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# Global Potassium Reserves and Potassium Fertilizer Use

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Symposium – Global Nutrient Cycling
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# Potassium (K) and Potash

- K present in most rocks and soils
- Economic sources …
  - sedimentary salt beds remaining from ancient inland seas (evaporite deposits)
  - salt lakes and natural brines
- Potash refers to a variety of K-bearing minerals

# Common K Minerals

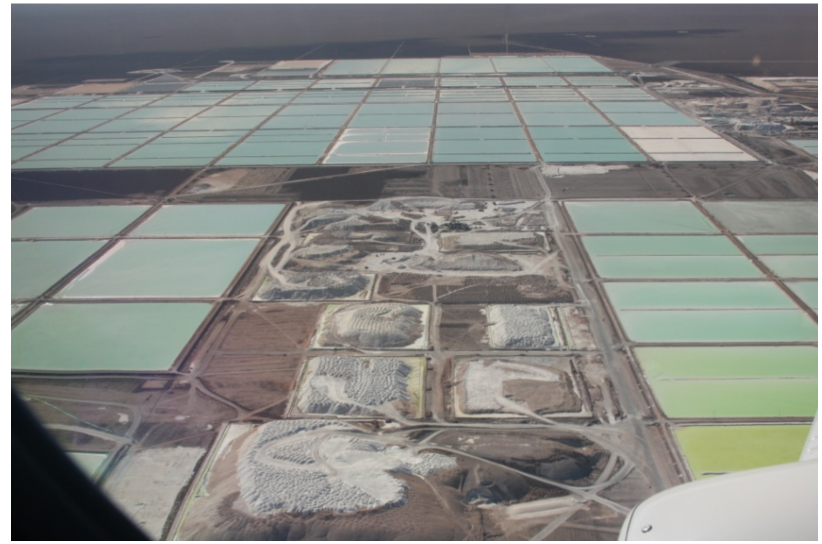
| Mineral | Composition | $K_2O$, % |
|---|---|---|
| Sylvite | $KCl$ | 63.1 |
| Sylvinite | $KCl/NaCl$ mixture | ~ 28.0 |
| Carnallite | $KCl \cdot MgCl_2 \cdot 6H_2O$ | 17.0 |
| Kainite | $4KCl \cdot 4MgSO_4 \cdot 11H_2O$ | 19.3 |
| Langbeinite | $K_2SO_4 \cdot 2MgSO_4$ | 22.7 |
| Polyhalite | $K_2SO_4 \cdot 2MgSO_4 \cdot 2CaSO_4 \cdot H_2O$ | 15.6 |
| Niter | $KNO_3$ | 46.5 |

# Common K Minerals

- Sylvite (KCl) … abundant in commercial deposits
- Sylvinite (KCl + NaCl) also common
- Hartsalz … ore deposits with $SO_4$ salts (kieserite [$MgSO_4$] or anhydrite [$CaSO_4$]) are limited … Europe
- Langbeinite occurs New Mexico and Ukraine

# World Potash Reserves

- About 100 large buried deposits + 100 brine deposits of commercial potential



- The world has an estimated 250 billion metric tons of $K_2O$ resources

*Source: U.S. Geological Survey*

# Potash Resources and Reserves

- Resources include proven, probable, and inferred reserves
  - Reserves: deposits of sufficient quantity and quality that are currently mined
  - Reserve base: reserves + deposits that are marginally economic or sub economic
- U.S. Geological Survey estimates global reserves at 18 billion t $K_2O$ … 8.3 billon t considered commercially exploitable.

*Source: U.S. Geological Survey, Mineral Commodity Summaries and Potash, January 2008*

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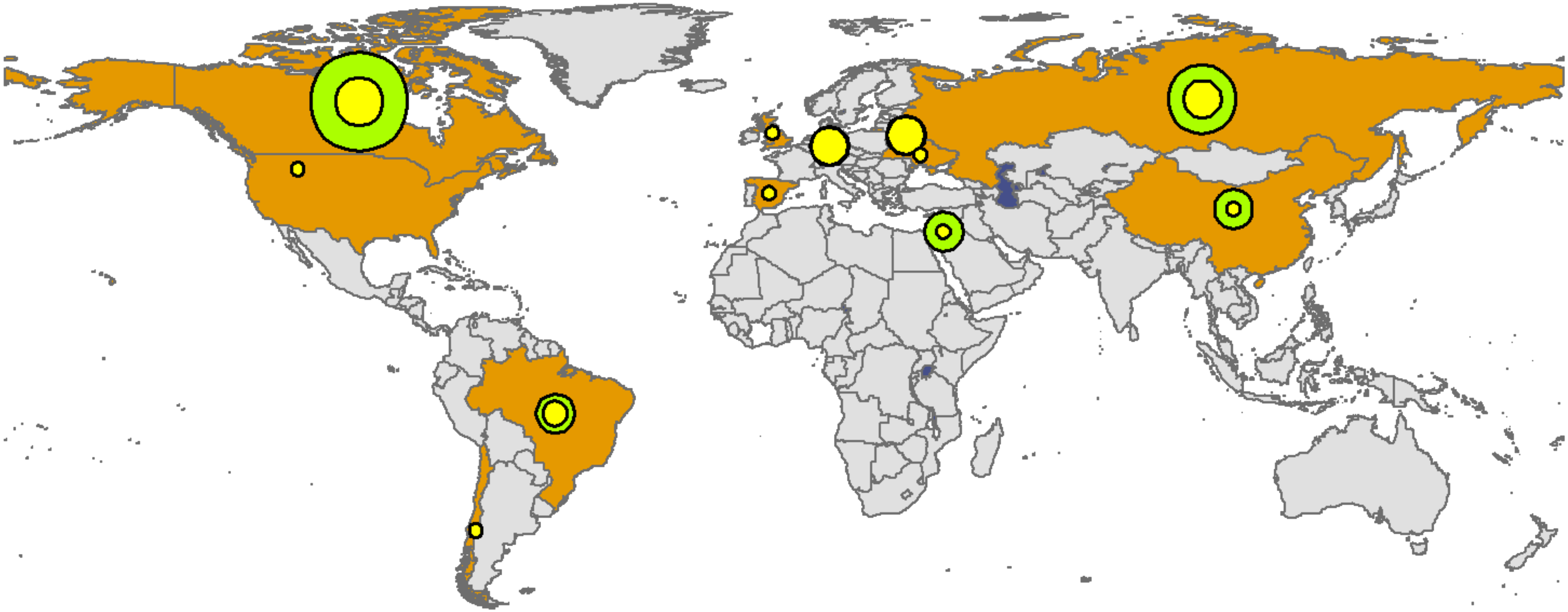
# Potash Reserves and Reserve Base




*Source: U.S. Geological Survey, Mineral Commodity Summaries and Potash, January 2008*

# Potash Deposits – North America

- World's largest reserves occur in Saskatchewan
- Ore is exceptionally high grade (25-30% $K_2O$) at depths of 950-1,100 m increasing to > 3,500 m
- Uniform thickness (2.4-3 m) and mineralization and no structural deformations
- Sylvinite, some carnallite, and clay


Potash Reserves In Saskatchewan

*Source: PPIC 1989*

# Potash Deposits – FSU

- FSU has extensive proven reserves of K minerals … second only to the deposits in Saskatchewan
- Russia – Verkhnekamsk deposit in the Urals near Solikamsk
  - Potash depth at 75 to 450 m in 13 potentially minable beds ranging in thickness from 26 to 30 m (sylvinite) and 70 to 80 m (zone of sylvinite-carnallite).
  - Mined beds 1.2 to 6 m thick with 15% $K_2O$ with 3 to 5% insolubles
- Belarus – Starobinsk deposit is 2$^{nd}$ largest in ore body in FSU near Soligorsk
  - 30 potash beds in 4 horizons. Most mining 350 to 620 m depth in second horizon (1.8 to 4.4 m thick)
  - Sylvinite ore averaging 11% $K_2O$ and 5% insolubles

*Source: Searls 2002, U.S. Geological Survey, Mineral s Yearbook; Stone, 2002, Canadian Minerals Yearbook*

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# Potash Deposits – Western Europe

- Oldest deposits are the Hessen and Thüringen beds in southern Germany
  - contain 15 to 20% sylvite, kieserite, and carnallite (~10% $K_2O$)
  - Beds are relatively flat-lying, but also folding, with some barren zones, sudden thickness changes, etc. making mining difficult
- Also carnallite and kieserite deposits in central Germany and sylvite and carnallite in northern Germany
- Sylvite deposits in England and sylvinite in Spain

*Source: Searls 2002, U.S. Geological Survey, Mineral s Yearbook; Stone, 2002, Canadian Minerals Yearbook*

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# Potash Deposits

- Middle East: K extracted from Dead Sea
  - contains an estimated 1 billion t KCl
- Latin America
  - sylvinite and carnallite in the Sergipe basin in Brazil
  - $KNO_3$ in Chile in Atacama Desert (est. 1 billion t $NaNO_3$ and 100 million t $KNO_3$) and Salar de Atacama, a high-attitude dry lake (brine est. at 120 million t KCl and 80 million t $K_2SO_4$
- Asia : Carnallite and K-bearing brines in Qinghai and Xinjiang Provinces
- Undeveloped Deposits
  - Thailand, Argentina, Amazon Basin in Brazil, Morocco, Poland, and additional deposits in the FSU

*Source: U.S. Geological Survey, Mineral Commodity Summaries and Potash, January 2008*

