Yara Fertilizer Industry Handbook

December 2012

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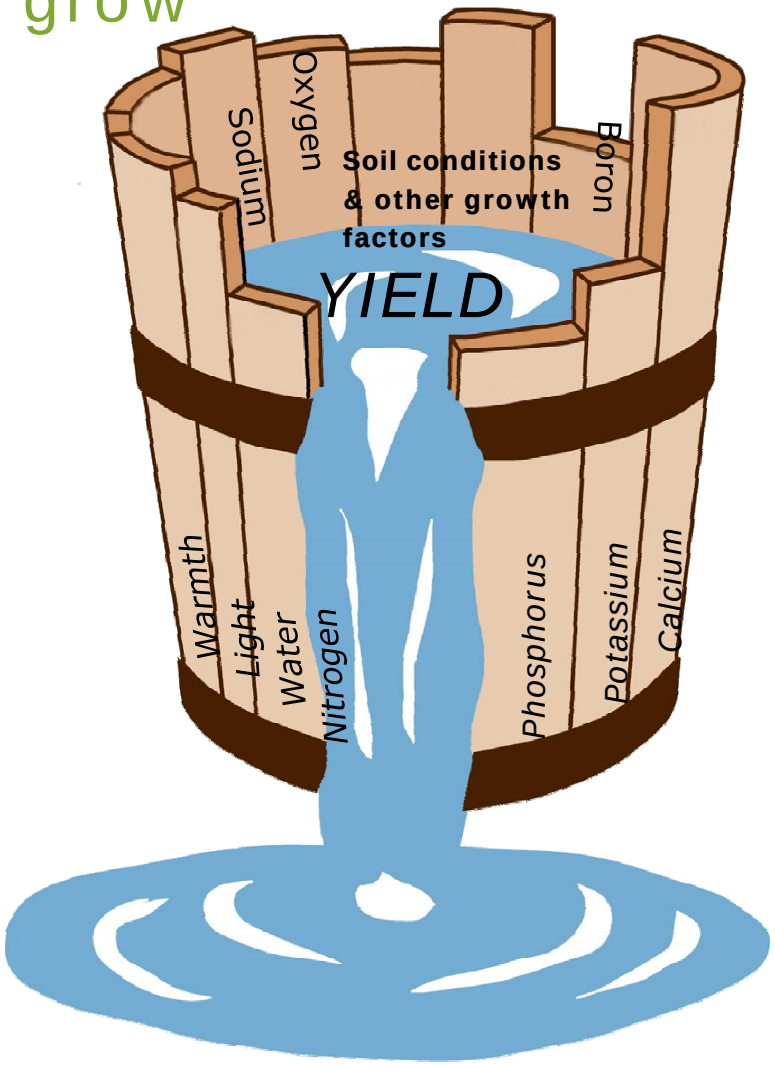
YARA
Knowledge grows
What is fertilizer?

Plants need nutrients to grow

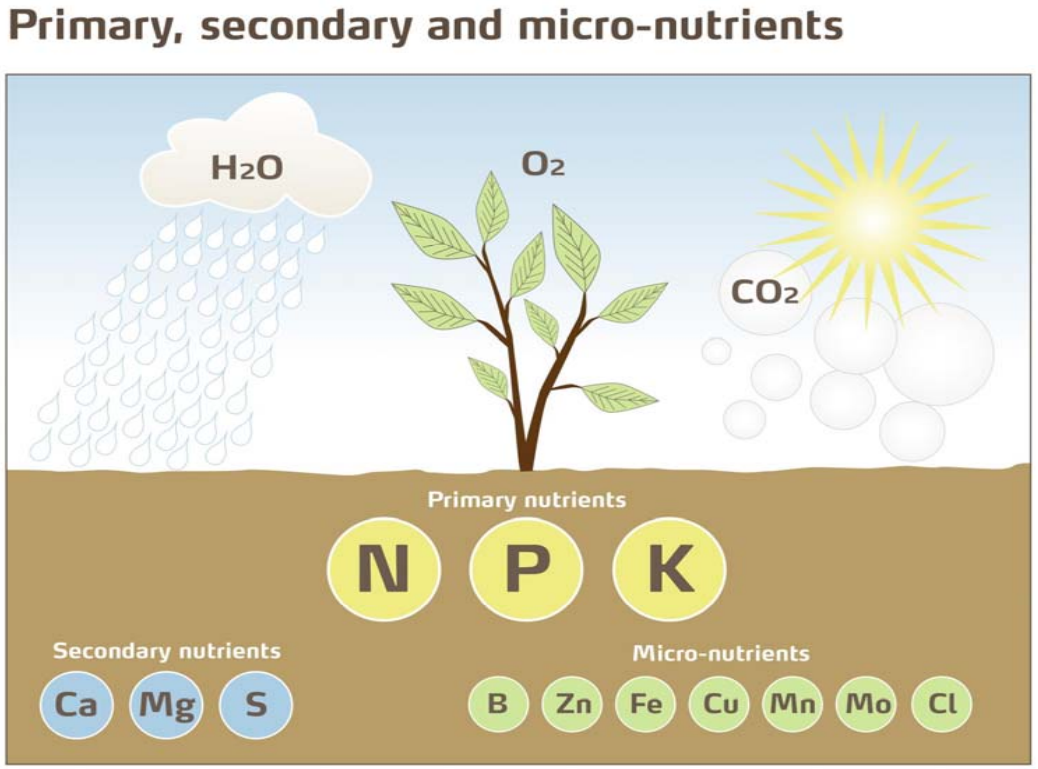
Nutrient behavior

- Nutrients have specific and essential functions in plant metabolisms

- They cannot replace each other, and lack of any one nutrient limits crop growth

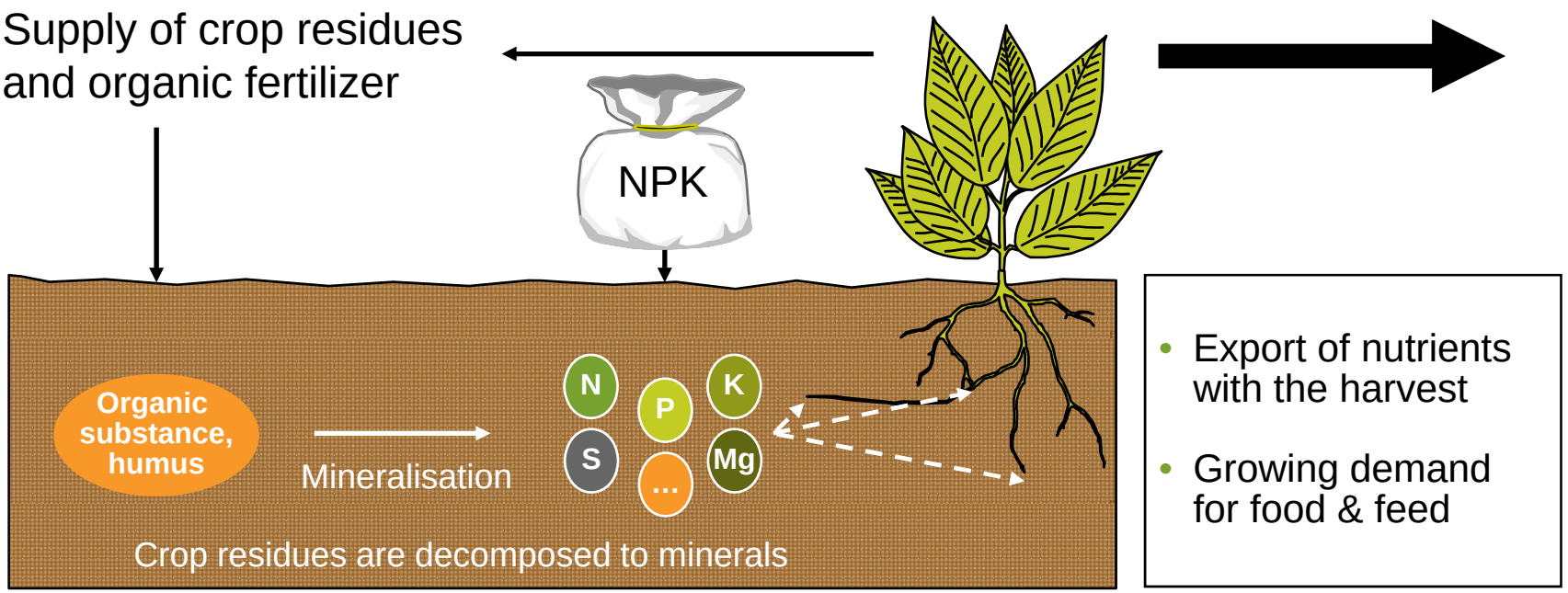


What is fertilizer?



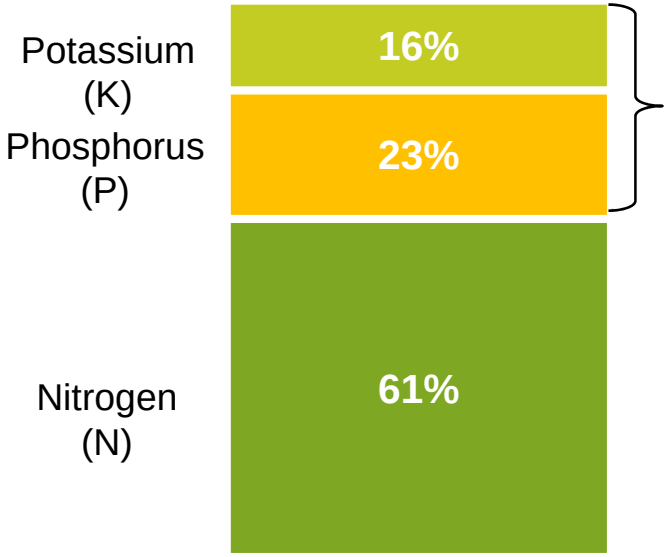
Nitrogen is the main driver of yield

Why mineral fertilizer ?



Mineral fertilizers are necessary to replace those nutrients that have been removed from the field

Nitrogen – the most important nutrient



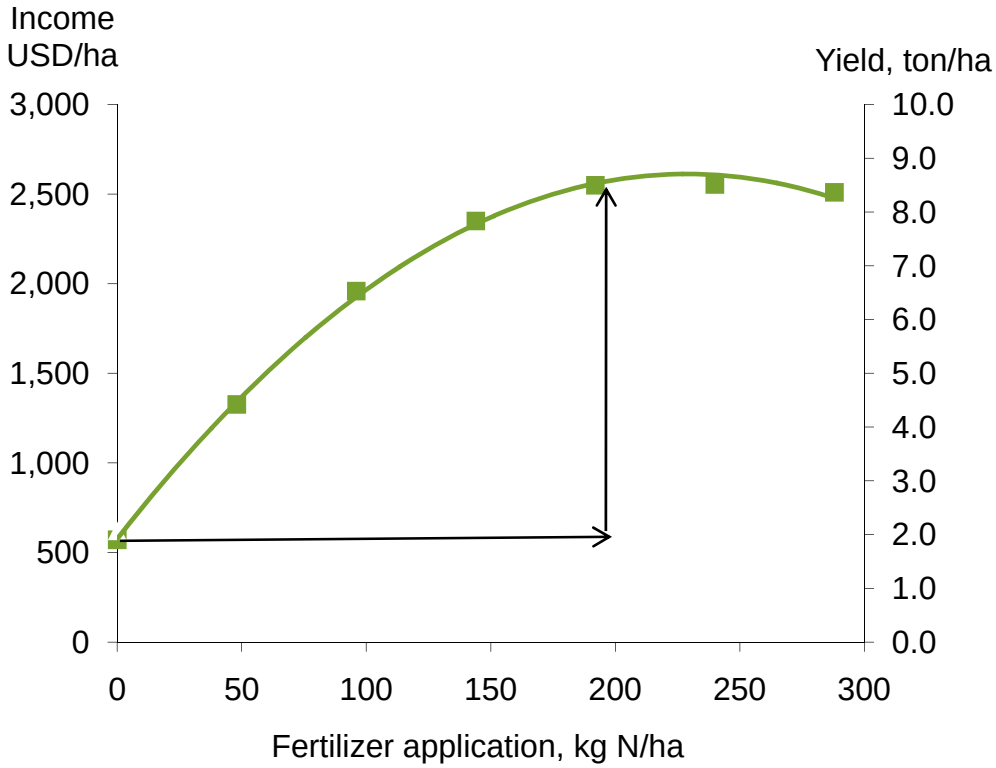
Nutrient characteristics

	Primary benefit	Application	Industry structure
Potassium (K) / Phosphorus (P)	• Improve crop quality	• Annual application not always done	• Fewer suppliers, production discipline
Nitrogen (N)	• Increase crop size • Most important and commonly lacking nutrient	• Annual application critical	• Industry more fragmented, under consolidation • More dynamic prices, but stable volume

Source: IFA (season 2010/11)

Profitability of investment in mineral fertilizers

Yield response (monetary value) to N fertilizer rate

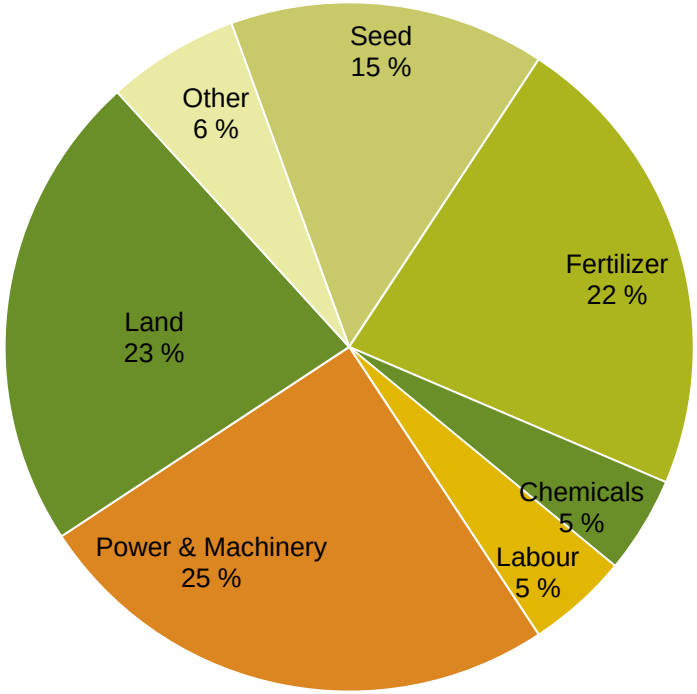


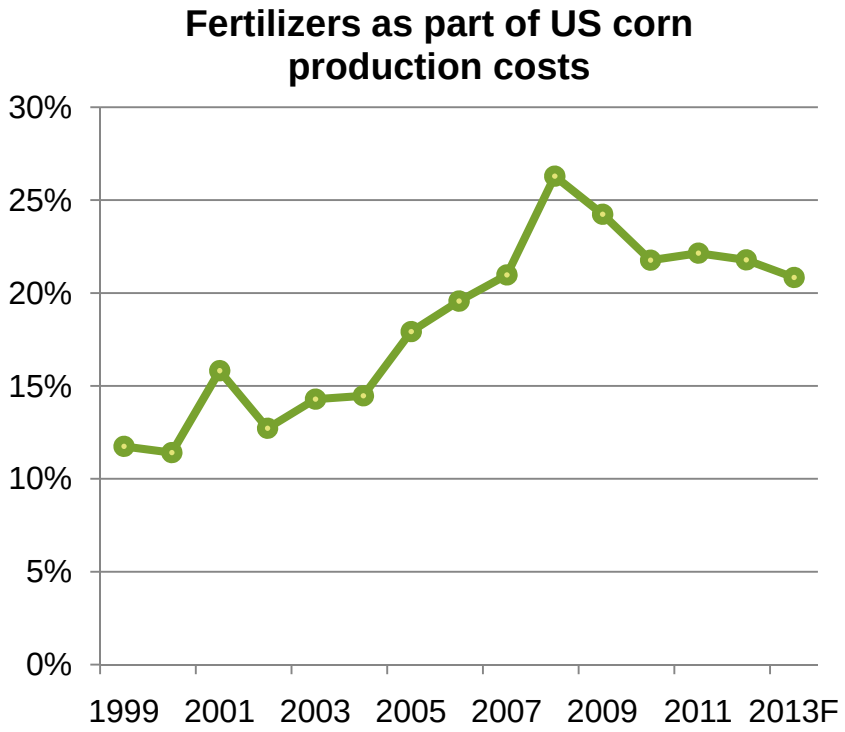
- The investment in nitrogen fertilizer is highly profitable for growers
- Fertilizer investment: 250 USD/ha
- Net return: 2,212 USD/ha
- **Net return > 9 x investment**

Source: Winter wheat yield data: Long term trial, Broadbalk, Rothamsted (since 1856).

Breakdown grain production costs

Example: 2012F average US corn production costs

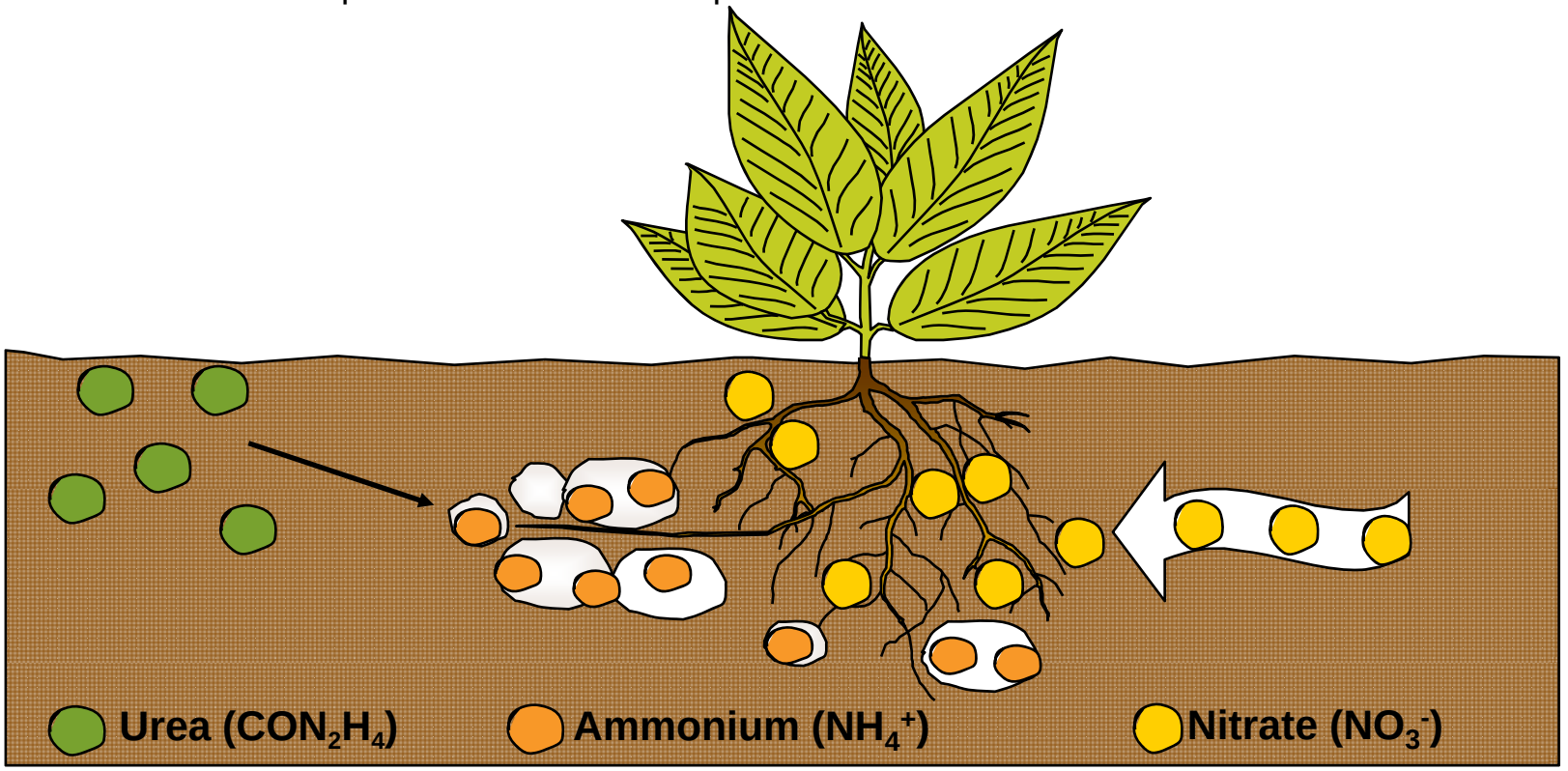




Source: USDA (Cost-of-production forecasts May 2012)

Nitrates vs. urea

Nitrate is the most important fertilizer in Europe



Urea-N needs to be converted into ammonium-N before it is plant available**.**

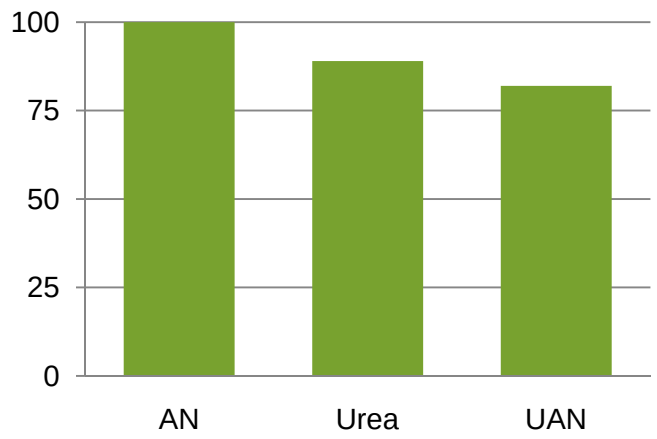
Ammonium-N is fixed onto clay minerals in the soil and therefore immobile. The plant roots have to grow actively towards the nutrient.

Nitrate-N is always dissolved in the soil water and is transported passively together with the water into the plant root. Thus, nitrate is rapidly effective.

Nitrate-based fertilizers are superior to urea both agronomically and environmentally

The agronomical efficiency of nitrates is superior to urea

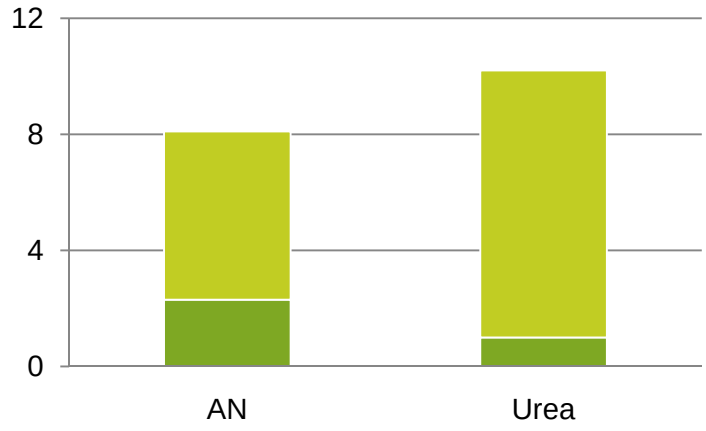
Nitrogen recovery (% of AN)



Urea requires up to 20% higher N application to achieve same cereal crop yield and quality as AN

The carbon footprint is lower than for Urea

Lifecycle carbon footprint (kg CO_2 eq/kg N)

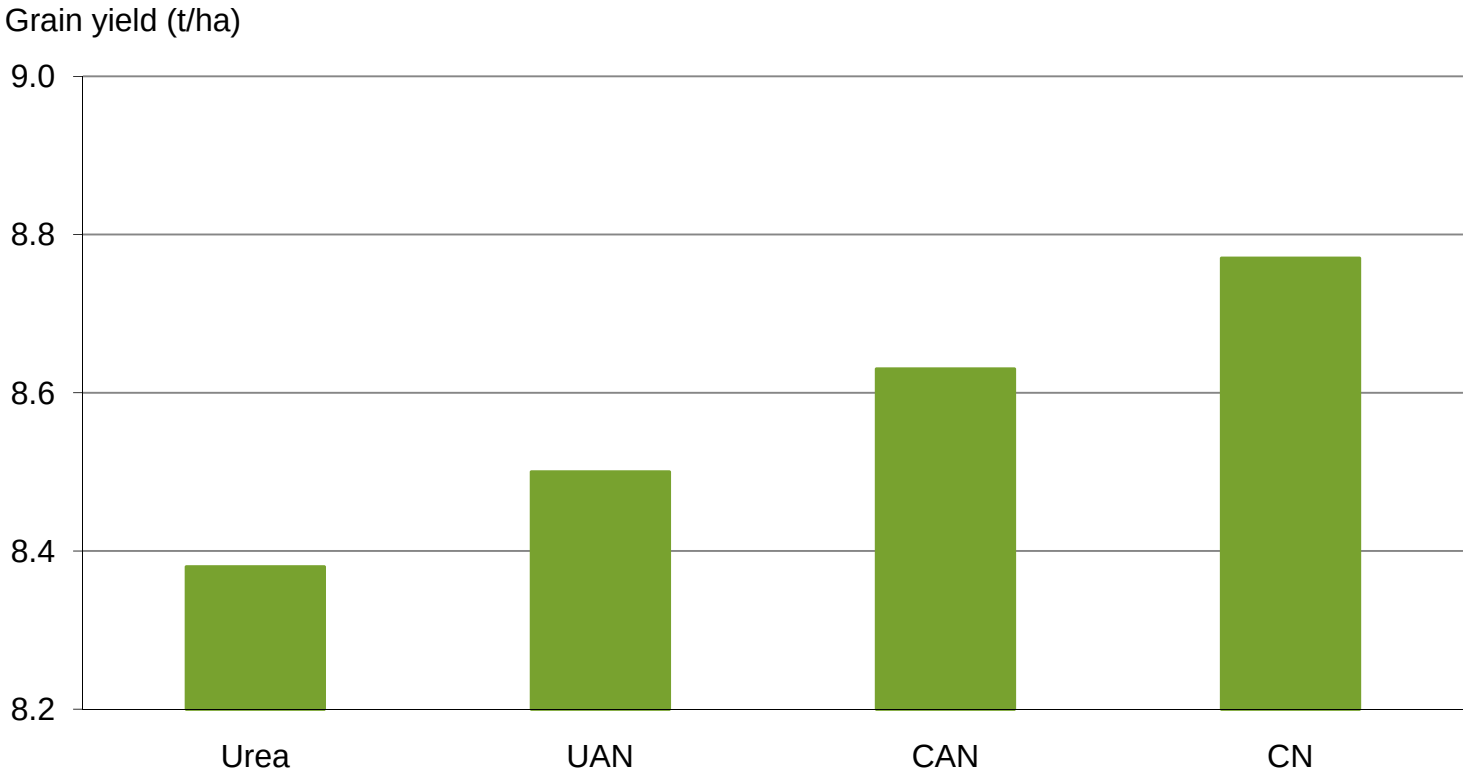


Although urea is more CO_2 efficient in production, CO_2 emissions and ammonia volatilization on application more than offset for this

Source: DEFRA (2006), NT26 project report; Fertilizer Europe; 2EMEP/EEA air pollutant emission inventory guidebook (2007); Yara

Trial results in arable crops

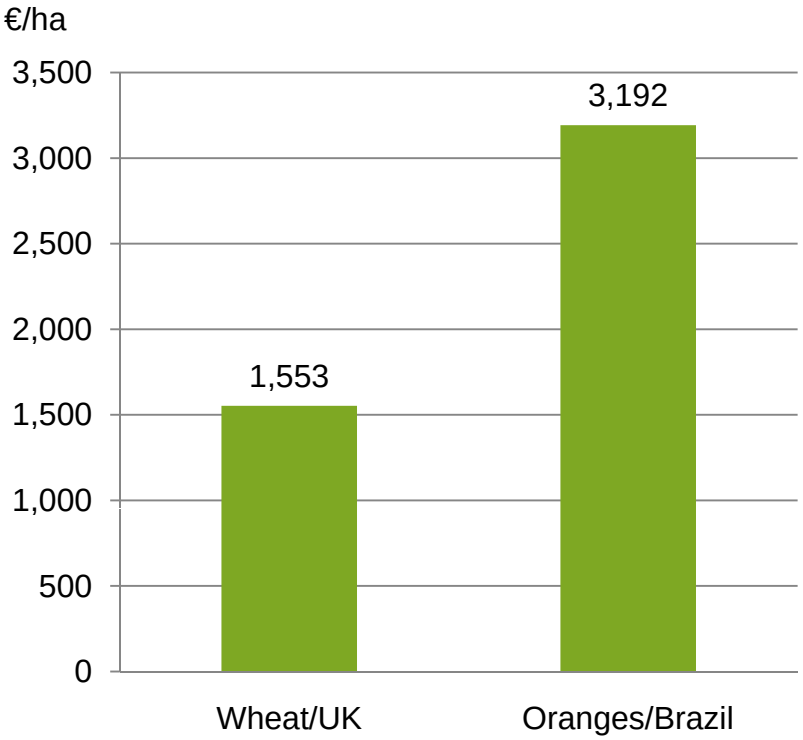
Winter wheat trials in UK from 1994-98
Application rate of 160 kg of N/ha



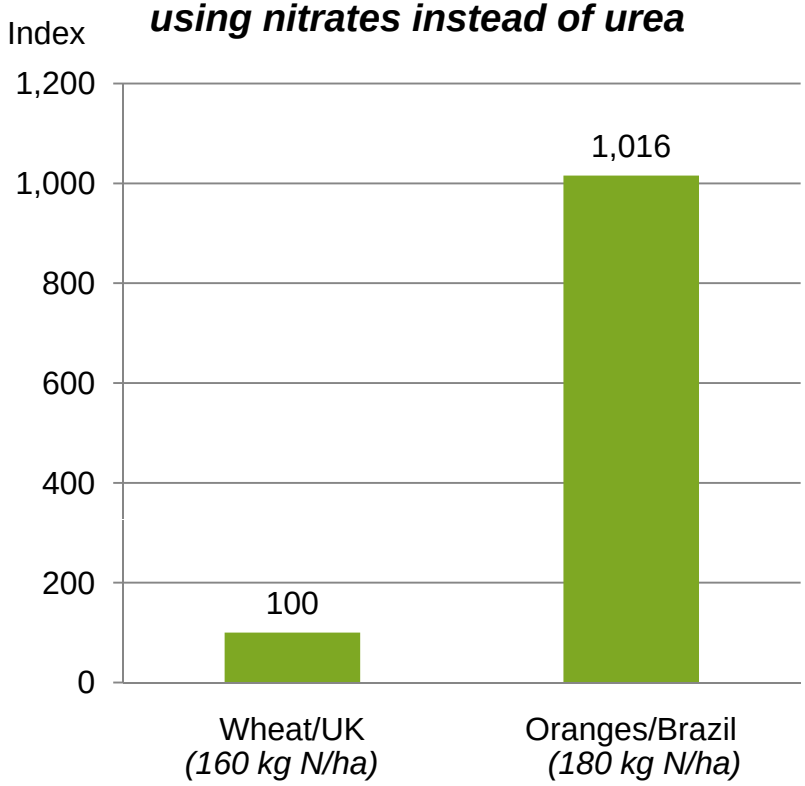
Source: Levington Agriculture, UK (1999)

