# Fertilizer **Indicators**

May 2013

International Fertilizer Industry Association

"IFA serves its member companies throughout the entire supply chain that contribute to global food security through the efficient and responsible production, distribution and use of plant nutrients on a world wide basis."

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# Fertilizers: nutrients for crops

**HUMANS**

| Essential elements | Sources |
|---|---|
| Protein, fats and carbohydrates, vitamines and minerals | Crops<br>Animals |

**CROPS**

| Essential elements | Sources |
|---|---|
| N, P, K, Ca, Mg, S and micronutrients | Soils<br>Manufactured fertilizers<br>Manure, compost, sewage<br>Atmospheric deposition |

Humans, animals and plants all need nutrients to survive. Nutrients can be '**macronutrients**' – because these are needed in greater quantities – such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sulphur (S) and magnesium (Mg) or '**micronutrients**' such as zinc (Zn), copper (Cu), iron (Fe), boron (B), and molybdenum (Mo) because they are needed in lesser quantities. Humans consume crop and animal products for nourishment while crops get most of their nutrient requirements from the soil. However, many soils do not provide all the nutrients in quantities needed by the crops. Soil nutrients removed by continuous cropping must be replaced through the addition of nutrient sources, such as fertilizers.

Fertilizers are any solid, liquid or gaseous substances containing one or more plant nutrients in known amount, that is applied to the soil, directly on the plant (foliage) or added to aqueous solutions (as in fertigation) to maintain soil fertility, improve crop development, yield and/or crop quality.

The purpose of fertilizer use, especially for higher yields, is identical in temperate and tropical climates:

- to supplement the natural soil nutrient supply and build up soil fertility in order to satisfy the demand of crops with a high yield potential;

- to compensate for the nutrients exported by the harvested products or lost by unavoidable leakages to the environment in order to maintain good soil conditions for cropping.

Fertilizers are classified into two major forms:

- organic,
- mineral/manufactured.

Manufactured fertilizers are classified according to different criteria as follows:

- Number of nutrients
  - single-nutrient or straight fertilizers (whether for macro or micronutrients)

    *examples:* urea (46-0-0), triple superphosphate (0-46-0), muriate of potash (0-0-60), zinc/iron chelates, boric acid, etc.
  - multi-nutrient/compound (multiple nutrients) fertilizers, with 2, 3 or more nutrients

    *examples:* compound fertilizers (15-15-15), diammonium phosphate (18-46-0), monopotassium phosphate (0-47-31), etc.

- Type of combination
  - mixed fertilizers or 'bulk-blends' are physical mixtures of two or more single-nutrient or multi-nutrient fertilizers;
  - complex fertilizers are products in which two or more of the nutrients are chemically combined (e.g. nitrophosphates, ammonium phosphates).

**Fertilizer grade** is the nutrient content expressed in weight percentages of N, $P_2O_5$ and $K_2O$ in that order. It normally includes only that amount of nutrients found by prescribed analytical procedures. For example, a grade of "46-0-0" (urea) indicates a fertilizer containing 46% N, while a grade of "0-46-0" (TSP) indicates a fertilizer containing 46% $P_2O_5$ and a grade of "0-0-60" (MOP) indicates a fertilizer containing 60% $K_2O$. A grade containing "10-15-18" indicates a fertilizer containing 10% N, 15% $P_2O_5$ and 18% $K_2O$ as found by prescribed analytical procedures.

In some instances "grade" is also referred to as "analysis".

In these Indicators: – fertilizers shall be interpreted as mineral/manufactured fertilizers – Mt=million tonnes

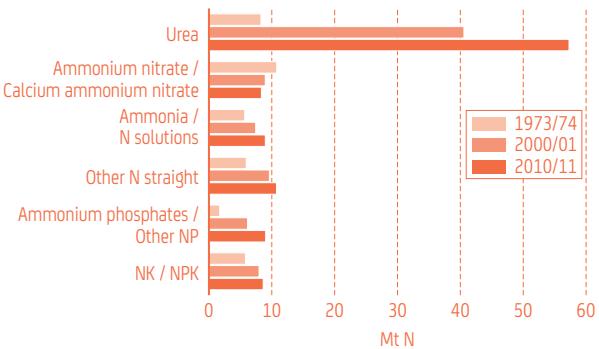
- **Physical condition**
  - solid (crystalline, powdered, prilled or granular) of various size ranges;
  - liquid (solutions and suspensions);
  - gaseous (liquid under pressure, e.g. ammonia).

