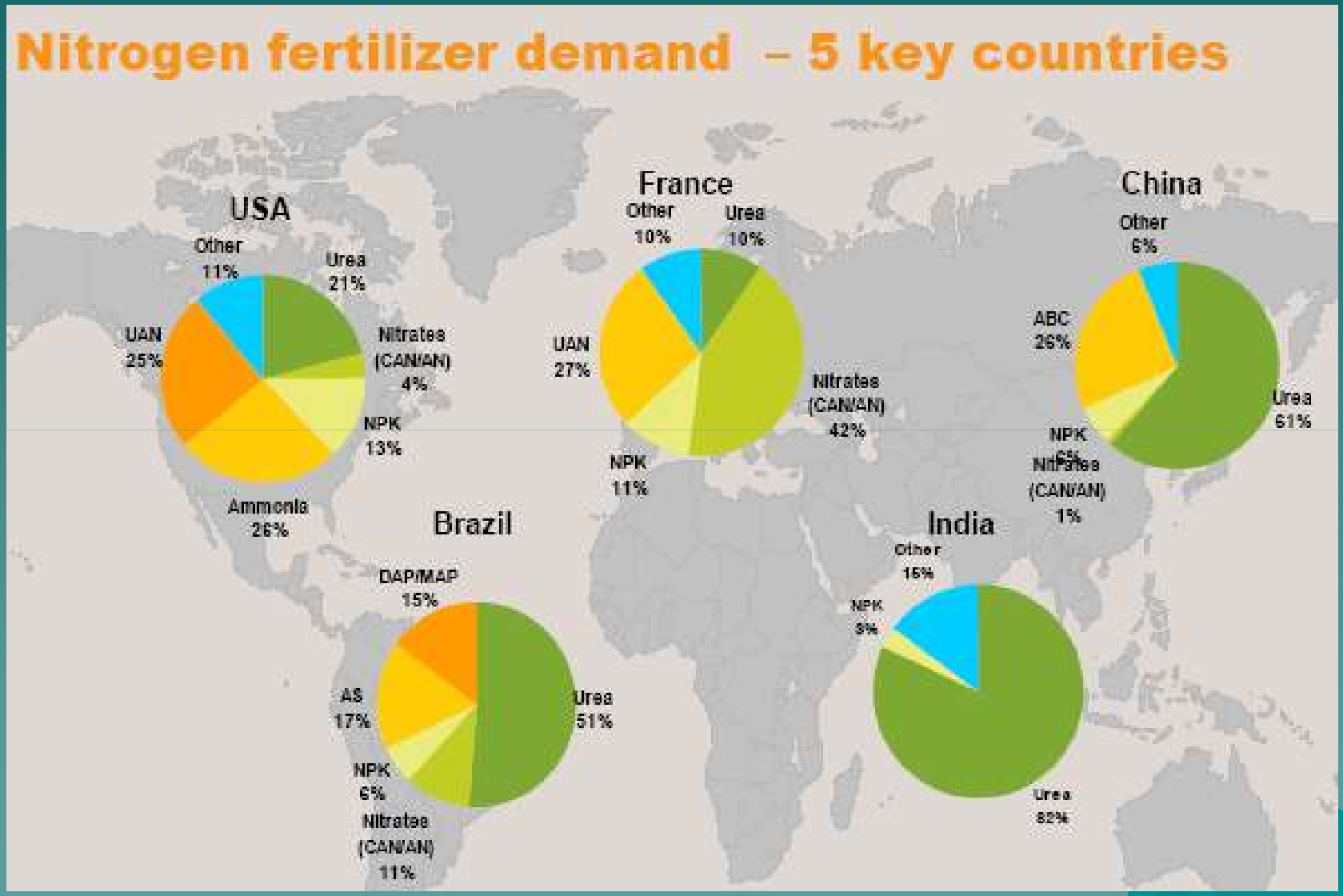
Nitrogen consumption per continent



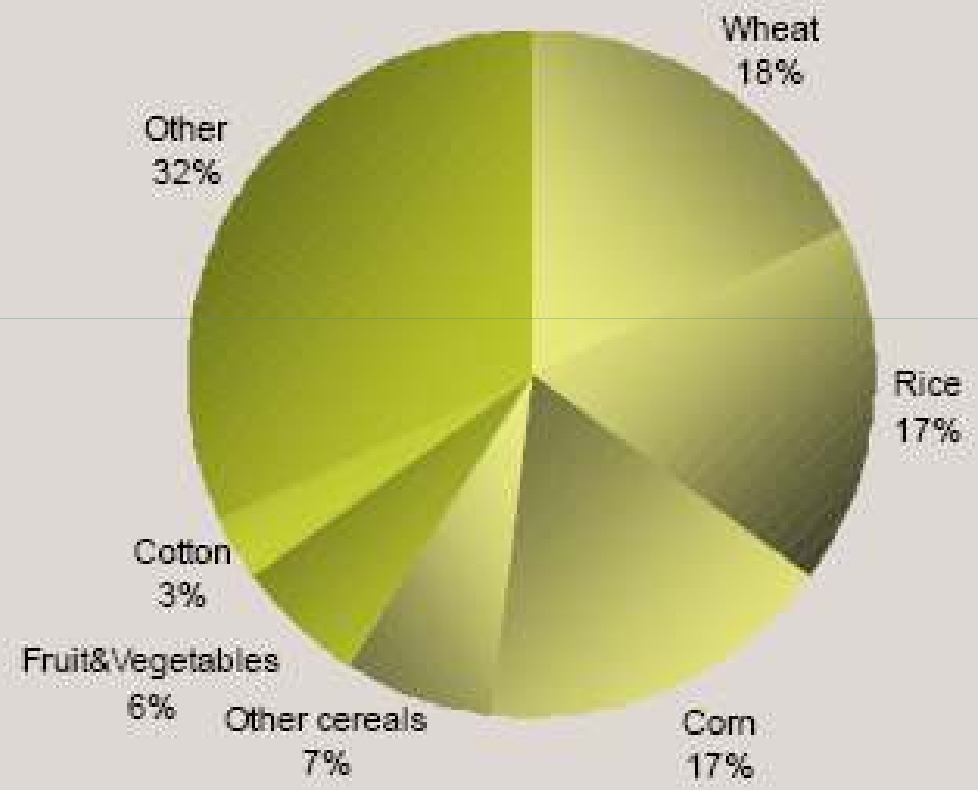
Key global fertilizer product categories



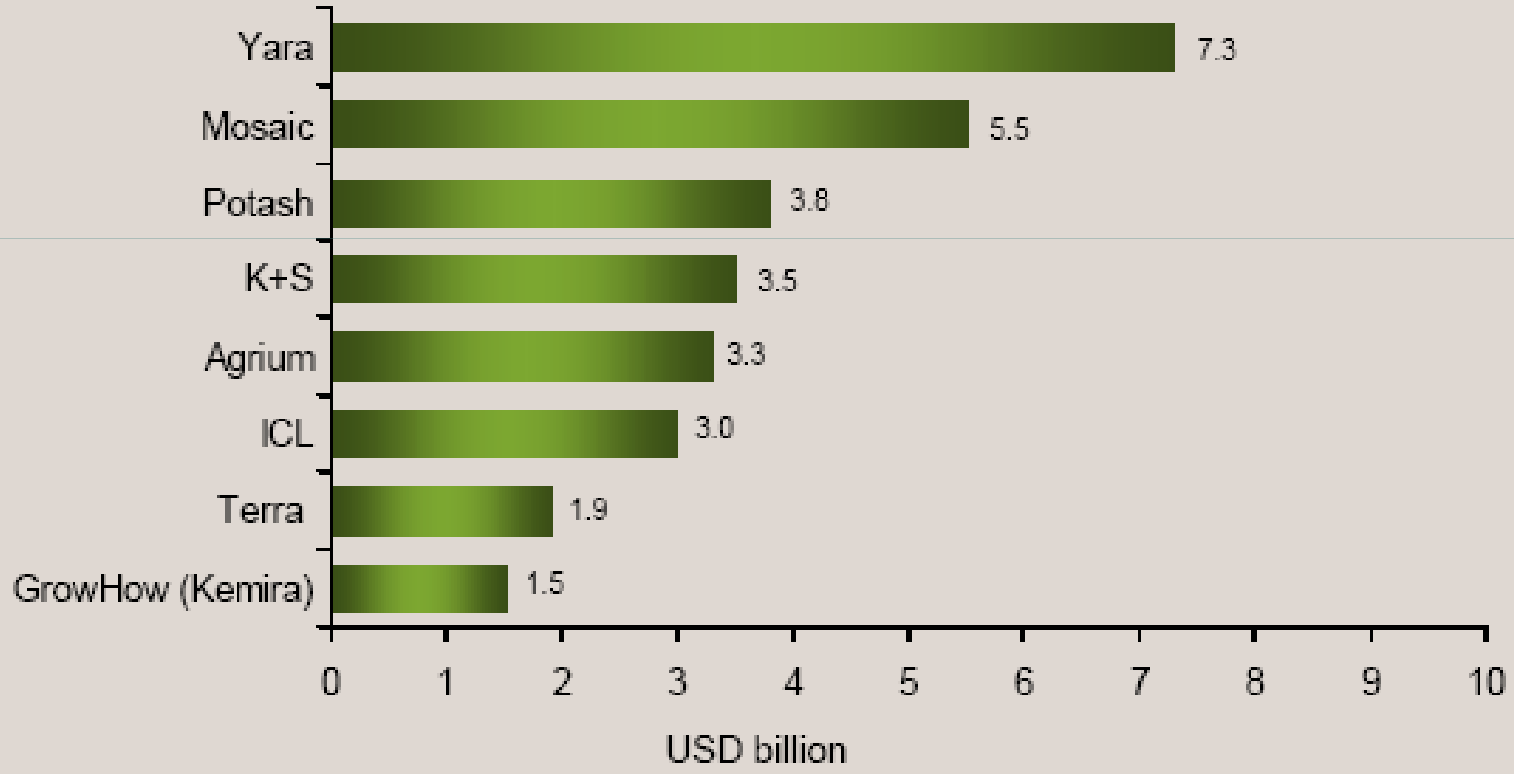
Nitrogen fertilizer demand – 5 key countries