Nitrates' agronomic advantage has higher value for cash crops than for commodity crops

Crop value with nitrates



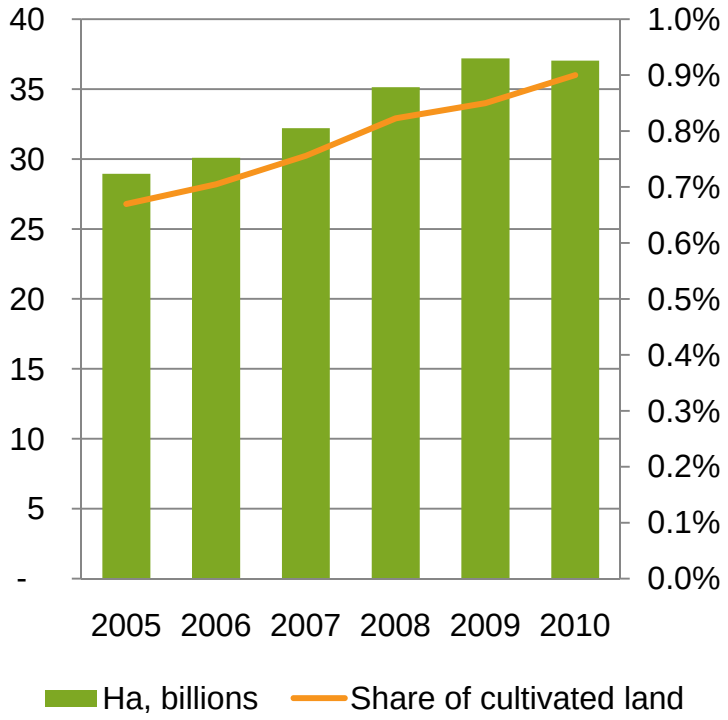
Increase in crop production value using nitrates instead of urea

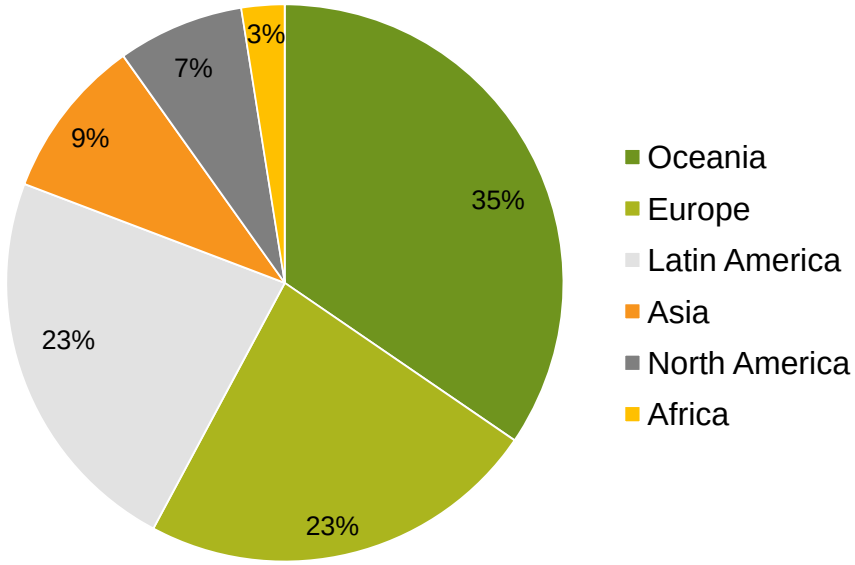


Fertilizer characteristics: Organic compared to mineral fertilizer

Characteristics	Organic fertilizer	Mineral fertilizer
Nutrient source	Crop residues and animal manures	Nitrogen from the air and minerals from the soil
Nutrient concentration	Low concentration	High concentration
Nutrient availability	Variable	Immediately available for the crop
Quality	Often inconsistent	Traceable and consistent

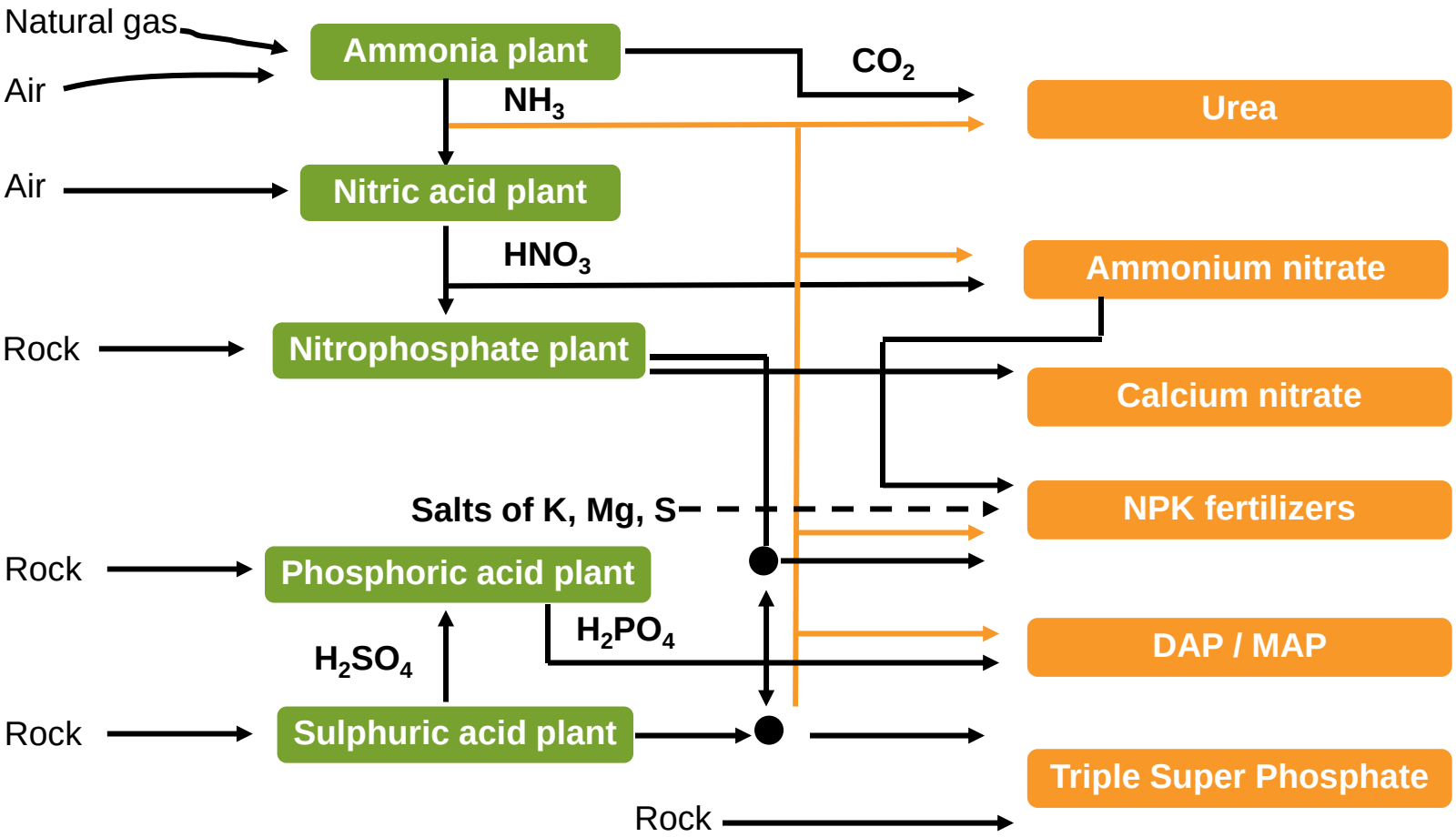
Organic farming represents only a marginal share of total cultivated land





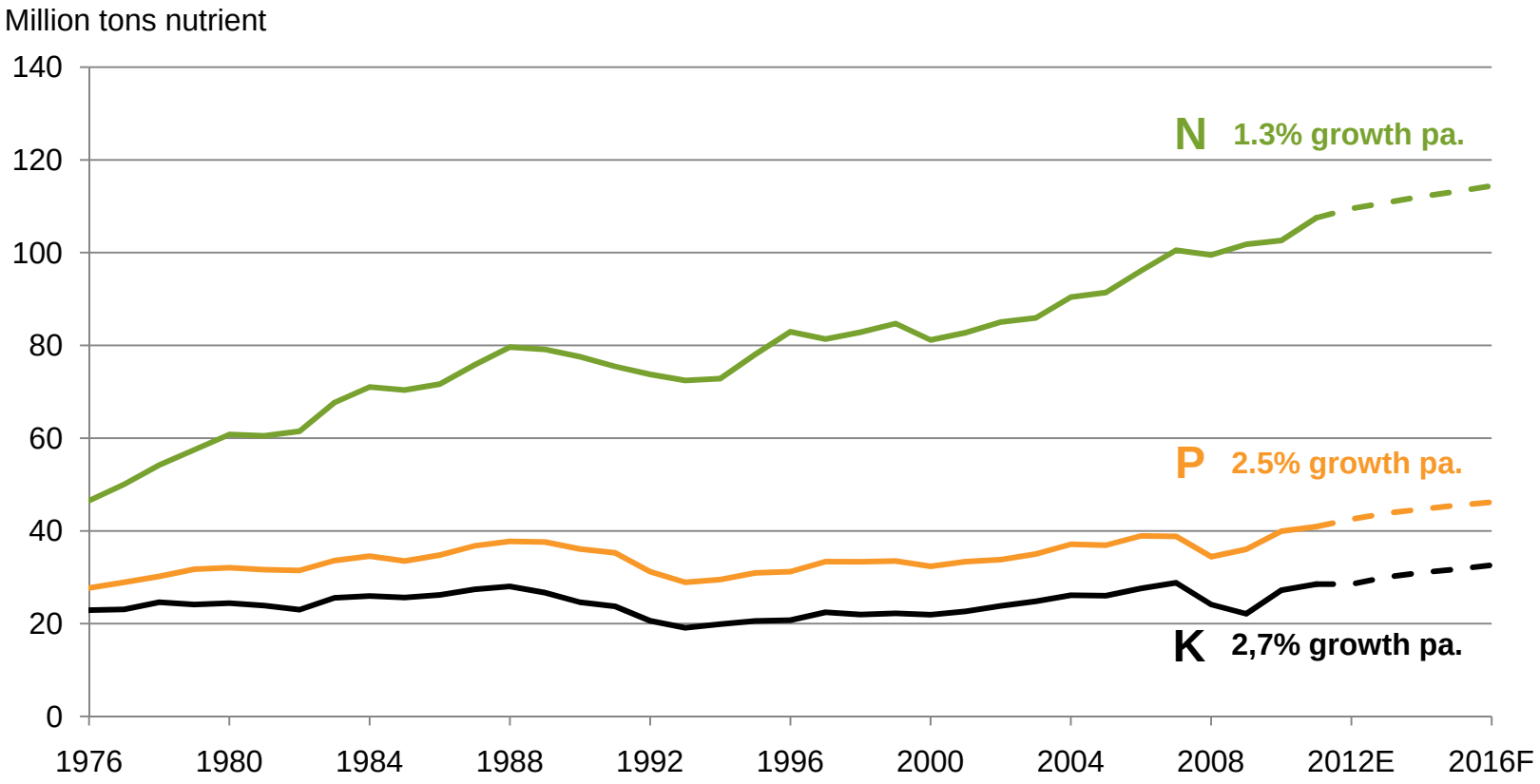
Source: Organic-world.net

Fertilizer production routes



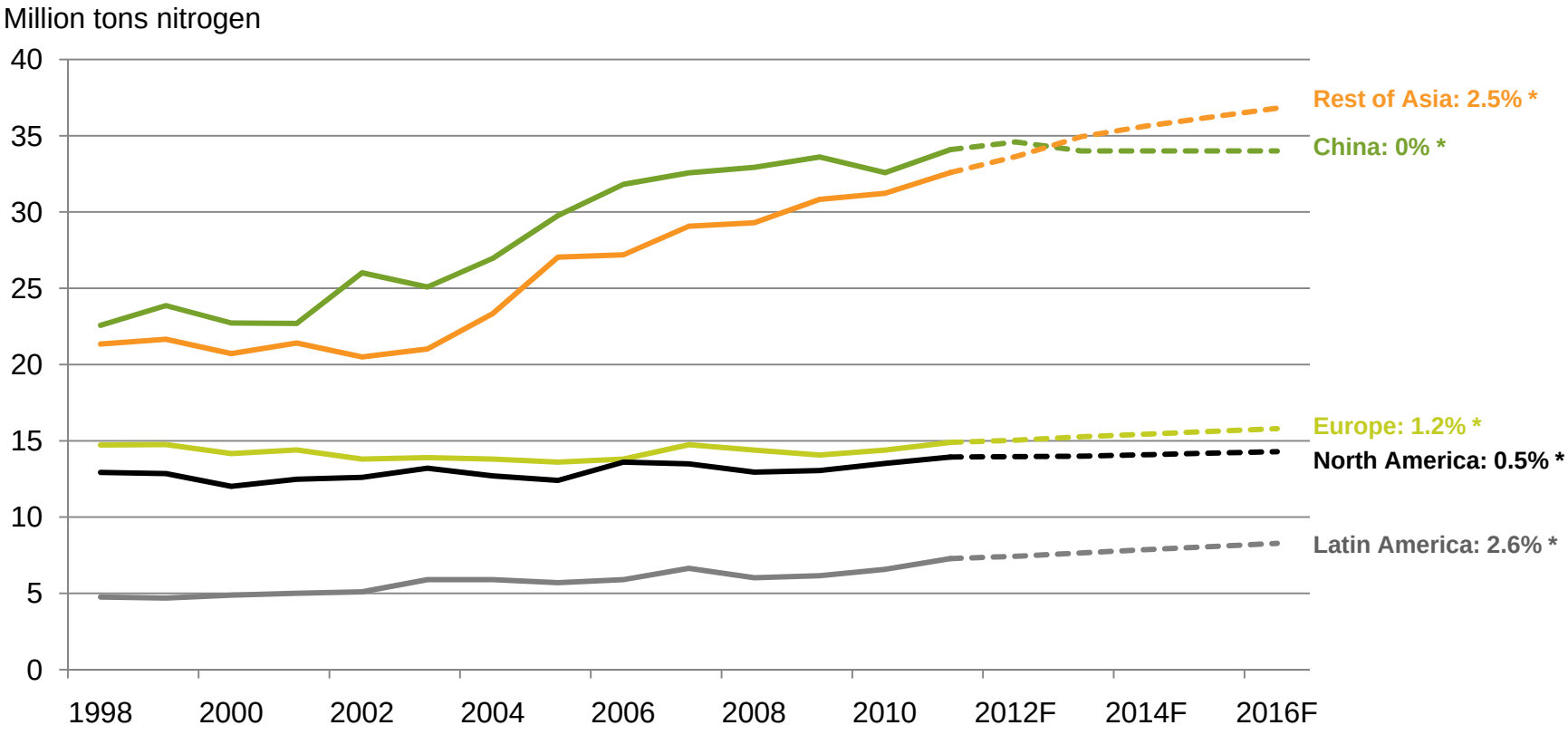
The fertilizer industry

Consumption per nutrient



Source: IFA, June 2012

Nitrogen consumption in key regions

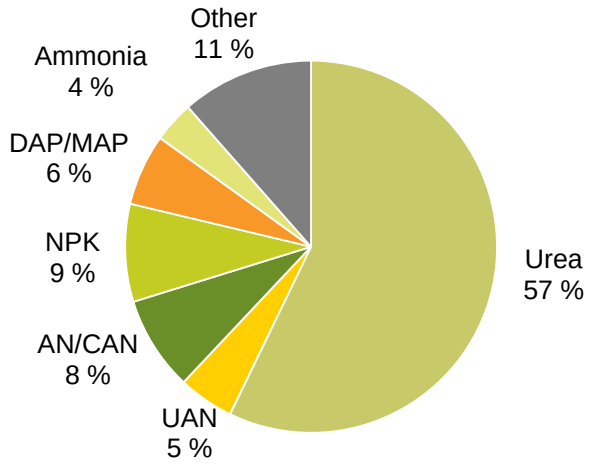


Source: IFA, May 2011

* CAGR 11-16

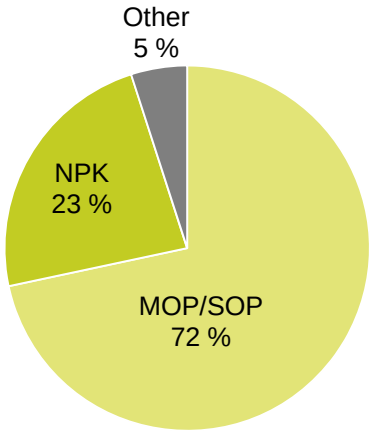
Key global fertilizer products

Nitrogen N



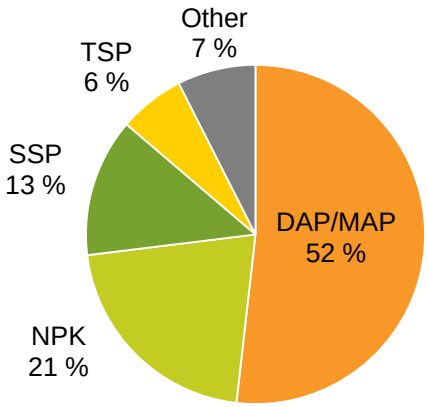
107 million tons*

Potash K_2O



29 million tons

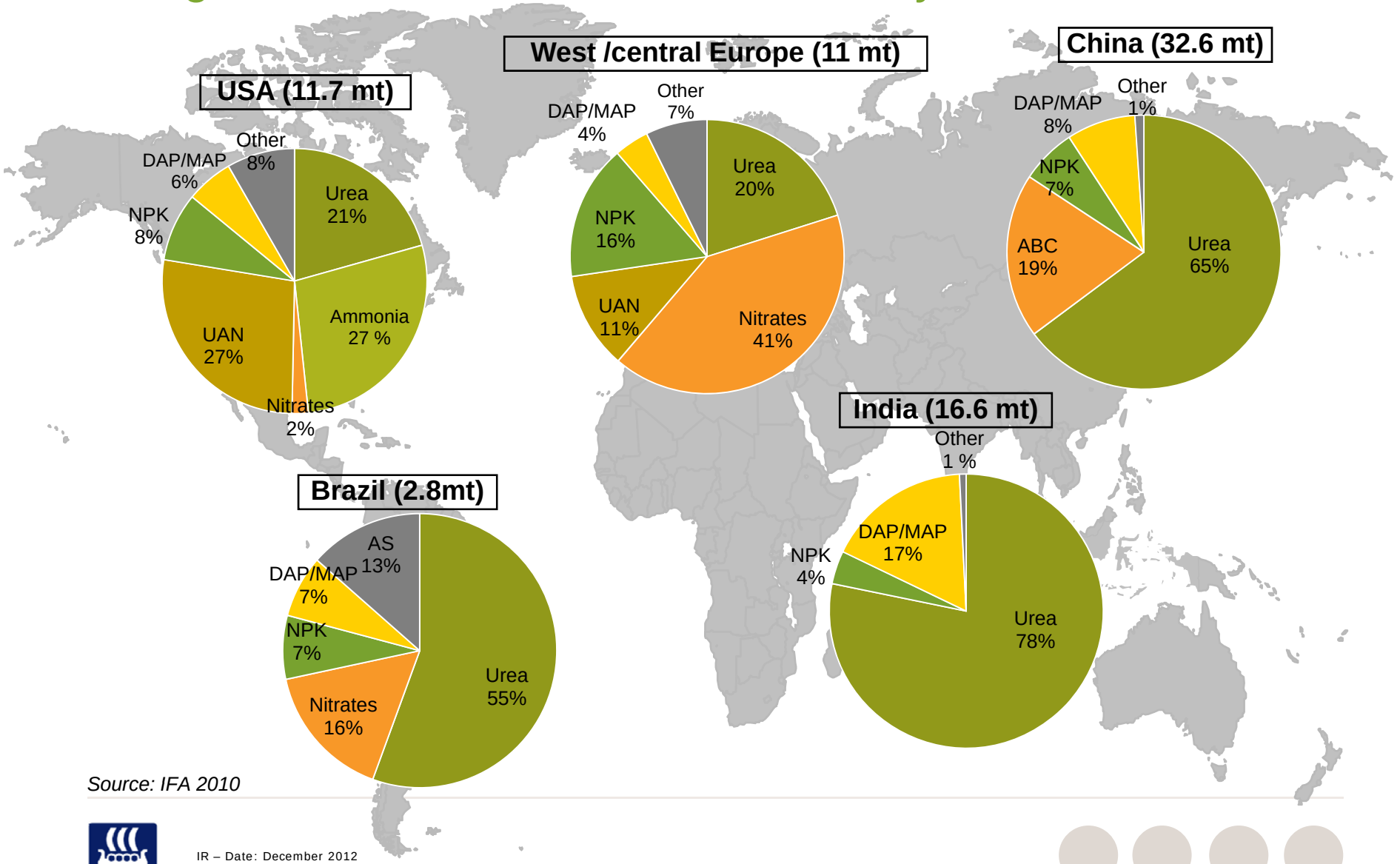
Phosphate P_2O_5



41 million tons

Source: IFA 2011 (nutrient totals) and 2008 (product split) * *Does not include industrial nitrogen applications*

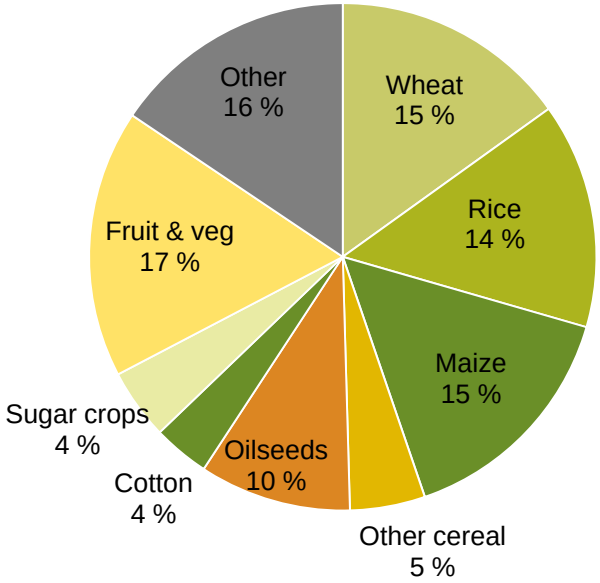
Nitrogen fertilizer demand – 5 key markets



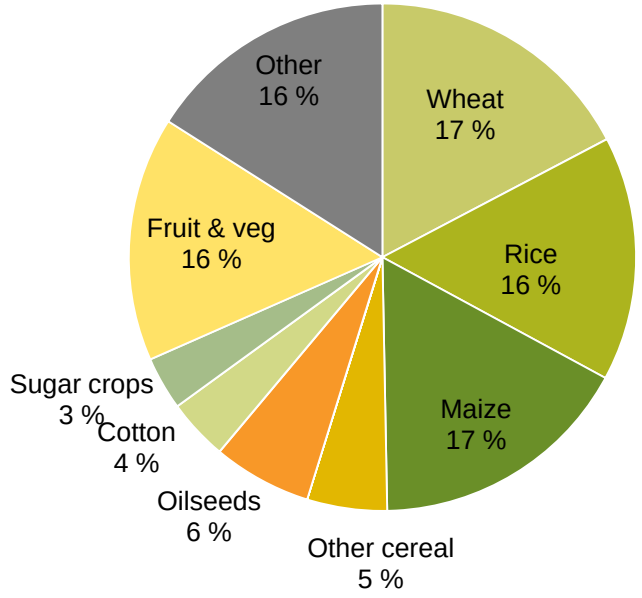
Source: IFA 2010

Nutrient application by crop

N + P + K

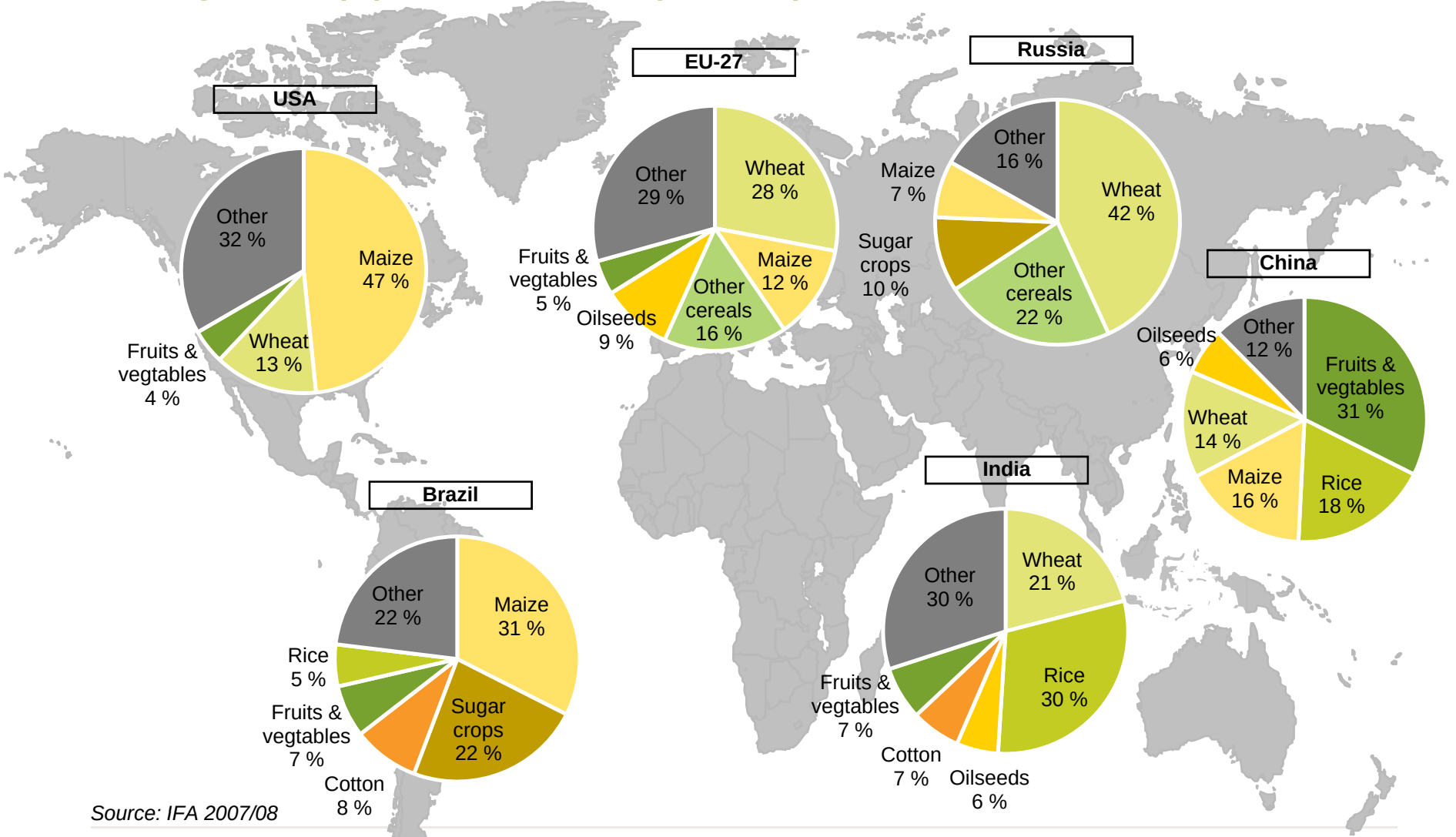


NITROGEN



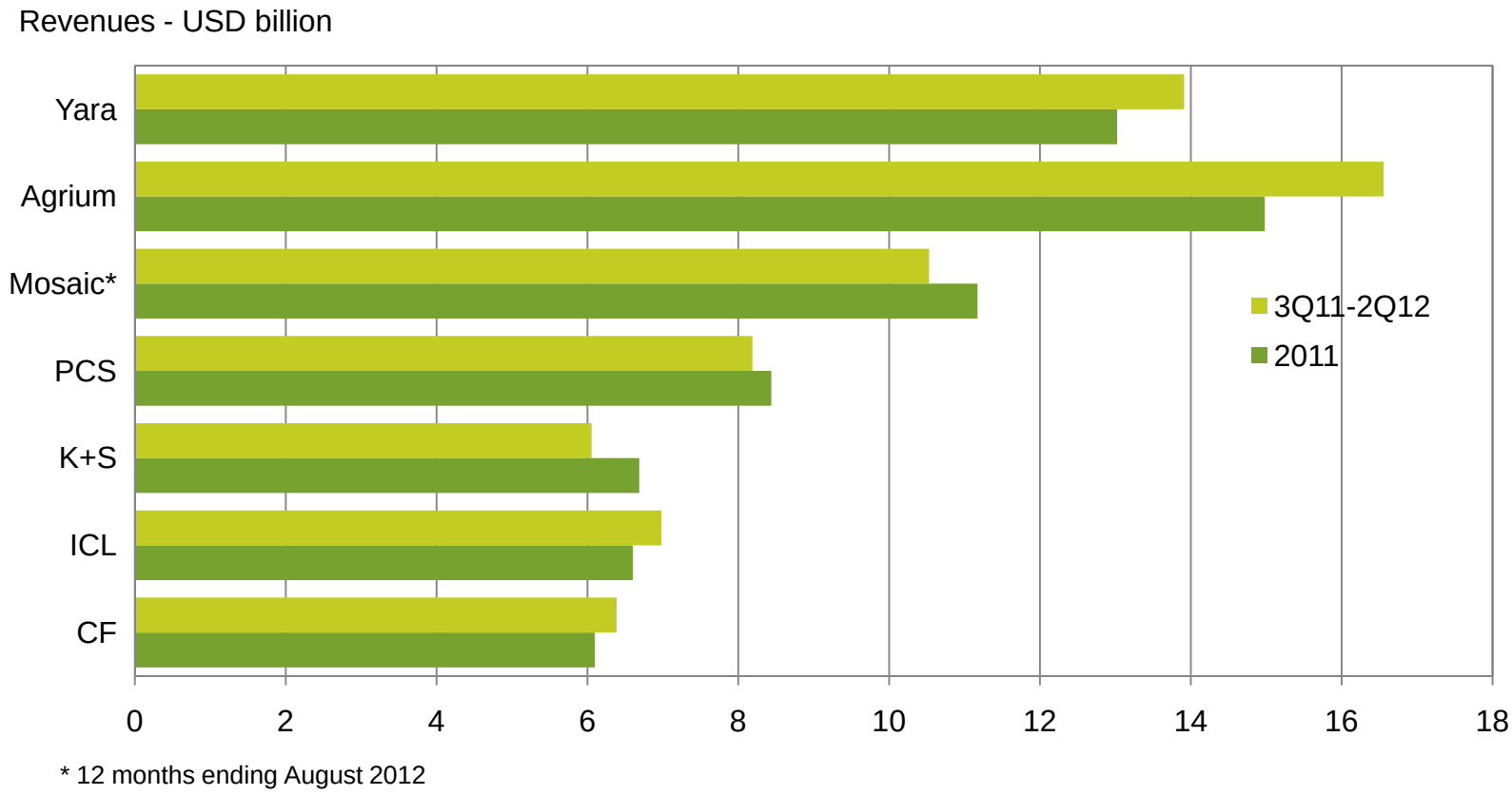
Source: IFA (2007/08)