- **Nutrient release**
  - quick-acting (water-soluble and immediately available);
  - slow-acting (transformation into soluble form required, e.g. direct application of phosphate rock);
  - controlled-release by coating;
  - stabilized by inhibitors.

The principles of the right use of nutrient source, rate, time and place form the minimum basis of any local nutrient stewardship system. Best management practices must be applied to all of these areas to achieve local economic, social and environmental goals.

# Main fertilizer products

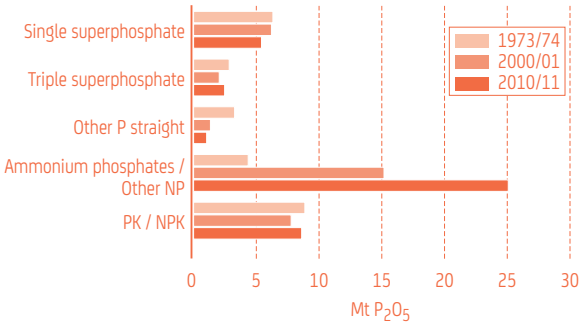
### World nitrogen fertilizer consumption




Nitrogen is the most consumed nutrient, due to its important role in crop production (N is an important component of many structural, genetic and metabolic compounds in plant cells). World demand

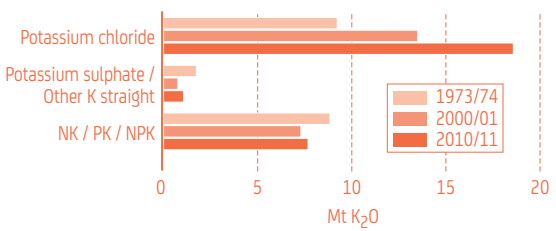
for high-analysis, easy to transport fertilizer products is steadily increasing. Urea (46-0-0) is currently the most popular N fertilizer source with about 56 percent of the world market and represents the major sectoral growth in the nitrogen industry. The growth in demand has stimulated a growth in production.

## World phosphate fertilizer consumption



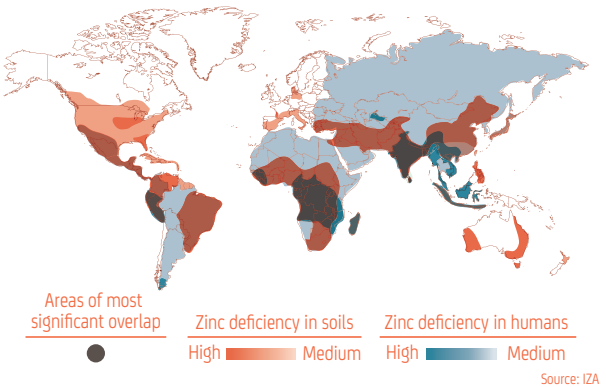

The trend in phosphate consumption by product shows that the single superphosphate (SSP) share in the P market has dropped over the years. This is due to the continuous increase in the use of high-analysis P fertilizers, such as ammonium phosphates, mainly diammonium phosphate (DAP), the share of which increased to more than 50 percent of the global P market. DAP is the most consumed P fertilizer worldwide, due to its high P and N concentration.

## World potash fertilizer consumption



Potassium chloride or muriate of potash (MOP) is the most used K fertilizer product worldwide, accounting for almost 70 percent of all demand for K fertilizers. In some countries, such as the United States, Brazil or India, it accounts for more than 90 percent of all K fertilizer sold.

## Zinc deficiency map




Source: IZA

Proper management of fertilizers can impact the composition of food crops and can contribute to healthy lives. For example, the zinc fertilization of wheat in Central Anatolia in Turkey and the supplementation of fertilizers with selenium in Finland have contributed not only to increased productivity but to improved human health in these countries. Enhancing the levels of health-beneficial compounds could be considered as a fertilization objective as well. For instance, K fertilization can enhance antioxidant concentration in tomato fruits and soybean seed.