Fertilizer market by application



Fertilizer company comparison – 2005 revenues*



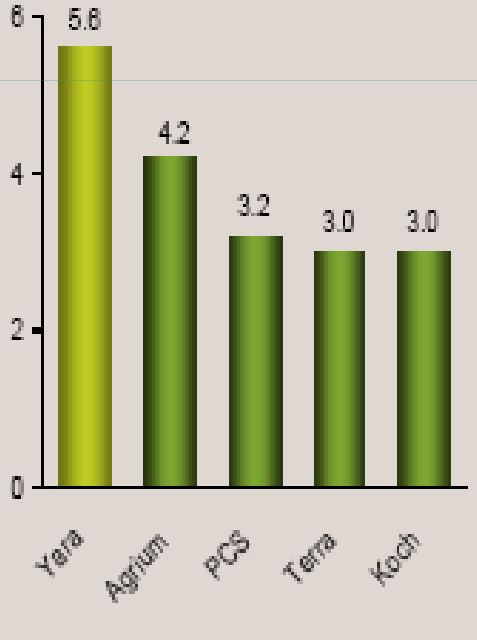
Yara is the largest fertilizer company measured by revenues

Other fertilizer-producing companies include: Sinochem (China), IFFCO (India), Eurochem (Russia), Phosagro (Russia), SAFCO (Saudi Arabia), Egyptian Fertilizer Company (EFC) and Arab Fertilizer and Chemicals Company (AFCCO) (Egypt), Uralkaly and TogliattiAzot (Russia), Cherkassy (Ukraine) and Koch (US)

Yara – the leader in nitrogen fertilizers

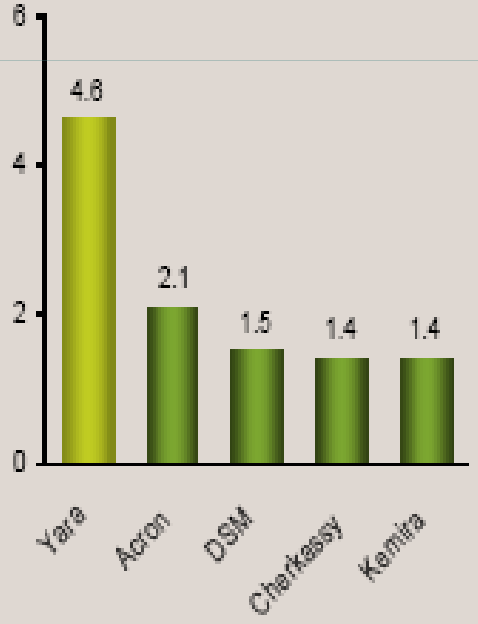
Global no 1 in ammonia

Production capacity* (mill t)



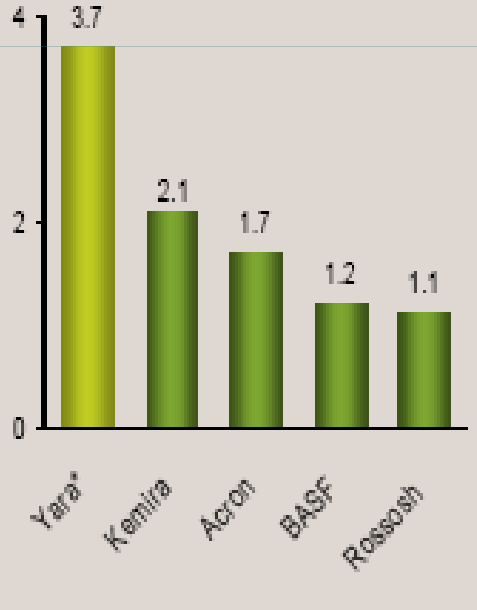
Global no 1 in nitrates[1]

Production capacity (mill t)