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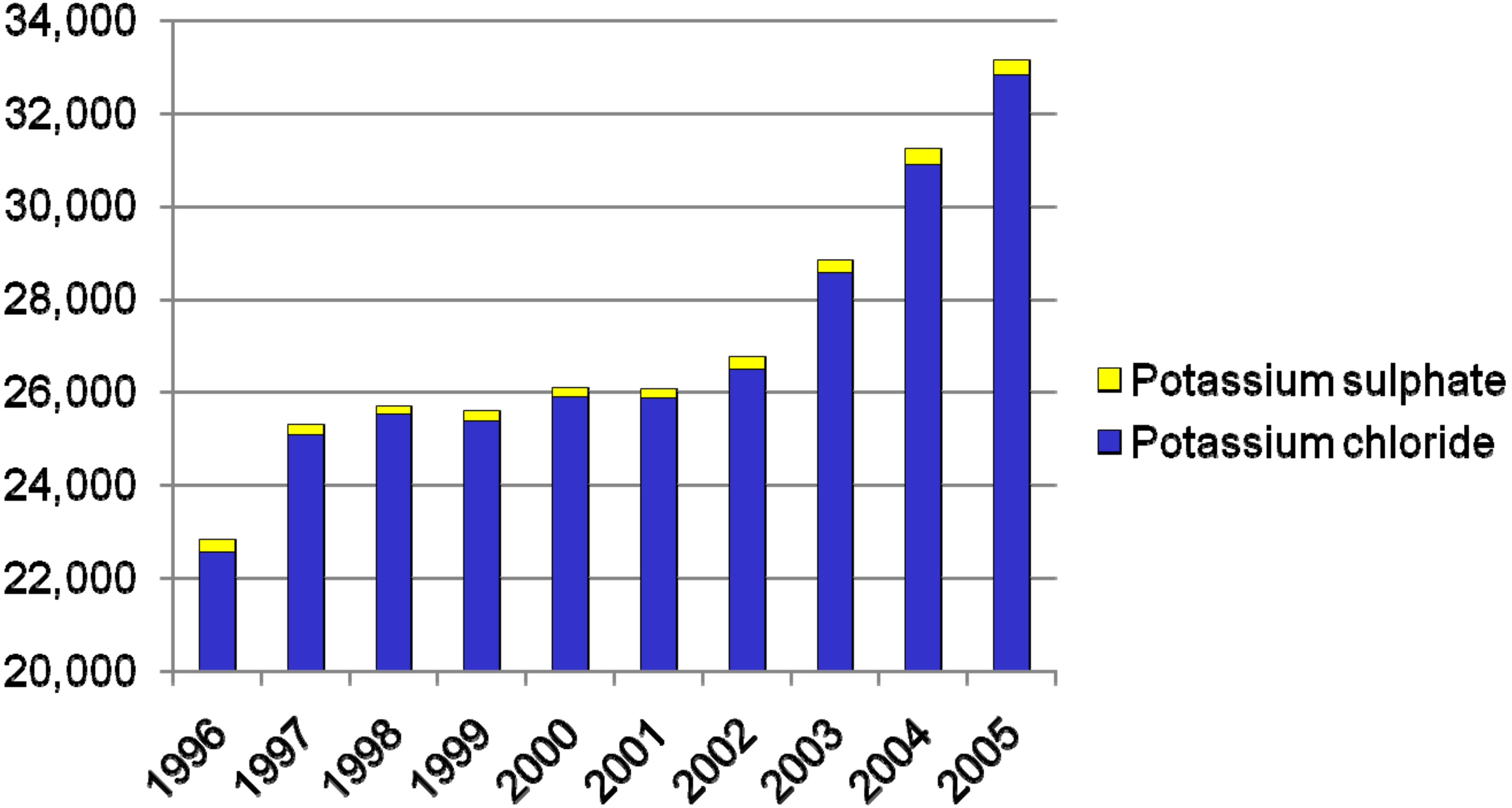
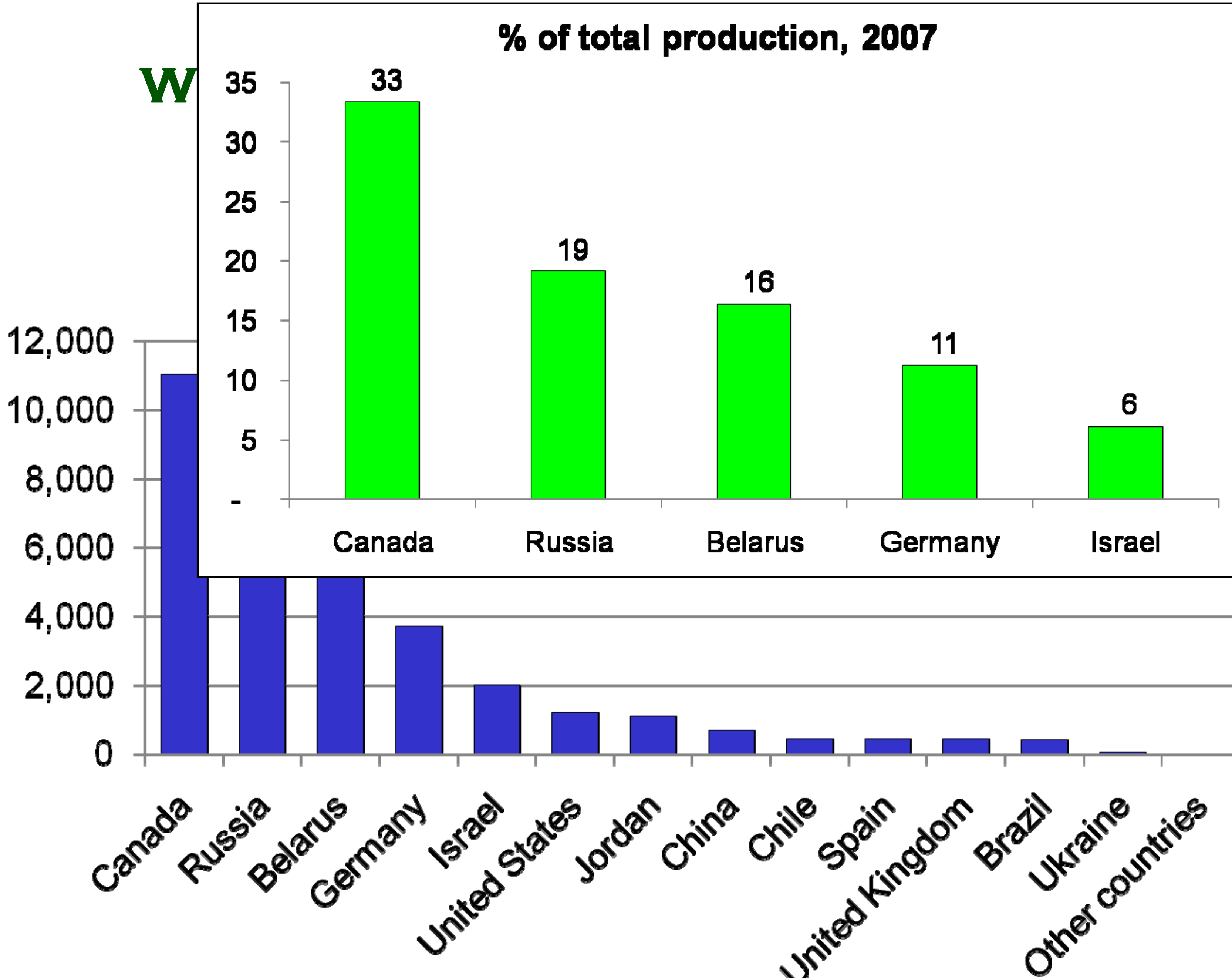
# Production of KCl and $K_2SO_4$, Mt