Nitrogen application by crop



Source: IFA 2007/08

Fertilizer company comparison



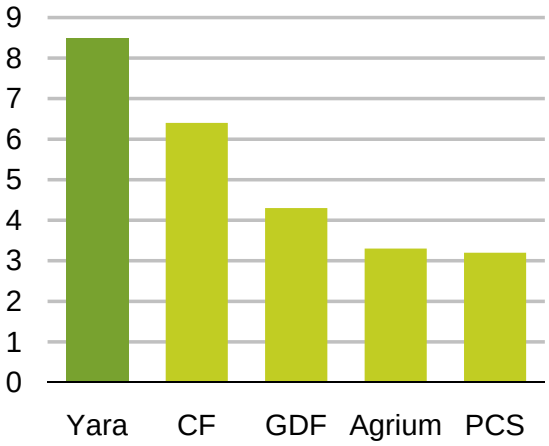
* 12 months ending August 2012

Source: Thomson Worldscope

Yara – the leader in nitrogen fertilizers

Global no 1 in ammonia

Production capacity* (mill t)

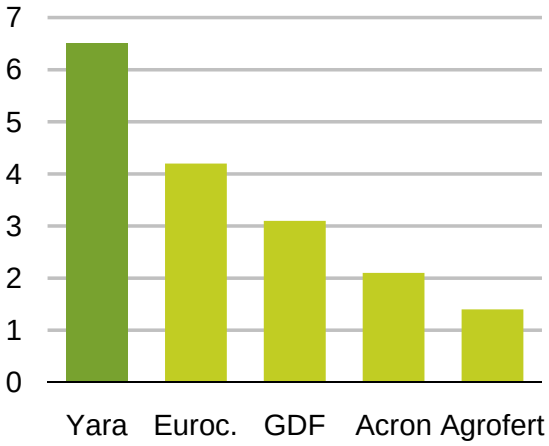


* Incl. companies' shares of JVs

Source: Yara & Fertecon

Global no 1 in nitrates

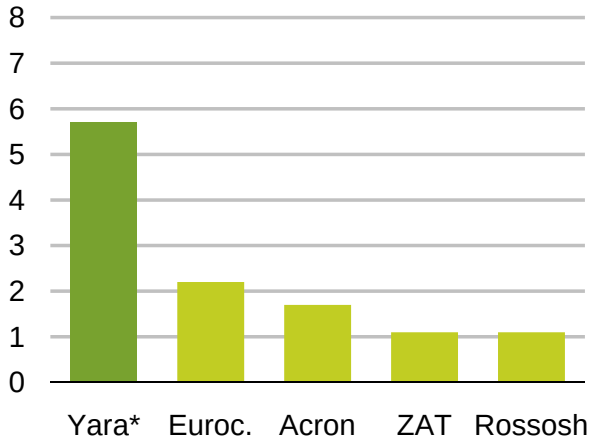
Production capacity* (mill t)



Source: Fertilizer Europe

Global no 1 in NPK complex fertilizer

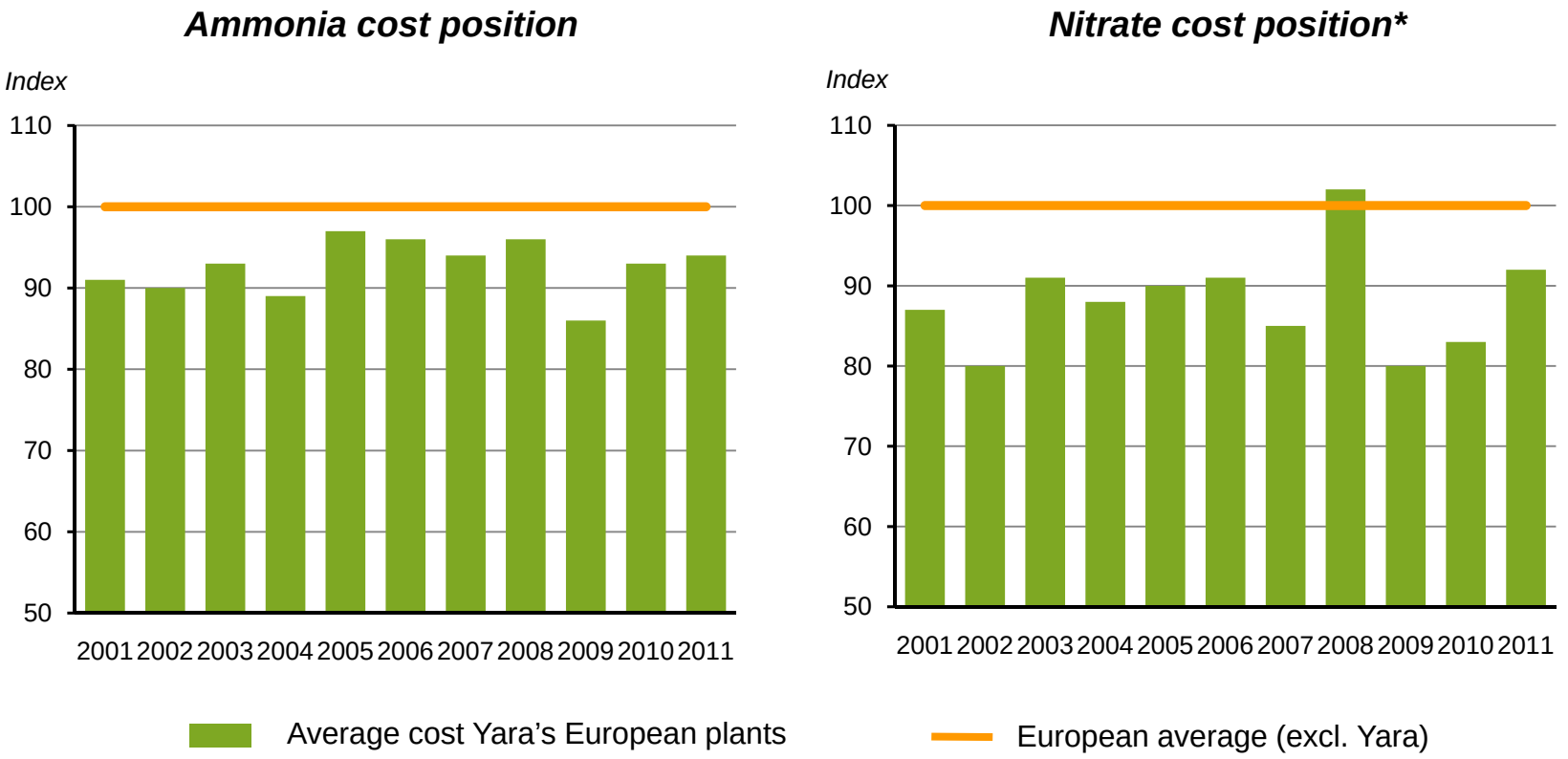
Production capacity* (mill t)



Source: Fertilizer Europe

Yara – the European cost leader

Production cost index: 100 = European EFMA average excl. Yara



Source: Fertilizer Europe

Fertilizer industry dynamics

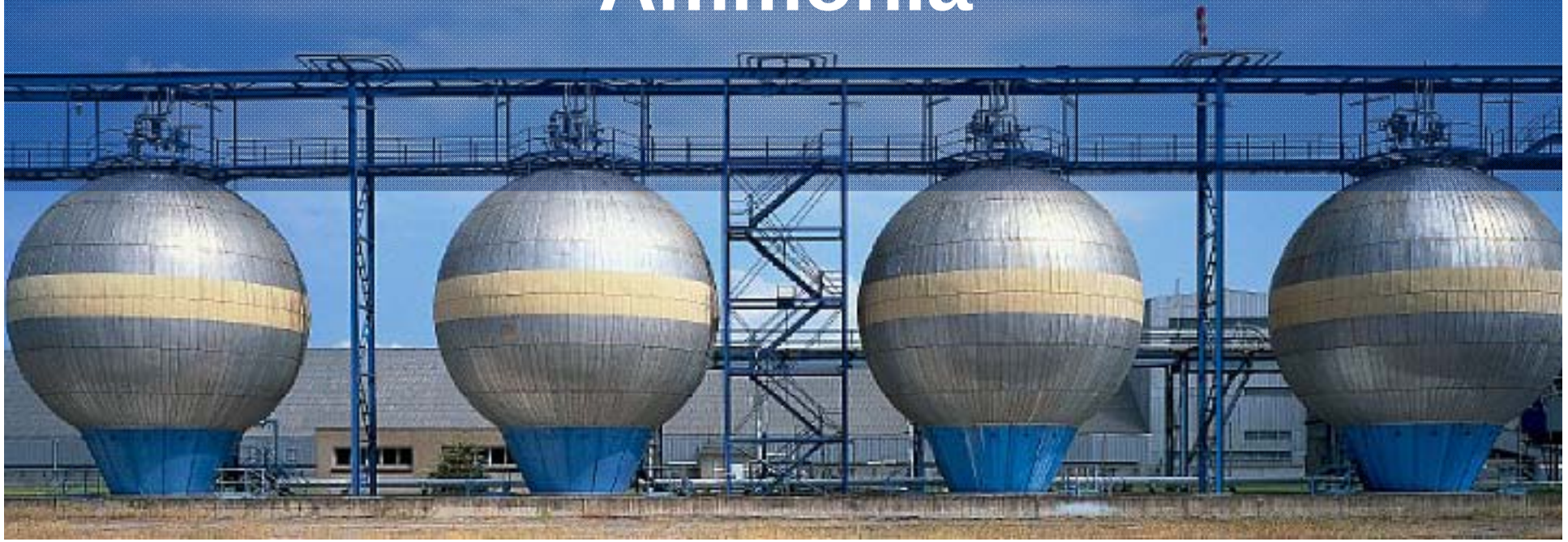
Potential industry concerns and associated mitigants

Weaknesses and risks	Mitigating factors
Over-investment at the top of the cycle	Rising construction costs and lead times, reduced state ownership
Weak players/lack of focus	Spin-offs from chemical/energy companies followed by consolidation
High cost of natural gas in Europe	Long-term trend of gas price convergence between regions, as pipeline and LNG investments increase liquidity
International trade restrictions	WTO accession
Regulatory regimes	Operational excellence
Terrorism, accidents, country, customer and currency risk	Increased management awareness of risk and better risk management

YARA

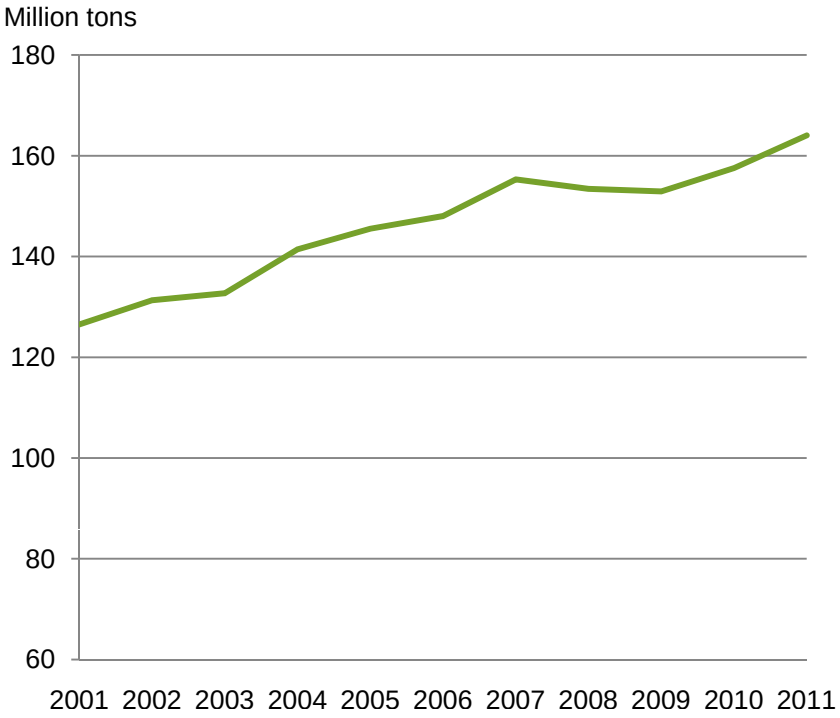
Knowledge grows

Ammonia



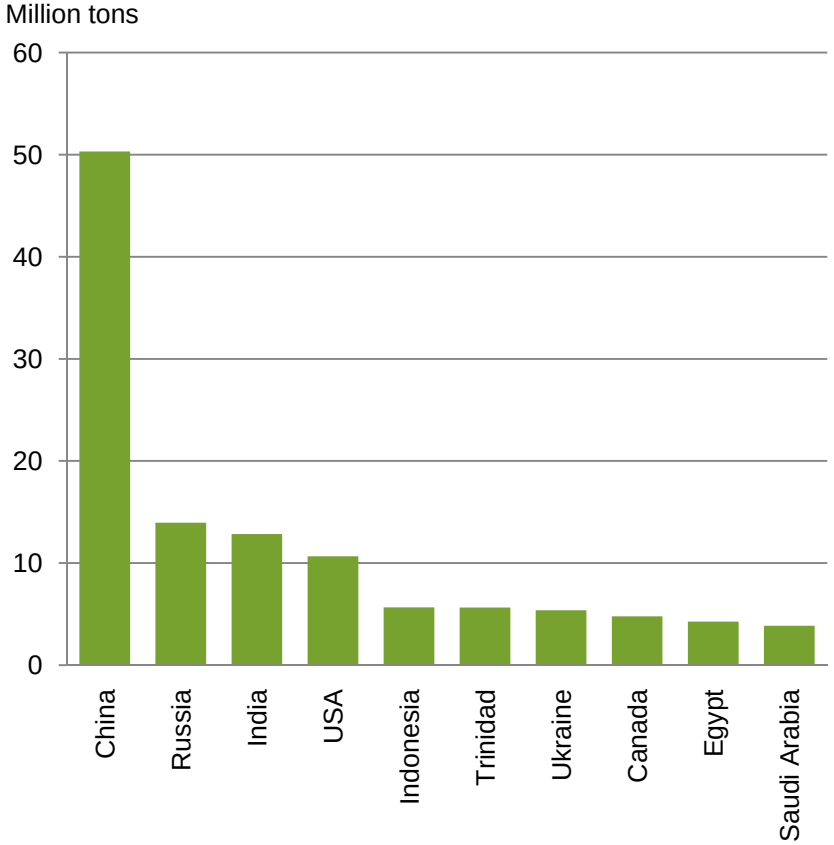
Ammonia production

Total production



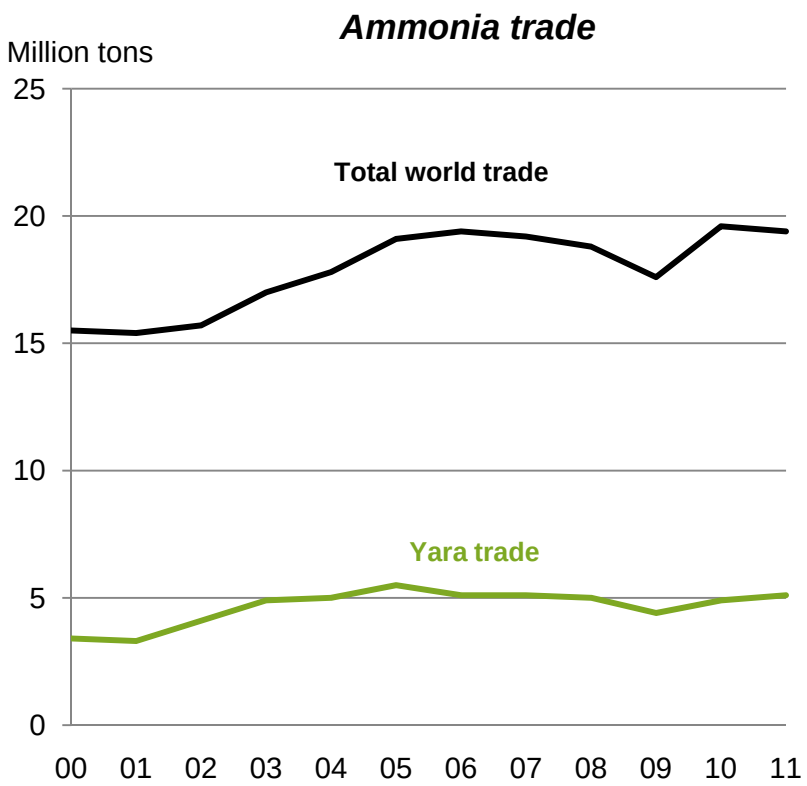
2001-2011 trend growth rate = 2.6%/year

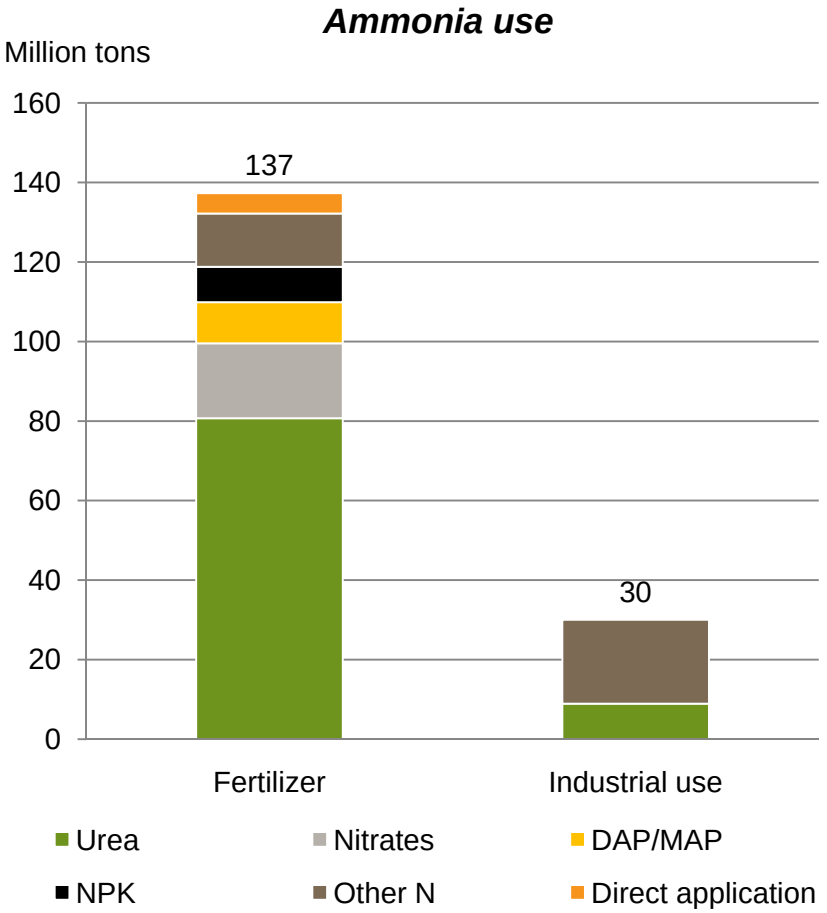
10 largest producers



Source: IFA

Most of the ammonia produced is upgraded to urea or other fertilizers

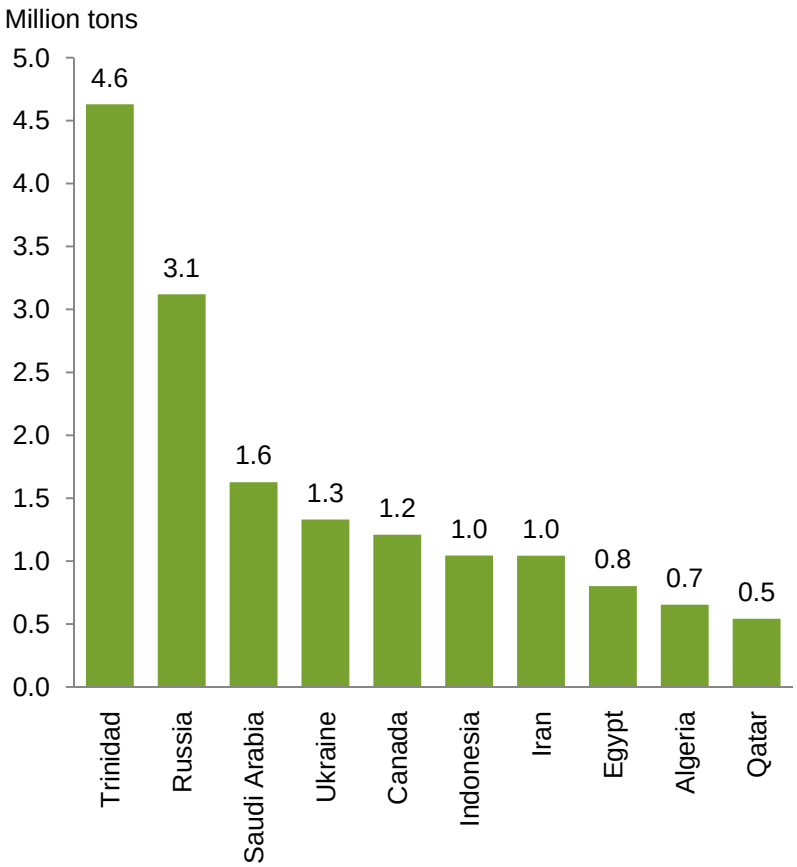




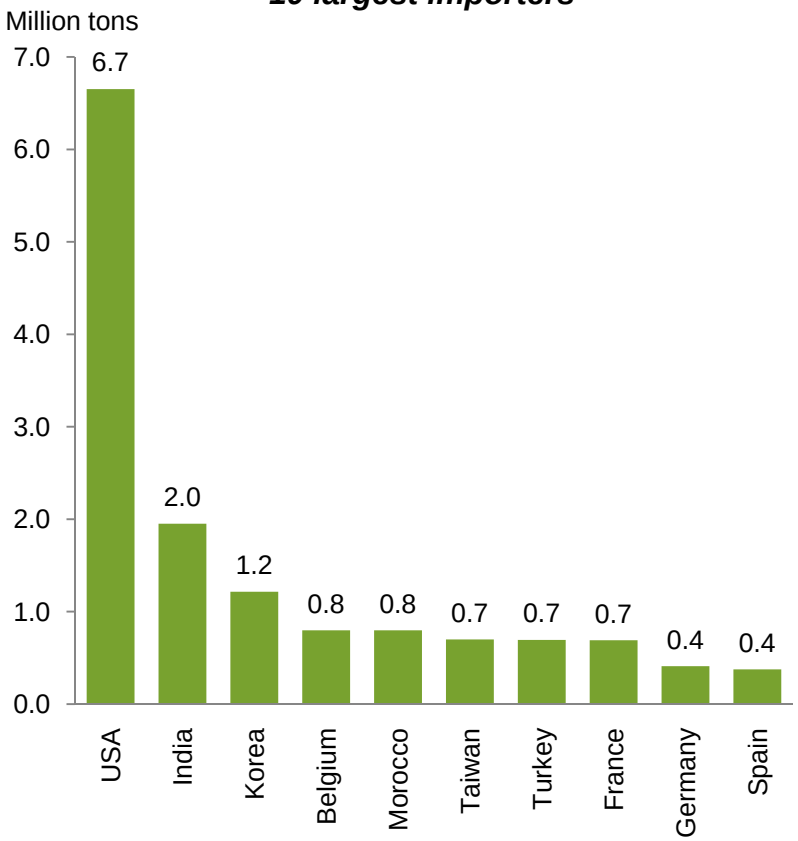
Source: Fertecon

Global ammonia trade in 2011

10 largest exporters



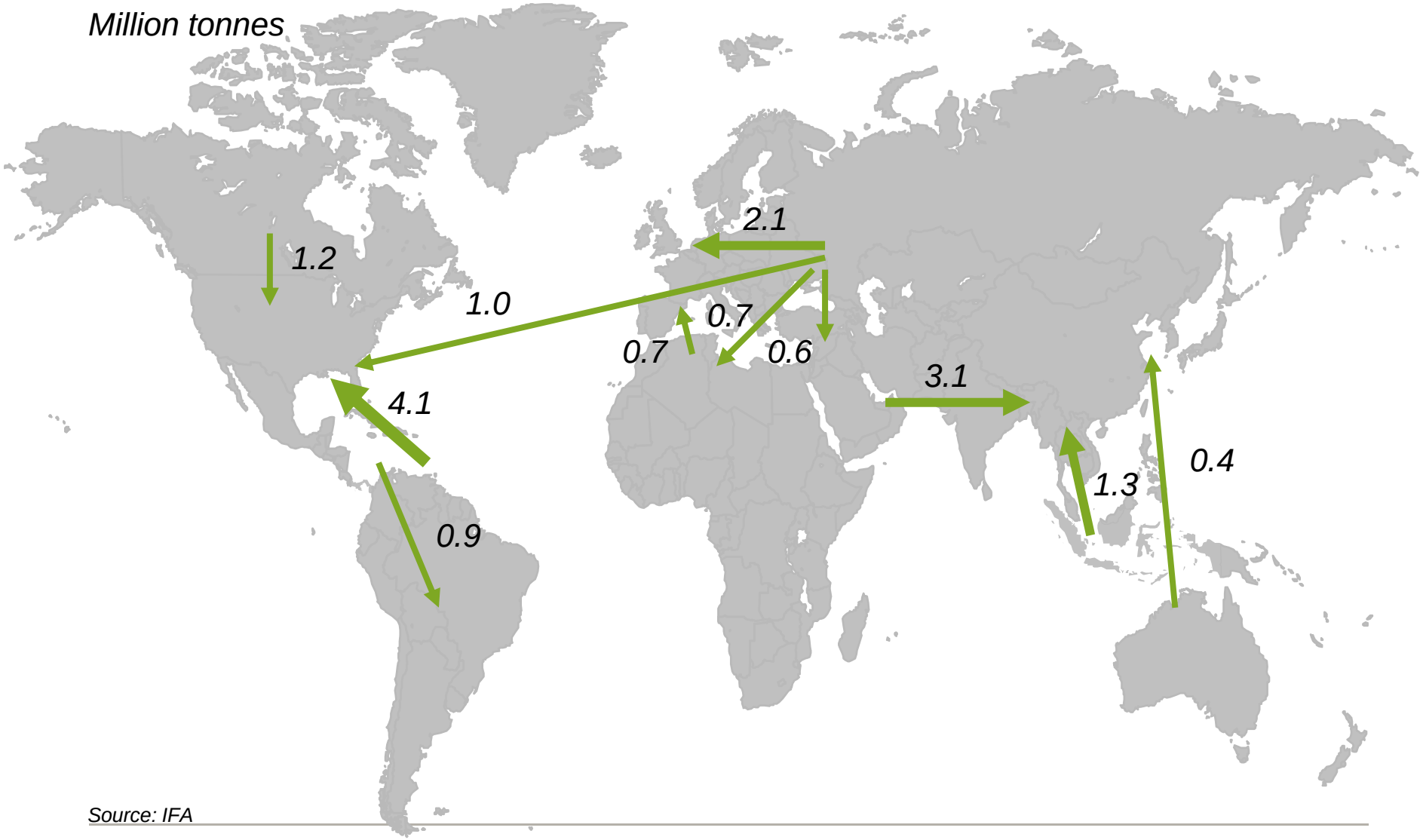
10 largest importers



Source: IFA

Main ammonia trade flows 2011

Million tonnes



Source: IFA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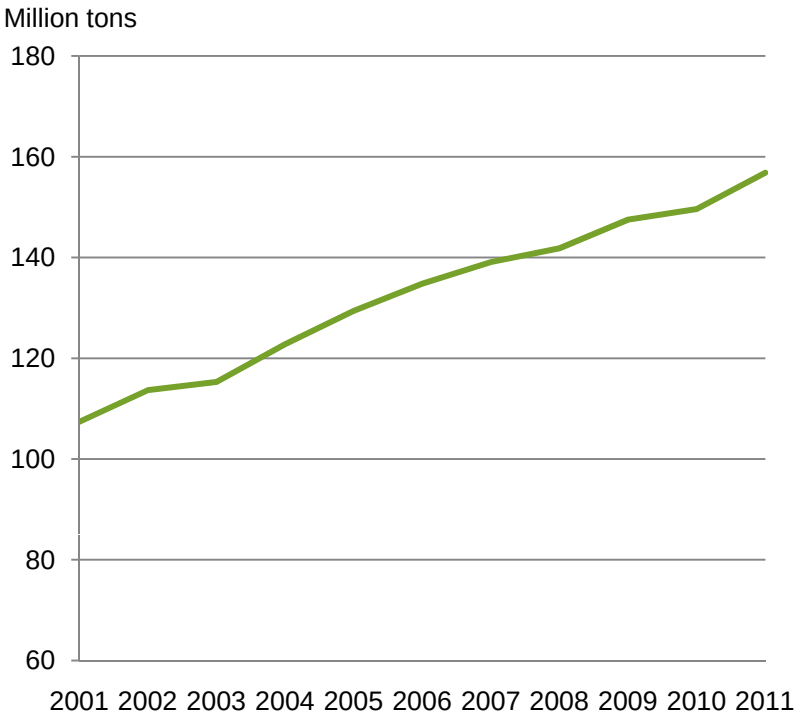
Knowledge grows
Urea

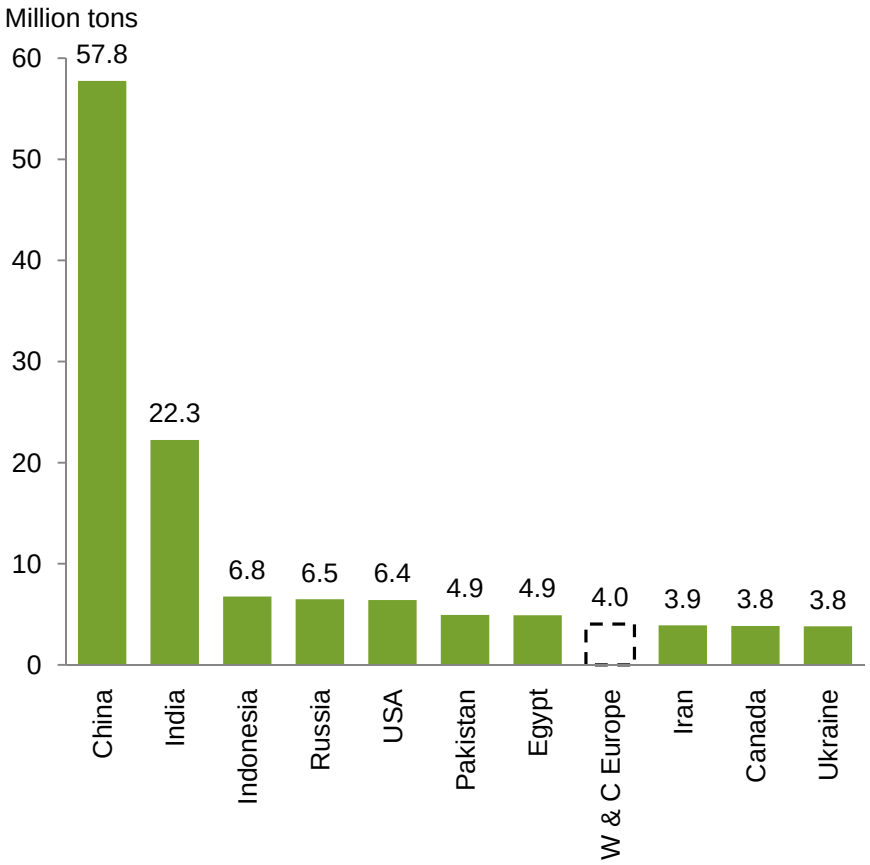
Urea production in 2011

Total production



2001-2011 trend growth rate = 3.8% p.a.