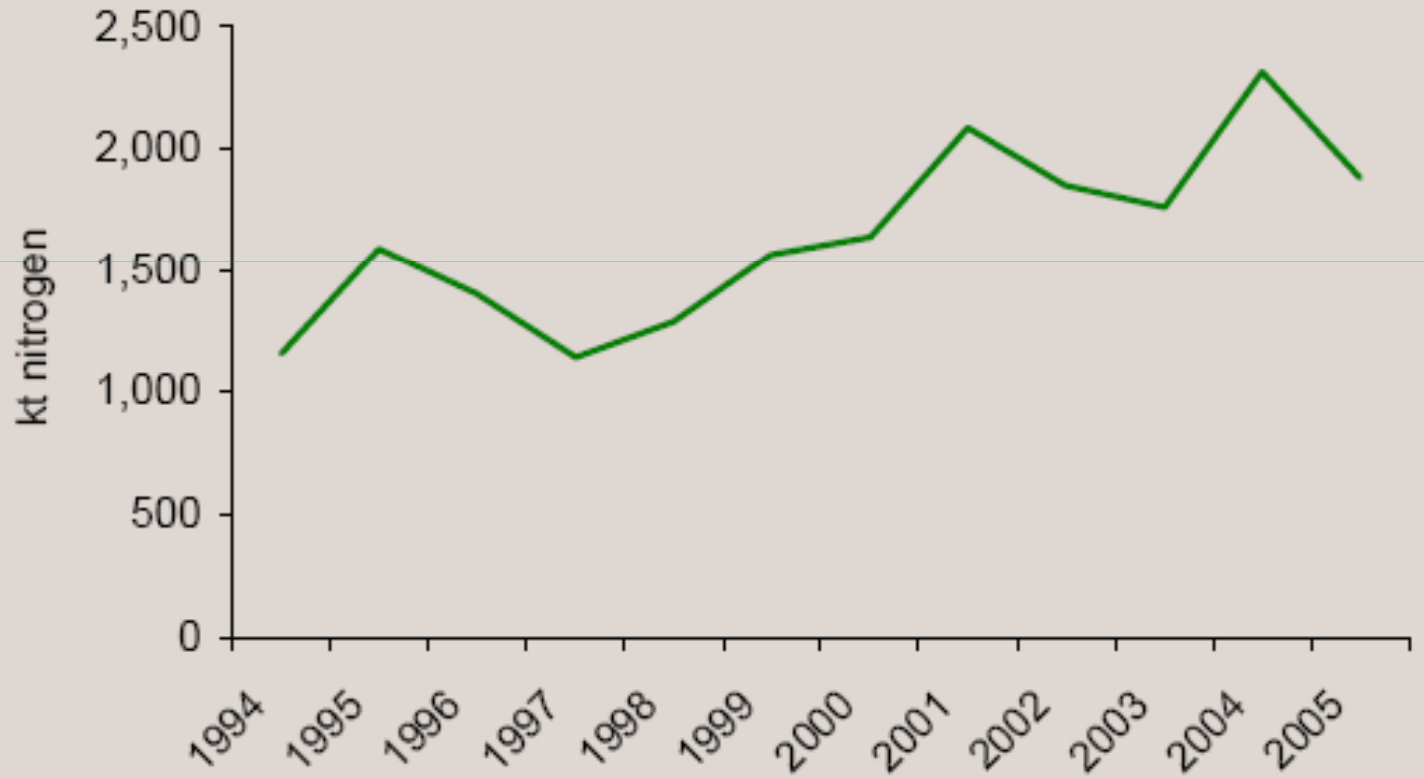


Global no 1 in NPK complex fertilizer

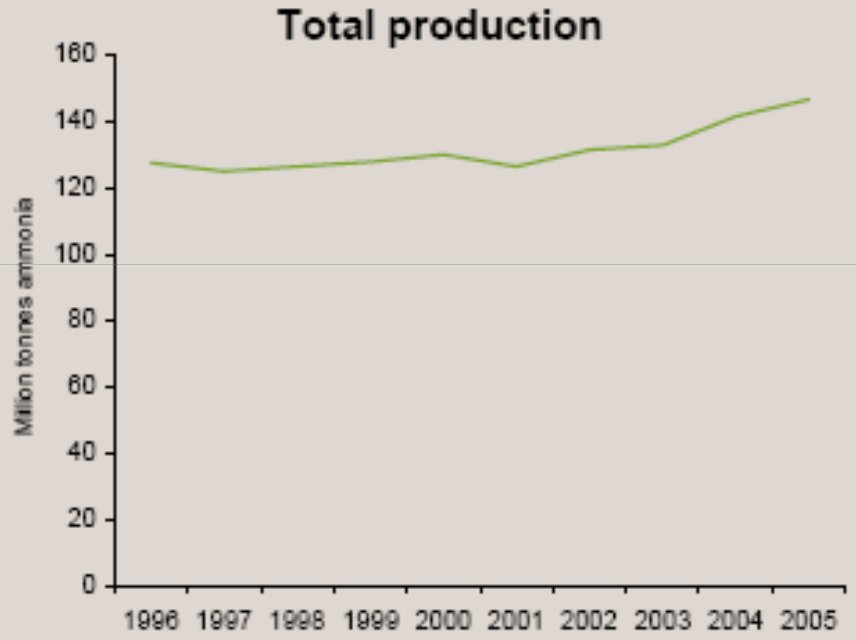
Production capacity (mill t)



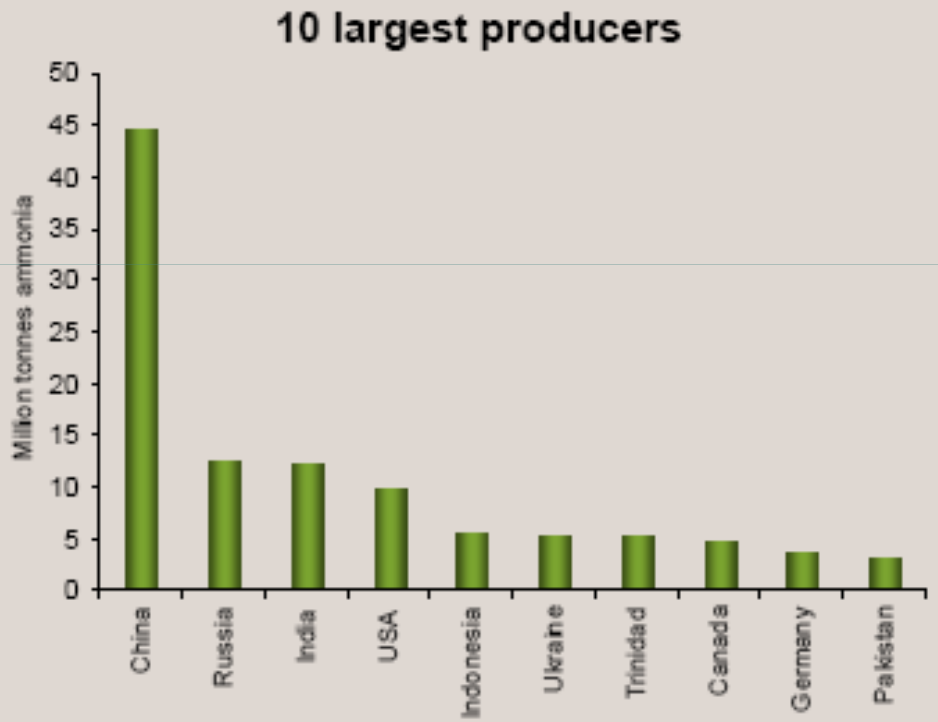
Net nitrogen imports to West Europe



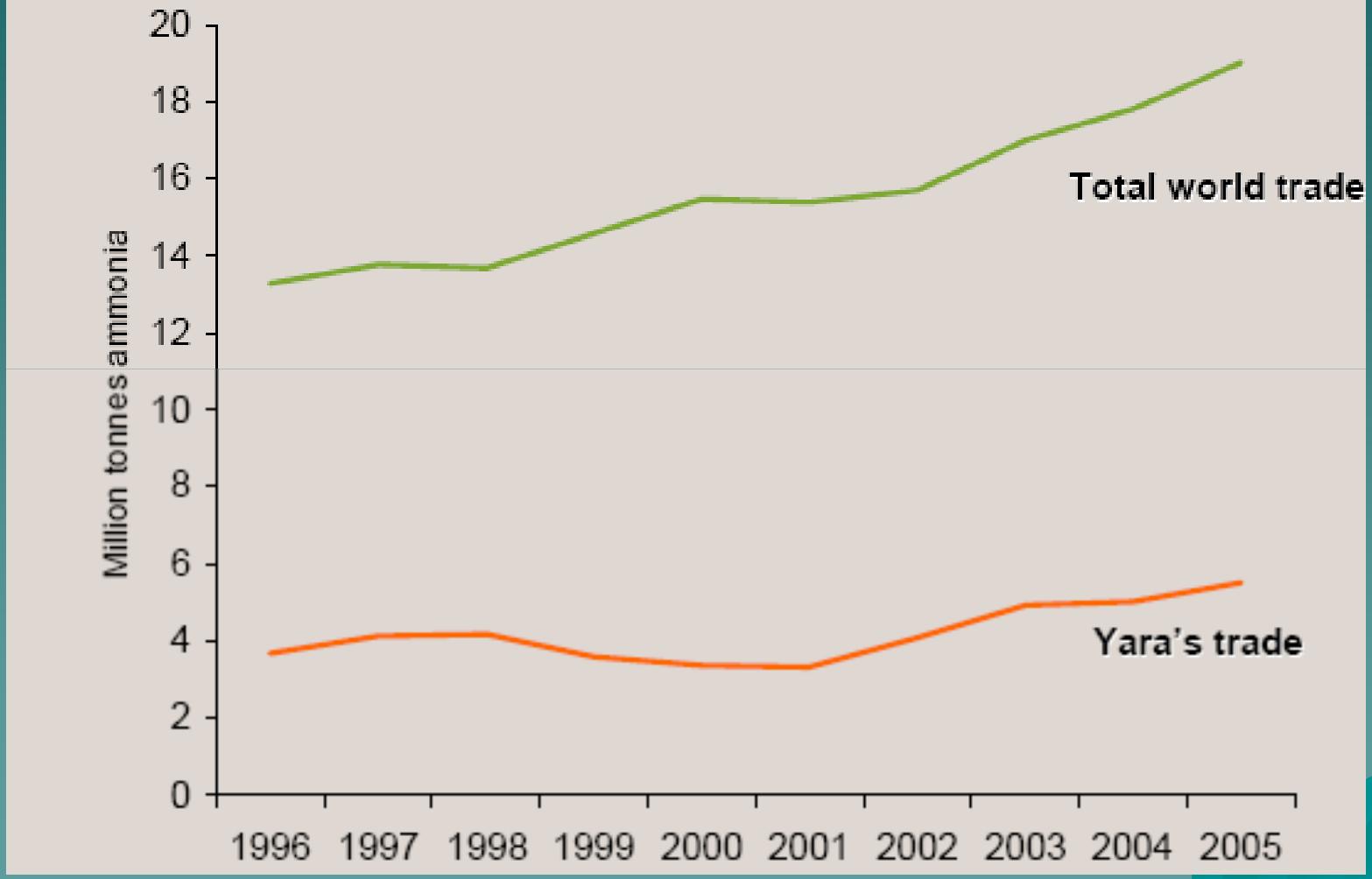
Ammonia production



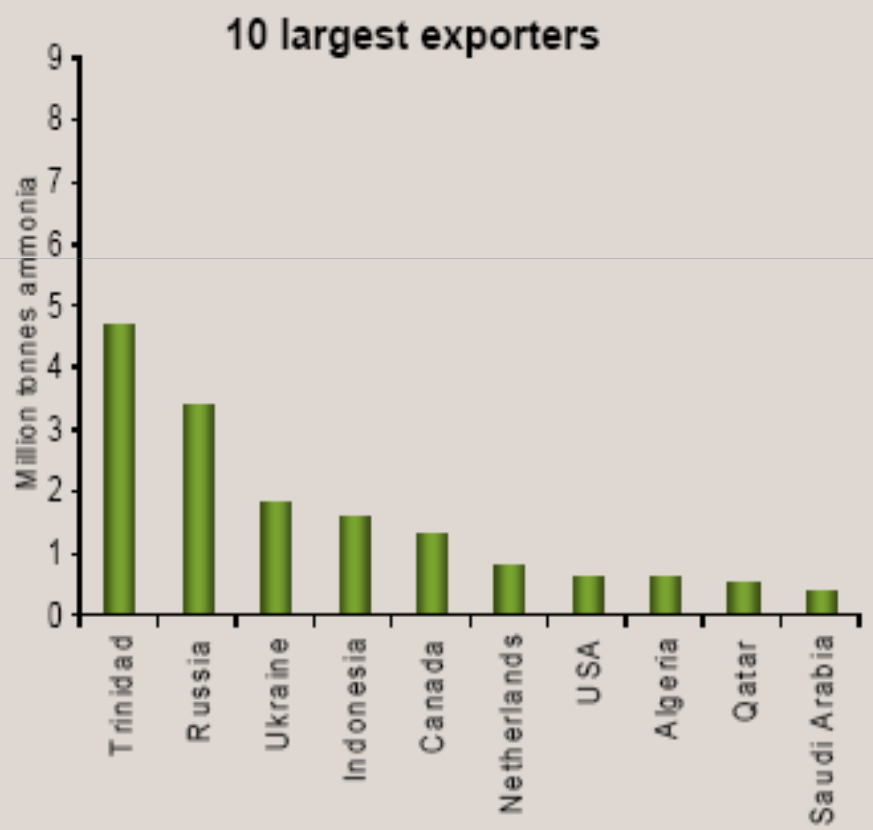
1996-2005 average annual growth rate = 1.6%