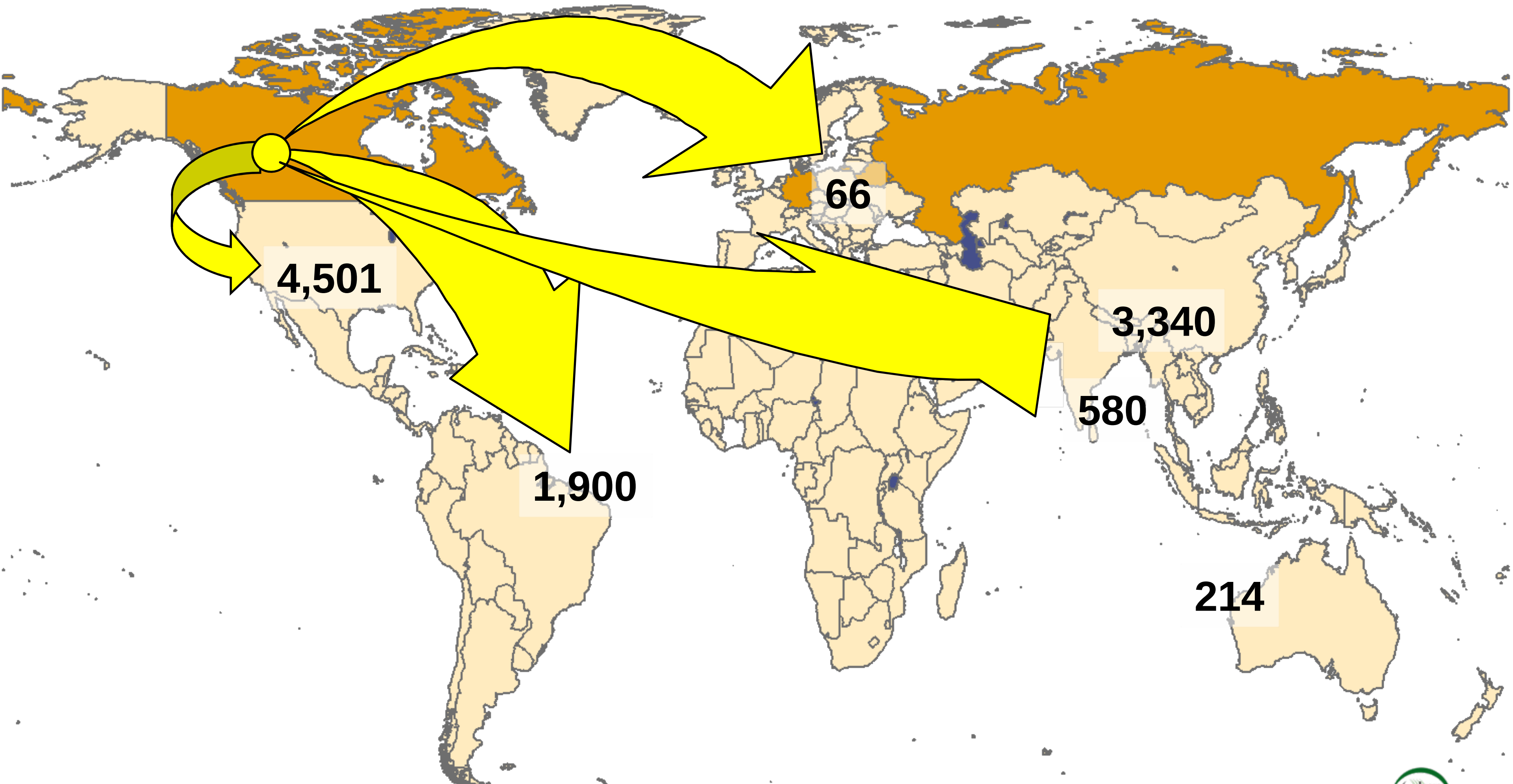



*Source: IFA Statistics*



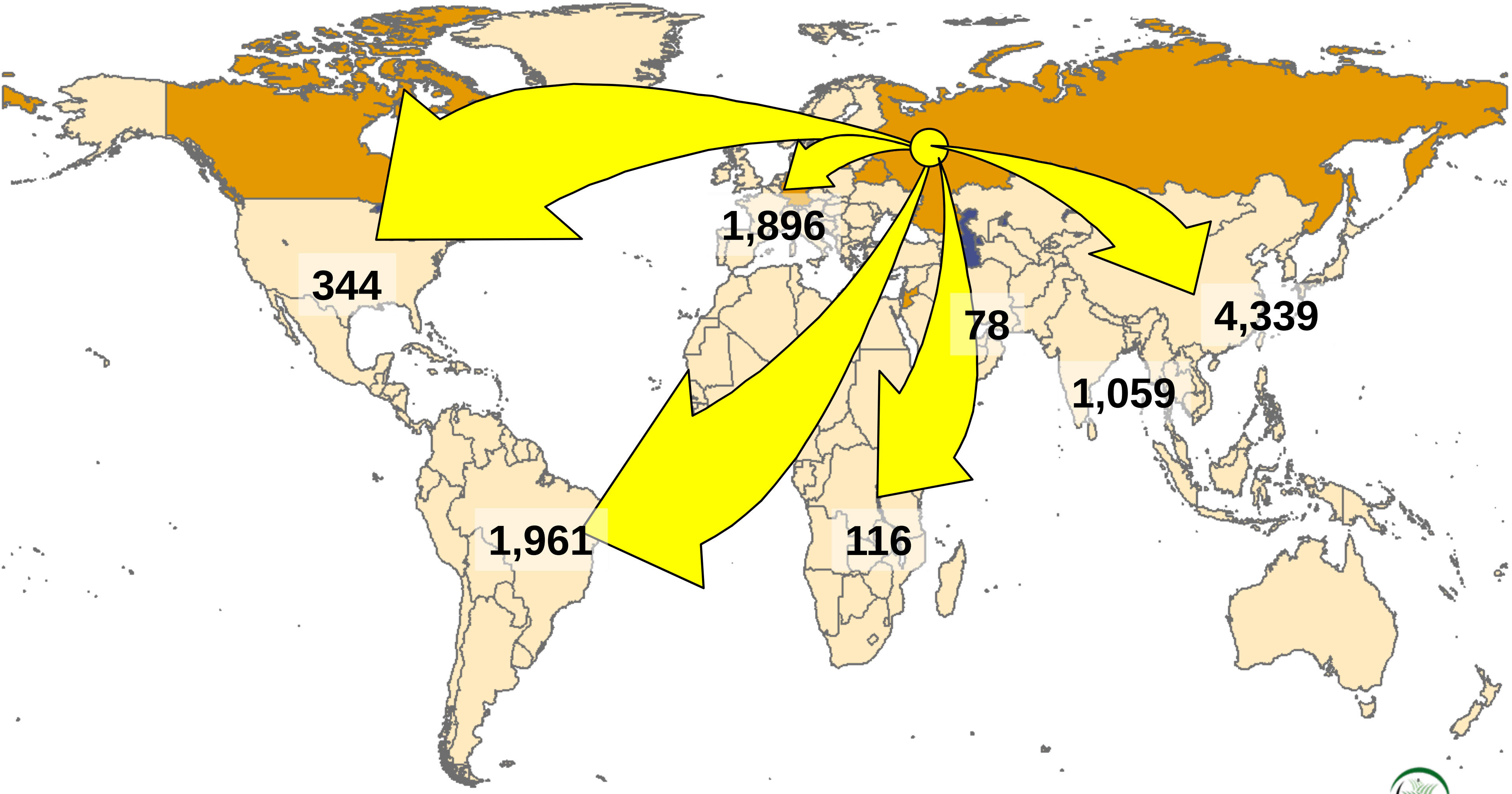

*Source: IFA Statistics*

# Canada: potash export by destination in 2007, '000 t $K_2O$




*Source: IFA Production and Trade Statistics*

# Russia: potash export by destination in 2007, '000 t $K_2O$




Source: IFA Production and Trade Statistics

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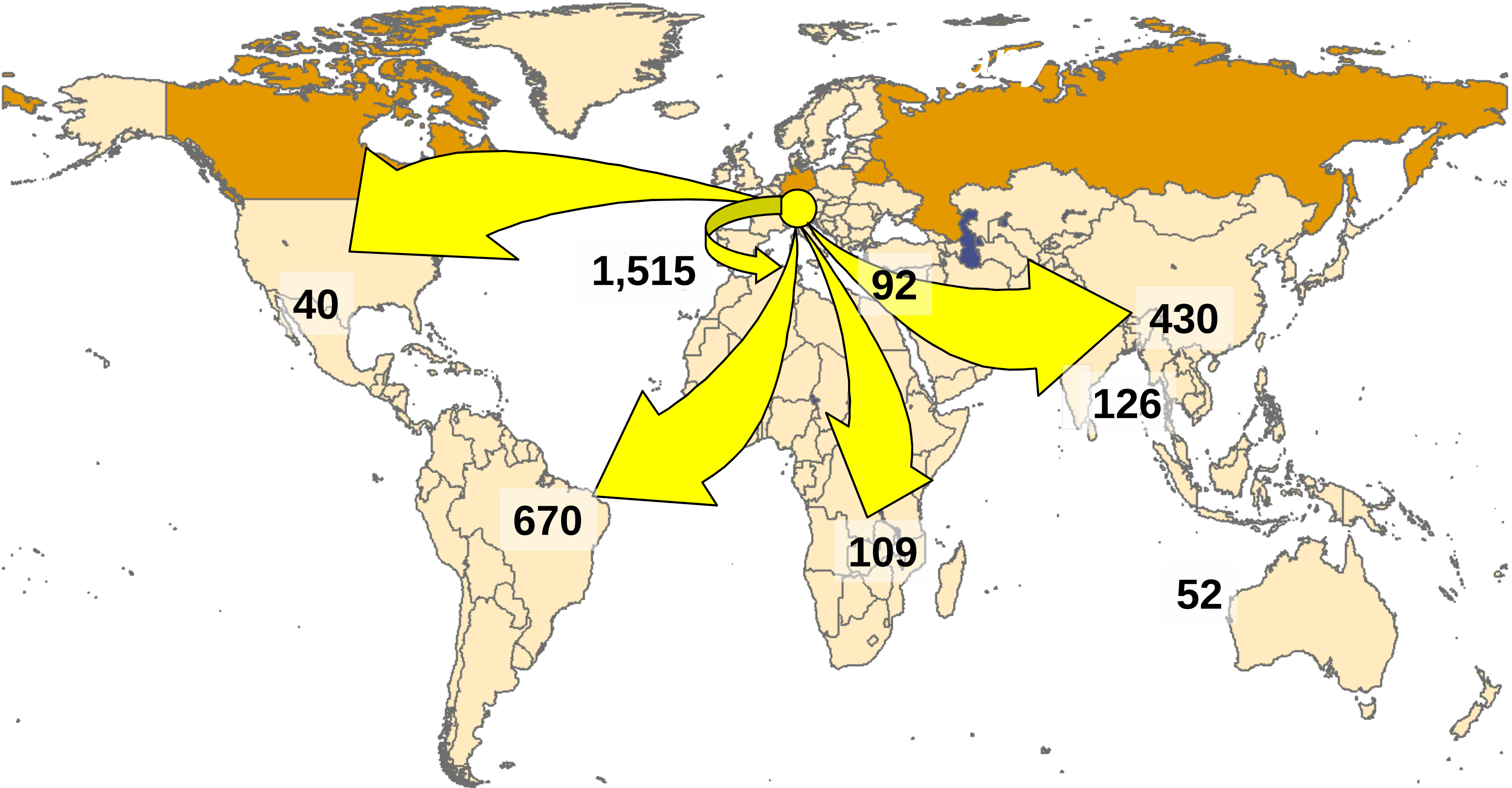
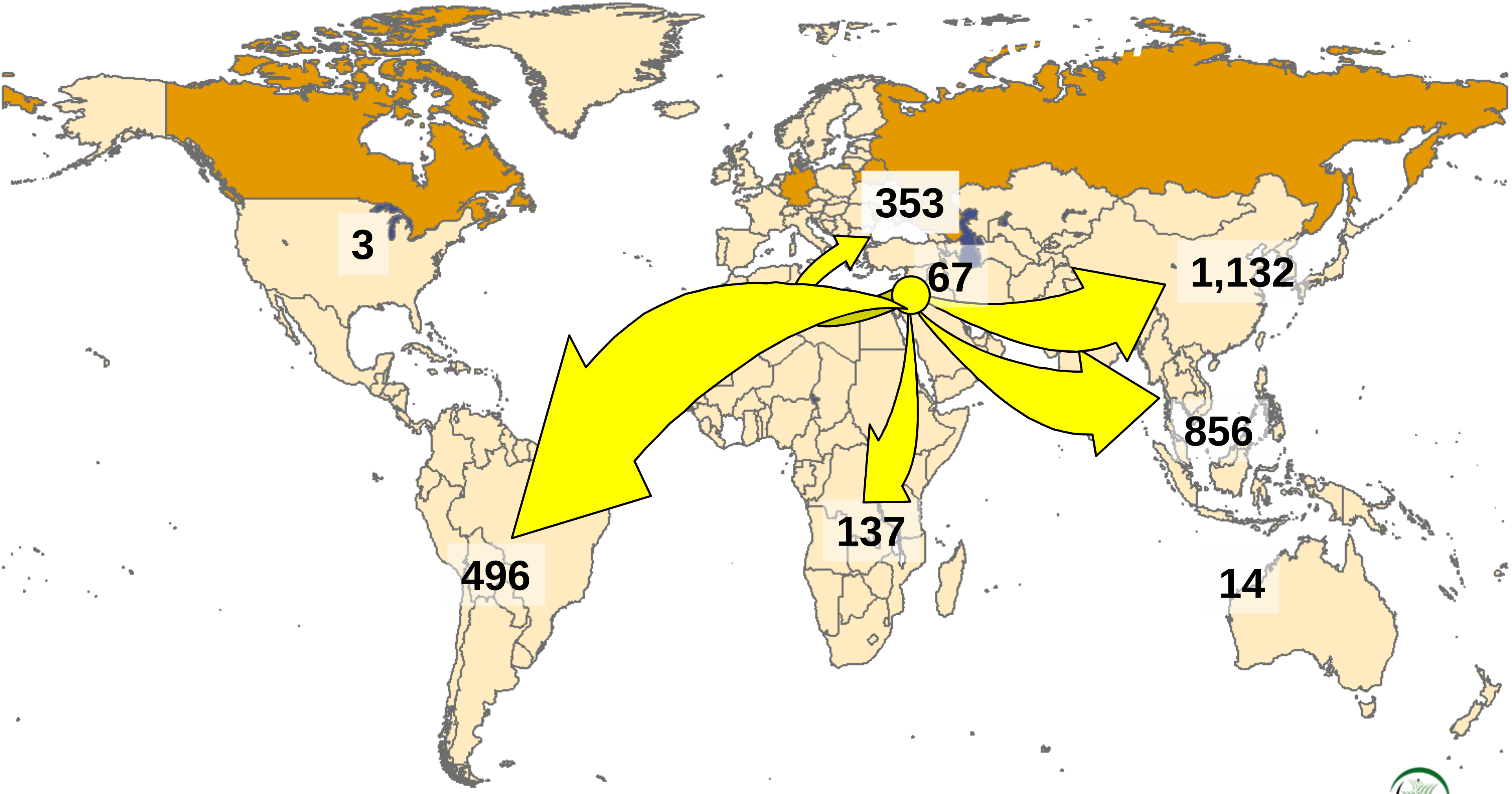
# Germany: potash export by destination in 2007, '000 t $K_2O$