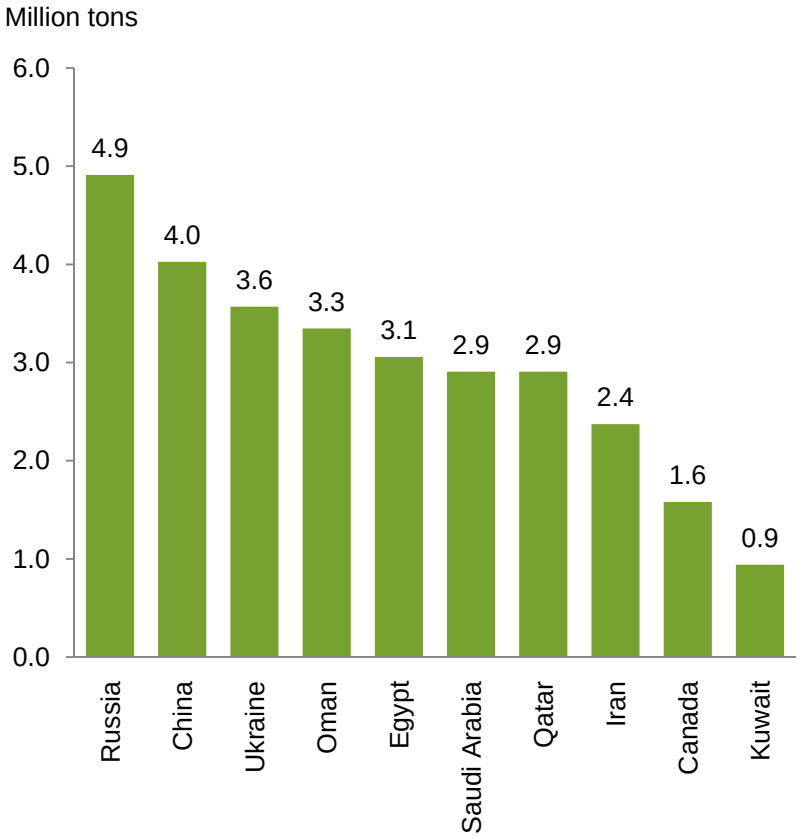
10 largest producers



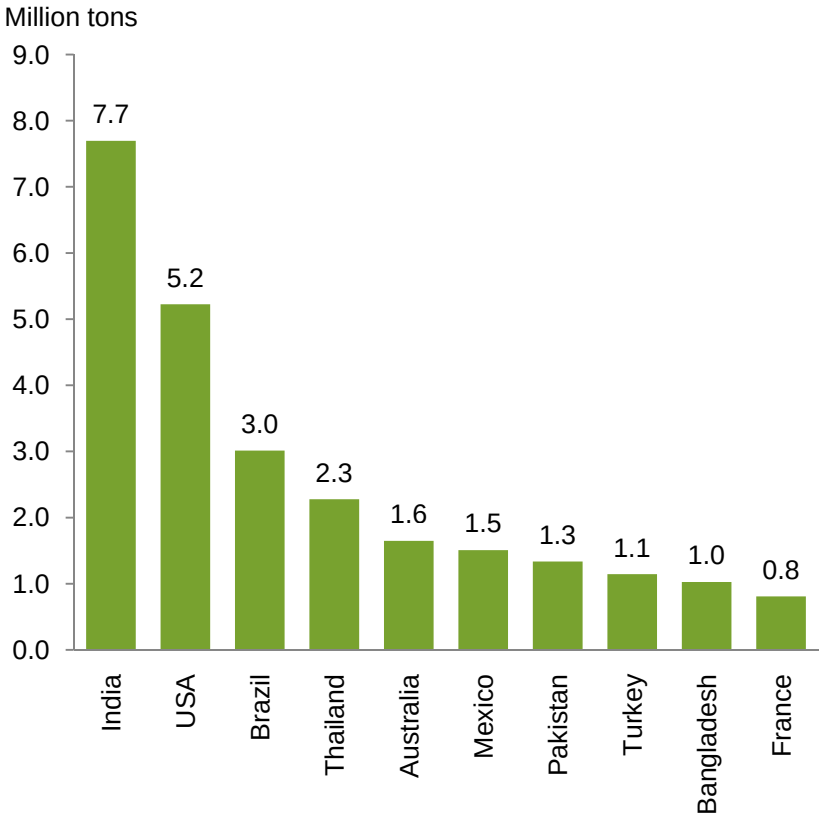
Source: IFA

Global urea trade in 2011

10 largest exporters



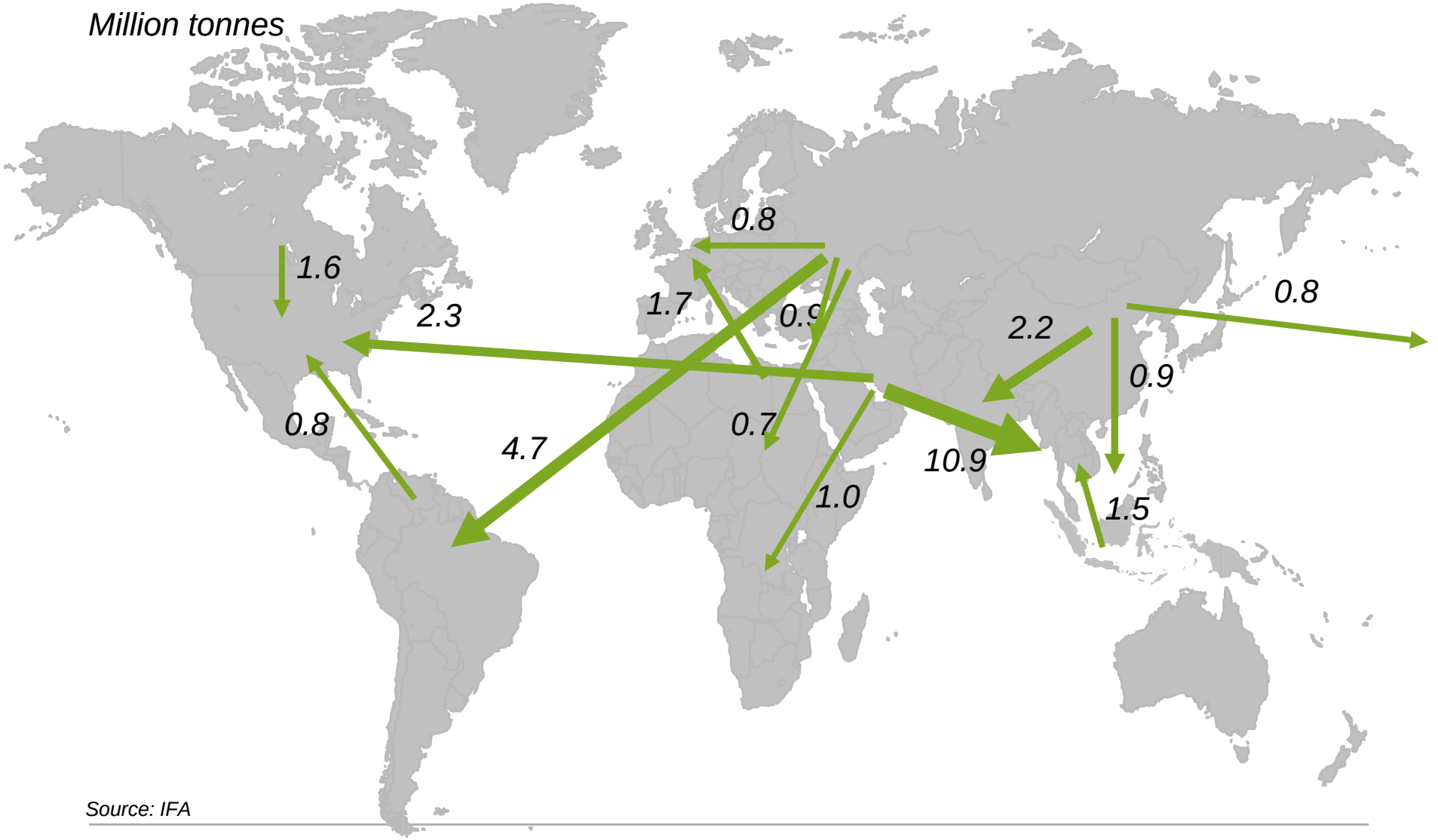
10 largest importers



Source: IFA

Main urea trade flows 2011

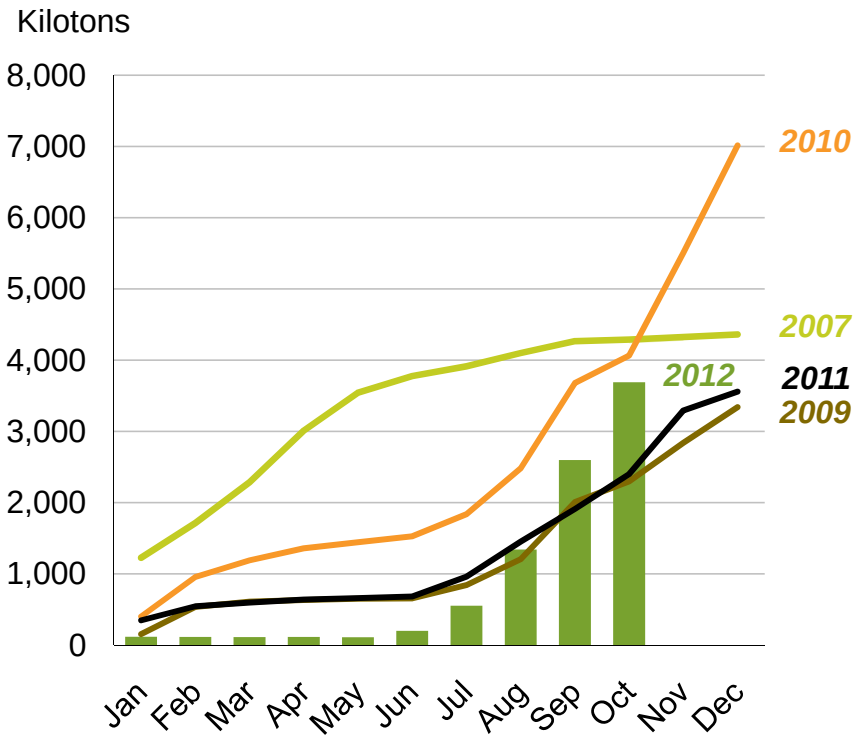
Million tonnes



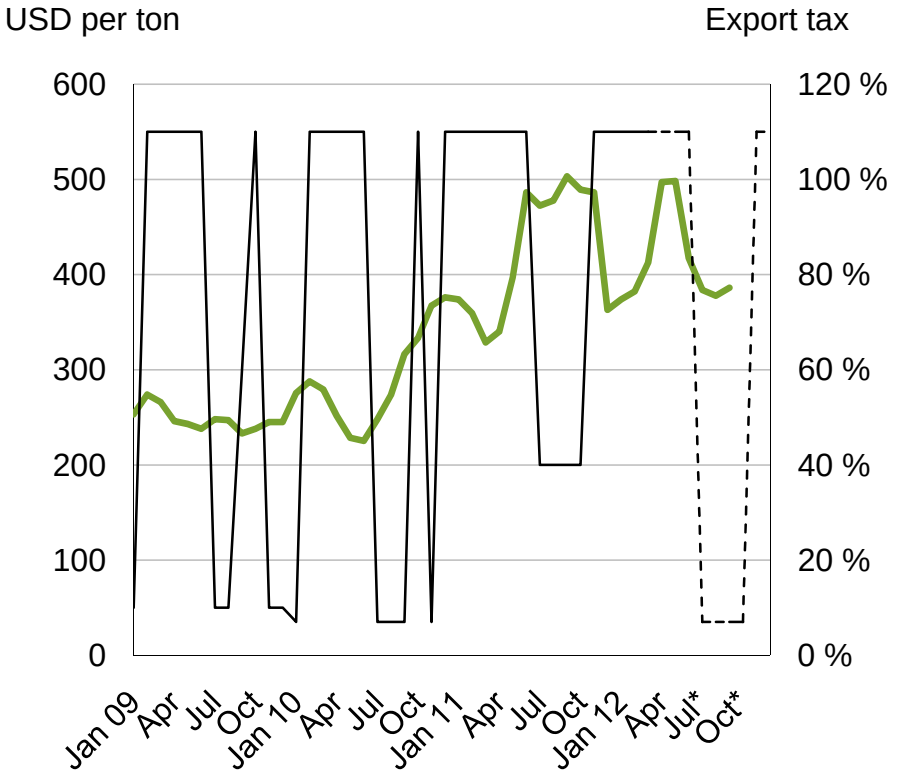
Source: IFA

Short-term urea balance impacted by Chinese export taxes

Accumulated urea exports



Urea price and export tax

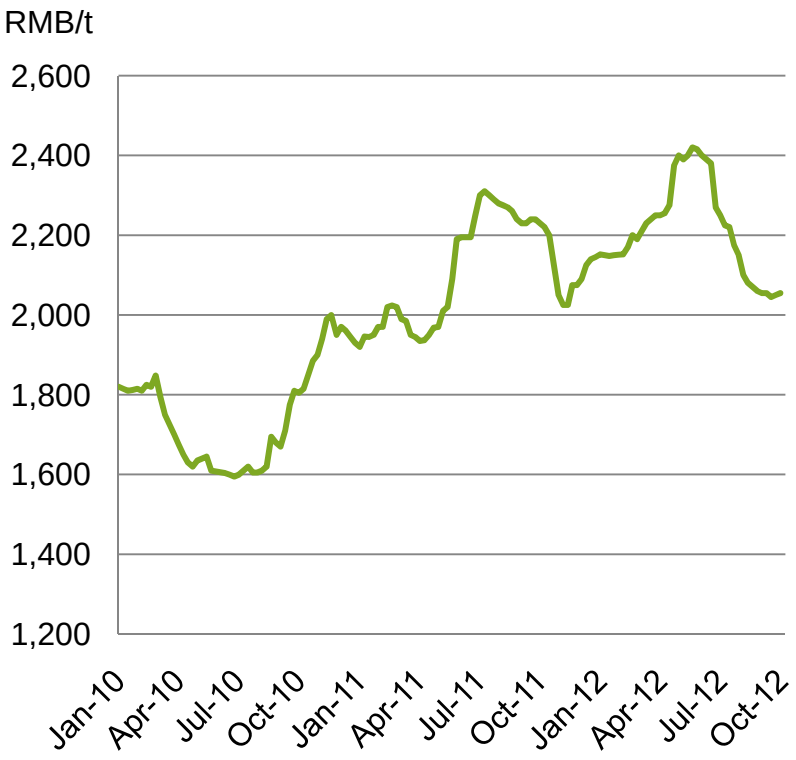


** Export tax during low tariff period depends on price level with 7% representing the minimum tax level*

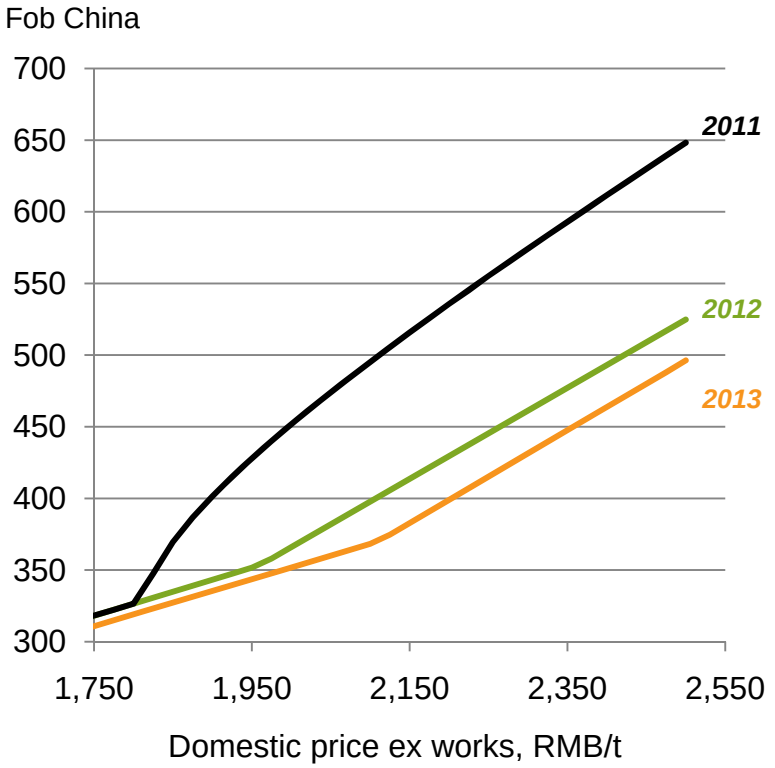
Source: BOABC

Chinese domestic urea price and export tax set the export floor price

Chinese domestic urea price



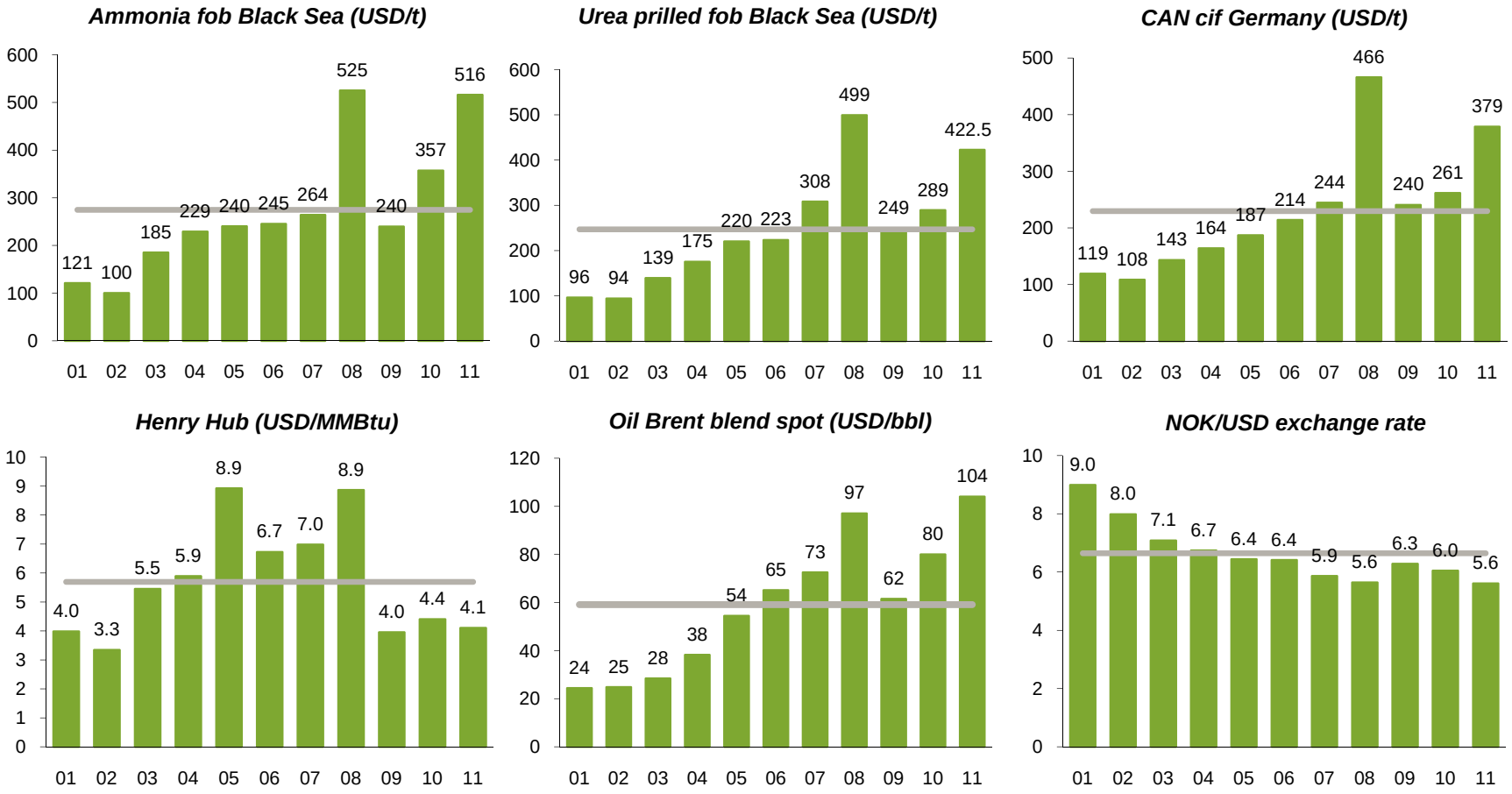
Chinese export tax 1 Jul – 1 Nov



Source: China Fertilizer Market Week

Industry value drivers

Key value drivers



Source: The Market, Fertecon, CERA, World Bank, Norges Bank

Average prices 2001 - 2011

Nitrogen fertilizer value drivers

	Drivers		Effect on
Revenue drivers	European / Ukrainian gas prices and Chinese coal prices	→	Supply-driven price for urea
	Grain inventories/prices	→	Urea demand
	New urea capacity vs. closures	→	Urea supply
	Global urea demand vs. supply	→	Urea price (above floor)
	Urea price	→	Most other nitrogen fertilizer prices
	Market segmentation	→	Value-added margins
Cost drivers	Oil product prices and LNG development	→	Gas cost in Europe
	Manning and maintenance	→	Fixed cost
	Productivity and economies of scale	→	Unit cost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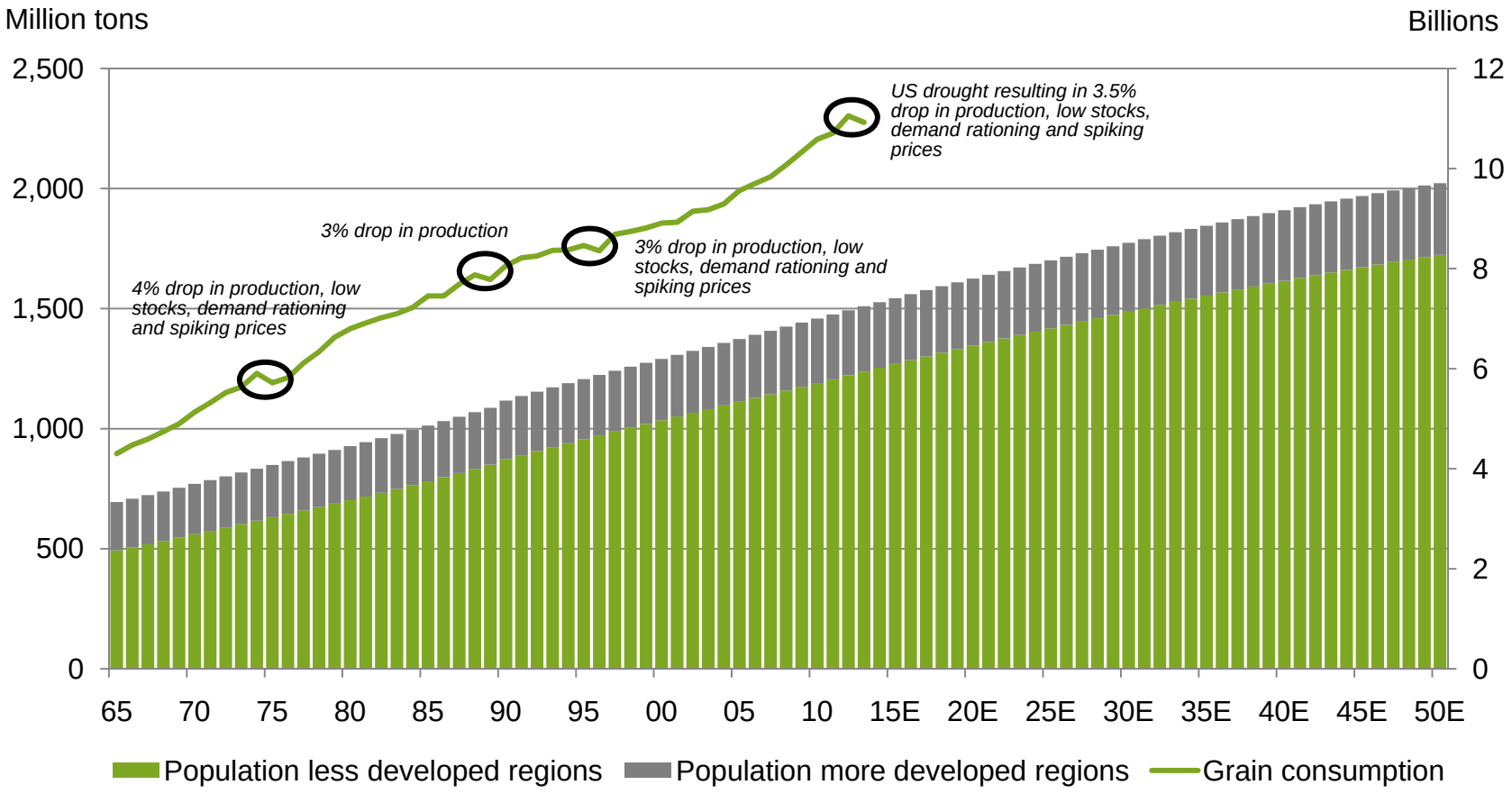
Drivers of demand

Drivers of nitrogen consumption growth

- Fertilizer consumption
  - Population growth
  - Economic growth (improved diets)
    - More meat consumption in developing countries
    - More protein-rich diets
    - More fruit and vegetables
    - Reduce hunger
  - Biofuels
- Industrial consumption
  - Economic growth
  - Environmental limits (e.g. reduction of NOx emissions)

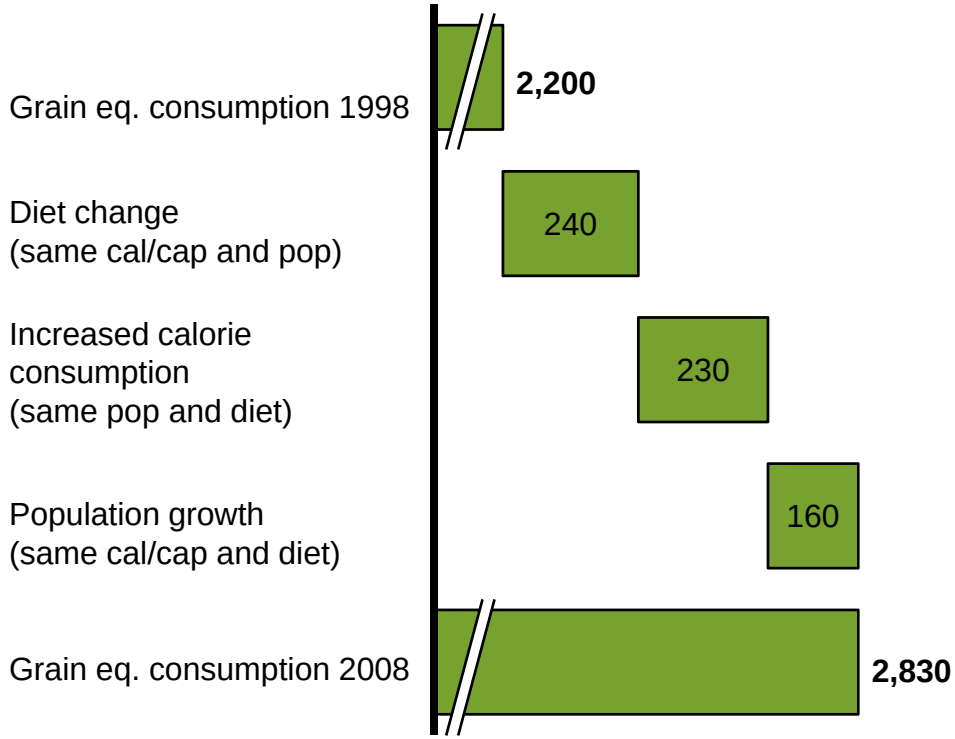
Grain consumption growth stronger than population growth