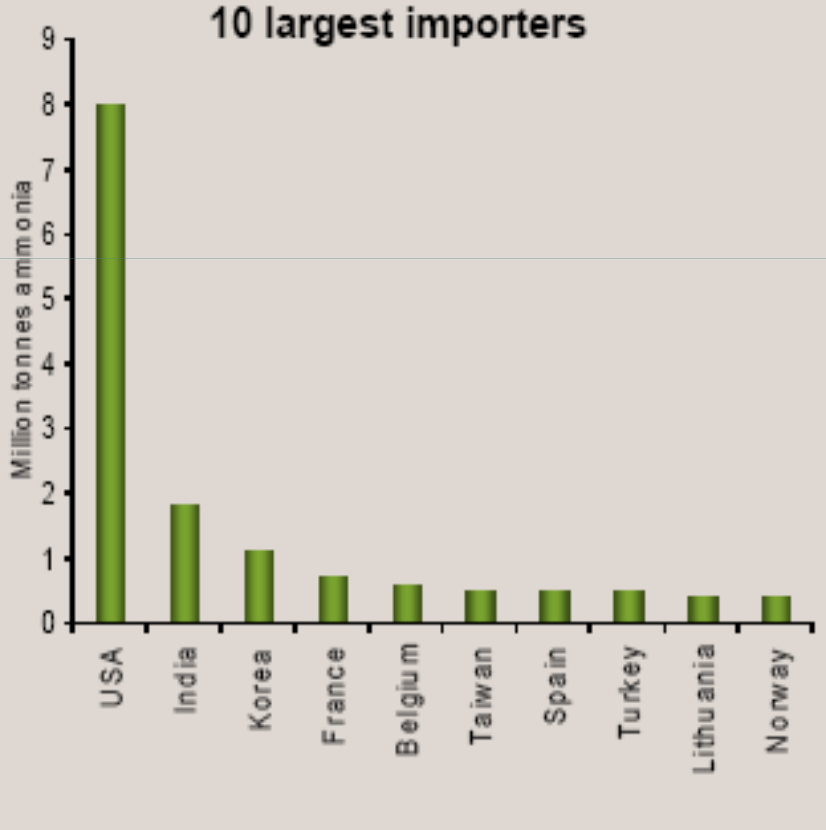


Ammonia trade



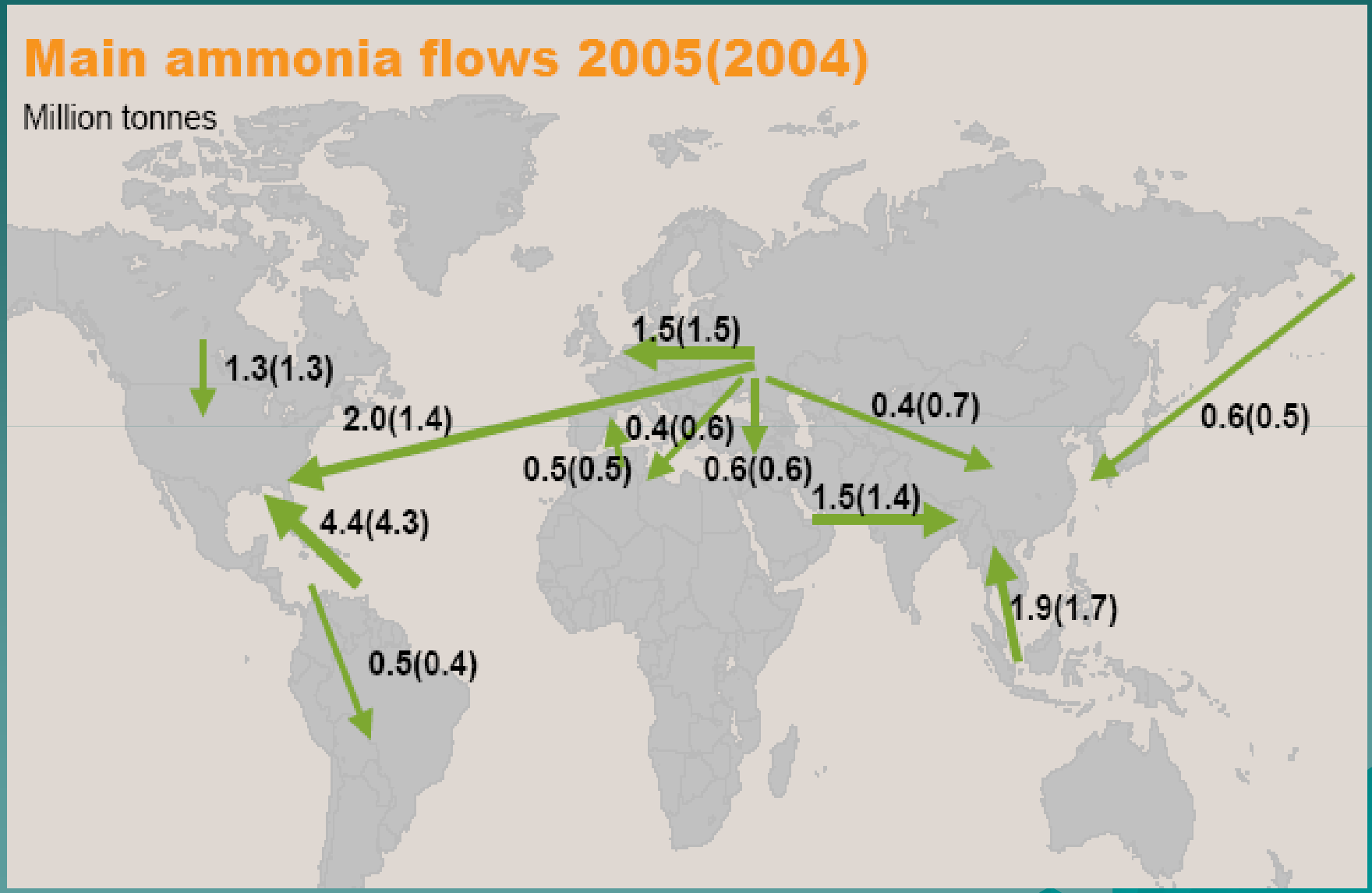
Global ammonia trade





Main ammonia flows 2005(2004)

Million tonnes

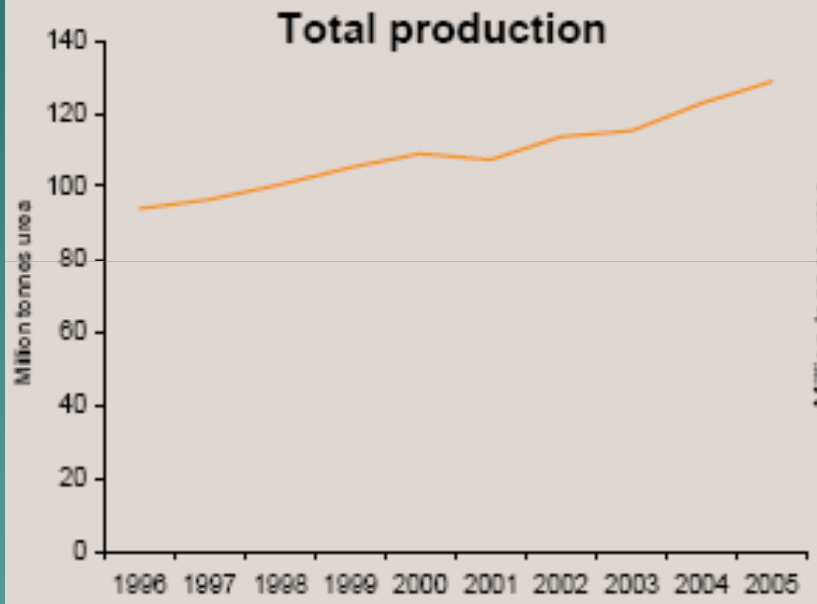


82% of the ammonia trade happens on the specific routes shown in the map, mainly from countries with cheaper gas