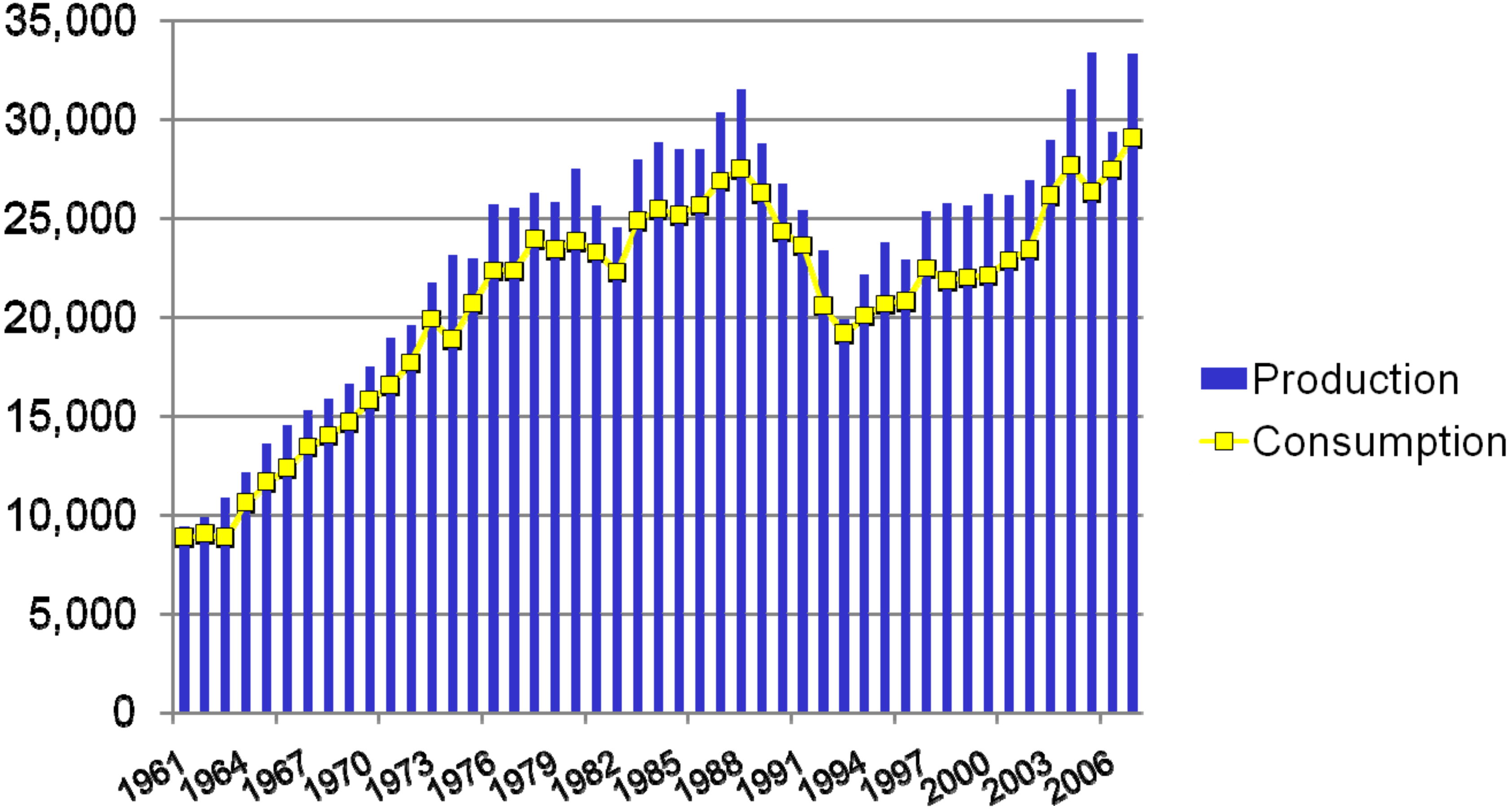

Source: IFA Production and Trade Statistics

# Israel/Jordan: potash export by destination in 2007, '000 t $K_2O$




*Source: IFA Production and Trade Statistics*

# World Potash Production and Consumption, Mt $K_2O$




*Source: IFA Statistics*

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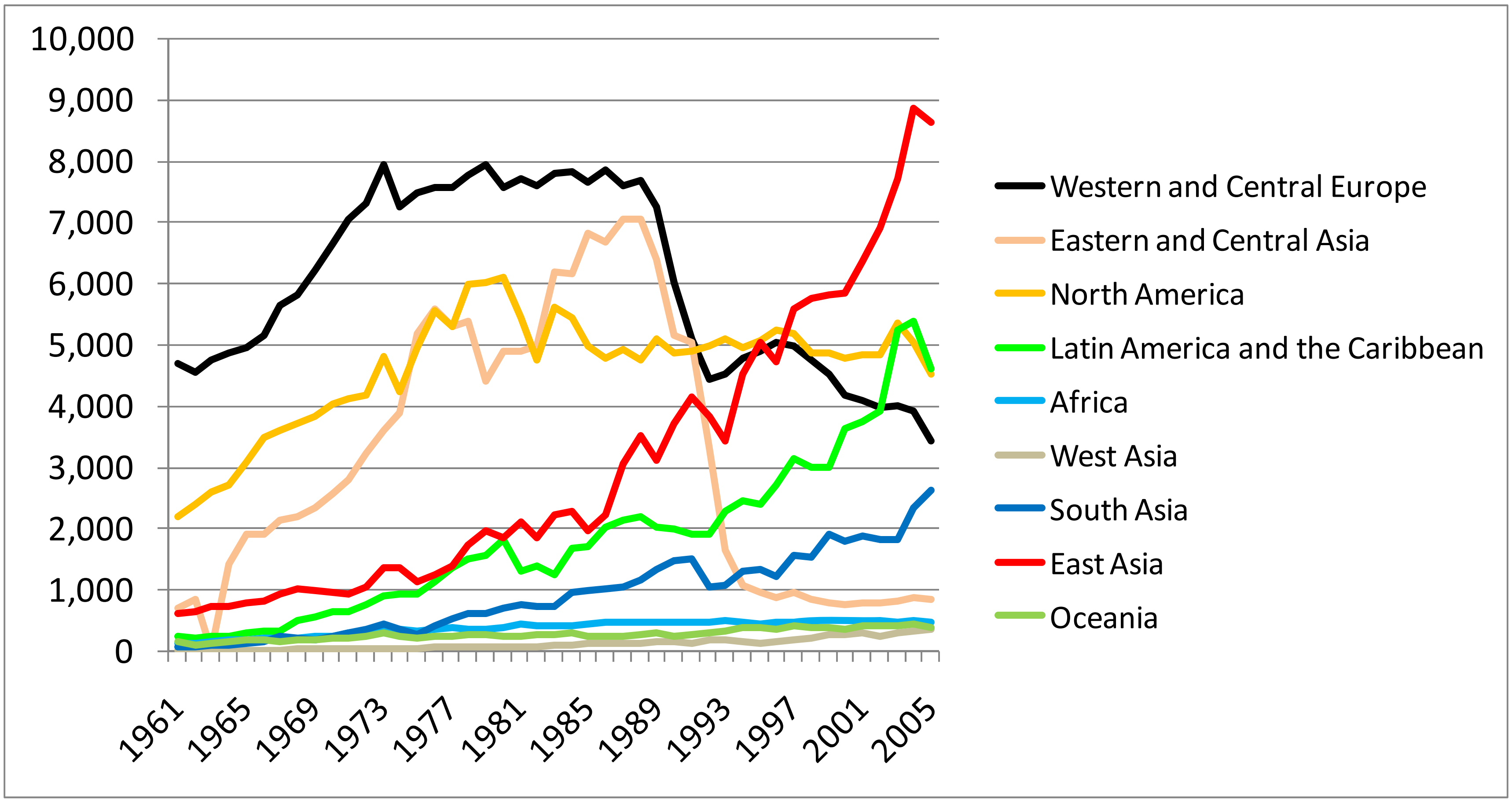
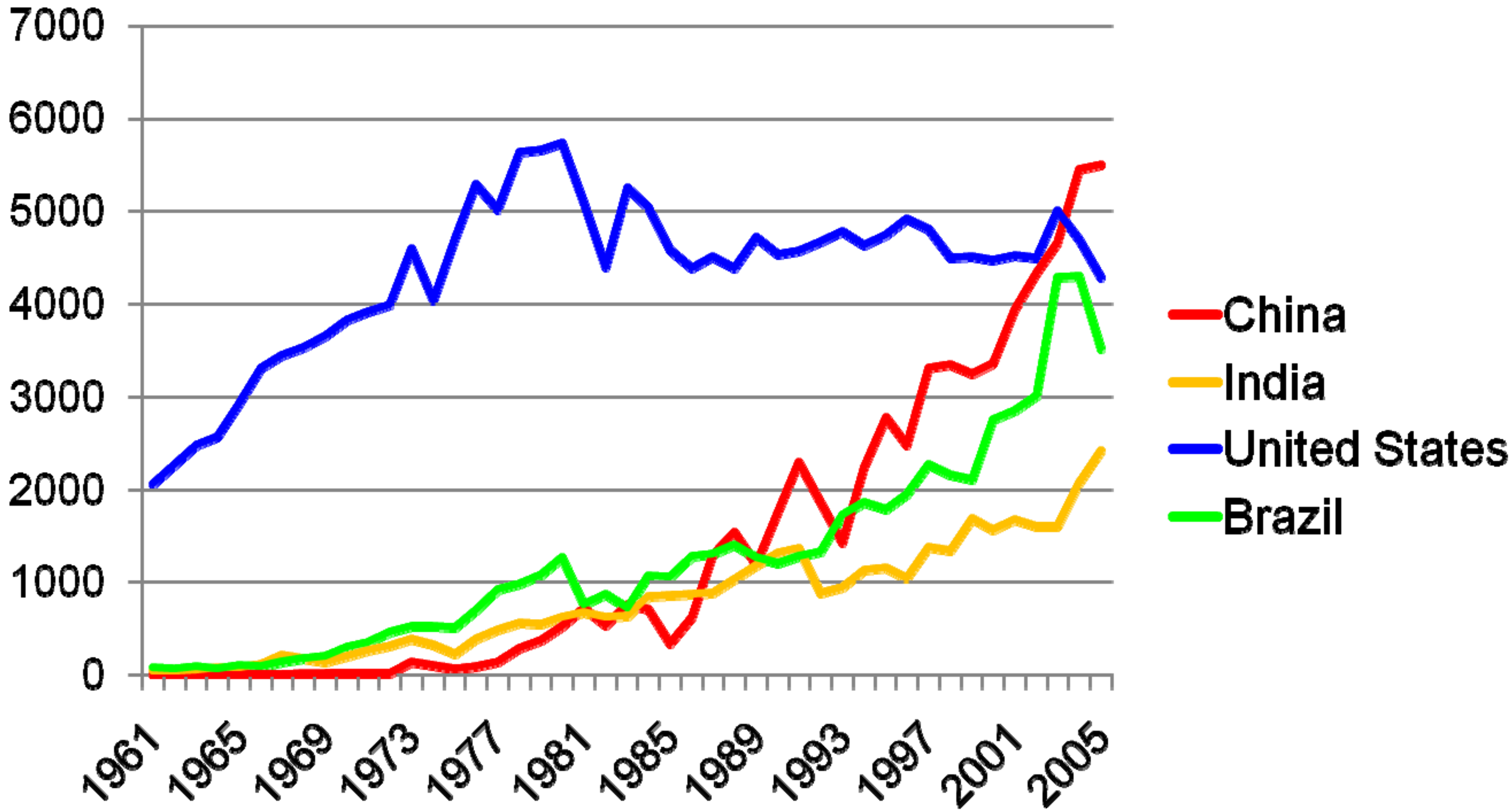
# Regional potash consumption, '000 t $K_2O$