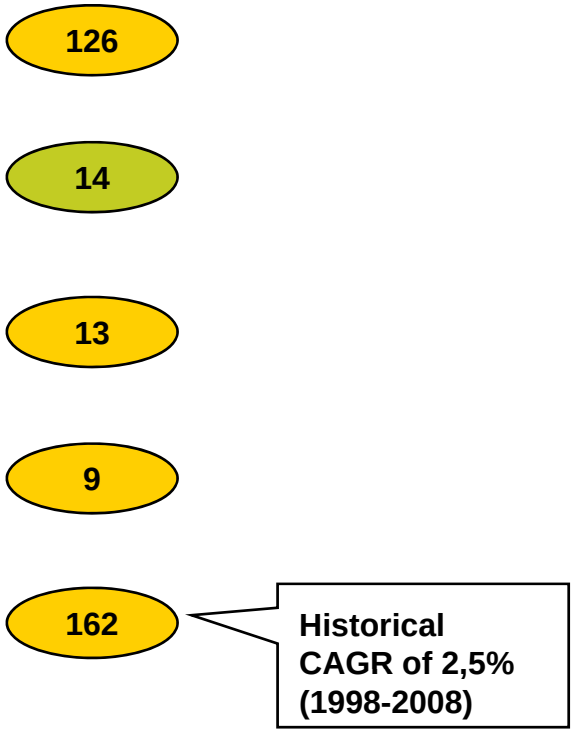
Source: US Department of Agriculture, United Nations

Diet change the most important factor for growth in food consumption

Impact on food consumption 1998-2008
Million tons grain equivalent*



Fertilizer consumption for food crop**
Million tons nutrients

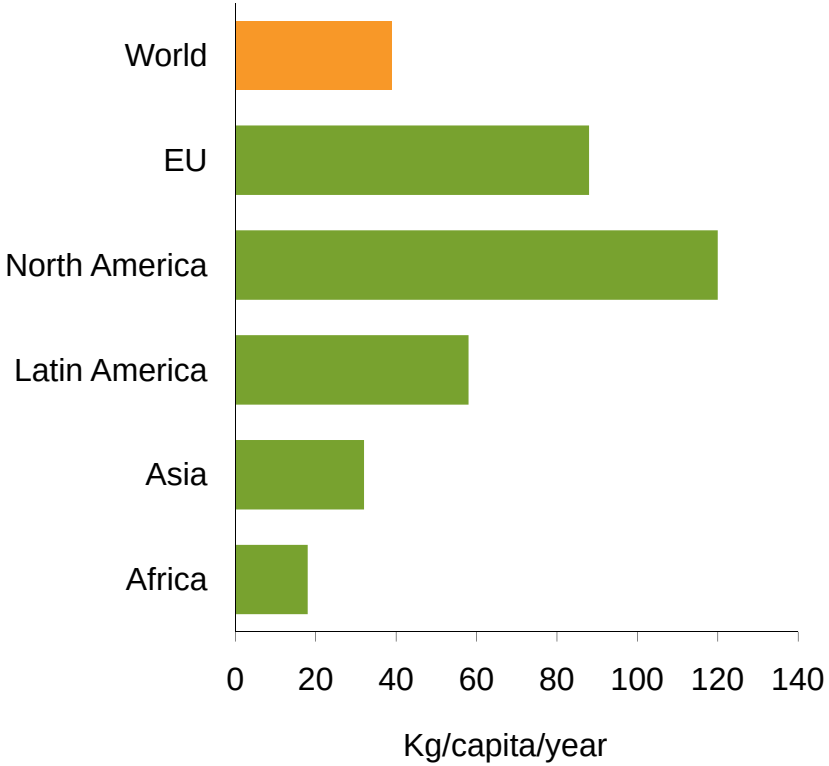


* Assumed 500 kcal/kg grain, 600 kcal/kg meat, meat/grain production factor of 3
** N, P and K demand. Average effective yield delivered to consumers of 2 ton cereal/ha; 120 kg fertilizer/ha

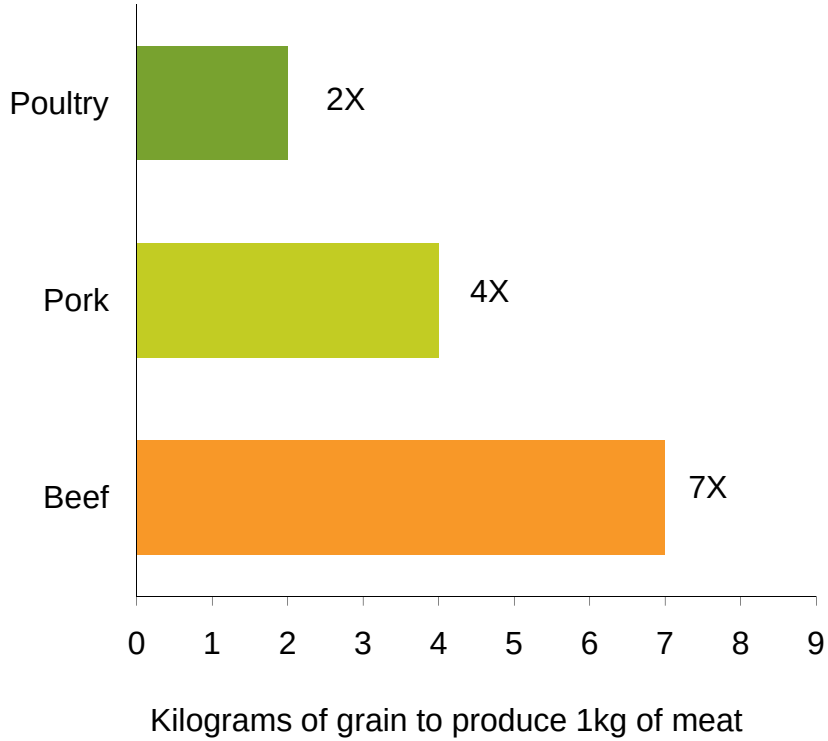
Source: McKinsey & Company

Higher meat consumption requires more feed grain

Significant potential for increasing meat consumption in emerging countries

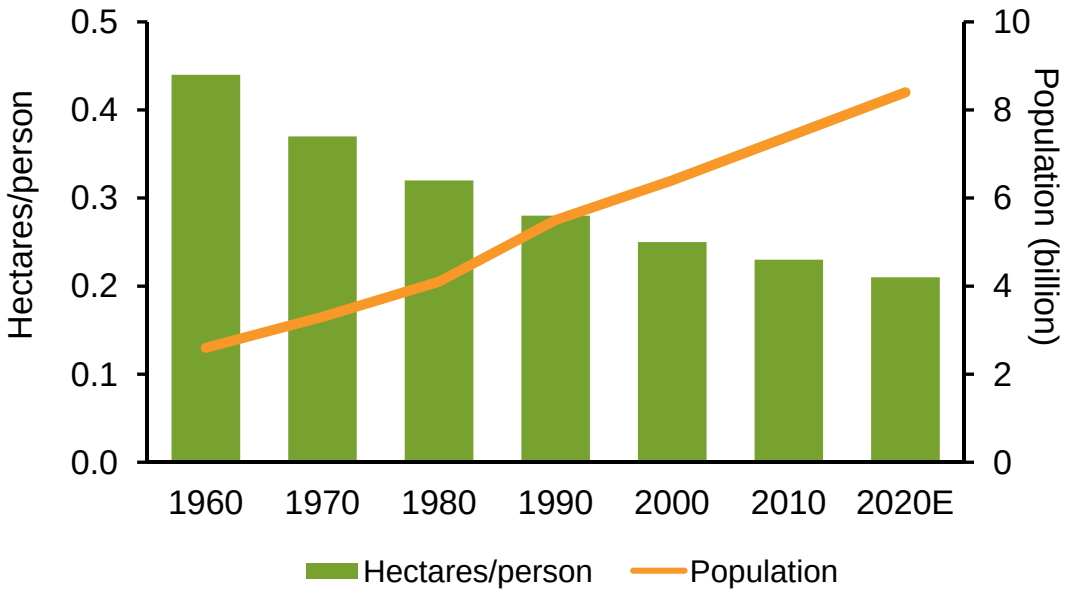


Feed grain multipliers for meat production



Source: FAO

Increasing population and reduced land available for food production per capita

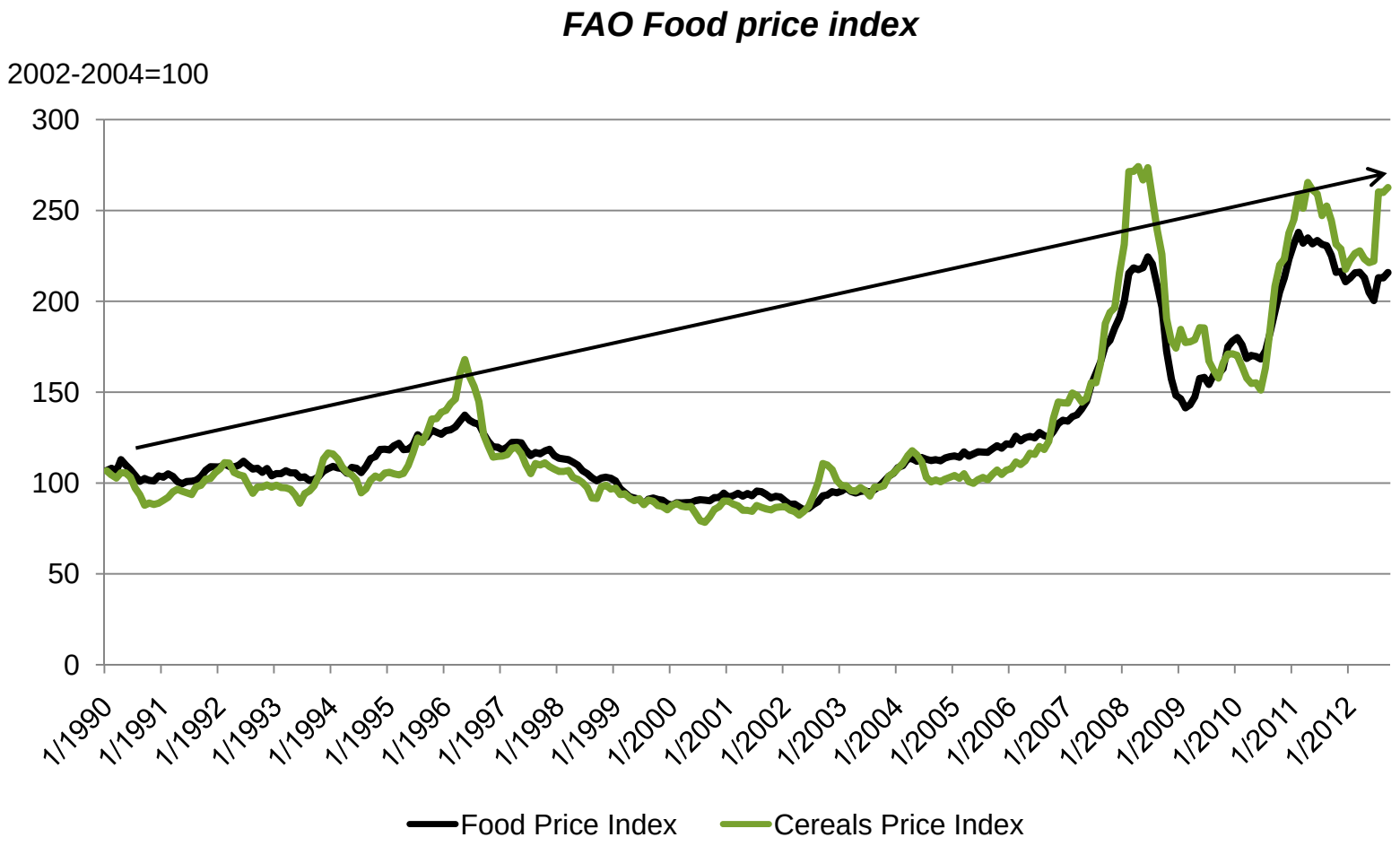


- Very limited potential to increase farmable land
- Improved living standards increase protein consumption per person, requiring more grain for animal feed

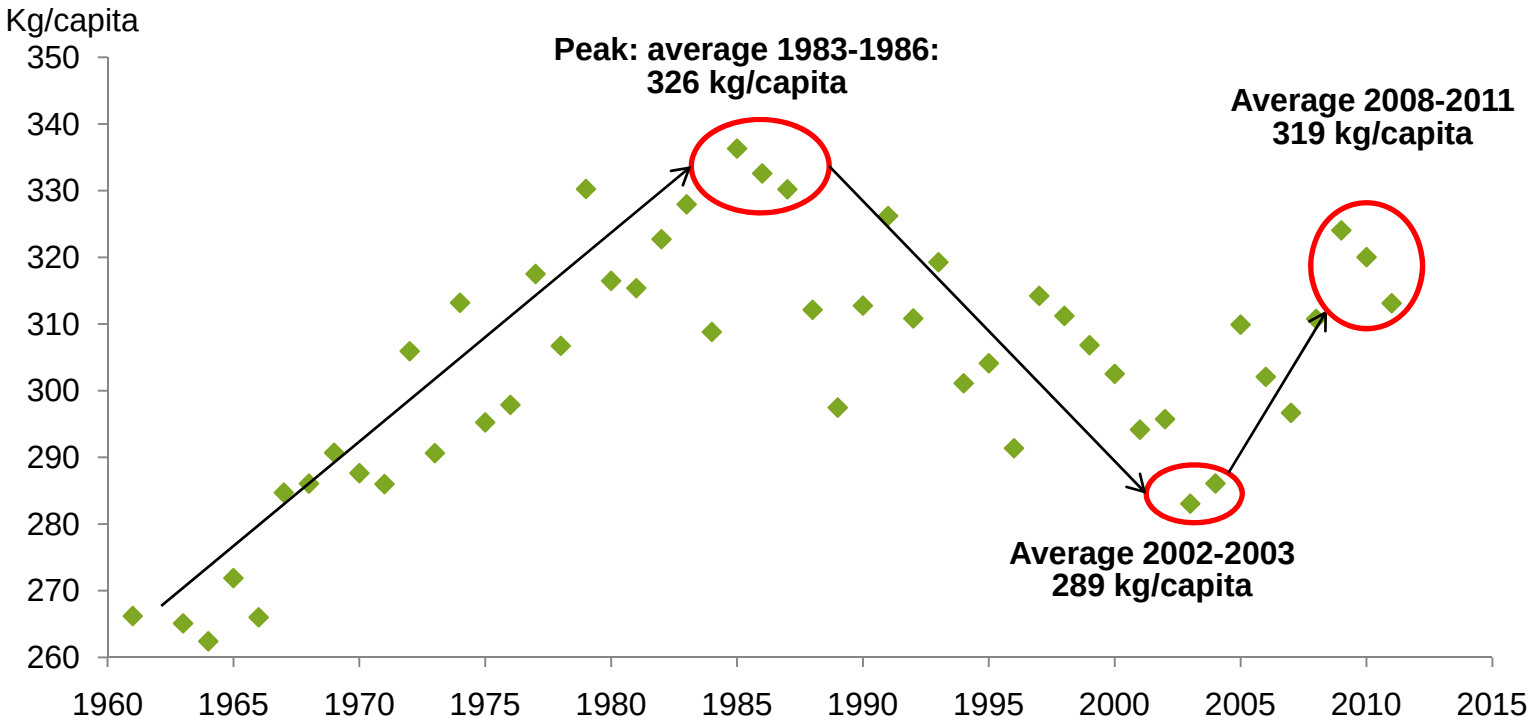
The only solution is to increase agricultural productivity

Source: IFA, Worldmarkets.com

Long-term grain price development underlines productivity challenge



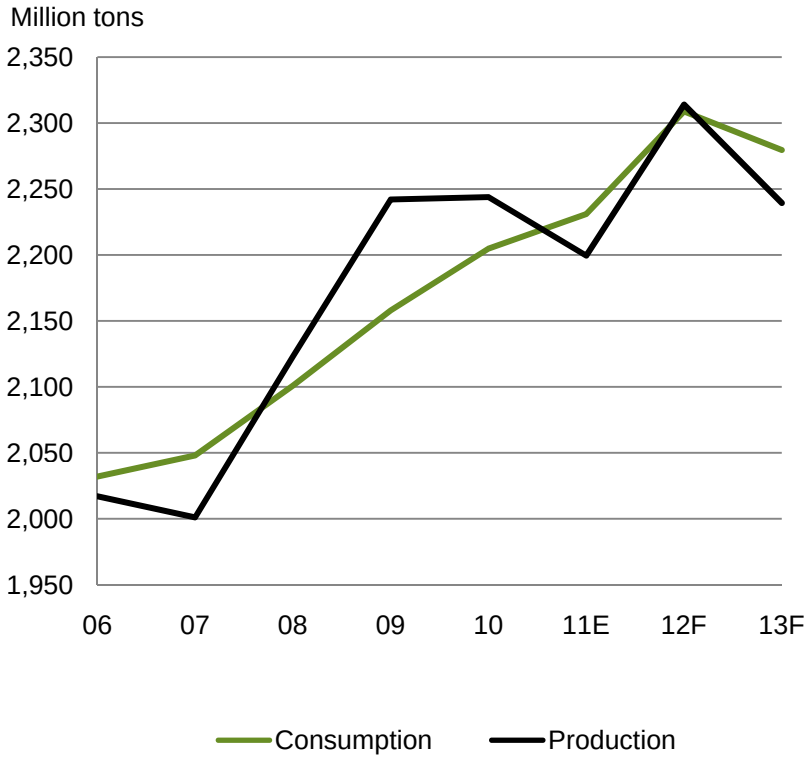
Production per capita has improved but remains lower today than in the 80s



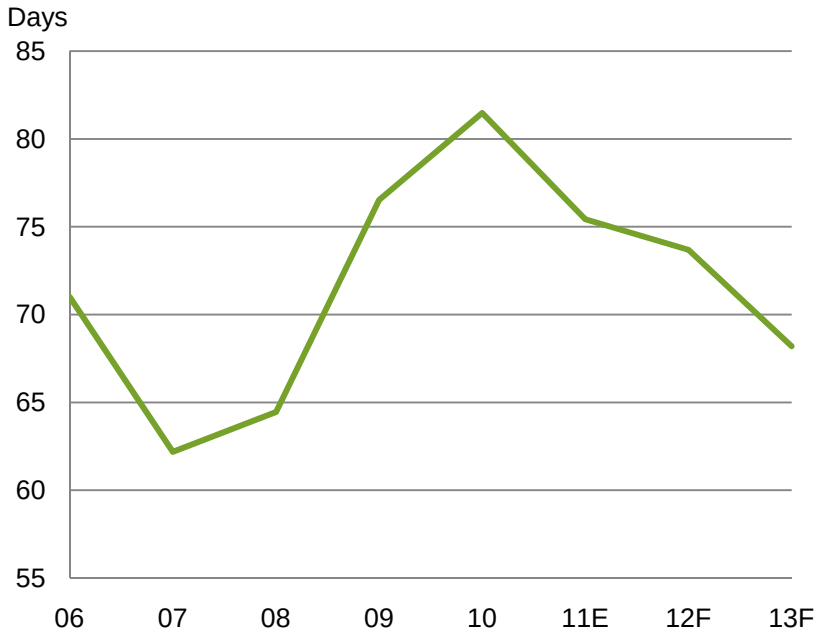
Source: USDA (cereal production) and UN (population)

Vulnerable to supply shocks with stocks at low levels

Grain production and consumption



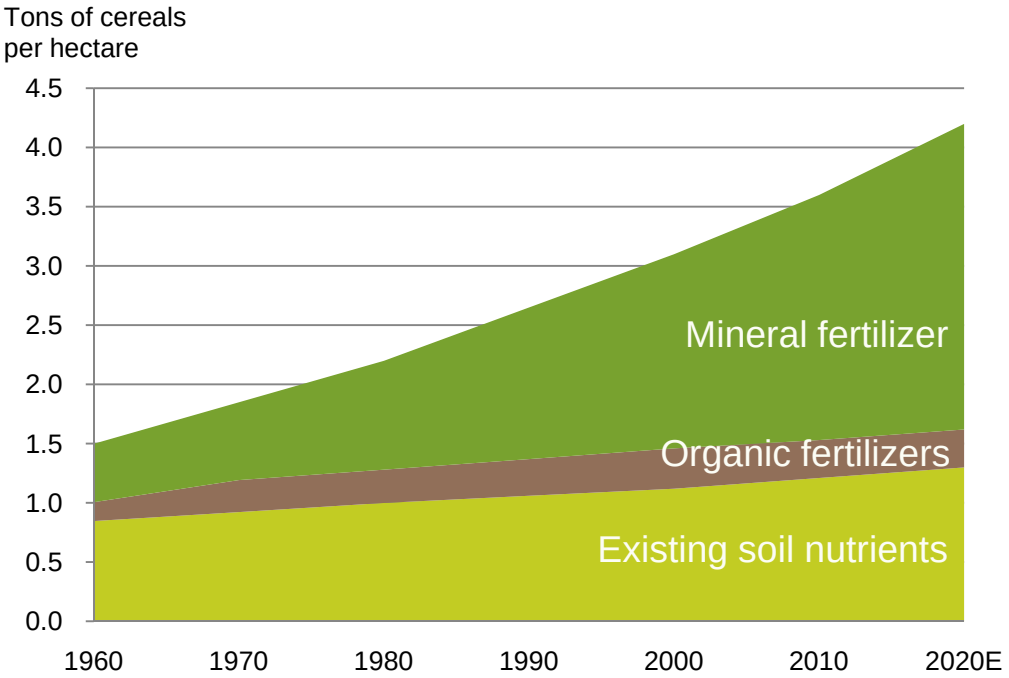
Days of consumption in stocks



Source: USDA, December 2012

Mineral fertilizer essential to sustain future yield increases

1 tonne of grain requires ~25kg nitrogen

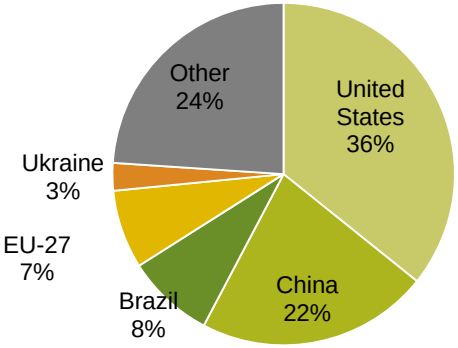


- Increased production of mineral fertilizers necessary to meet future nutrient demand
- Limited potential for recycling organic material
- Nutrient reserves in the soil do not increase

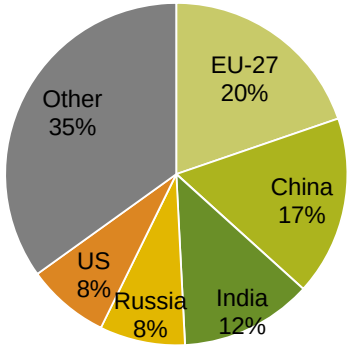
Source: FAO, Worldmarkets.com, Yara

Key crops by producing country

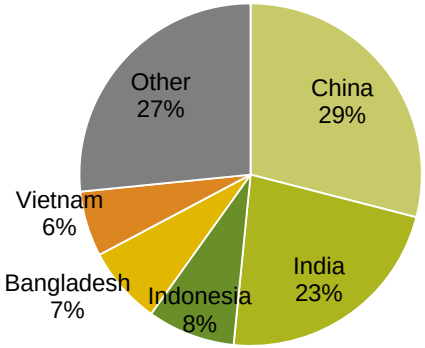
Maize-global production 877 mt



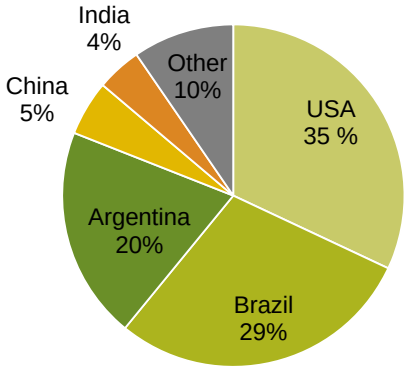
Wheat-global production 696 mt



Rice-global production 693 mt



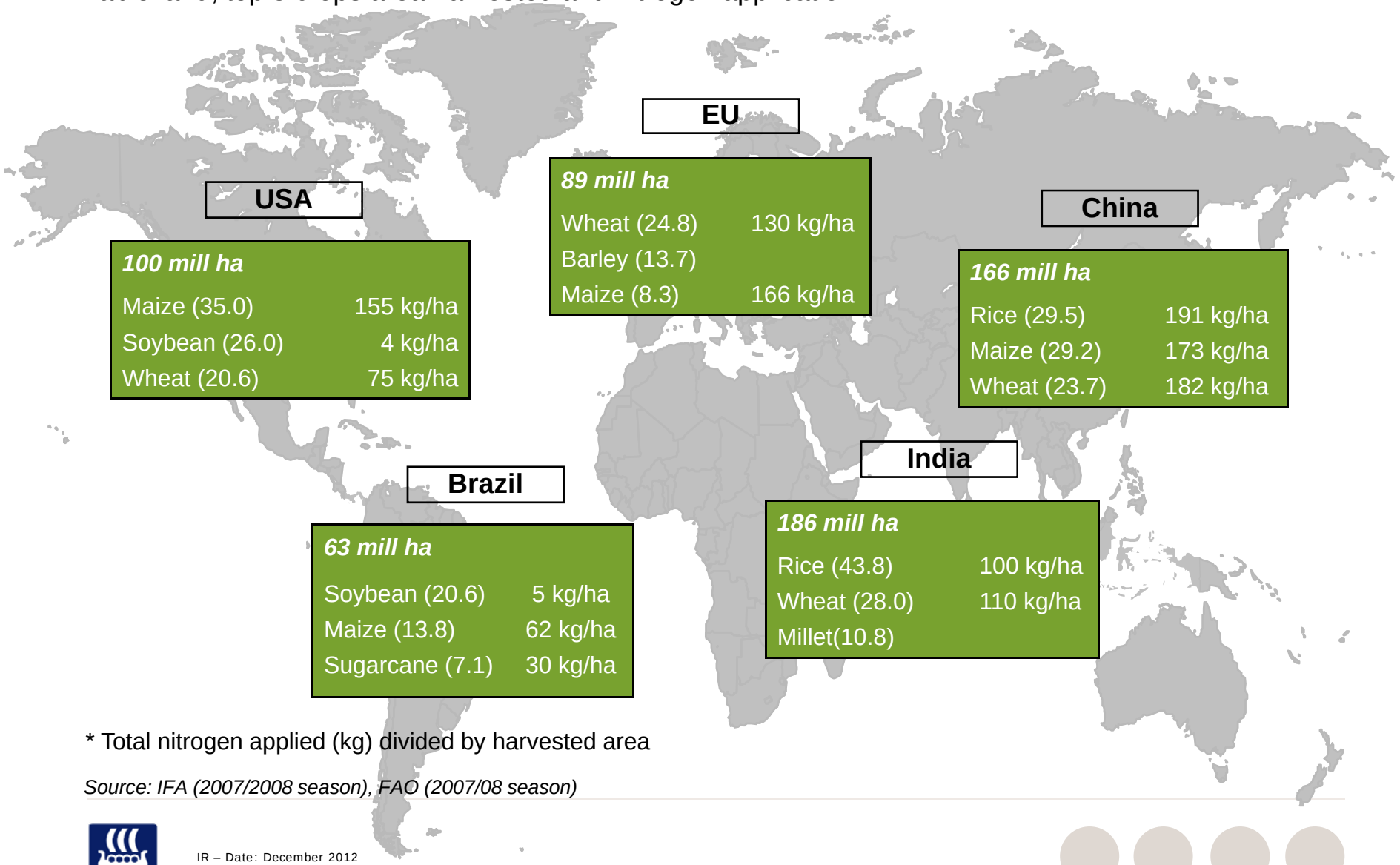
Soybeans-global production 259 mt



Source: USDA, 2011/12 season

Agricultural profile – key regions

Arable land, top 3 crops area harvested and nitrogen application*

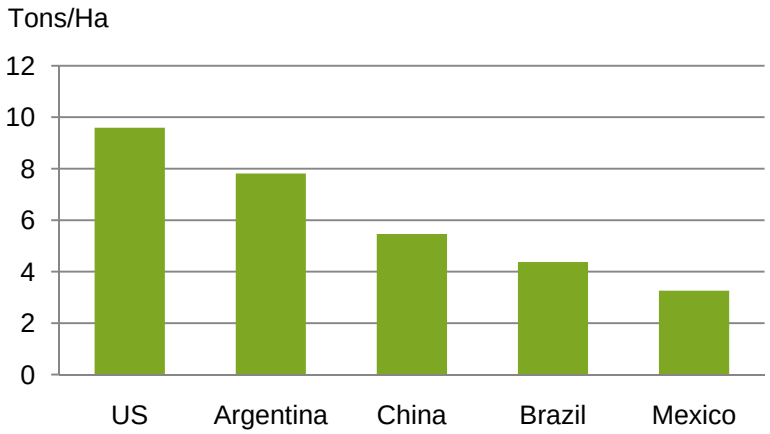


* Total nitrogen applied (kg) divided by harvested area

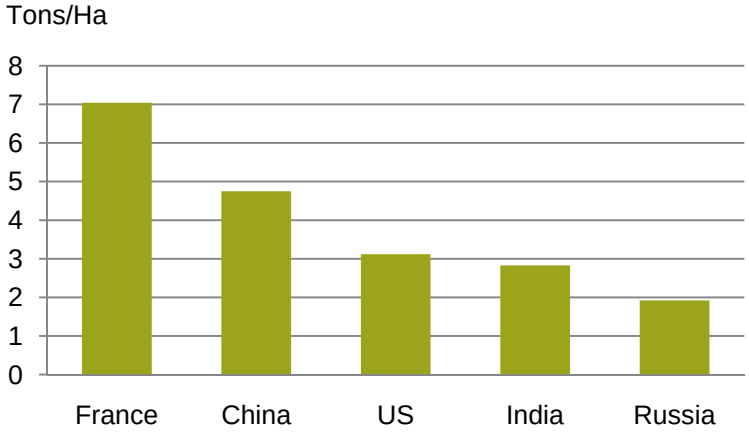
Source: IFA (2007/2008 season), FAO (2007/08 season)