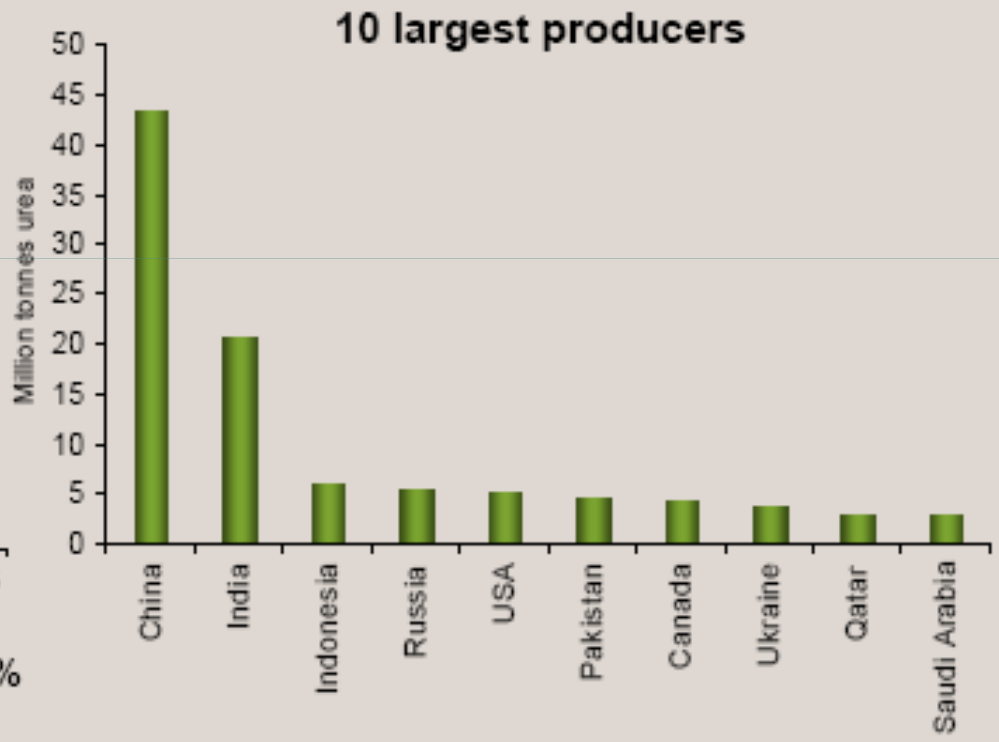
The key centre for ammonia trade is Yuzhnyy in the Black Sea. This is the most liquid location, and where most spot trades take place. Russian and Ukrainian ammonia is sold wherever netbacks are the highest, and since they are key suppliers to USA, Europe and Mediterranean, relative pricing for the various locations West of Suez is very stable.

Asia is almost in a balanced situation. If there is a deficit, imports from the Black Sea are necessary, and fob prices in Asia increase. If there is a surplus, Asian exporters have to compete West of Suez, and Asian fob price levels suffer.

Urea production



1996-2005 annual average growth rate = 3.6%



Urea is the main nitrogen fertilizer product. Approximately 50% of all ammonia is upgraded to urea

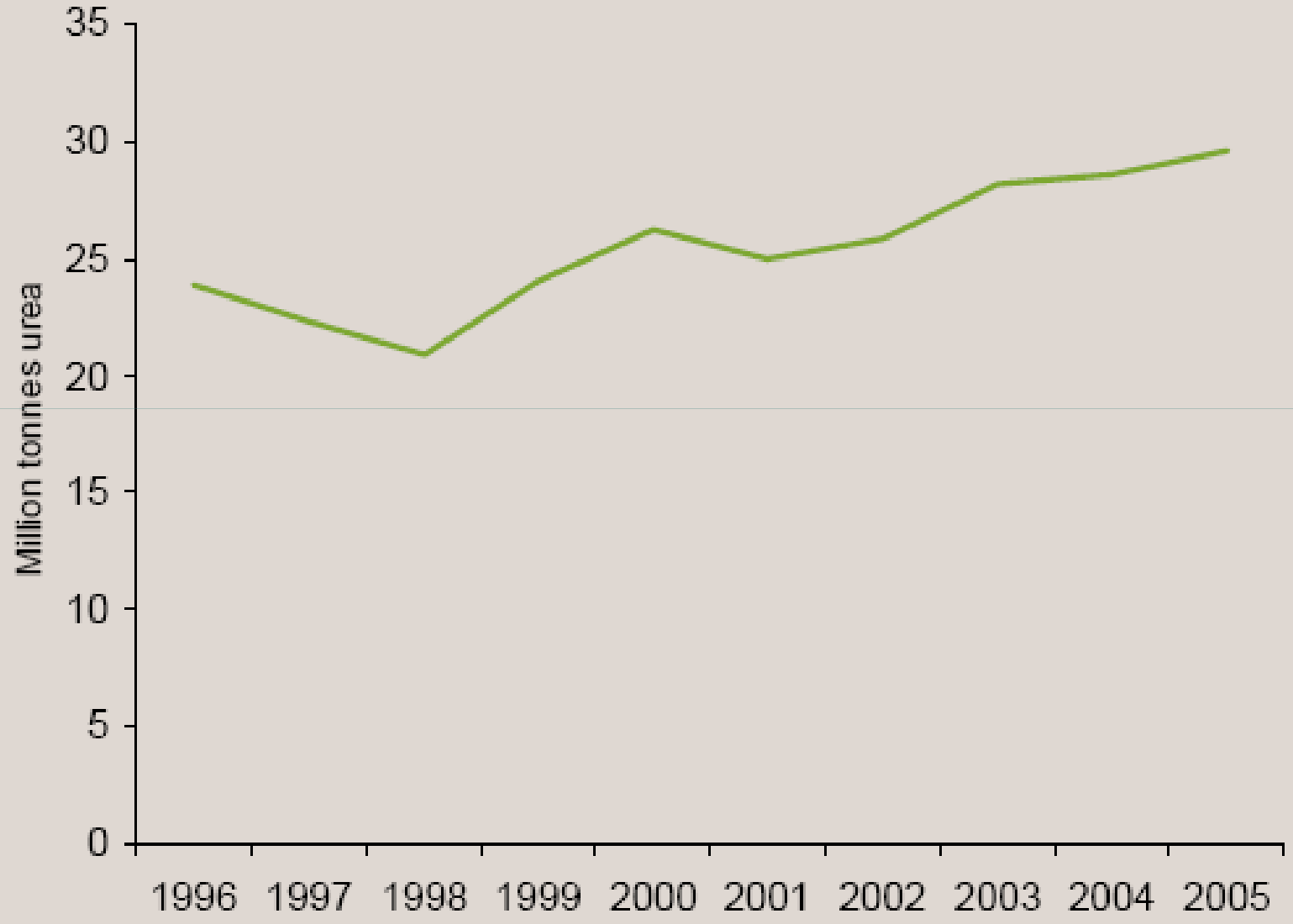
Urea production is estimated at 128.7 million tonnes in 2005. During the years 1996-2005, urea production grew at 3.6% per year. The largest producers are also the largest consumers, namely China and India. Both countries are basically self-sufficient on nitrogen fertilizer.

Most of the new nitrogen capacity in the world is urea, so it is natural that the production/consumption growth rates are higher for urea than for ammonia/total nitrogen. Lately, the difference has been quite large, since urea has taken market share, particularly from ammonium bicarbonate in China. In addition, a major share of the capacity shutdowns in high energy cost regions have been stand-alone ammonia plants.

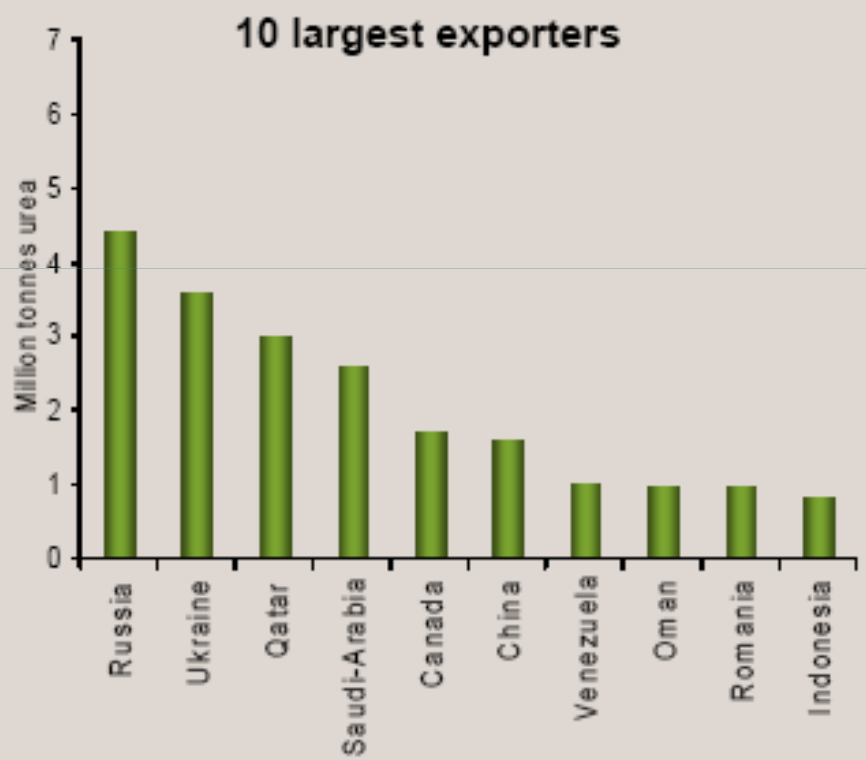
As urea has a high nitrogen content (46%), transport is relatively cheap. In addition, demand growth is to a large extent taking place in climates where urea is suitable.