*Source: IFA Production and Trade Statistics*

# Potash consumption, ‘000 t $K_2O$




- 4 countries accounted for two-thirds of potash imports
  - US 18%, Brazil 16%, China 21%, and India 9%

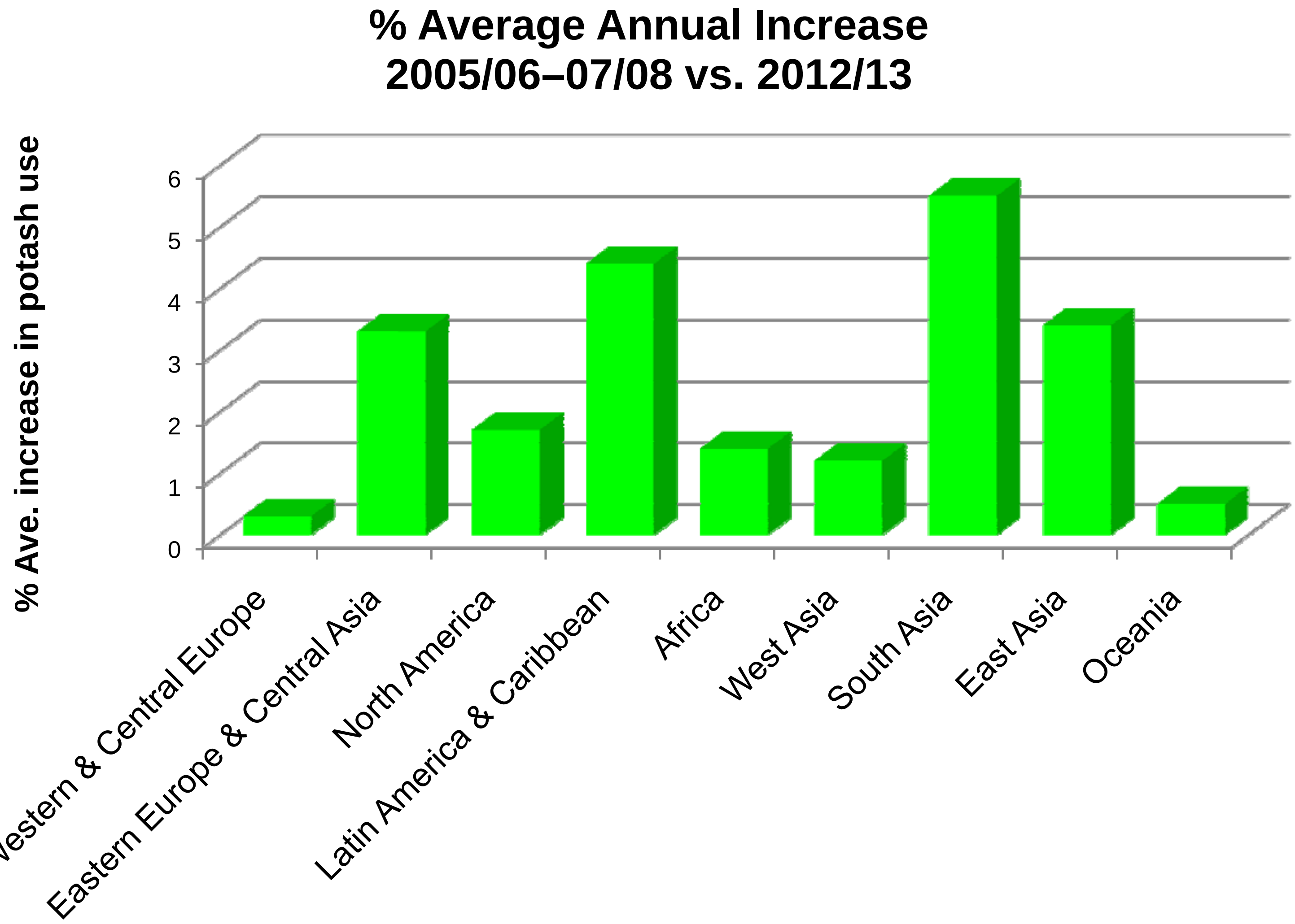
*Source: IFA Production and Trade Statistics*

# Global Fertilizer Consumption Forecasts to 2012/13 (Mt nutrients)

| | N | $P_2O_5$ | $K_2O$ | Total |
|---|---|---|---|---|
| Ave. 2005/06 to 2007/08 (e) | 95.5 | 38.6 | 27.6 | 162.1 |
| 2012/13 (f) | 115.6 | 45.7 | 33.0 | 194.3 |
| Ave. Annual Change | +3.2% | +2.8% | +3.0% | +3.1% |

*Source: P. Heffer, 2008. Medium-Term Outlook for World Agriculture and Fertilizer Demand 2007/08 – 20012/13. IFA Annual Conference, Vienna, Austria*

# Forecast Potash Demand Through 2012/13




*Source: P. Heffer, 2008. Medium-Term Outlook for World Agriculture and Fertilizer Demand 2007/08 – 20012/13. IFA Annual Conference, Vienna, Austria*

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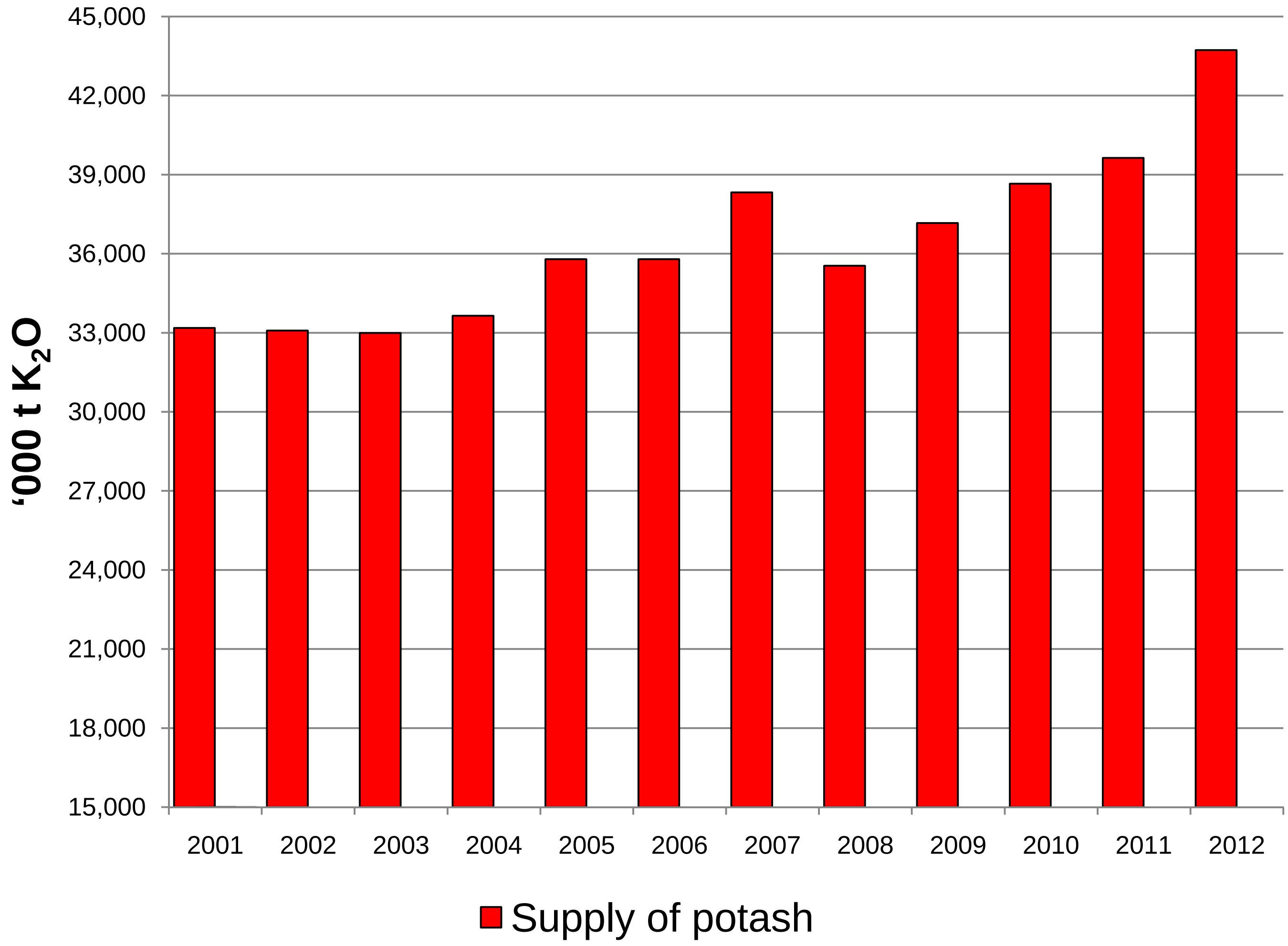
# World potash supply/demand balance