*For further information*:
**Fertilizing crops to improve human health: a scientific review**
T.W. Bruulsema, P. Heffer, M.R. Welch, I. Cakmak, K. Moran.
IPNI, IFA, October 2012. 290 pp.
www.fertilizer.org in section Library/Fertilizer use

# Fertilizer consumption

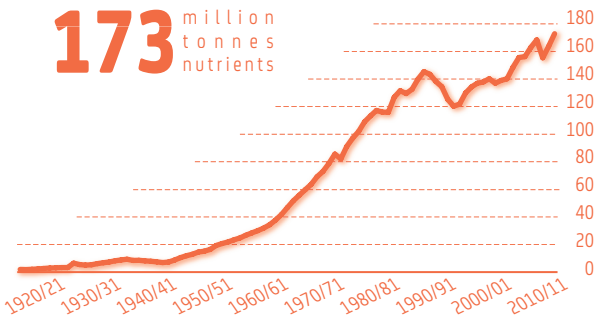
There are three main sources of growth in crop production:

- expanding the land area;
- increasing the frequency with which it is cropped;
- boosting yields.

Given the limited availability of arable land, sustainable intensification of agriculture where fertilizers play an important role is the way forward. Fertilizers in combination with good agricultural practices can increase crop yields, helping food production to keep pace with population growth while minimizing their impact on the environment.

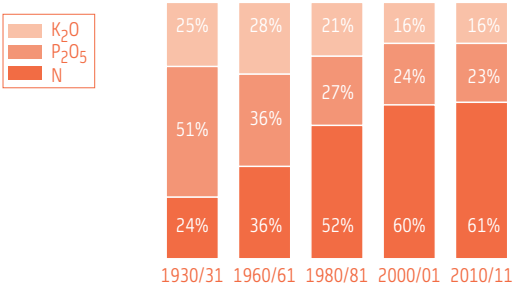
Countries in sub-Saharan Africa, with the lowest levels of mineral fertilizer use per hectare also have the lowest levels of agricultural productivity and the highest levels of hunger.

**Global fertilizer consumption**



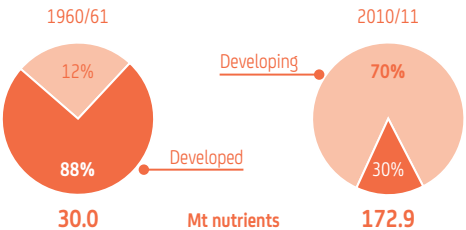

World fertilizer consumption has been increasing steadily with a temporary halt in the early 1990s due to the collapse of the Former Soviet Union. Global consumption in 2010/11 is estimated at some 173 Mt nutrients.

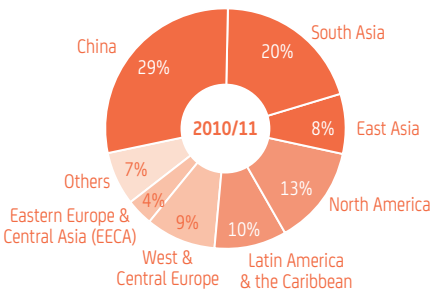
## Relative importance of N, $P_2O_5$ and $K_2O$ in global consumption




N fertilizer has driven expansion of world fertilizer consumption in the past half century. Underuse of P and K relative to N raises concerns in many parts of the world as it leads to unbalanced nutrition.

## Global fertilizer consumption - regional shares

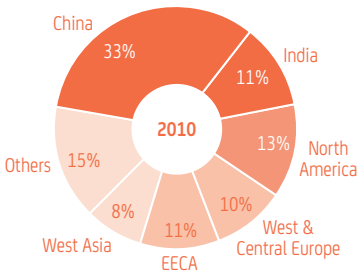



Over the past five decades, most of the growth in demand came from developing countries, especially from Asia.