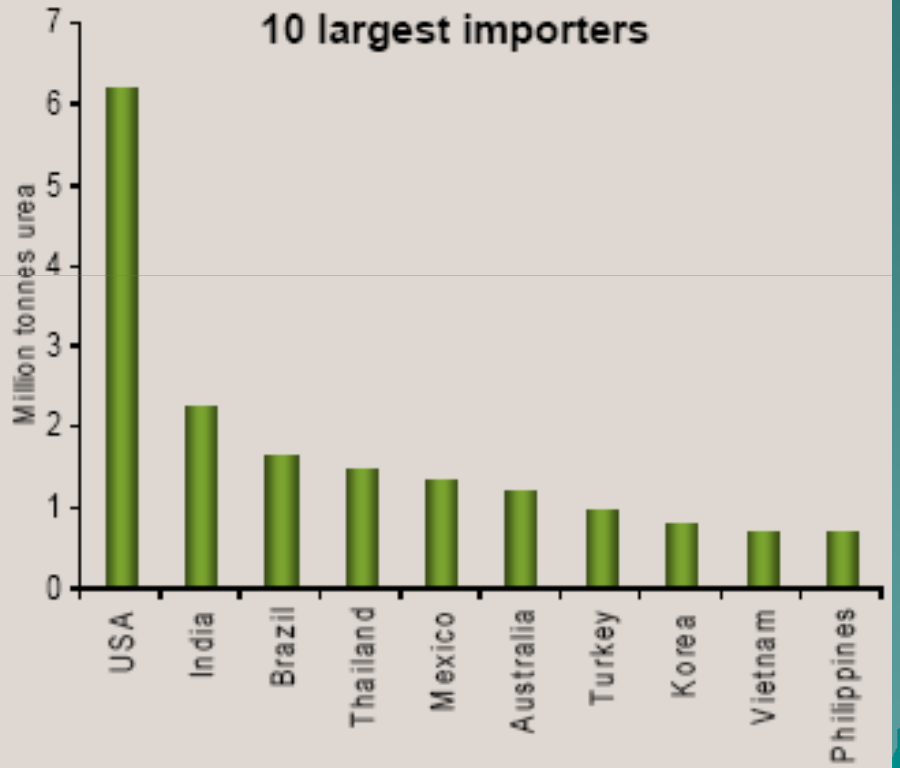
90% of all urea is consumed as fertilizer, whereas the remaining 10% is used for technical applications (CRU estimate).

Urea trade


Million tonnes urea
35
30
25
20
15
10
5
0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

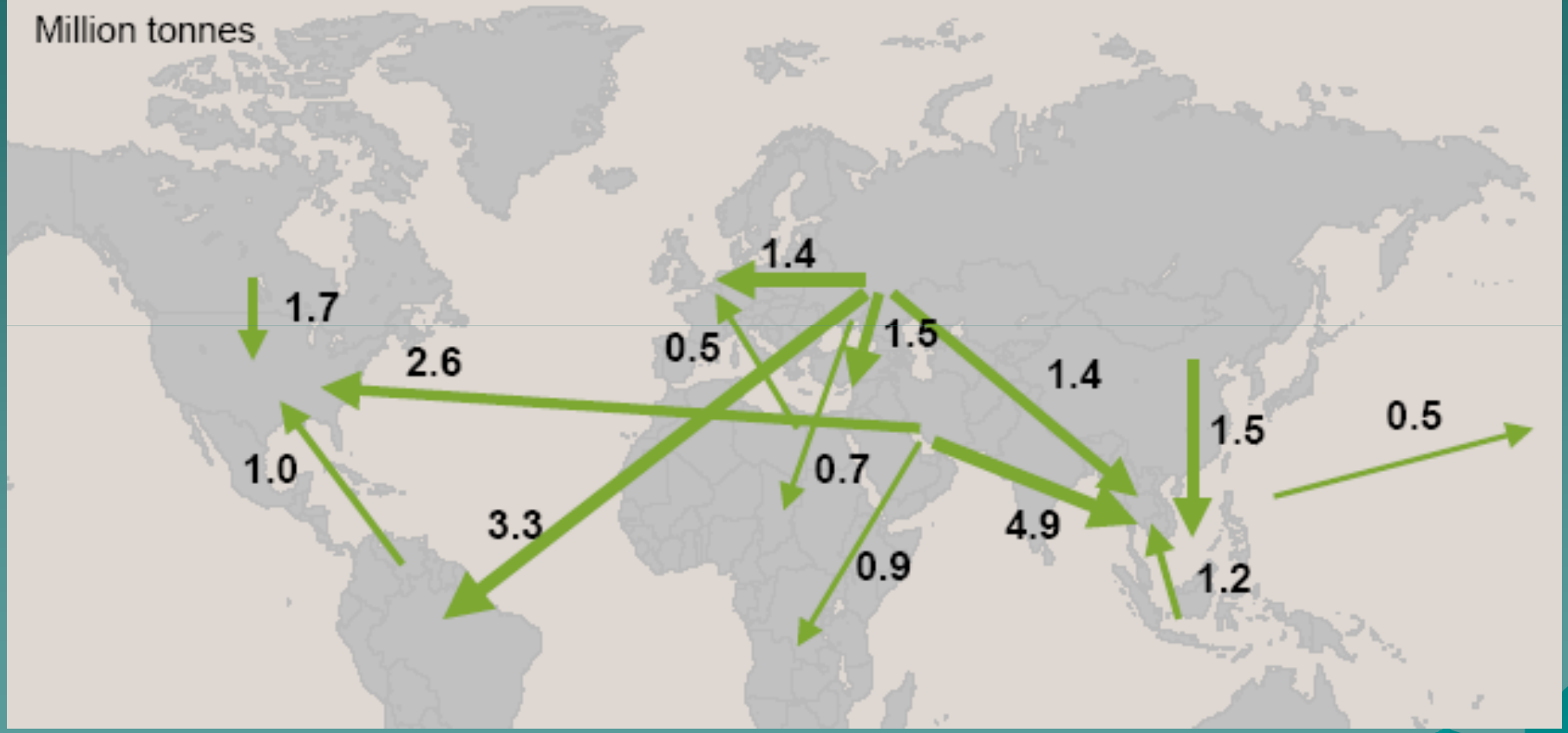
Urea trade


10 largest exporters
Million tonnes urea
0
1
2
3
4
5
6
7
Russia
Ukraine
Qatar
Saudi-Arabia
Canada
China
Venezuela
Oman
Romania
Indonesia