Large variations in yields across regions

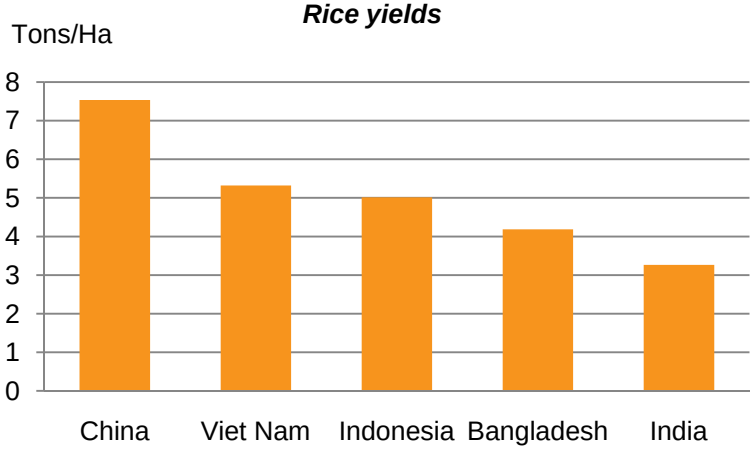
Maize yields



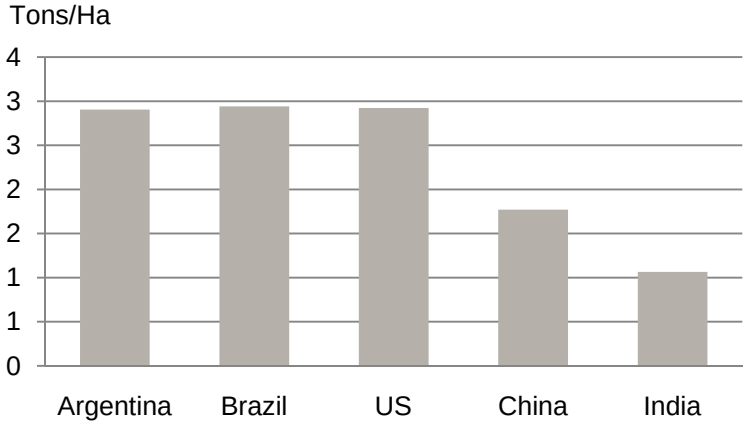
Wheat yields



Rice yields

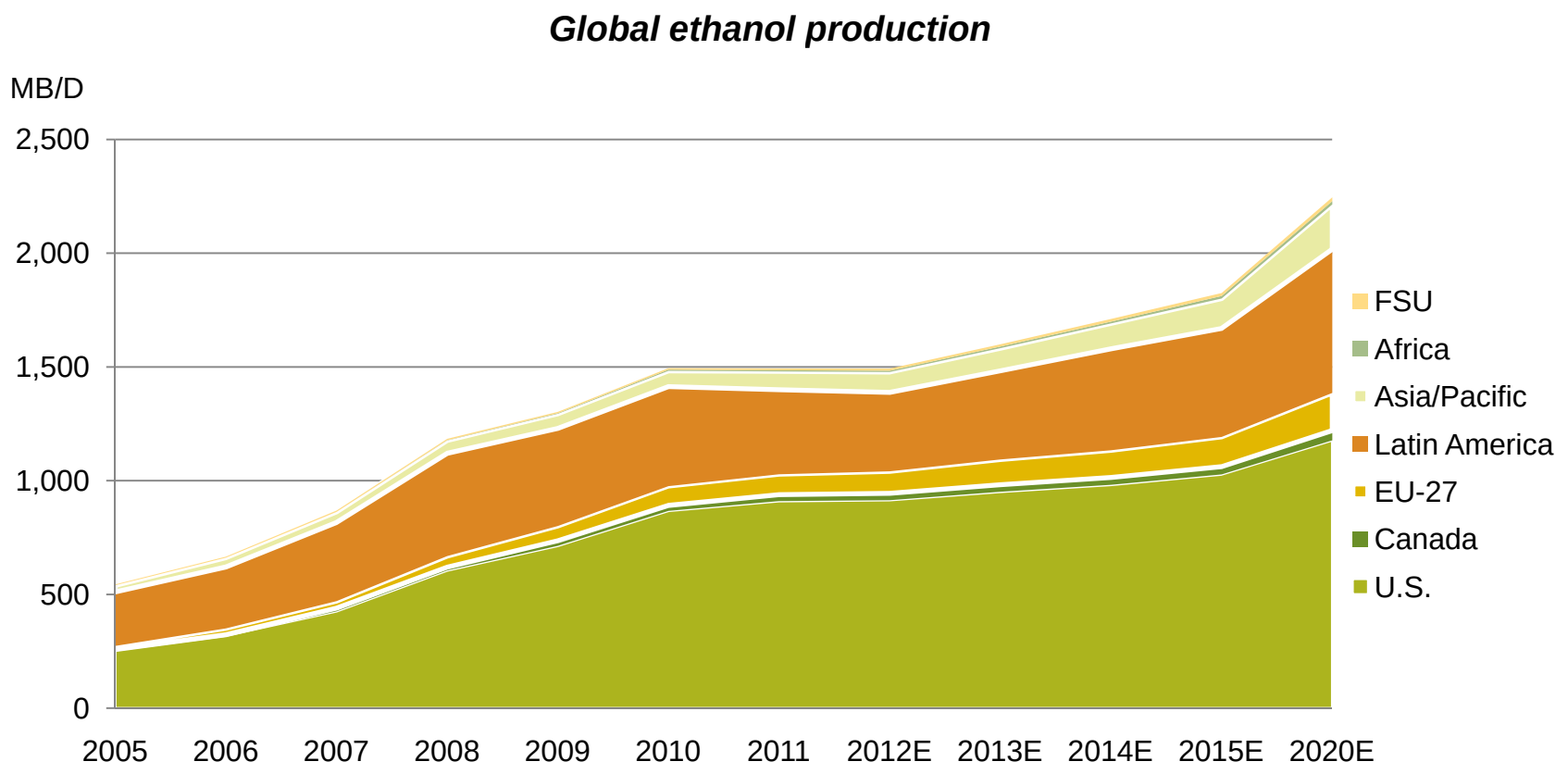


Soybean yields



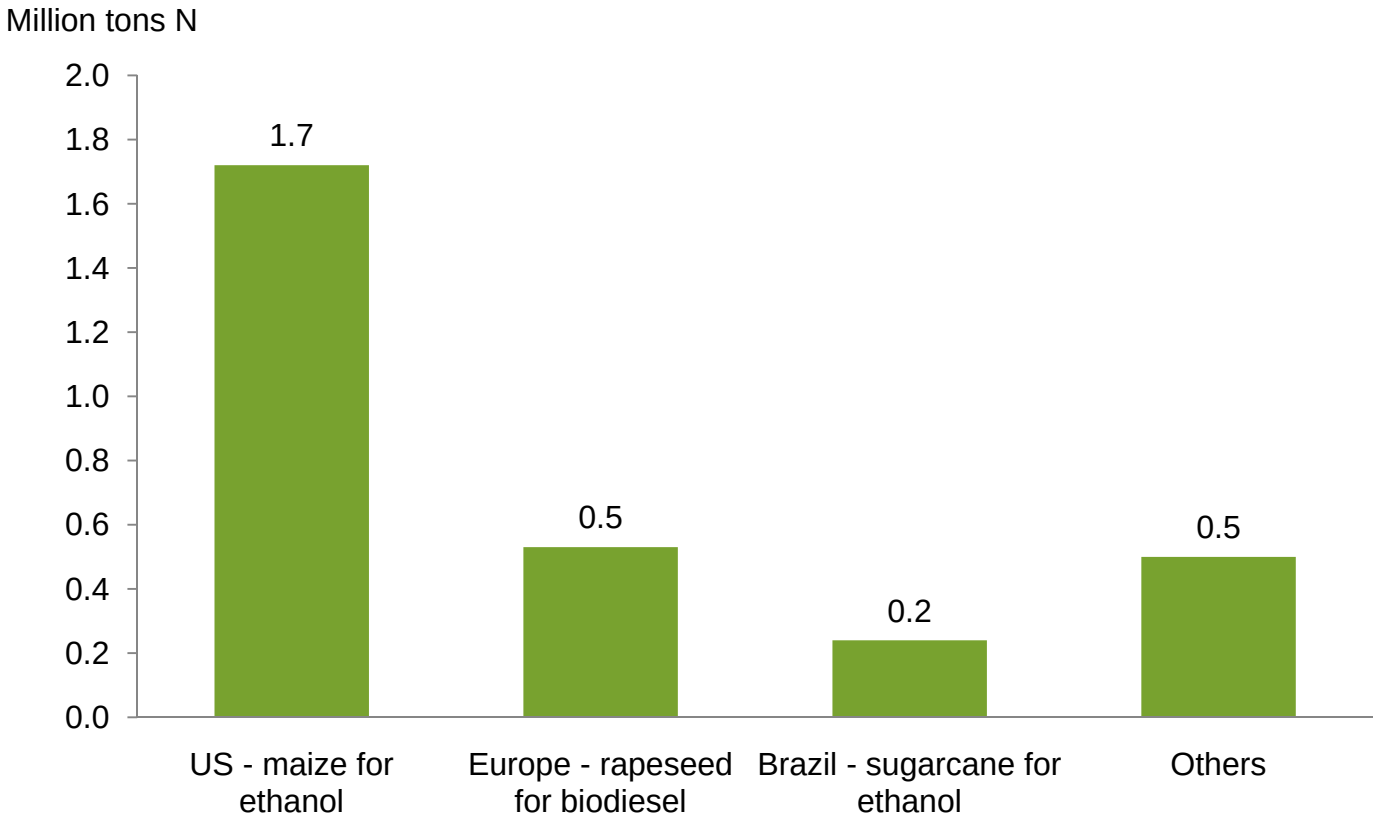
Source: FAOSTAT. 2010

Biofuels: high-level outlook



Source: PIRA, July 2012

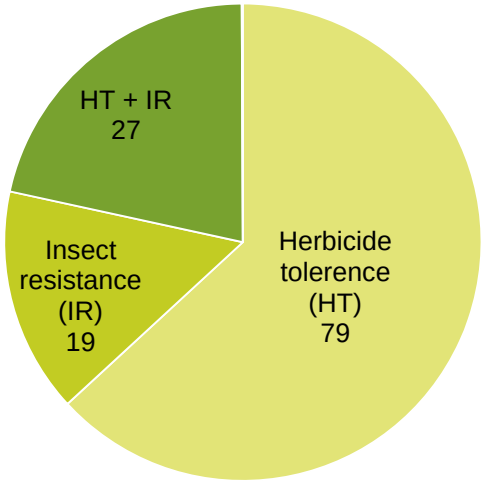
N-fertilizer consumption from biofuels production



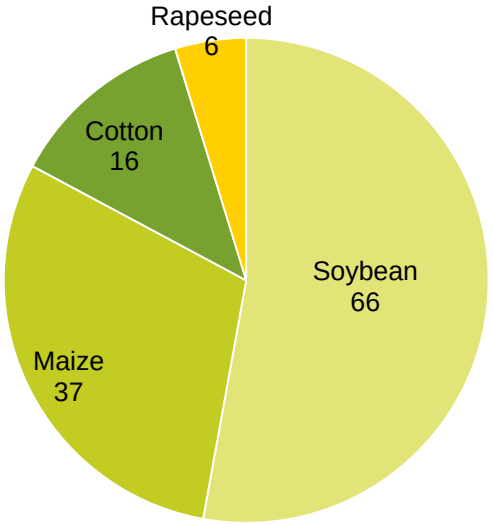
Source: IFA

The effect on fertilizer consumption of genetically modified crops

Cropped area by trait, Million hectares



Cropped area by crop, Million hectares



Source: ISAAA

Fertilizer reduces carbon footprint from farming

Fertilizer - an efficient solar energy catalyst

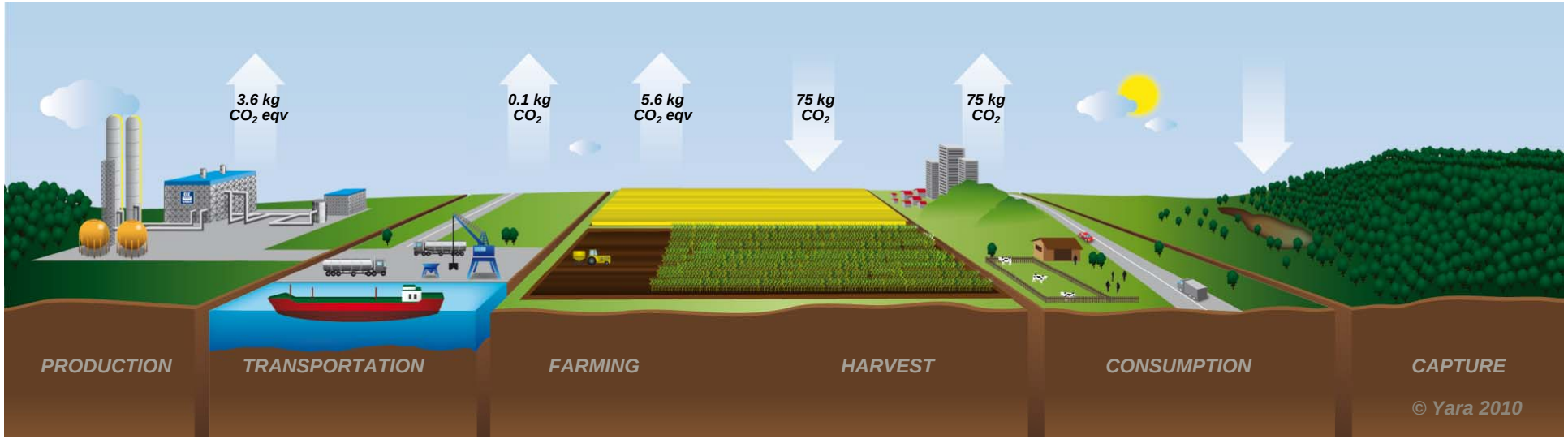
- Production marginal part of carbon footprint - efficient application more important
- Huge positive effects of fertilizer use by lower land use

Production

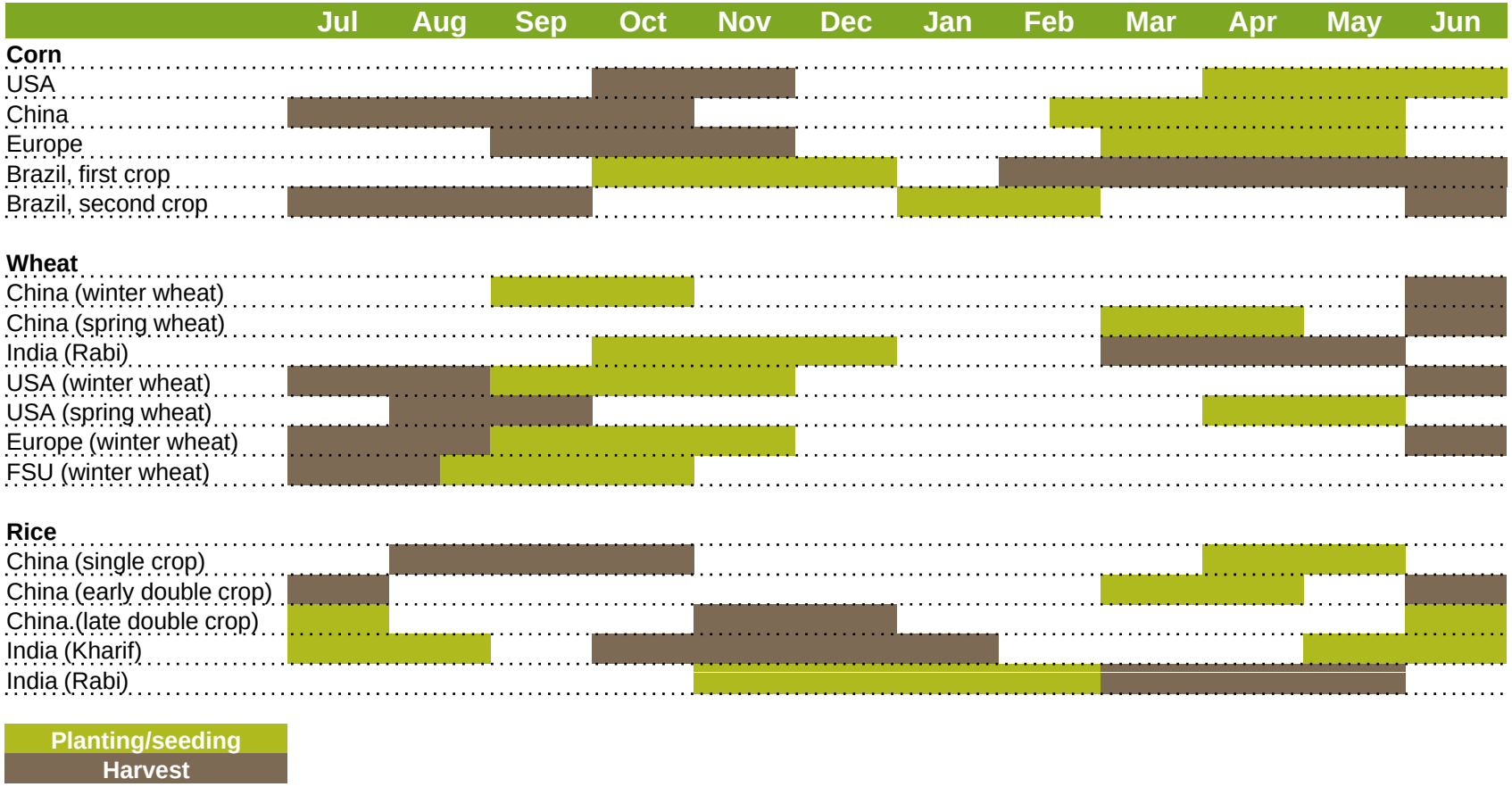
- Yara's production more energy-efficient than competitor average
- Yara developed N_2O catalyst

Application

- Nitrates better than urea
- Precision farming (N-tester etc.)
- Balanced fertilization (NPK)



Seasonality in fertilizer consumption

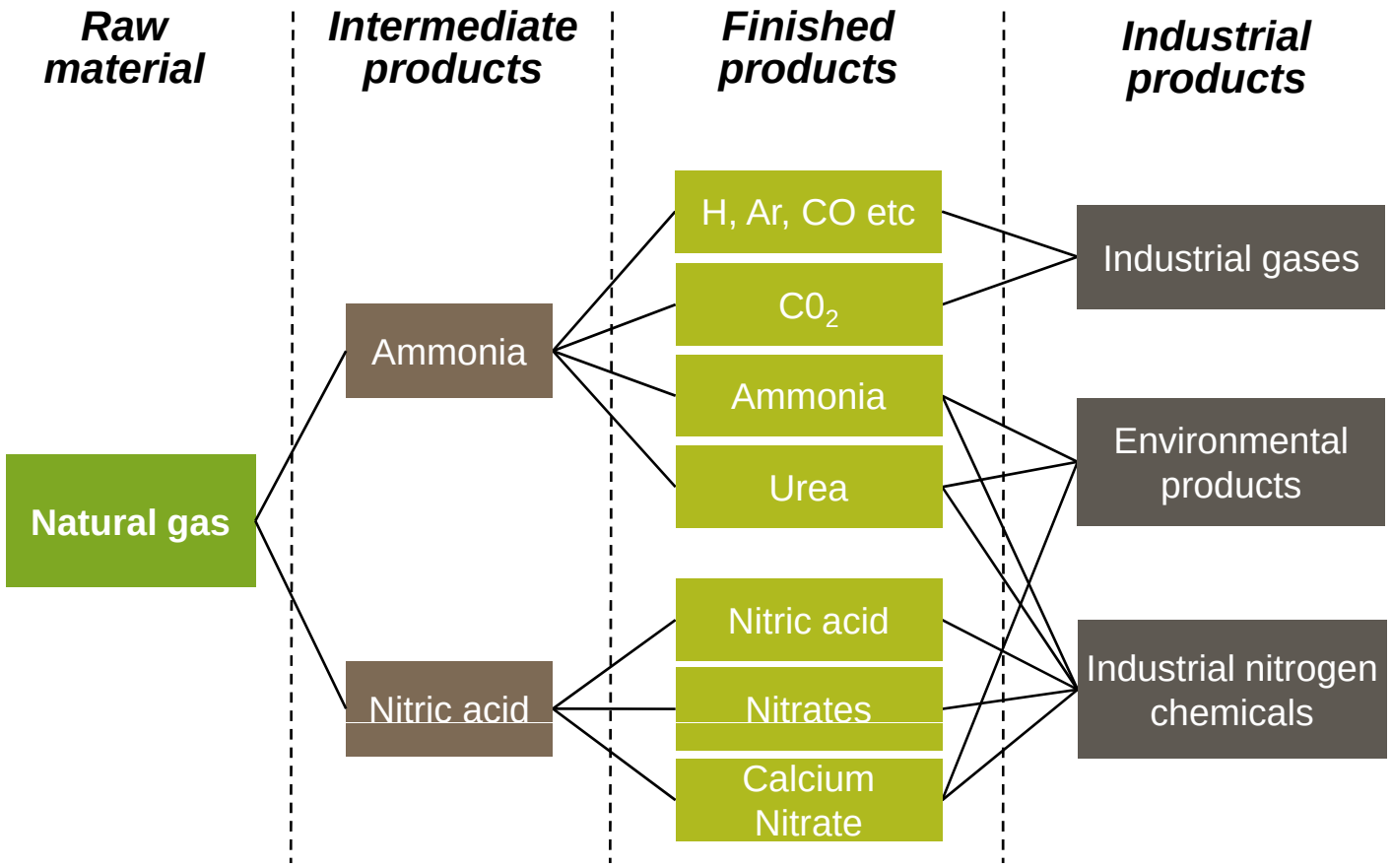


Source: USDA

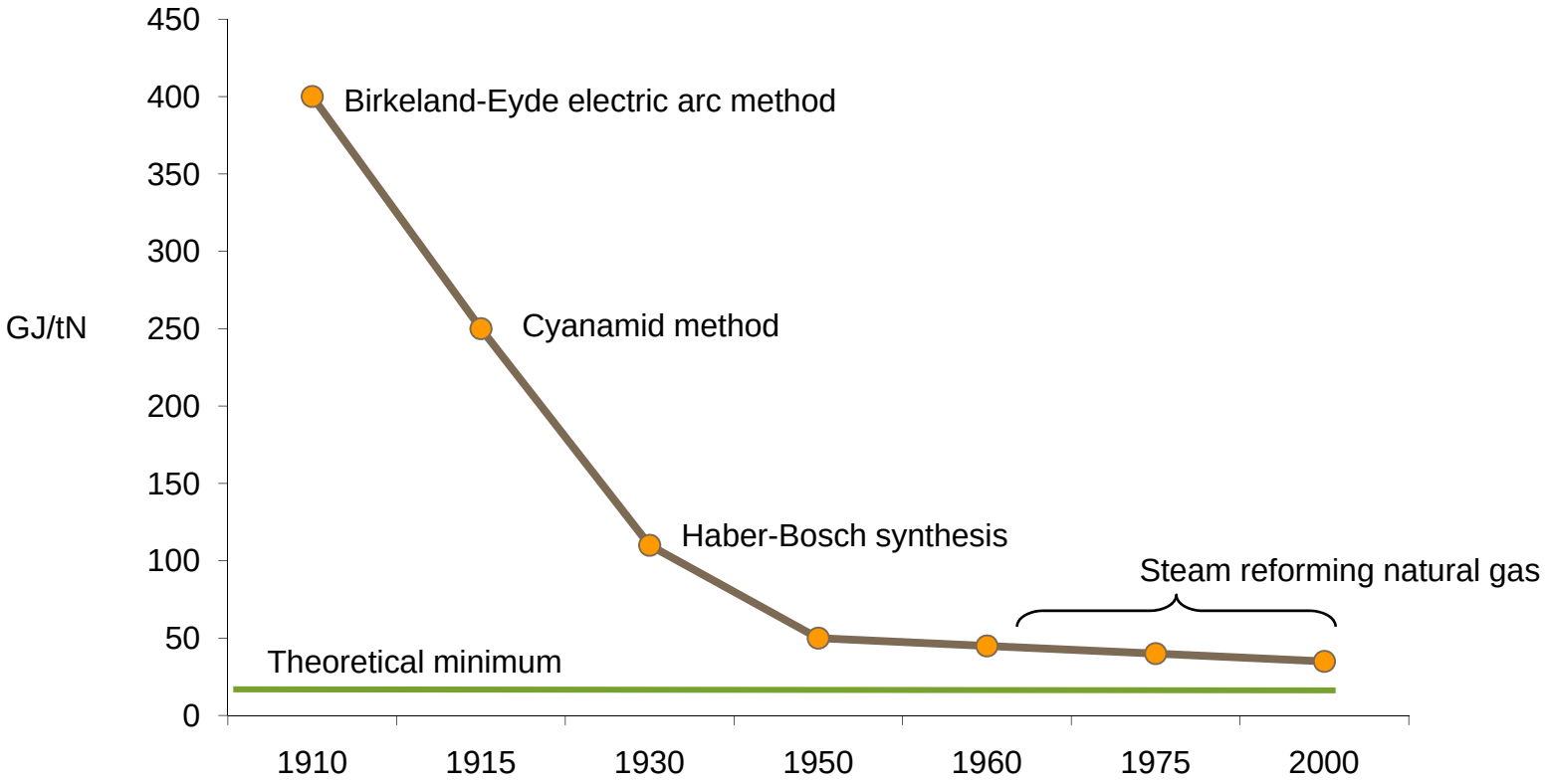
Knowledge grows

Drivers of supply

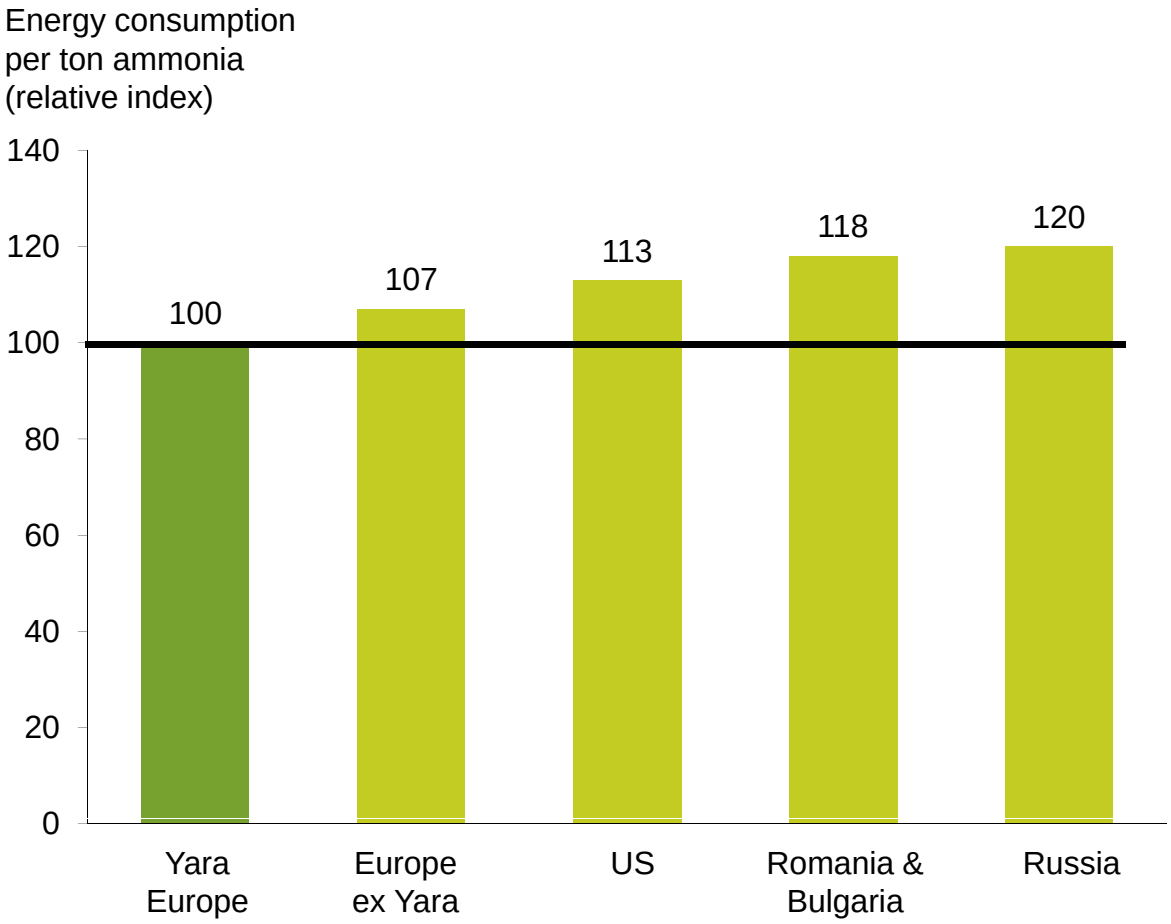
Nitrogen value chain



Nitrogen technology developments



Energy consumption in ammonia production



China's coal-fired ammonia plants use 70% more energy and emit 2.5 times more CO_2