# Fertilizer production

## Nitrogen fertilizer production

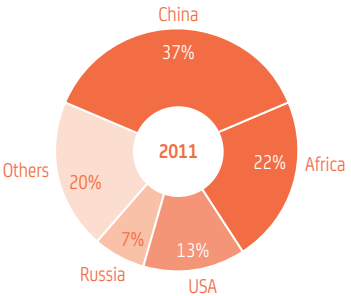




Since 1980, the share of nitrogen fertilizer production from developing countries has more than doubled. Most of this expansion was observed in China, and to a lesser extent in India, Pakistan, and Brazil as these countries invested in new capacity to reduce their high reliance on imports.

In 2010, China accounted for one-third of world production of nitrogen fertilizers, following a massive increase in high-analysis fertilizers (urea) and a certain rationalization of low-grade N fertilizer capacity (notably ABC).

## Phosphate rock production

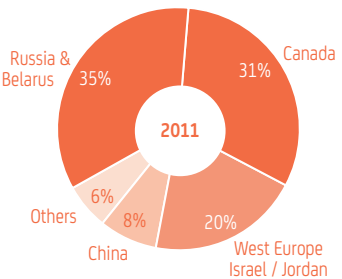
**58.6** Mt $P_2O_5$




In 2011, China dominated world phosphate rock production, with a 37 percent share. Chinese rock production is essentially used domestically for the manufacture of phosphate fertilizers, and for the production of yellow phosphorus derivatives and animal feed additives.

## Potash production

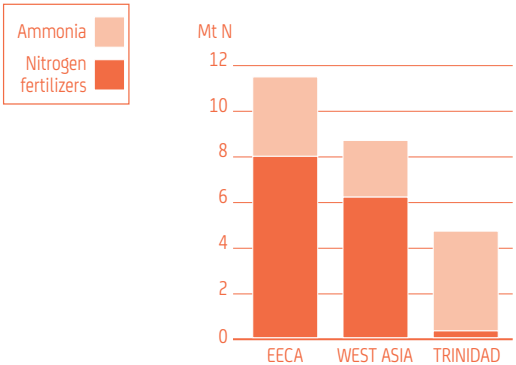
**34.4** Mt $K_2O$




Potash production is concentrated in a fewer countries, where deposits of high potassium content and large proven reserves are found. Three countries (Canada, Russia and Belarus) accounted for two-thirds of world MOP production in 2011. Other large producing countries include Germany, Israel, and Jordan. Since the early 2000s, new potash production capacity emerged in China and Chile.

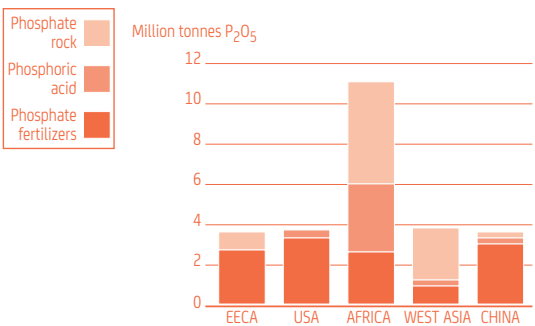
# Fertilizer trade

## 2010 nitrogen exports



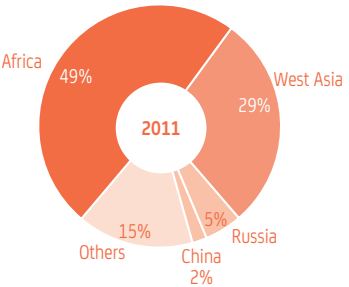

Trinidad and Tobago is the world's largest exporter of ammonia, with a 25 percent share of global trade. Other large exporters comprise Canada, EECA (Russia and Ukraine) and a few countries in West Asia (notably Iran, Qatar and Saudi Arabia). Nitrogen capacity has been expanding in countries benefiting from a large supply of relative low cost feedstock, especially natural gas. The collapse of fertilizer consumption in the Former Soviet Union in the late 1980s gave rise to large export opportunities for EECA countries.