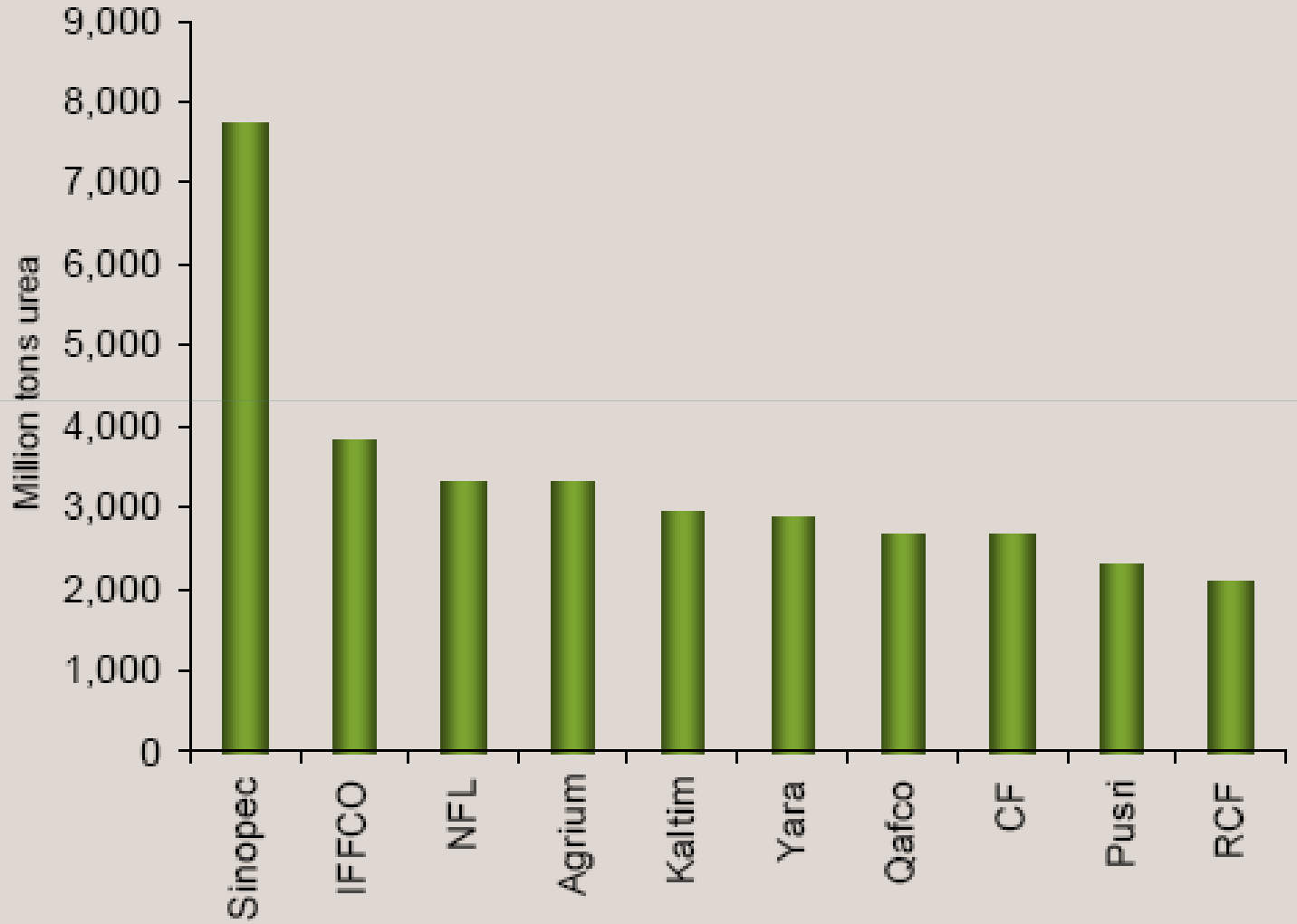

10 largest importers
Million tonnes urea
0
1
2
3
4
5
6
7
USA
India
Brazil
Thailand
Mexico
Australia
Turkey
Korea
Vietnam
Philippines

Main urea flows

Million tonnes



10 largest urea producers



Ammonia-Urea Production Capacity in Bangladesh

Plant capacity, t/yr	NGFF	UFFL	ZFCL	PUFF	CUFL	JFCL	KAFCO
Urea	106,000	469,260	528,000	95,000	561,000	561,000	575,425
Ammonia	66,000	272,250	307,000	56,160	330,000	355,740	499,500

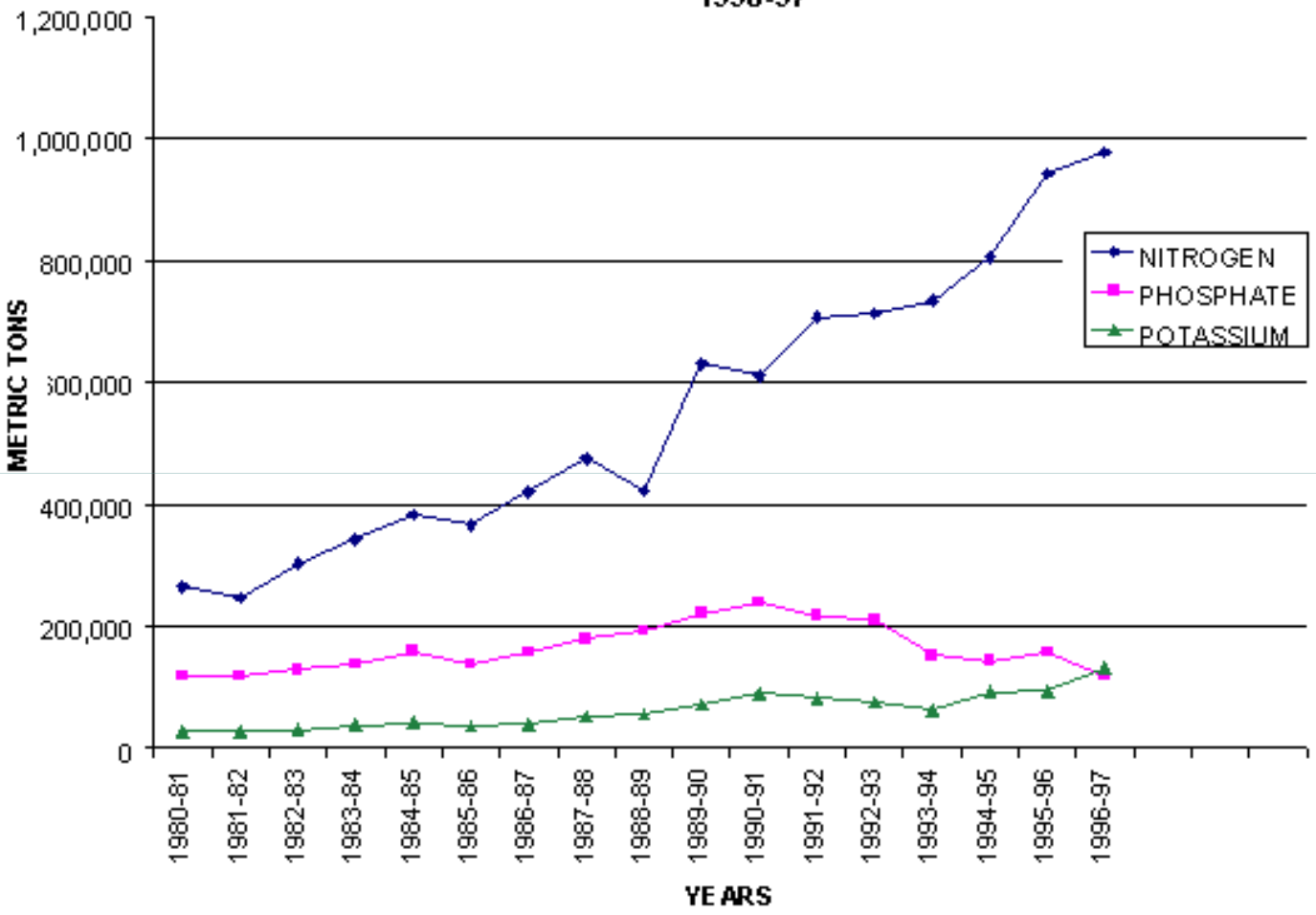
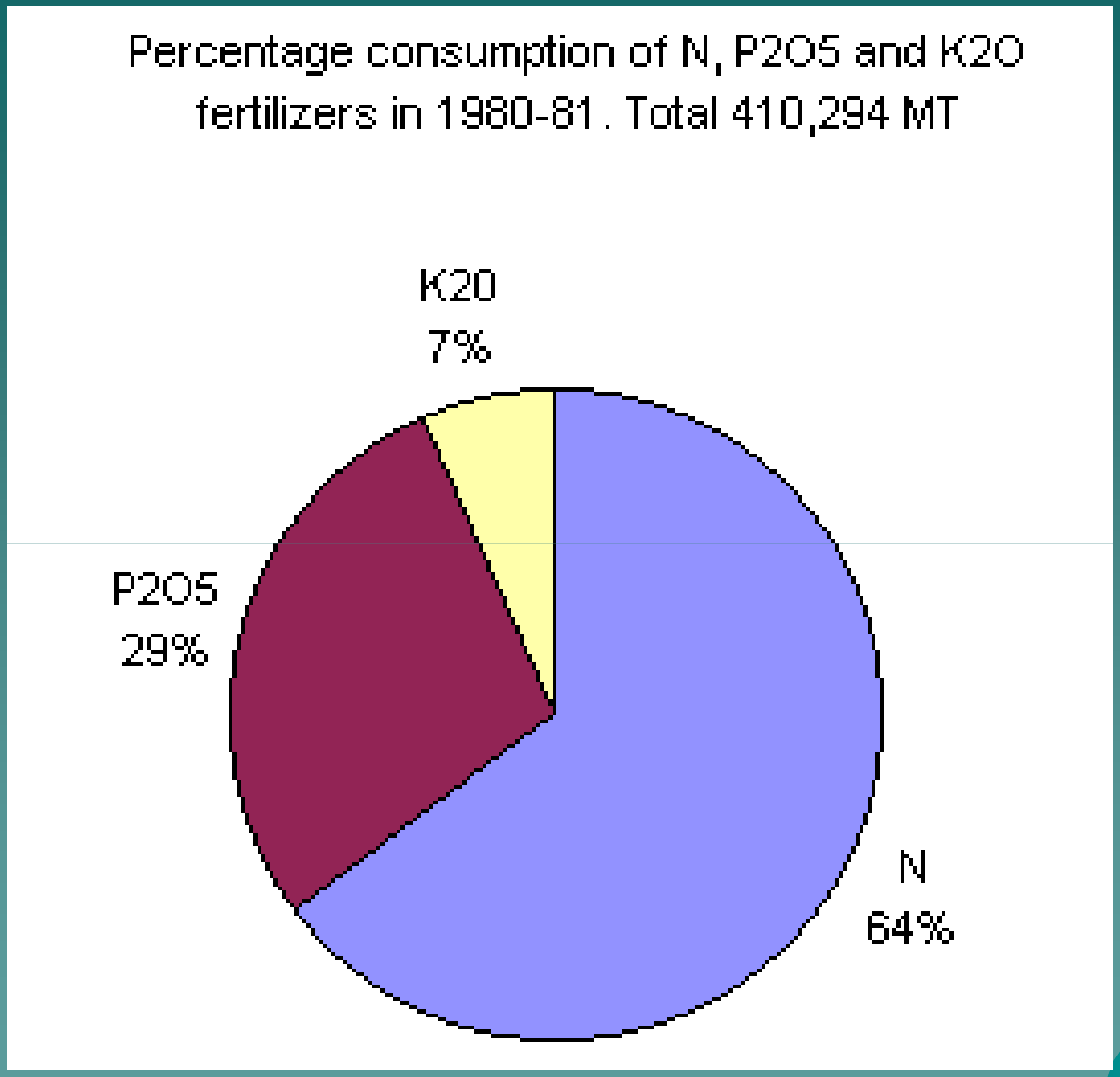
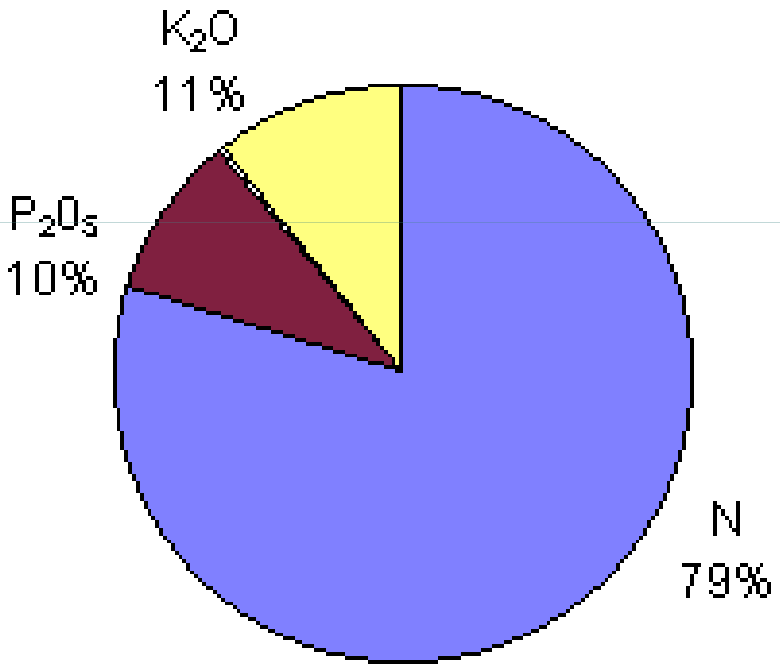