*Source: Prud'homme 2008. Global Fertilizers and Raw Materials Supply and Supply/Demand Balances 2008-2012.IFA Production and Trade*

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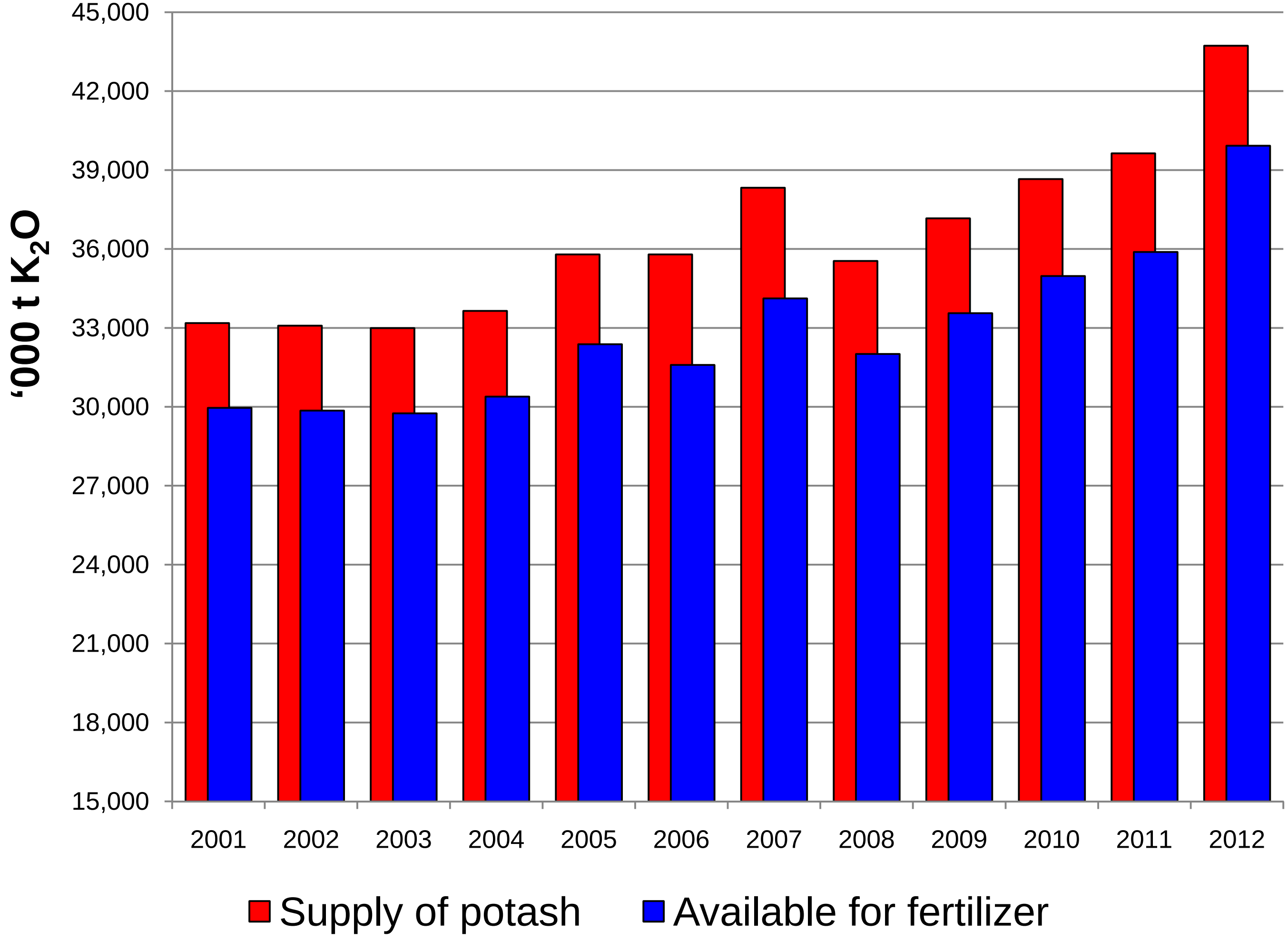


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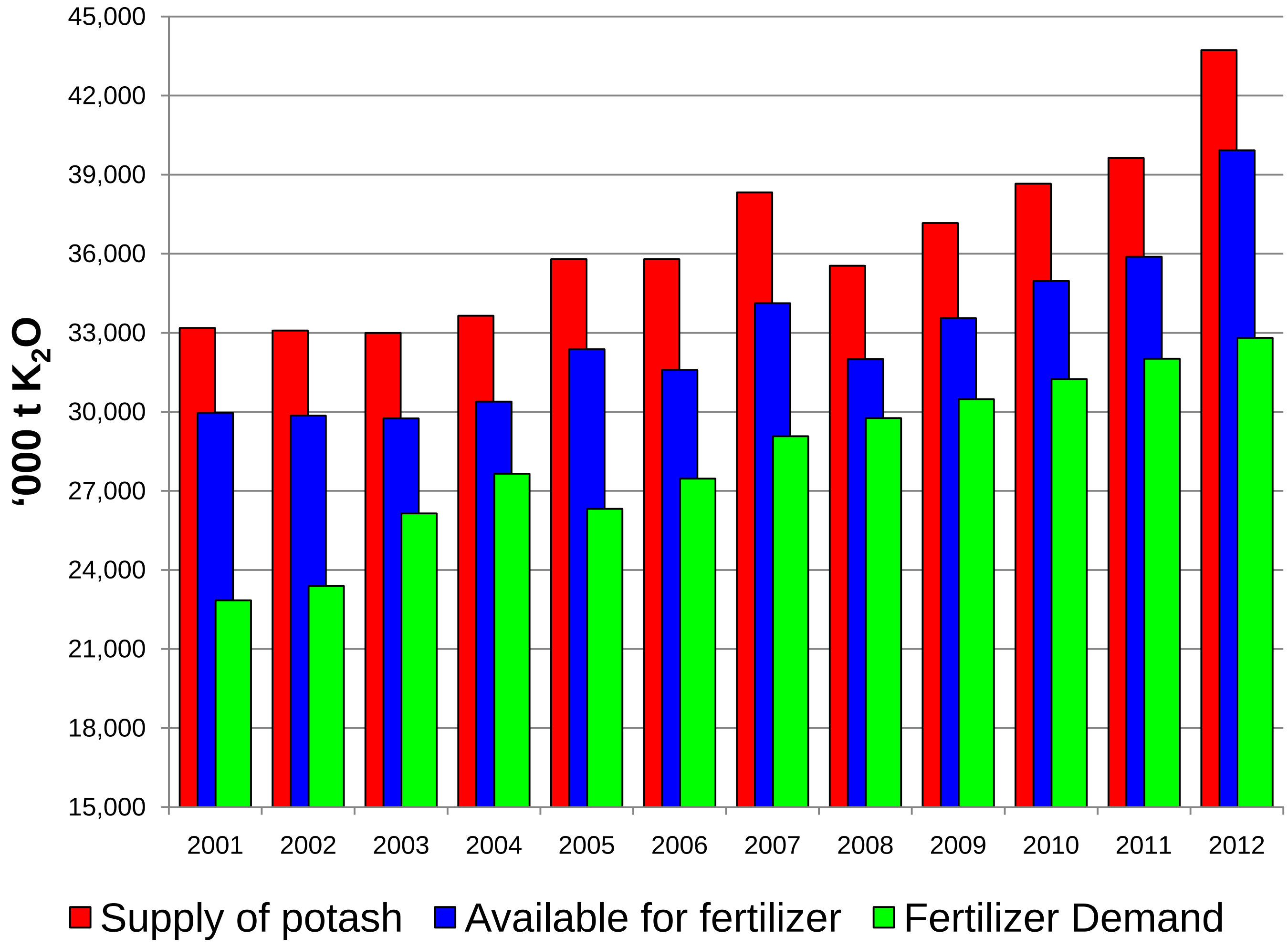