## 2010 phosphate exports



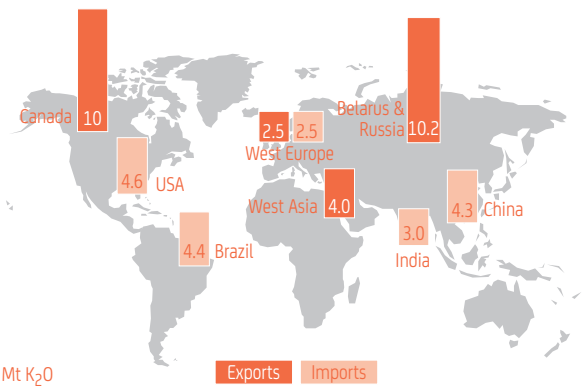
## Phosphate rock exports

**9.8** Mt $P_2O_5$




The trade of phosphate products is dominated by phosphate rock and processed phosphate fertilizers such as DAP, MAP and TSP. Morocco accounts for half of world's export of phosphate rock, while the trade of processed phosphates is more widely distributed by a larger range of countries, including Jordan, Russia, Tunisia, and the United States. Since mid-2000, new exporting countries have emerged: Algeria, Egypt and Peru for phosphate rock and China (2006) and Saudia Arabia (2012) for phosphoric acid.

## Potash trade 2011

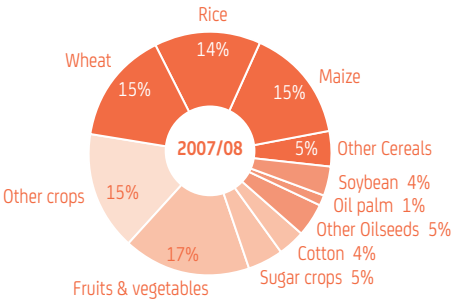



Potash trade accounts for 80 percent of world deliveries. Exports supply comes for a few producing countries, in which domestic consumption remains at relatively low levels. The largest exporting

countries are Canada, Russia, Belarus, Germany, Israel and Jordan. Over the past decade, Chile has become a large exporter of MOP and potassium nitrate. Potassium products are imported into more than 50 countries. Brazil, China, India, Indonesia/Malaysia and the United States contribute 70 percent of global MOP imports.

# Fertilizer use by crops

### Fertilizer use by crop at the global level




Estimates of global fertilizer consumption by crop in 2007/08 reveal that cereals receive about 50 percent of all fertilizer applications. Almost equal to the consumption of each of the three most important cereals are fruits and vegetables.

# Key drivers of world agriculture and fertilizer demand

- Continued world population growth;
- Urbanization;
- Income growth and diet diversification;
- Limited available arable land;
- Environmental challenges;
- Improvement in technologies.

# Nutrient stewardship

The main objective of nutrient stewardship is to manage the flow of nutrients to produce enough affordable and healthy foods while sustaining soil fertility, protecting the environment, conserving natural resources and creating an atmosphere of trust with consumers and policy makers concerning food production. Nutrient stewardship brings together concepts such as balanced fertilization, site-specific nutrient management or integrated plant nutrient management.

### Nutrient stewardship approach

**10-30%**
Efficiency increases can be achieved from the precise management of fertilizer use*

*FAO/IFDC

**Right Source**
Match fertilizer type to crop needs


**Right Rate**
Match amount of fertilizer to crop needs

**Right Time**
Make nutrients available when crops need them

**Right Place**
Keep nutrients where crops can use them

# Safety, health and environmental benchmarking

Safety, health and environmental (SHE) management has become a central element in the fertilizer industry's operational model. Benchmarking reports undertaken by IFA, demonstrate the strong inroads being made by global producers in using energy resources more efficiently, reducing plant emissions to the environment and proactively reducing accidents and health hazards in fertilizer production.

- **Energy**

IFA conducts an industry-wide benchmarking study to estimate energy efficiency in ammonia production plants, which accounts for the bulk of energy consumption in the fertilizer sector. The 2012 report indicates that the most efficient producers consume between 28 and 33 gigajoules (GJ) per metric tonne of ammonia, while the average net carbon dioxide emissions per tonne of ammonia for the facilities surveyed was 1.29 metric tonnes.

- **Environment**

IFA's biennial environmental benchmarking survey allows the industry to monitor progress in roughly 30 emissions areas spanning the production of N, P, and K fertilizers. Data collected since 2002 indicates that best-available technology has reduced pollutants resulting from the manufacture of mineral fertilizers to very low levels.