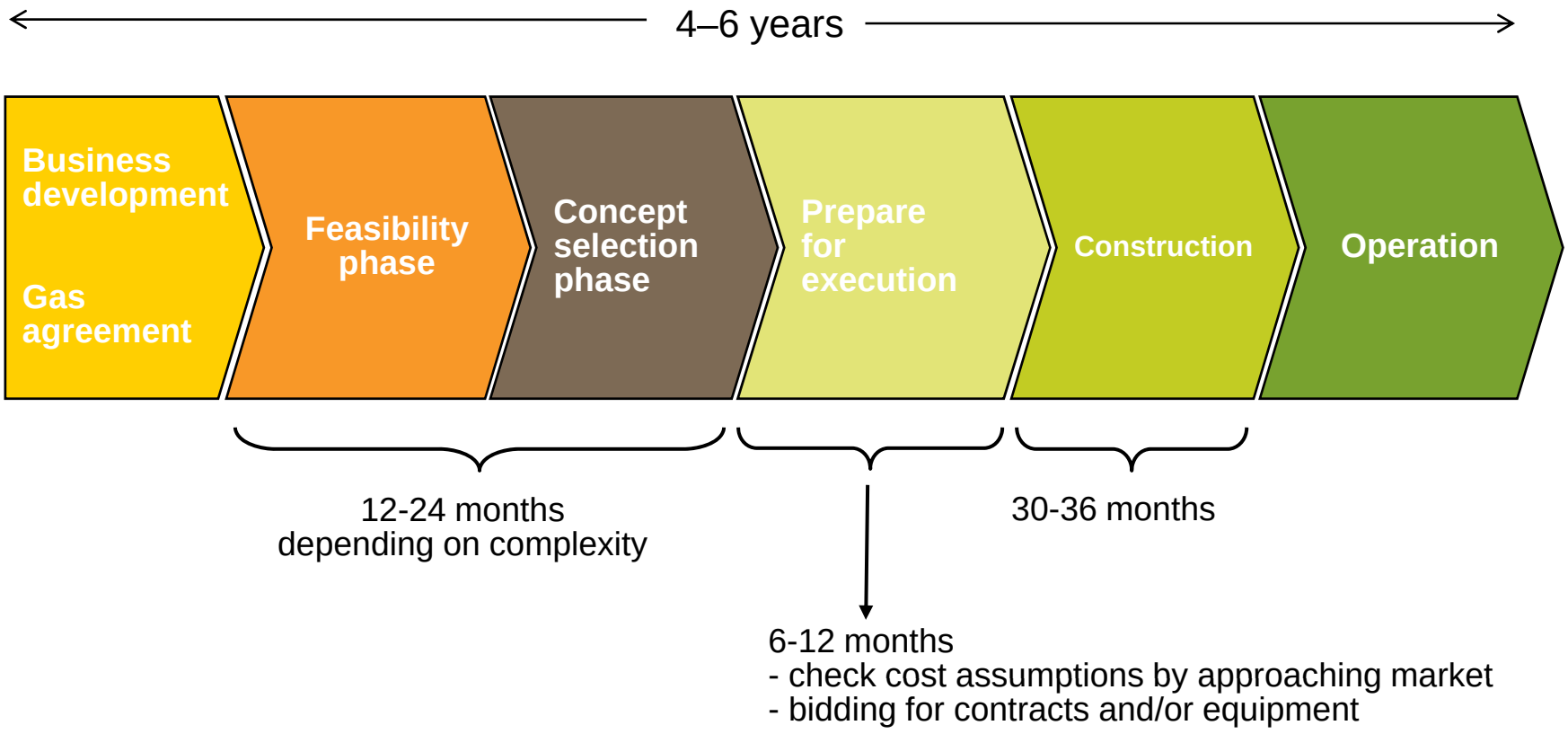
Source: Fertilizer Europe (2008)

Projected nitrogen capacity additions outside China in line with historical consumption growth

Year	Driving regions		Urea capacity growth relative to nitrogen capacity	
	World	**Excluding China**	**World**	**Excluding China**
2011	China 36% Pakistan 24%	Pakistan 37% Iran 18%	1.2% (1.3%)	1.2% (1.3%)
2012	China 60% Qatar 14%	Qatar 34% Vietnam 20%	3.5% (4.1%)	2.2% (2.1%)
2013	China 63% Algeria 14%	Algeria 38% UAE 18%	4.4% (2.7%)	2.6% (3.1%)
2014	China 45% Egypt 13%	Egypt 25% Algeria 16%	1.7% (1.0%)	1.5% (1.2%)
2015	China 42% Saudi Arabia 9%	Saudi Arabia 15% Brazil 14%	2.6% (1.2%)	2.5% (1.9%)
Gross annual addition 2011-2015				**~2.0%**
Assumed annual closures				~0.5%
Net annual addition 2011-2015				**~1.5%**
Trend consumption growth from 2001			**2.5%**	**2.1%**

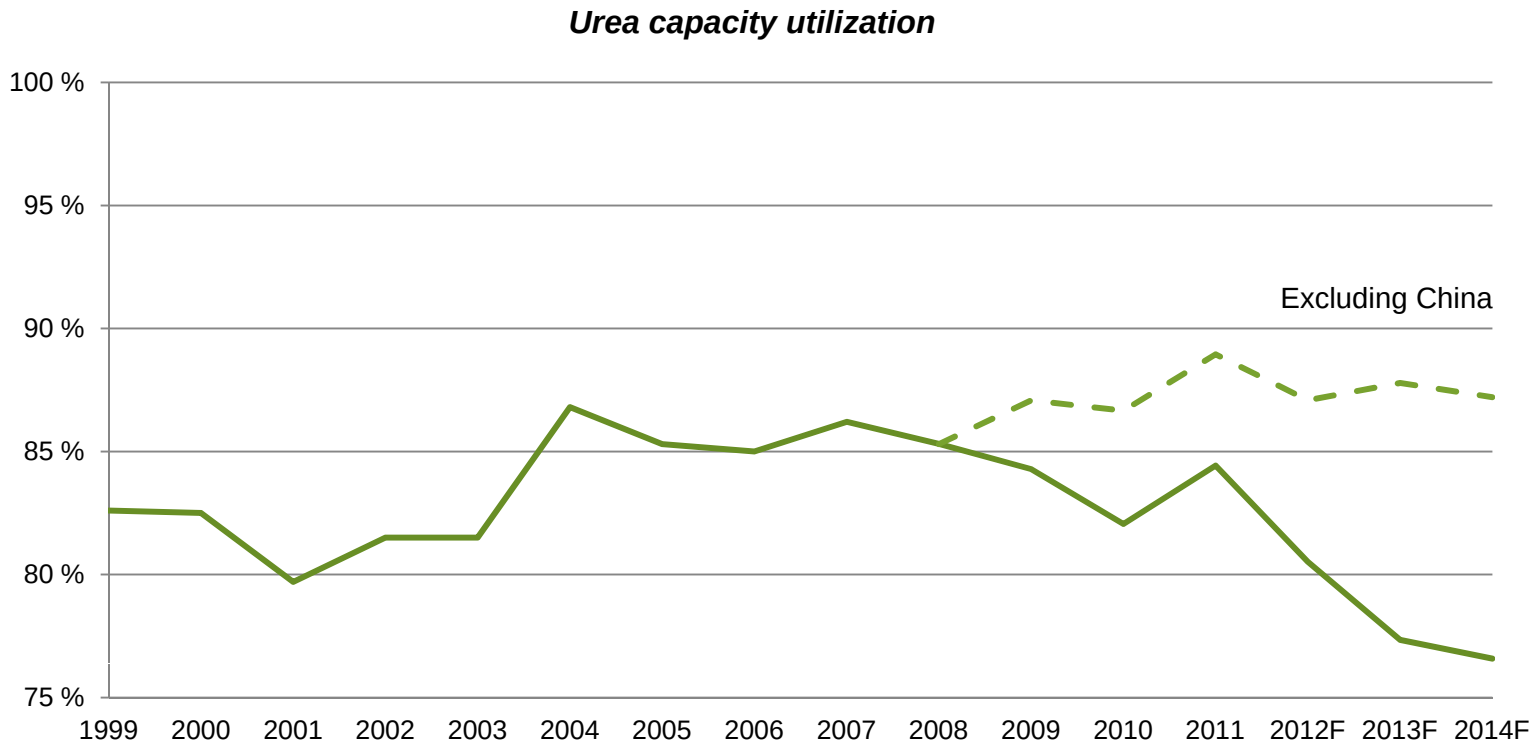
Source: Fertecon urea update October 2012. Consumption data source is IFA. Previous update in brackets.

5 year typical construction time for nitrogen fertilizer projects*



* Ammonia and urea plant example

Global nitrogen capacity utilization

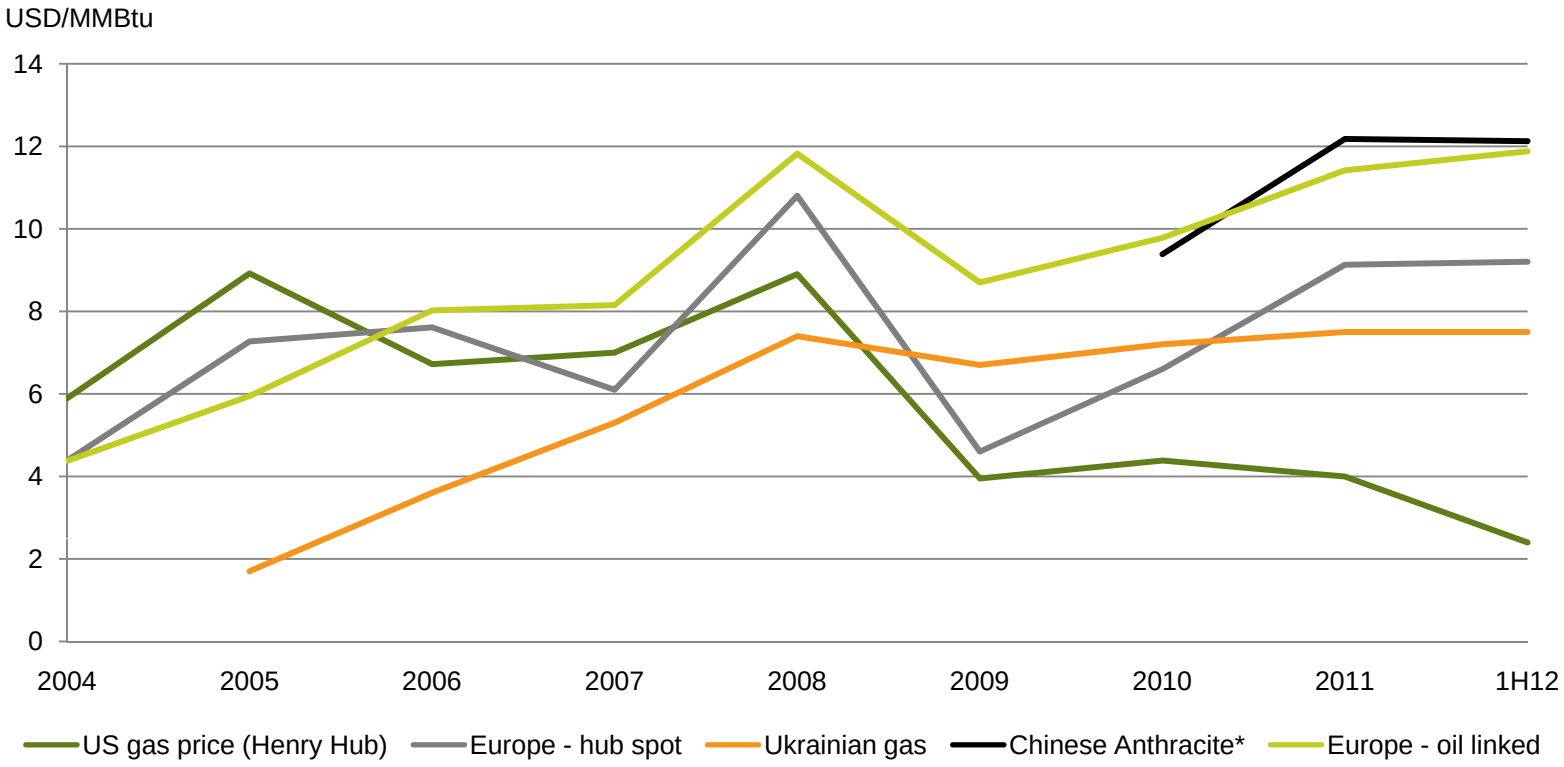


Source: Fertecon Oct 2012

Price relations

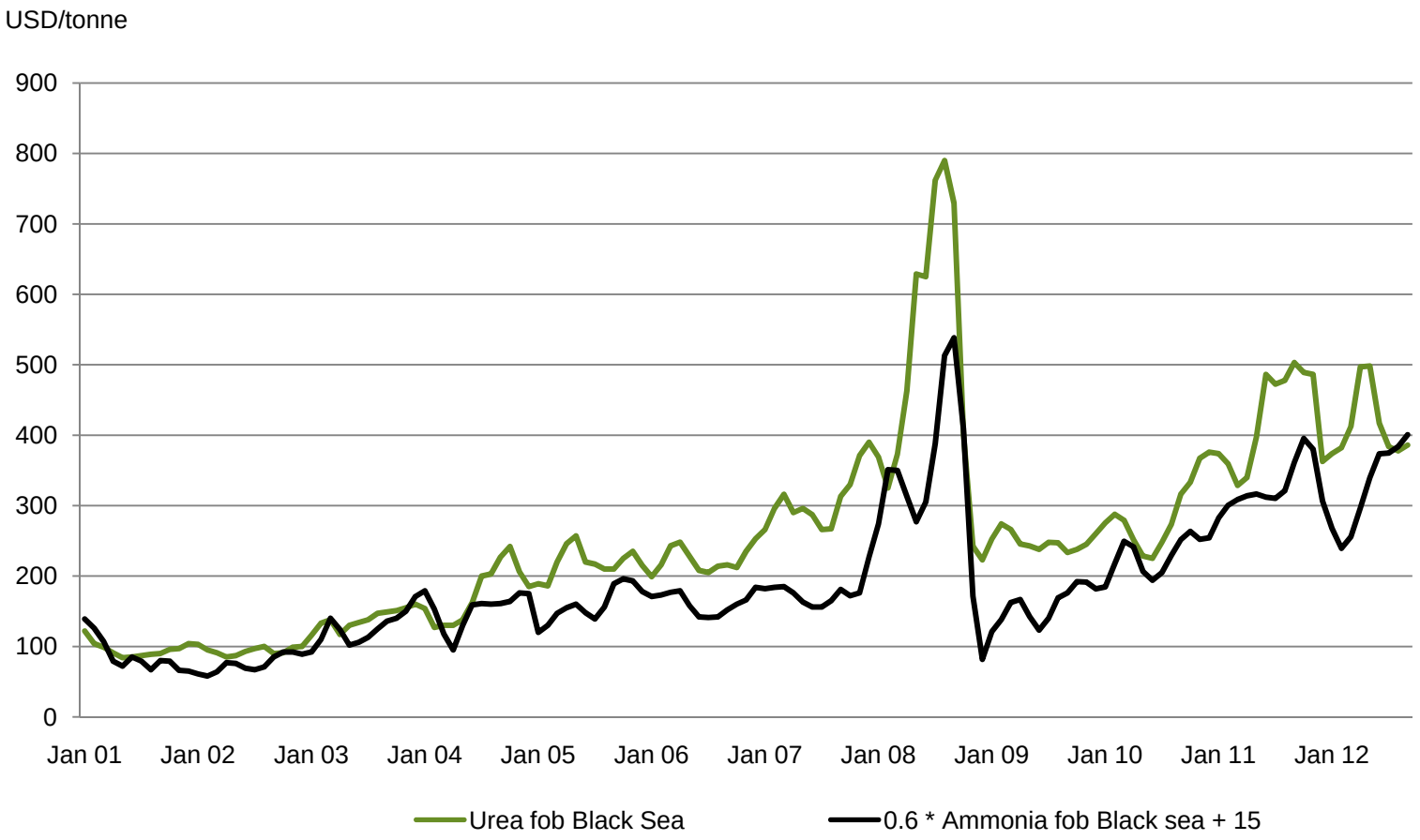
Feed-stock costs

Yearly average gas prices



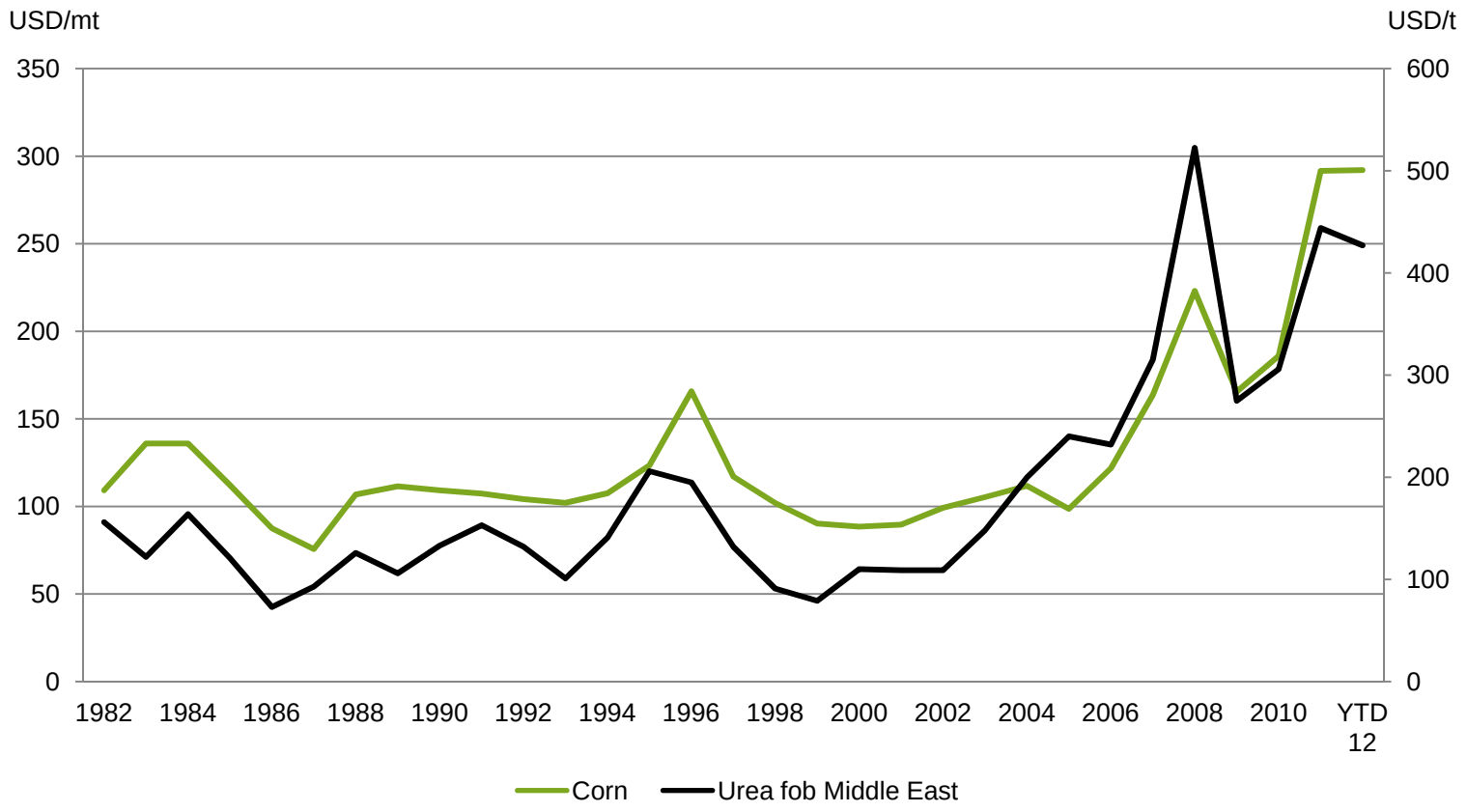
Source: World Bank, Fertecon, Pira (average import price into EU from World Bank used up to 1999)

Ammonia sets the floor for urea



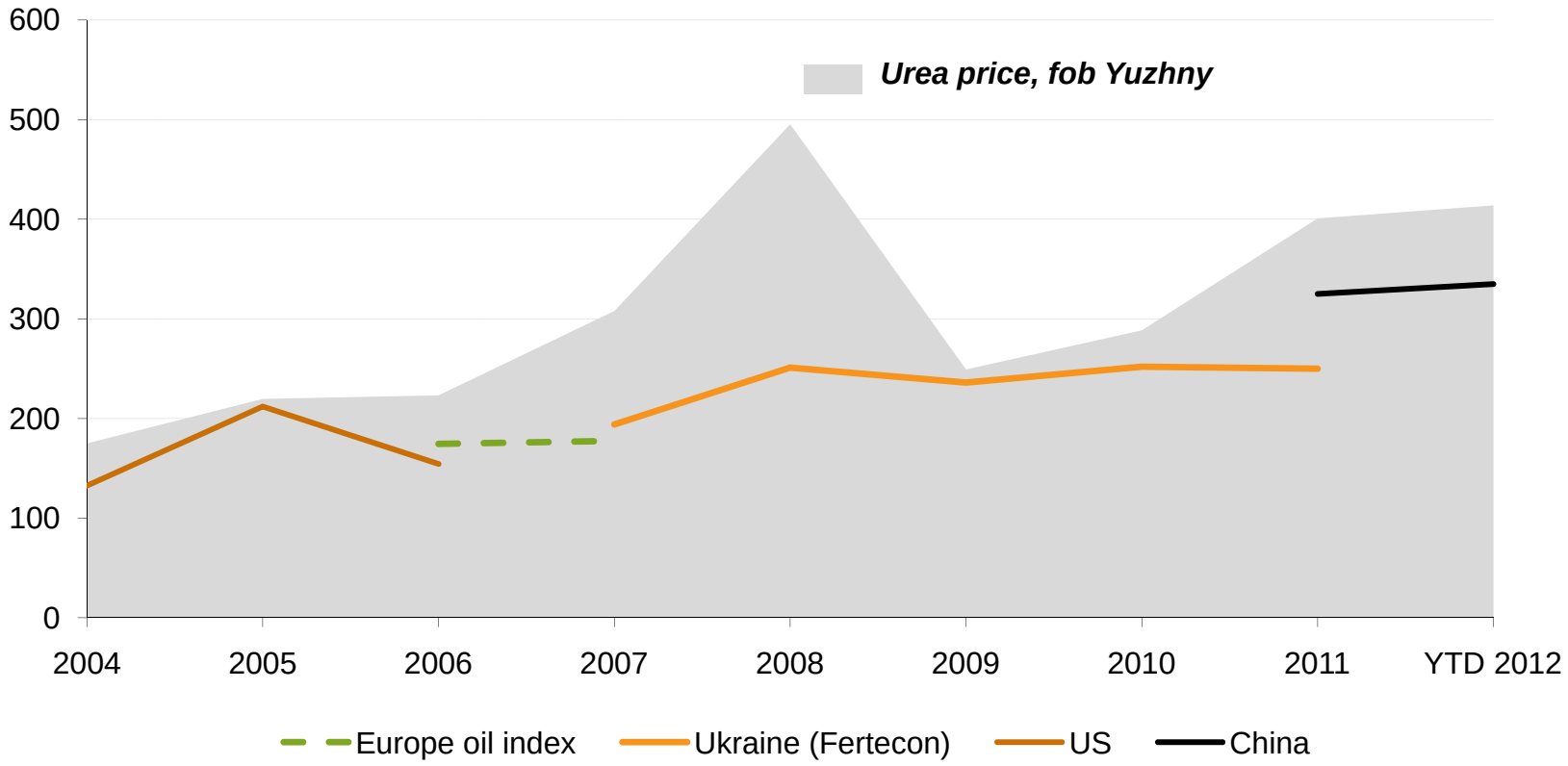
Source: Average of international publications

Grain prices set the ceiling for urea



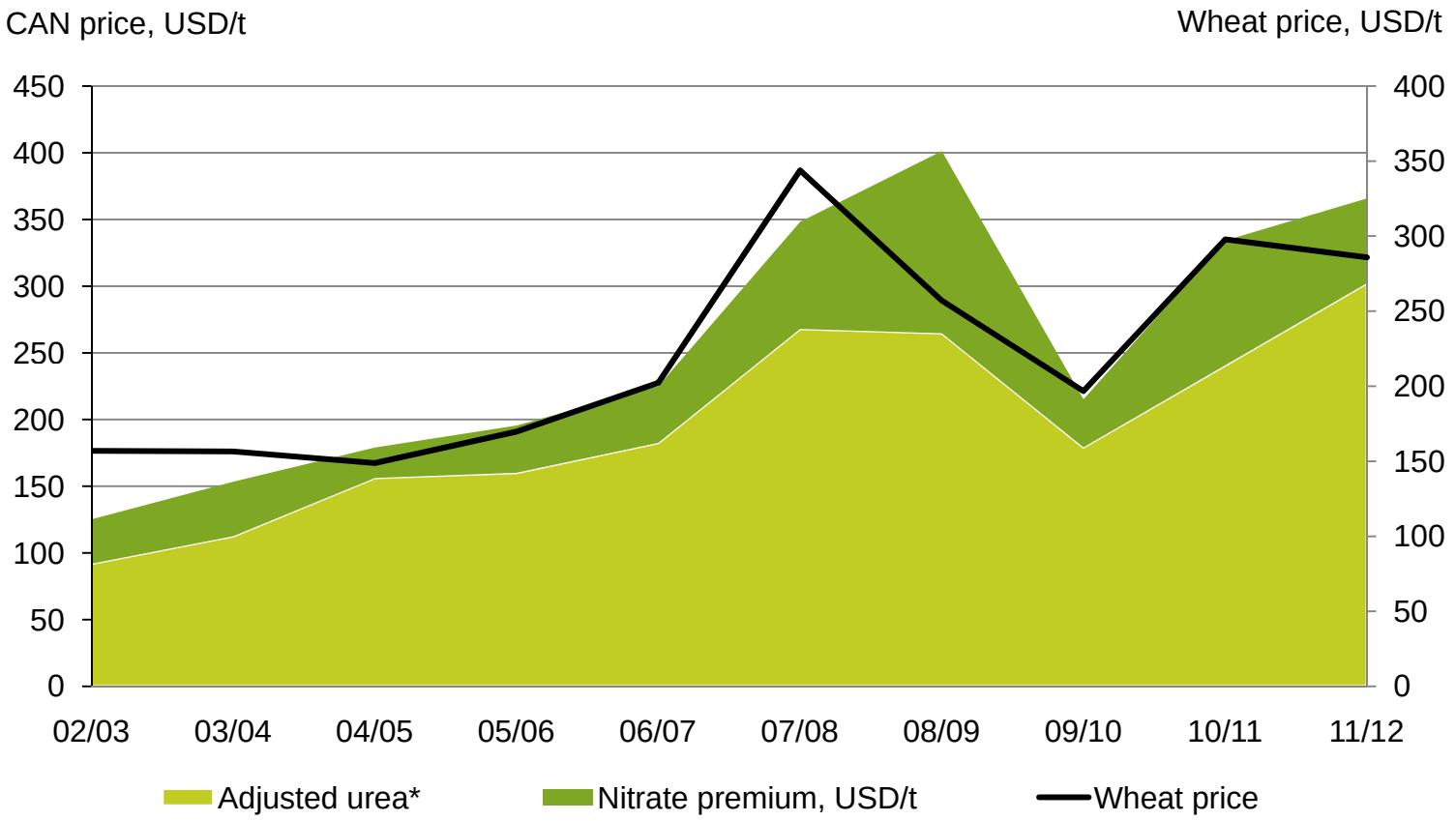
Source: World Bank, Fertilizer publications

Only shorter periods with supply-driven urea market



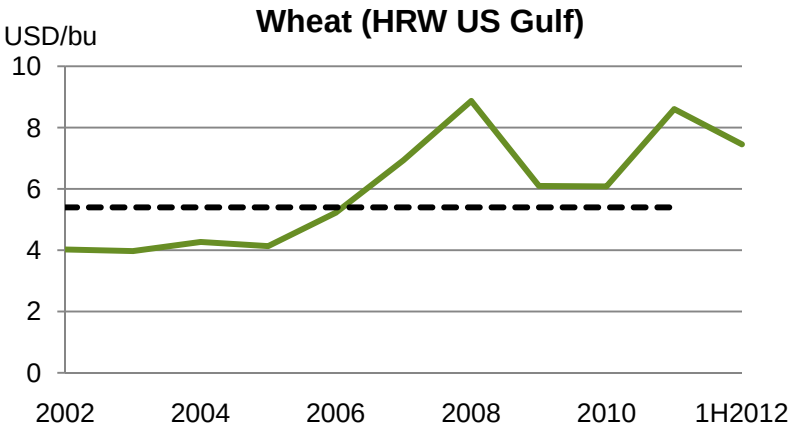
Source: Fertecon (Ukraine), Yara estimates

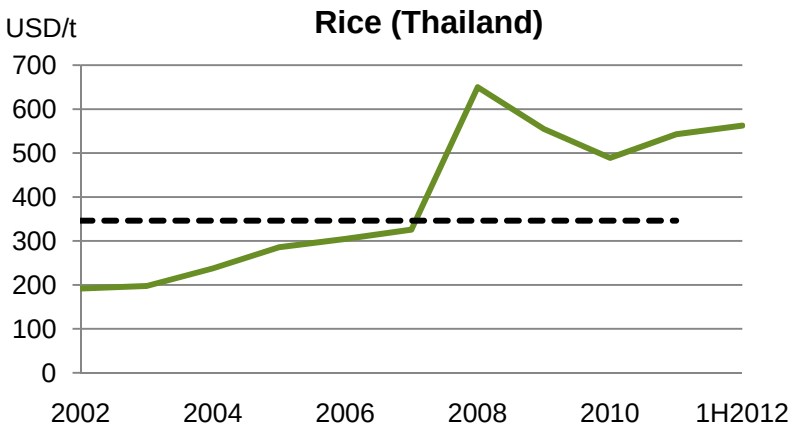
Nitrate premium is mainly a function of crop prices and proper marketing

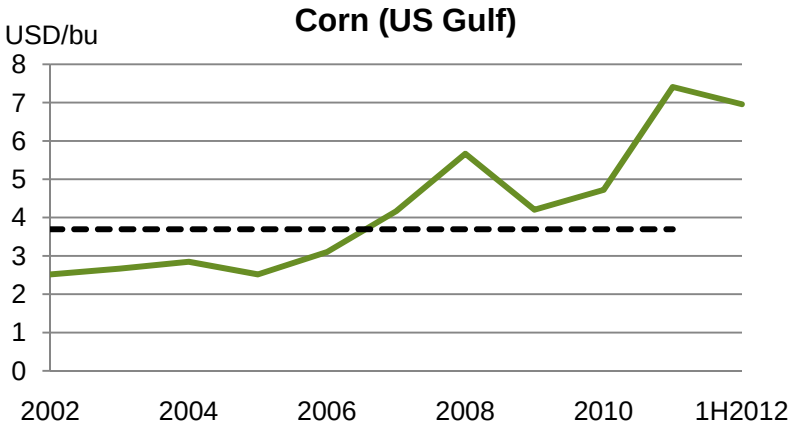


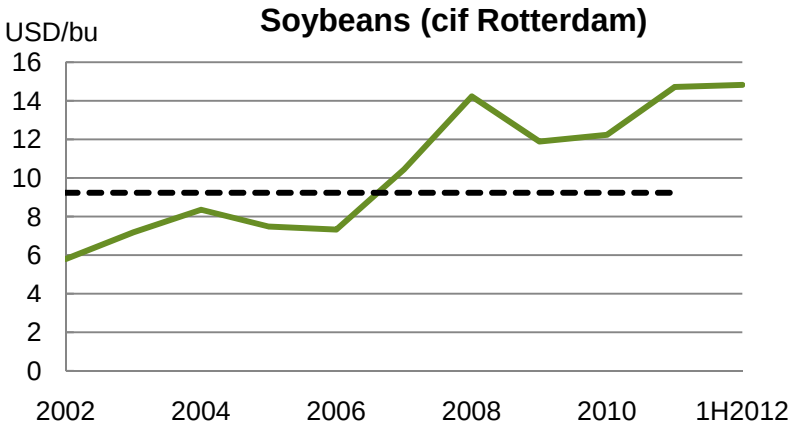
** Urea fob Black sea adjusted for import costs into Europe and nitrogen content similar to CAN*