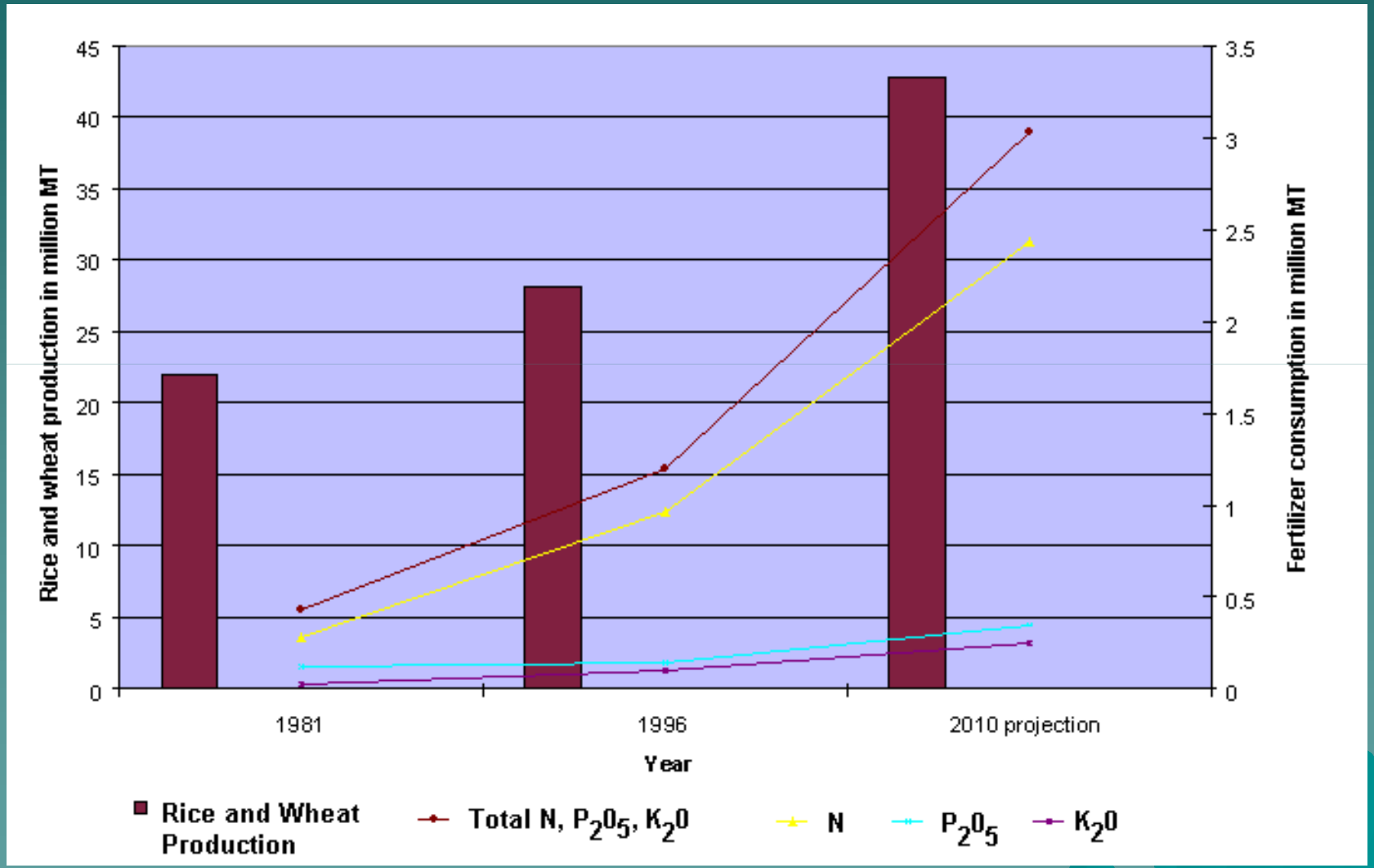
Chart 4.1.1-1: Bangladesh annual consumption of fertilizer nutrient from 1980-81 to 1996-97


Percentage consumption of N, P2O5 and K2O fertilizers in 1980-81. Total 410,294 MT
K20
7%
P2O5
29%
N
64%

Percentage consumption of N, P_2O_5 and K_2O fertilizers in 1996-97. Total 1,226,593 MT.



Projected value of consumption in 2010



Projected value of consumption in 2010

	WHEAT AND RICE PRODUCTION (millionMT)				
CROP	**1981[1]**	**1996[2]**	**Diff. btw. 1981-1996**	**2010 projection[3]**	**1996-2010**
Rice	20.9	26.7	5.8	40.8	14.1
Wheat	1.0	1.4	0.4	2.0	0.6
Total	21.9	28.1	6.2	42.8	14.7
	FERTILIZER CONSUMPTION (millionMT)				
FERTILIZER	**1981[4]**	**1996[5]**	**Diff. btw. 1981-1996**	**2010 projection**	**1996-2010**
N	0.28	0.96	0.68	**2.43[7]**	1.47
P_2O_5	0.12	0.14	0.02	**0.35[7]**	0.21
K_2O	0.03	0.1	0.07	**0.25[7]**	0.15
Total	0.43	1.2	0.77	**3.03[6]**	1.83

Price of fertilizer, Tk/50 kg

NAME OF PRODUCT	FACTORY/PORT PRICE	WHOLESALE PRICE	RETAIL PRICE
UREA	247	264	273
TSP	454	658	664
SSP	231	266	289
MOP	342	351	366
ZINC	840	920	1000
GYPSUM	90	105	135

Pollution and its Control: Ammonia- Urea Complex

Two Types
1. Air
2. Water

Pollutants
- Ammonia
- Urea -Carbamate solution
- Urea dust
- Formaldehyde
- Catalyst dust
- Carbon monoxide
- Benfield solution

Pollution and its Control: Ammonia- Urea Complex

Measures to control Pollution

- Process control to minimize pollution
- Treatment of the liquid effluents
- Treatment of the gaseous effluents and dusts