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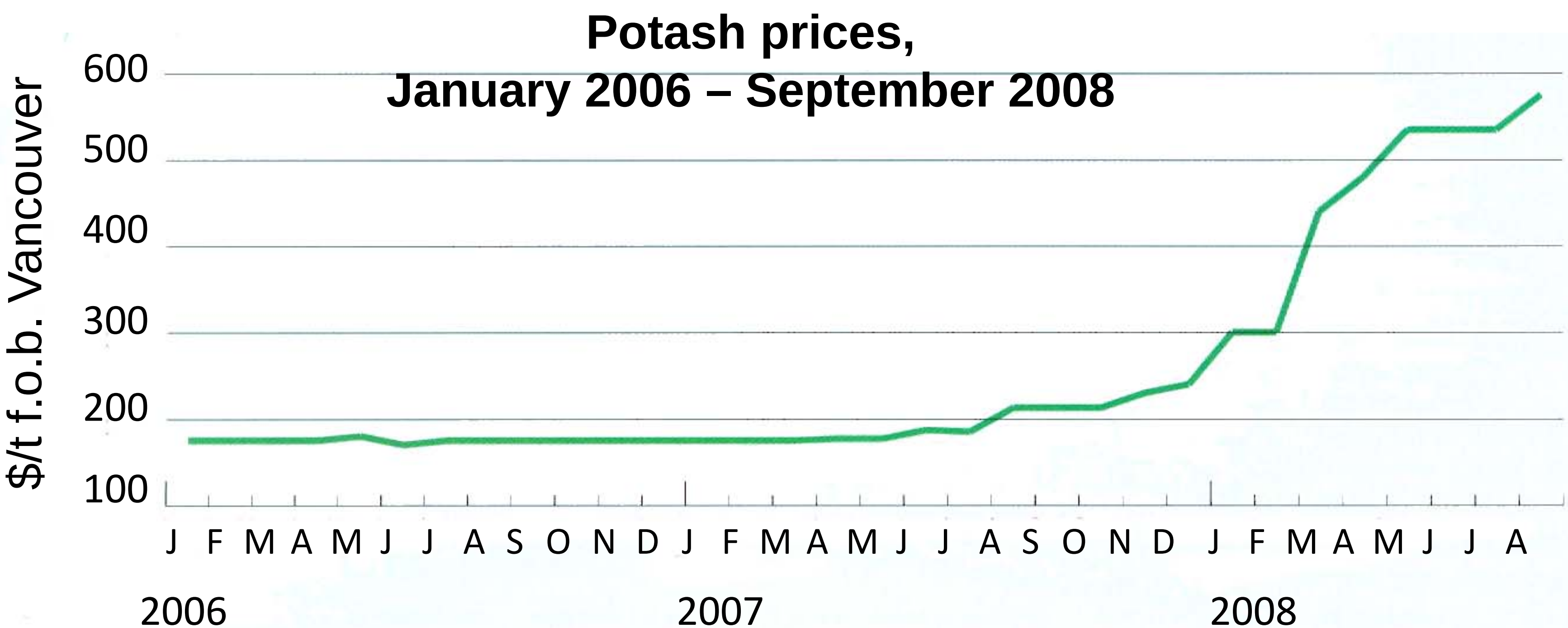
# World potash supply/demand balance

- Supply/demand balance is considered very tight and is expected to be so for the next few years … triggered an increase in world potash prices



# New Potash Capacity 2008 to 2012

| Year | Mt $K_2O$ | Country |
| --- | --- | --- |
| 2008 | 0.0 | |
| 2009 | 0.84 | Jordan, Russia, Israel, Canada, USA |
| 2010 | 1.02 | Canada, Russia, Israel |
| 2011 | 1.14 | Canada, Russia, Israel |
| 2012 | 4.74 | Canada, Argentina, Belarus, Jordan |
| Total | 7.74 | |

*Source: Prud'homme 2008. Global Fertilizers and Raw Materials Supply and Supply/Demand Balances 2008-2012.IFA Production and Trade*

# Tight supply/demand balance ... new interest in potash mining

- Saskatchewan is the world's largest producer with 37% of supply and > 50% of global potash reserves
  - No potash exploration permits issued 15 years prior to 2004 ... next 3 years the area under lease increased from 250,000 to 3 million hectares
  - New companies ... BHP Bilton, Potash One Inc., Potash North Resource Corp., Athabasca Potash, Ivany Potash, Sidon International Resources, Grizzly Diamonds Ltd., Alix Resources Corp., Geo Minerals Ltd., and JSC Acron
- Estimated capital cost for a conventional mine ... $2.8 billion, excluding infrastructure outside the plant gate and with no production for 5-7 years.

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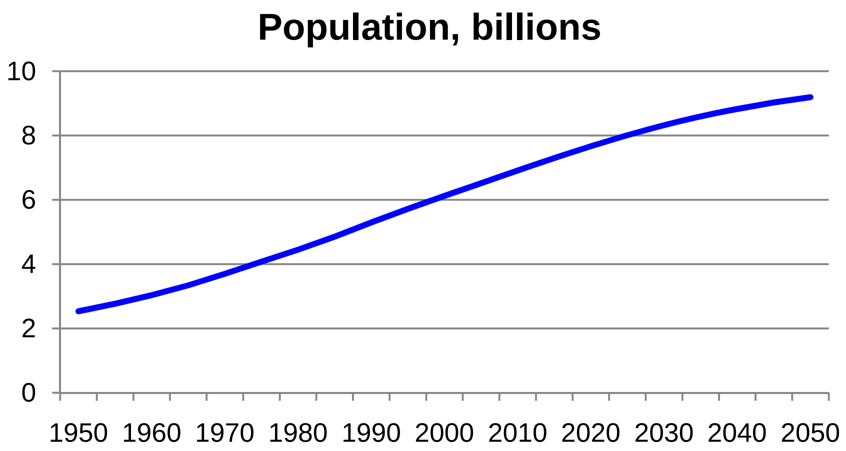
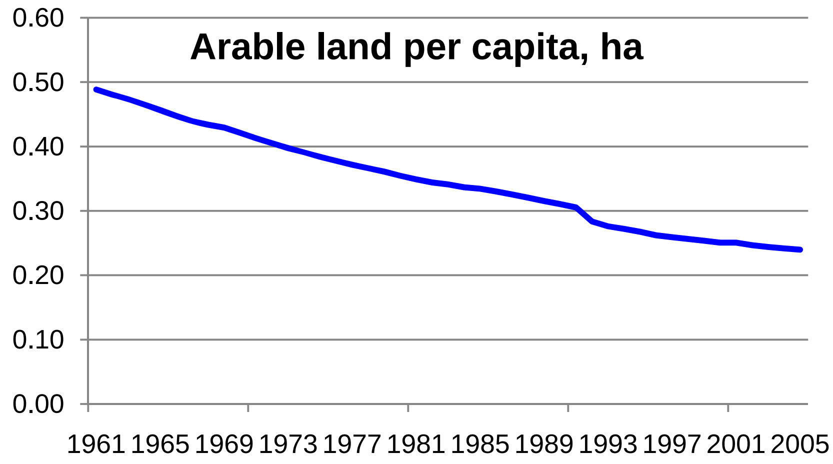
# Why the increased demand for fertilizer?

- Increased food demand and less land to produce it

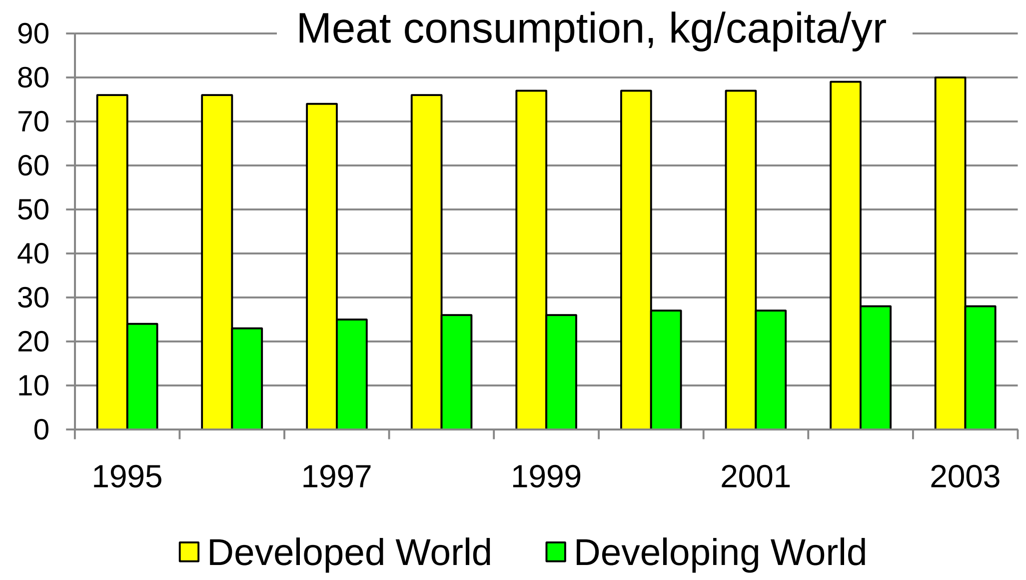



*Source: FAO*

# Why the increased demand for fertilizer?

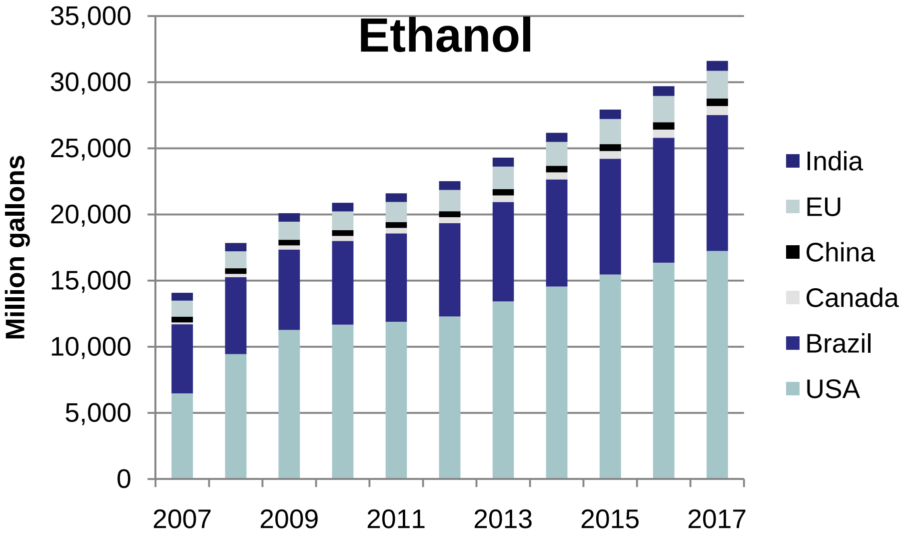
- Diets are changing … more protein
- Requires more feed grains to produce protein
  - 7 kg/kg beef,
  - 4 kg/kg pork, and
  - 2 kg/kg poultry