Grain/oilseed prices – yearly averages





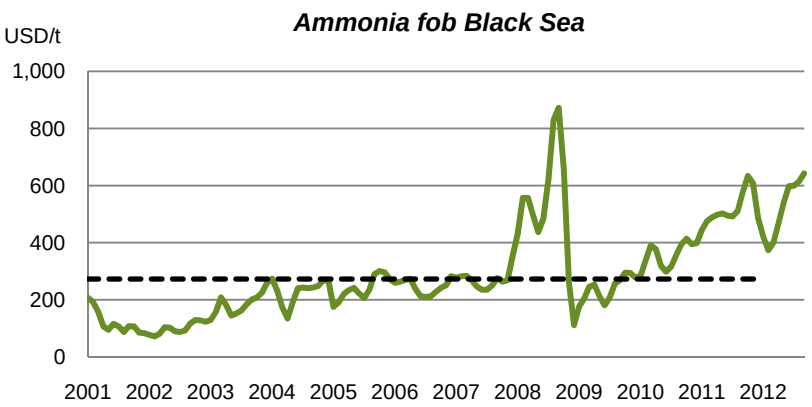


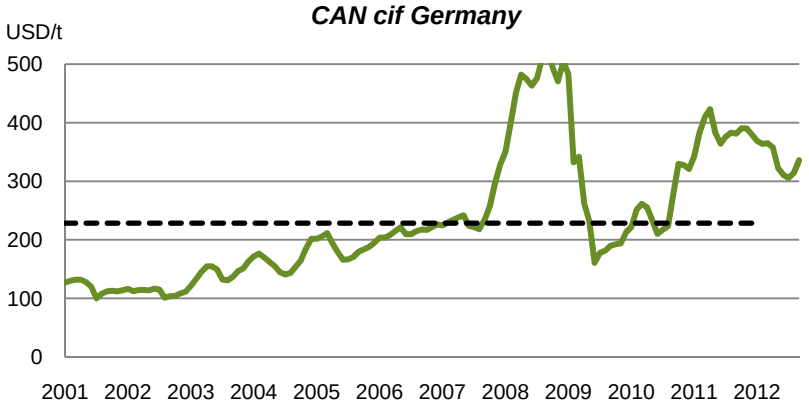


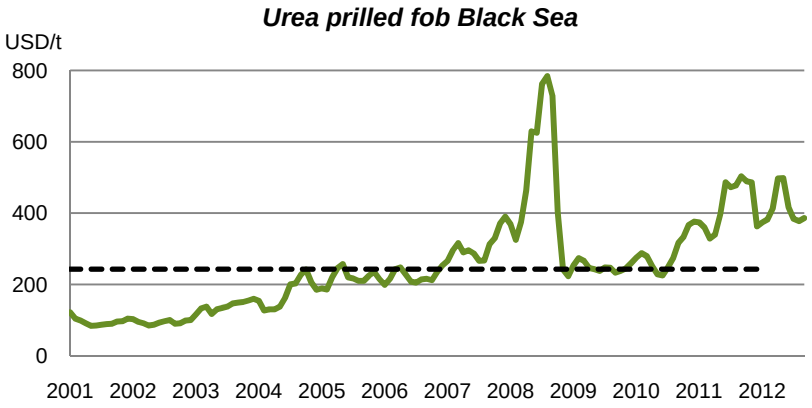
Source: World Bank, Aug 2012

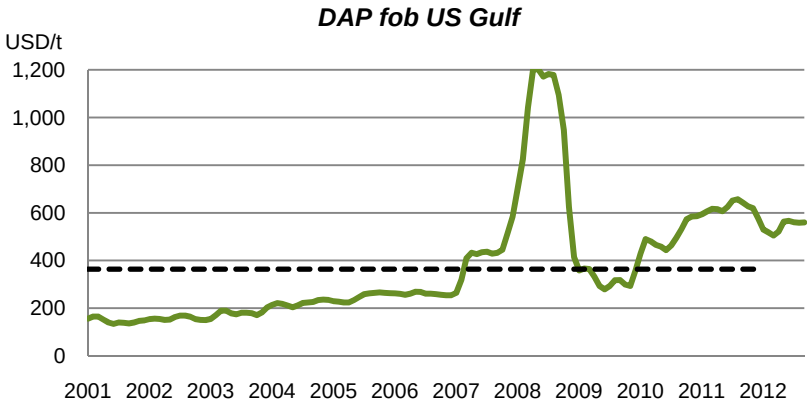
Average prices 2001-2011

Fertilizer prices – monthly averages









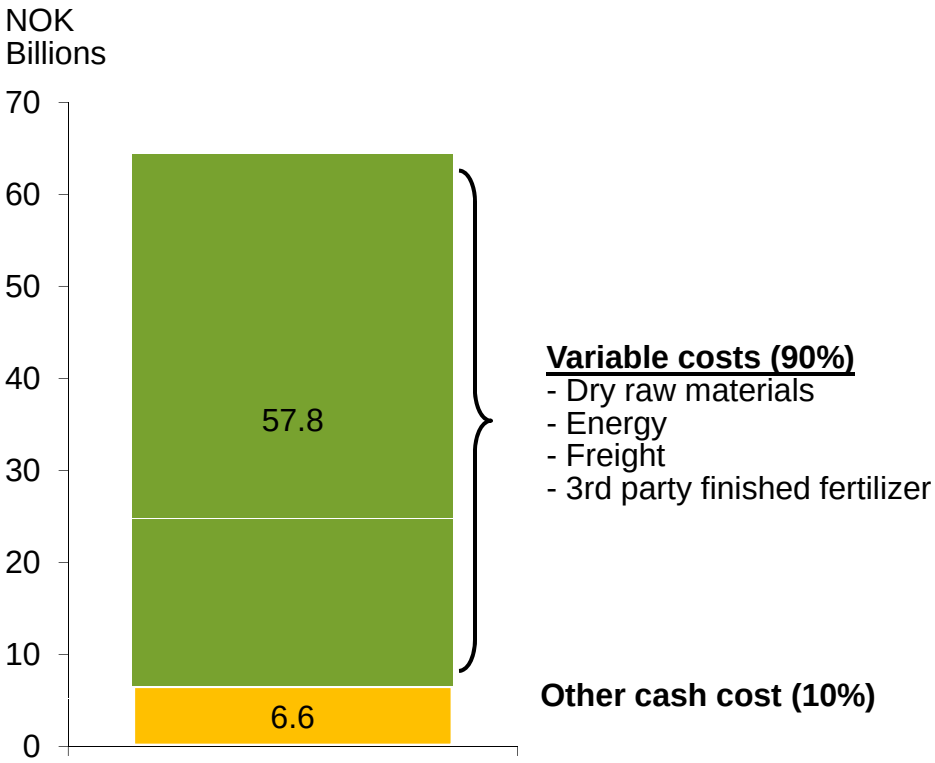
Average prices 2001 - 2011

Source: Average of international publications


YARA
Knowledge grows
Production economics

Yara's operating cash costs are mainly variable

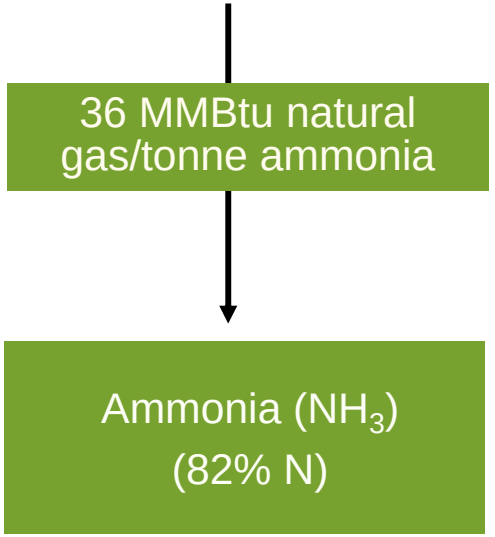
Operating cash costs 2011



- Temporary plant closures can be made speedy and with limited stop/start costs
- Example for ammonia/urea plants:
  - Takes half a week to stop and a week to start
  - Cost of stopping is 2 days energy consumption
  - Cost of starting is 3 days energy consumption

Ammonia cash cost build-up – example

	Gas price:	8	USD/MMBtu
x	Gas consumption:	36	MMBtu/mt NH_3
=	Gas cost:	288	USD/mt NH_3
+	Other prod. cost:	26	USD/mt NH_3
=	Total cash cost	314	USD/mt NH_3

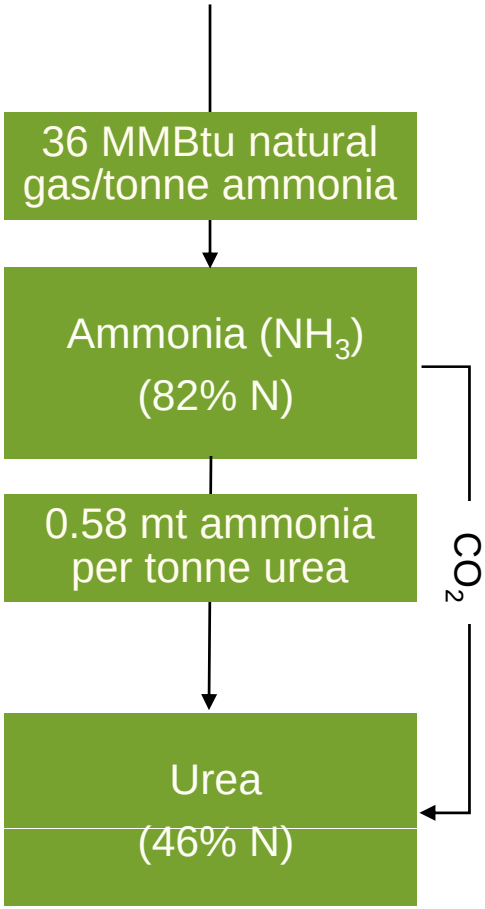


Typical natural gas consumption for ammonia production

Source: Blue Johnson & Associates.

Urea cash cost build-up – example

	Ammonia price:	314	USD/mt NH_3
x	Ammonia use:	0.58	NH_3/mt urea
=	Ammonia cost	182	USD/mt urea
+	Process gas cost*	41	USD/mt urea
+	Other prod. cost**:	22	USD/mt urea
=	Total cash cost	245	USD/mt urea

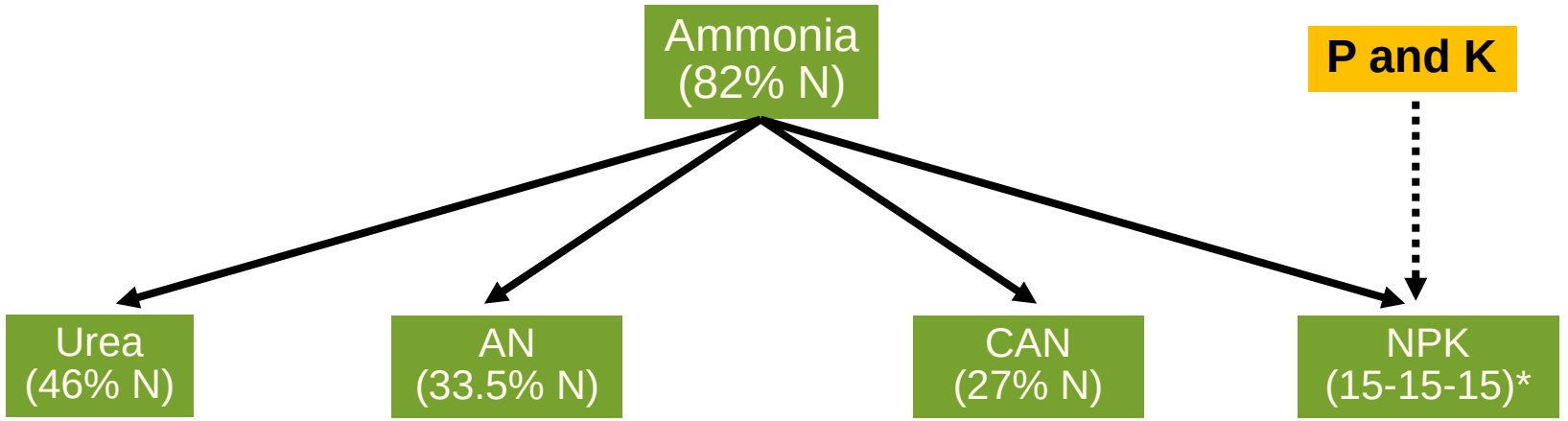


* Process gas cost is linked to natural gas price

** Including load-out

Source: Blue Johnson & Associates.

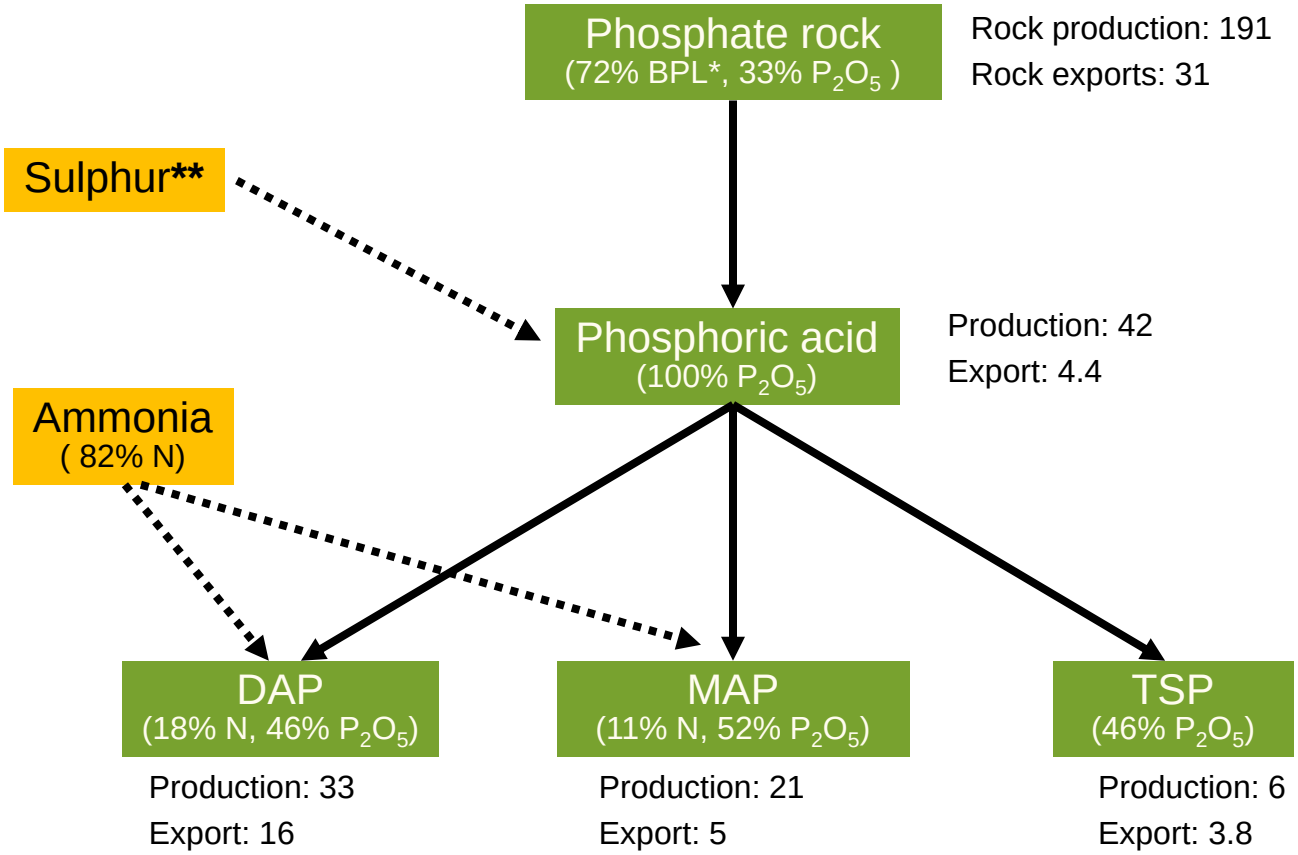
Theoretical consumption factors



* There are several NPK formulas. 15-15-15 is just an example

Main phosphate processing routes

2006 production and exports, million tons P_2O_5



* P2O5 content of phosphate rock varies. This is an example.

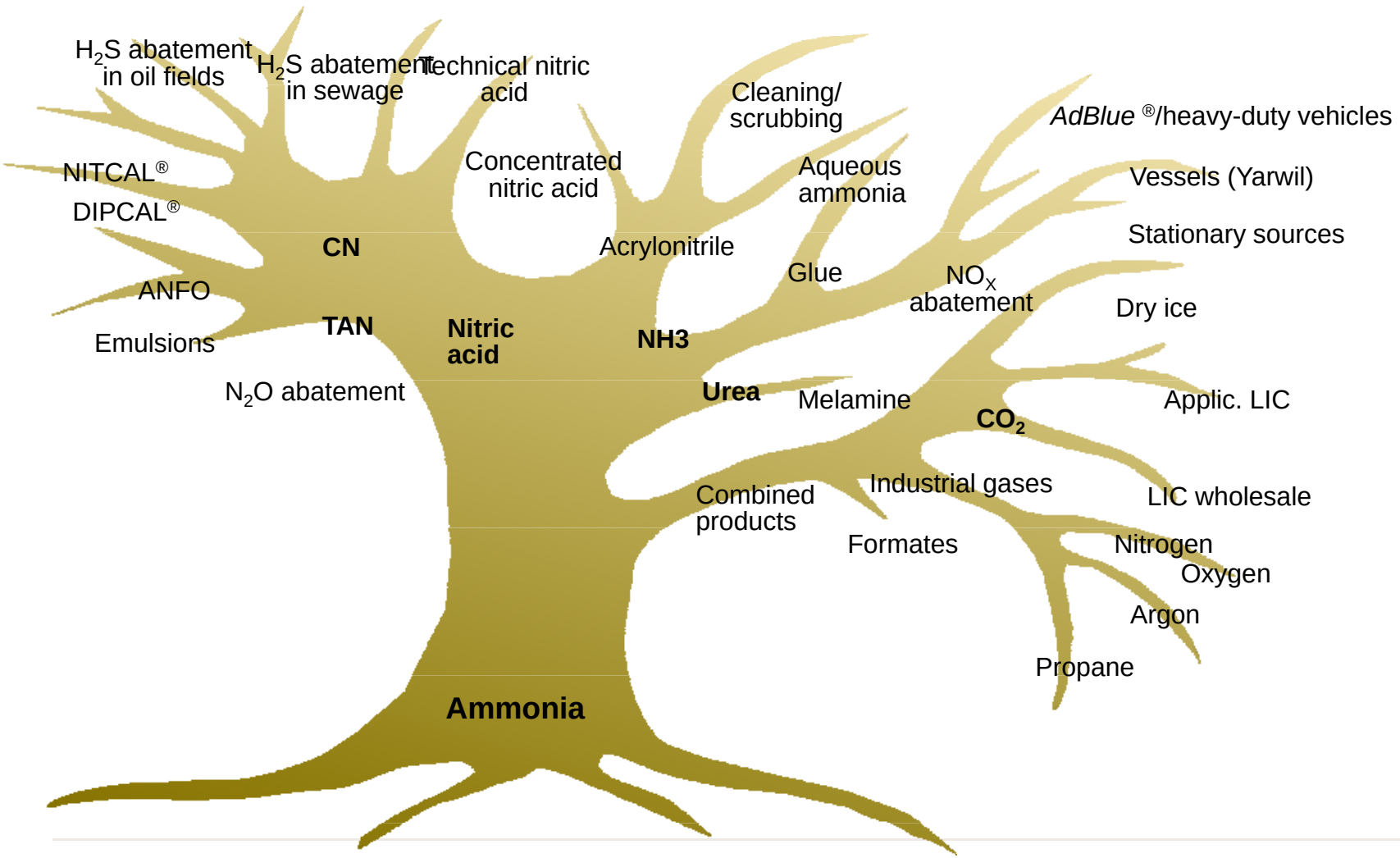
** 1 ton of phosphoric acid requires 1 ton of sulphur.

Source: IFA

Knowledge grows

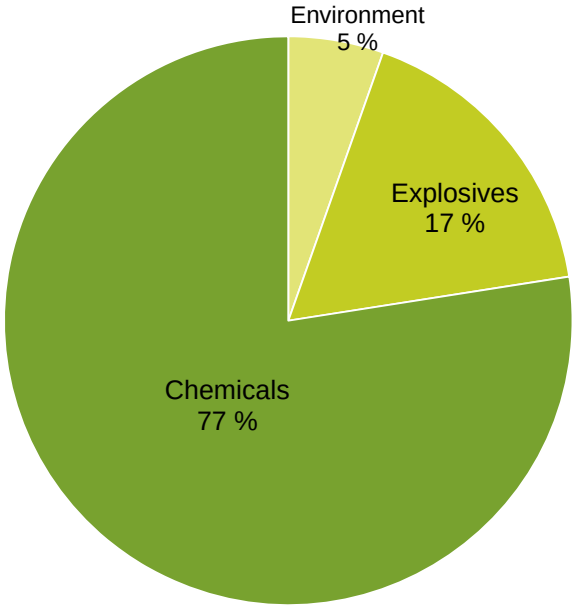
Industrial applications

Industrial nitrogen applications



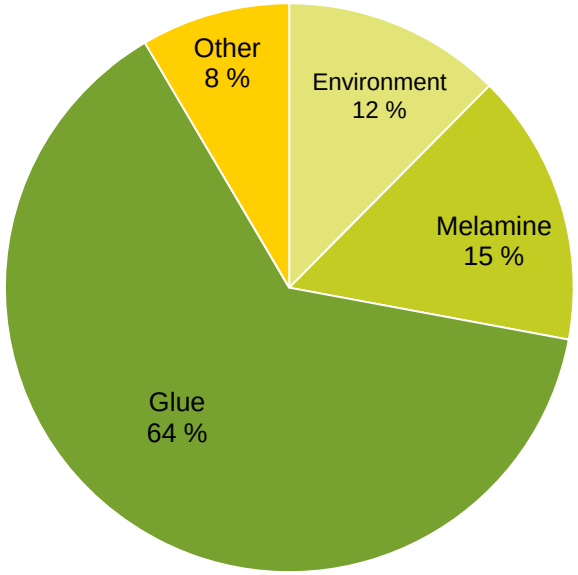
Industrial use accounts for 18% of global nitrogen consumption

~22 million tons N



18% of total N consumption

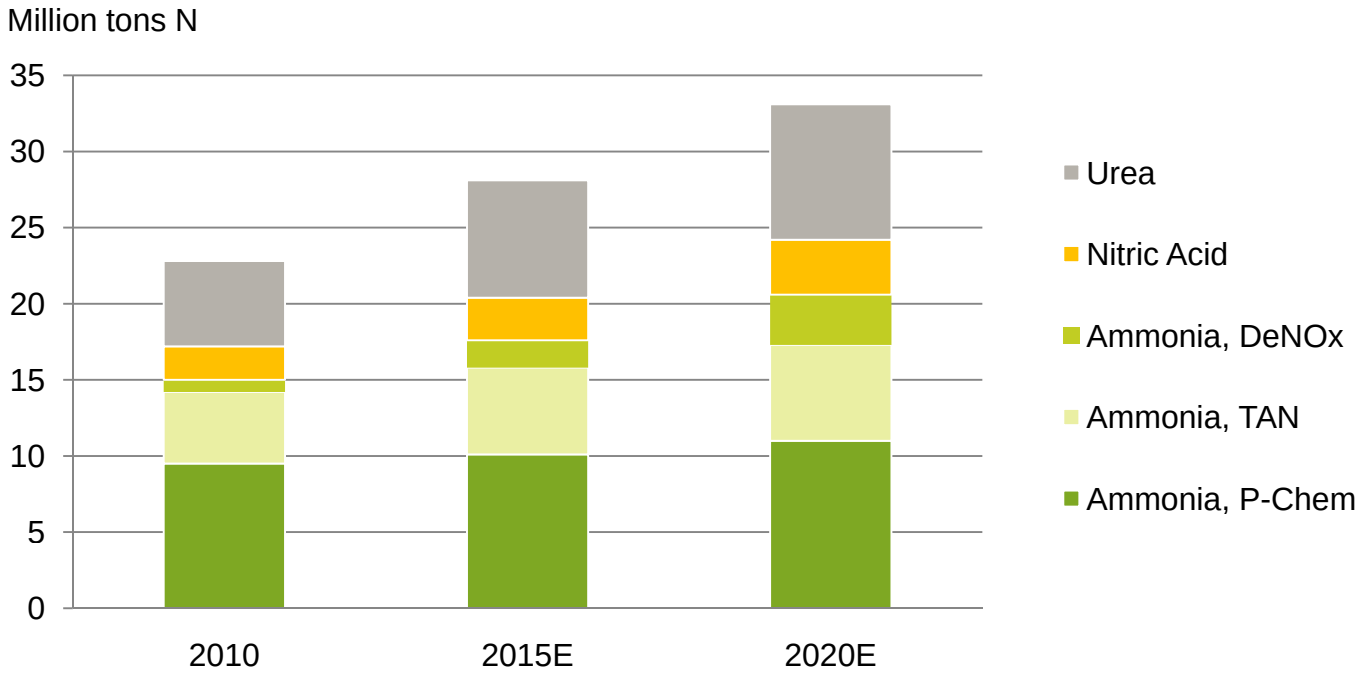
~7 million tons N as urea



10% of total urea consumption

Source: Yara estimates

Global demand development of nitrogen chemicals for industrial applications is strong



Estimated growth of Industrial applications is 10 million tons N (3.3 % annual growth)

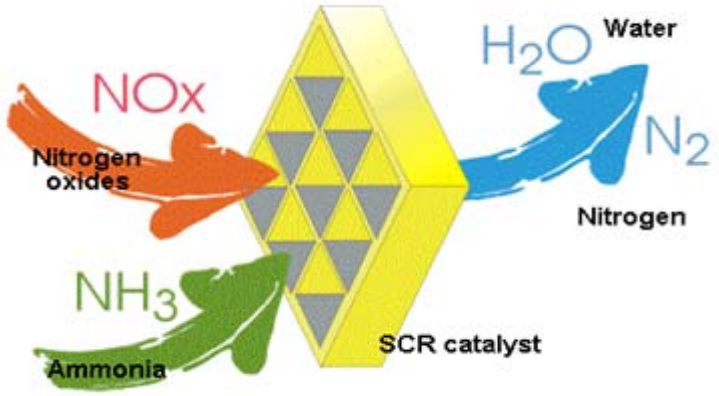
Source: Fertecon

Example

Urea and ammonia based solutions to improve air quality

Air1
NO_xCare
Yarwil

Automotive, off and on road
Stationary
Maritime



Nitrogen oxides emissions lead to ground ozone layer and acid rain

Urea or ammonia combined with an SCR catalyst, eliminates up to 90% NO_x emissions

Legislation requires emission limits from mobile sources (transport fleets on land and at sea) and from industrial sources (power plants, cement factories, waste incinerators, refineries…)

AdBlue/DEF is a generic name for urea-based solution
Air1 is Yara's brand name for AdBlue/DEF

Example

Technical Nitrates for Civil Explosives

Various grades of Ammonium Nitrate and Calcium Nitrate for use in the civil explosives and mining industries

Example:

CO_2 has numerous industrial applications

Food additive:
High-quality CO_2
for beverage carbonisation

Food care:
CO_2 for greenhouses, chilling and freezing, processing and transport

Animal care:
Controlled atmosphere for livestock stunning

Manufacturing:
Welding and cutting gases

Blasting :
Multipurpose cleaning

Industries Served :

- ✓ Breweries
- ✓ Dairies
- ✓ Bakeries
- ✓ Meat and Poultry processing
- ✓ Fish Farming and processing
- ✓ Greenhouses
- ✓ Airline catering
- ✓ Refrigerated transport

Calcium nitrate for H_2S abatment

- Hydrogen Sulphide (H_2S) is a highly toxic, odorous, and corrosive gas formed in wastewater systems. It represents a significant health risk potentially causing loss of smell, eye irritation, rhinitis and respiratory difficulties amongst other symptoms
- Yara's calcium nitrate application is a natural biological system that removes and prevents the formation of H_2S in sewage systems and waste water treatment plants

Industries Served :

- ✓ Municipalities
- ✓ Wastewater treatment plants
- ✓ Dairies
- ✓ Pulp and paper industry
- ✓ Slaughter houses
- ✓ Breweries
- ✓ Oil fields

Sources of market information

- Fertilizer market information
  - FMB — www.fmb-group.co.uk
  - Fertecon — www.fertecon.com
  - Fertilizer Week — www.cruonline.crugroup.com
  - Profercy — www.profercy.com
  - The Market — www.icispricing.com
  - Green Markets (USA) — www.greenmarkets.pf.com
  - Beijing Orient Business (China) — www.boabc.com
  - China Fertilizer Market Week — www.fertmarket.com

- Fertilizer industry associations
  - International Fertilizer Industry Association (IFA) — www.fertilizer.org
  - Fertilizers Europe (EFMA) — www.efma.org

- Food and grain market information
  - Food and Agriculture Organization of the UN — www.fao.org
  - International Grain Council — www.igc.org.uk
  - Chicago Board of Trade — www.cbot.com
  - World Bank commodity prices — www.worldbank.org
  - US Department of Agriculture (USDA) — www.usda.gov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