- **Safety**

IFA evaluates 2 key indicators for industrial safety through measuring Lost-Time Injuries (LTI) and Total Recordable Injuries (TRI) in order to establish a baseline average upon which companies can compare their performance and measure progress in safety practices. A postive downward trend for LTI rate (LITR) has been confirmed and in 2011, the industry's top performers consistently generated a LITR of below 3 on a yearly basis. In 2013, IFA introduced an Employee Safety Perceptions Survey to expand ongoing safety efforts.

# Product stewardship

Product stewardship is the "next step" in SHE management, a step that broadens SHE management beyond the factory gate to include wider issues such as security. In many respects, it is about putting into place responsible business management processes across a product's lifecycle. Industry should take greater responsibility not only for how its products are produced, but also for how they are sourced, stored, transported and used.

As a demonstration of the commitment to acting as good global citizens, IFA members agree with certain safety, health and environmental standards – such as the IFA SHE Principles. Through the industry-driven Protect & Sustain initiative, IFA members are looking to roll this commitment out to every aspect of the product lifespan. **www.protectandsustain.org/**

# IFA 12 SHE Principles

- All members shall demonstrate leadership and management commitment with regards to safety, security, health and environmental issues in fertilizer production, distribution and sales.
- All members shall strive for zero harm and adverse environmental impact whilst maintaining a healthy work place for all employees and contractual staff.
- All members shall ensure that safety, security, health and environment issues are integrated into their corporate policy and receive the utmost importance and priority.
- All members shall ensure adequate financial and human resources for continual improvement of safety, security, health and the environment performance.
- All members shall comply with local safety, security, health and environmental laws and strive to embrace international laws and best practices as much as possible.
- All members shall establish and improve their safety, security, health and environmental performance through annual objectives, targets or key performance indicators.
- All members shall establish adequate procedures and controls to ensure that safety, security, health and environment are not jeopardized at any time or in any form.
- All members shall ensure that all employees and contractual staff have the right competence and are adequately trained and informed about safety, security, health and environment related to their specific activities, and shall encourage the participation of employees and contractual staff for further improvements.
- All members shall adhere to the principles of hazard and risk assessment in evaluating all their activities to ensure that safety, security, health and environment standards are continually enhanced.
- All members shall strive to subscribe to safety, security, health and environment management systems that will be subjected to internal and external auditing.
- All members shall voluntarily share information with regards to experiences and lessons related to safety, health and the environment with all employees and contractual staff, and with other IFA members, unless under legal constraints or if the information is of proprietary nature.
- All members shall strive to continually promote safety, security, health and environmental matters to enhance the social responsibility and accountability of the global fertilizer industry.

# Annex 1. Statistics

## World fertilizer consumption (Mt nutrients)

| | N | $P_2O_5$ | $K_2O$ | Total |
|---|---|---|---|---|
| 1920/21 | NEG | 1.8 | NEG | 1.8 |
| 1930/31 | 1.3 | 2.8 | 1.4 | 5.5 |
| 1960/61 | 10.8 | 10.7 | 8.5 | 30.0 |
| 1970/71 | 31.8 | 21.1 | 16.3 | 69.2 |
| 1980/81 | 60.8 | 32.0 | 24.4 | 117.2 |
| 1990/91 | 77.6 | 36.1 | 24.6 | 138.2 |
| 2000/01 | 82.1 | 32.8 | 22.1 | 137.0 |
| 2010/11 | 104.7 | 40.5 | 27.7 | 172.9 |

## Regional fertilizer consumption in 2010/11 (Mt nutrients)

| | N | $P_2O_5$ | $K_2O$ | Total |
|---|---|---|---|---|
| **WORLD** | **104.7** | **40.5** | **27.7** | **172.9** |
| Western & Central Europe | 11.0 | 2.6 | 2.9 | 16.5 |
| Eastern Europe & Central Asia (EECA) | 4.0 | 1.2 | 1.2 | 6.4 |
| North America | 13.7 | 4.7 | 4.7 | 23.1 |
| Latin America & the Caribbean | 6.7 | 5.1 | 5.1 | 16.9 |
| Africa | 3.3 | 1.0 | 0.5 | 4.8 |
| West Asia | 3.0 | 1.2 | 0.2 | 4.4 |
| South Asia | 21.2 | 9.3 | 3.8 | 34.3 |
| East Asia | 40.4 | 14.4 | 8.9 | 63.7 |
| Oceania | 1.4 | 1.2 | 0.3 | 2.8 |