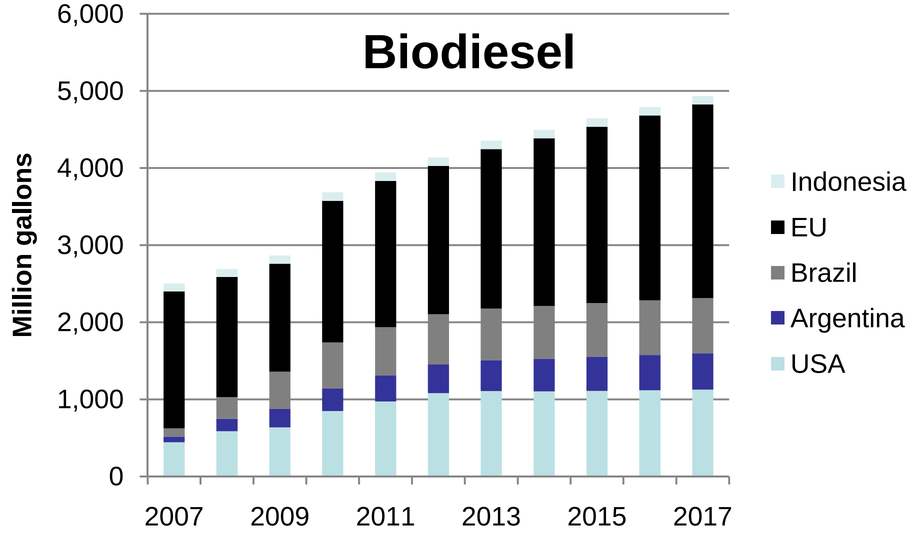



*Source: FAO*

# Why the increased demand for fertilizer?

- Biofuels … continued expected growth … leads to increasing demand for corn and other crops

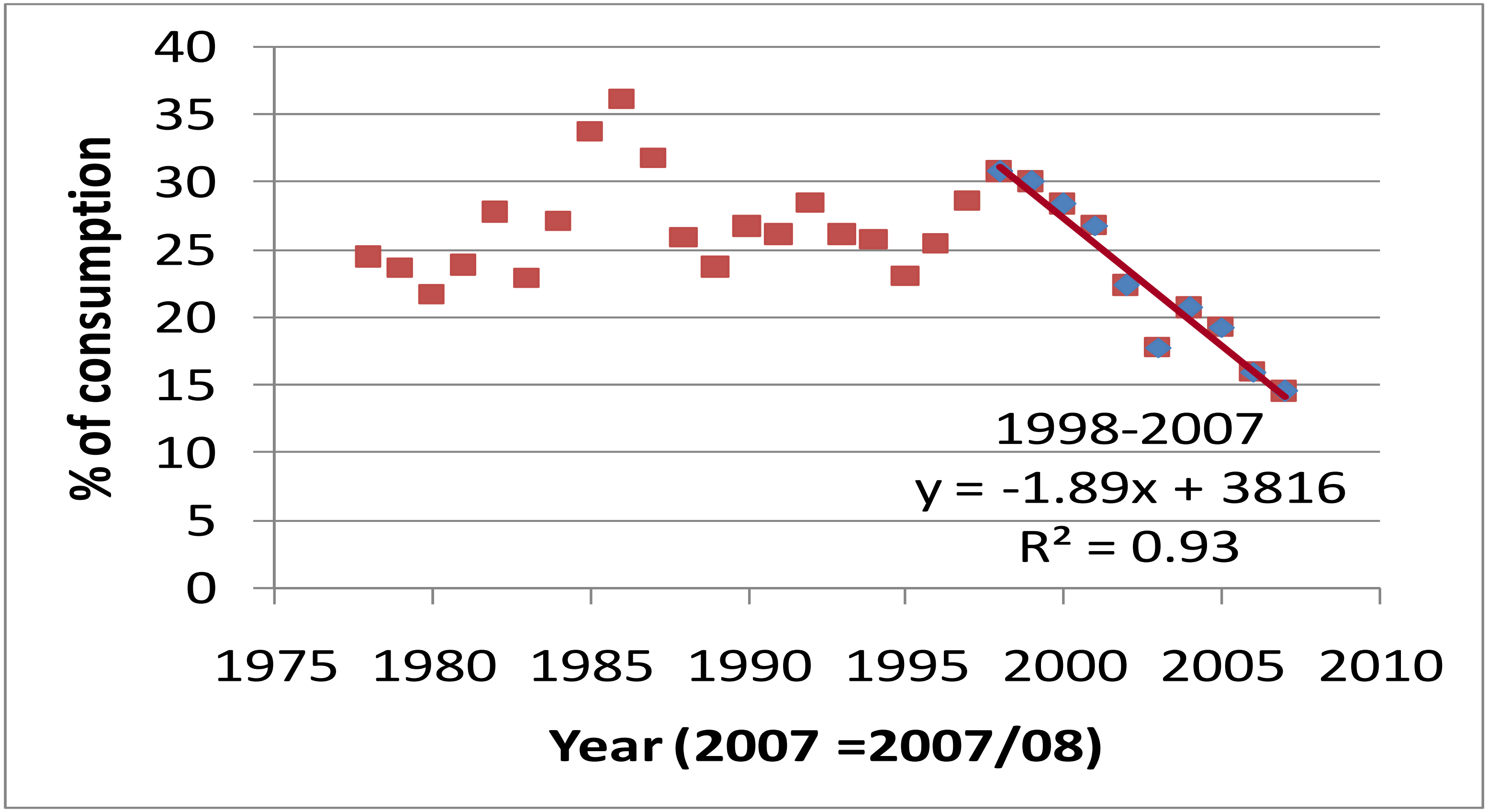



*Source: FAPRI 2008*

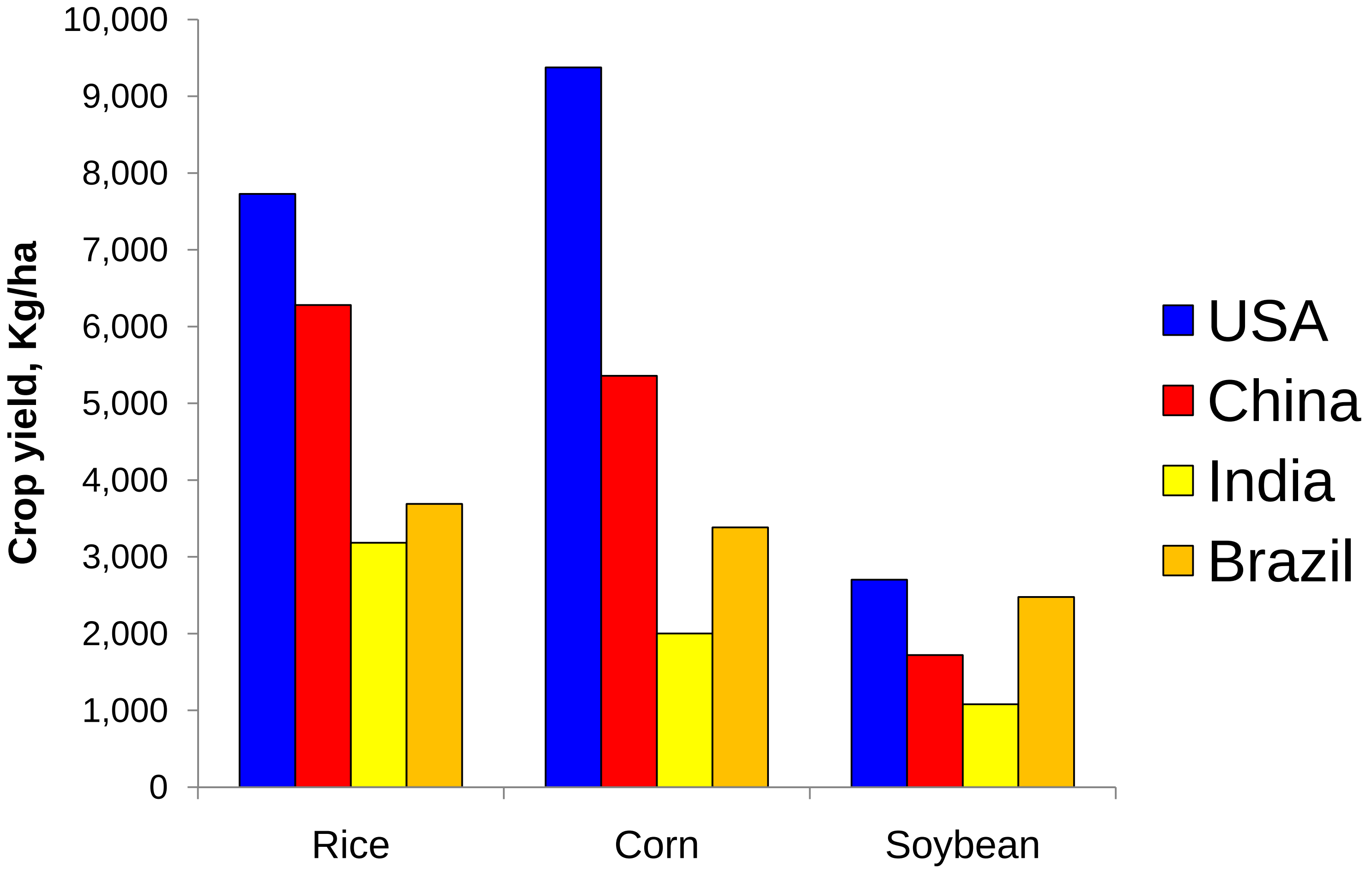
# Why the increased demand for fertilizer?

**World wheat plus coarse grains ending stocks**




*Source: USDA-FAS, 12/2007*

# Low crop yields in the developing world (Ave. 2005 – 2007)




*Source: FAO*

# Concluding Remarks

- Global potash supply/balance will remain tight through 2012
  - During this time demand will absorb capacity increases
  - Potential surplus … 2.2 and 3.9 Mt $K_2O$, which is considered marginal given plant's production configuration and ramp-up stages
- 2012 … potential capacity should exceed demand

# Concluding Remarks

- At present levels of production (33 Mt $K_2O$ per year) and with current/planned capacity, the industry can easily meet future demand
- Reserves (8.3 billion t) are sufficient to supply potash for 250 years … another 250+ considering the reserve base (18 billion t)
- Allowing for known resources (250 billion t) … there is sufficient potash to meet demand for thousands of years

# Thank You