## **World nutrient capacity** in 2011 (Mt nutrients)

| | Ammonia | Phosphoric acid | Potash |
|---|---|---|---|
| **WORLD** | **161.3** | **51.4** | **43.0** |
| Western & Central Europe | 16.4 | 1.6 | 5.6 |
| Eastern Europe & Central Asia | 21.6 | 5.0 | 12.4 |
| North America | 13.3 | 10.0 | 16.0 |
| Latin America & the Caribbean | 9.1 | 2.4 | 1.5 |
| Africa | 5.9 | 7.6 | – |
| West Asia | 12.7 | 3.7 | 4.0 |
| China | 55.0 | 16.9 | 3.4 |
| Other Asia | 27.2 | 4.1 | 0.1 |
| Oceania | 2.1 | 0.6 | – |

## **Nitrogen fertilizer** production in 2010 (Mt nutrients)

| | Nitrogen |
|---|---|
| **WORLD** | **109.0** |
| Western & Central Europe | 10.5 |
| Eastern Europe & Central Asia | 11.7 |
| North America | 13.8 |
| Latin America & the Caribbean | 3.1 |
| Africa | 4.4 |
| China | 36.0 |
| India | 12.2 |
| West Asia | 8.3 |
| East Asia | 5.3 |
| South Asia | 3.3 |
| Oceania | 0.5 |

## **Phosphate rock** production in 2011 (Mt product)

| | Phosphate rock | $P_2O_5$ equivalent |
|---|---|---|
| **WORLD** | **191.1** | ***58.6*** |
| China | 73.0 | *21.9* |
| Africa | 41.3 | *13.0* |
| USA | 27.6 | *7.9* |
| Russia | 10.3 | *4.0* |
| Others | 38.8 | *11.7* |

## **Potash** production in 2011 (Mt $K_2O$)

| | $K_2O$ |
|---|---|
| **WORLD** | **34.4** |
| Russia and Belarus | 11.9 |
| Canada | 10.8 |
| West Europe (incl. Israel & Jordan) | 7.0 |
| China | 2.6 |
| Others | 2.1 |

## **Sulphur** production (all forms) in 2011 (Mt S)

| | S |
|---|---|
| **WORLD** | **81.1** |
| China | 18.0 |
| North America | 16.7 |
| Eastern Europe & Central Asia | 11.4 |
| West Asia | 10.2 |
| East Asia (excluding China) | 7.4 |
| West Europe | 6.7 |
| Others | 11.4 |

## **Nitrogen** exports in 2010 (Mt N)

| | Ammonia | Nitrogen fertilizers |
|---|---|---|
| **WORLD** | **16.0** | **32.6** |
| Eastern Europe & Central Asia | 3.5 | 8.0 |
| Trinidad & Tobago | 4.4 | 0.3 |
| West Asia | 2.5 | 6.2 |
| Others | 5.6 | 18.1 |

## **Phosphate** exports in 2010 (Mt $P_2O_5$)

| | Phosphate rock | Phosphoric acid | Phosphate fertilizers |
|---|---|---|---|
| **WORLD** | **9.6** | **4.7** | **14.6** |
| Eastern Europe & Central Asia | 0.9 | – | 2.7 |
| USA | – | 0.4 | 3.3 |
| Africa | 5.1 | 3.4 | 2.6 |
| West Asia | 2.6 | 0.3 | 0.9 |
| China | 0.3 | 0.3 | 3.0 |
| Others | 0.7 | 0.3 | 2.1 |

## **Phosphate** rock exports in 2011 (Mt product)

| | Phosphate rock |
|---|---|
| **WORLD** | **31.1** |
| Africa | 15.3 |
| West Asia | 9.0 |
| Russia | 1.4 |
| Others | 5.4 |

# Annex 2. Composition of some important fertilizers

| Common names | N | $P_2O_5$ | $K_2O$ | S | MgO |
|---|---|---|---|---|---|
| | Nutrients as % of product | | | | |
| **Nitrogen Fertilizers** | | | | | |
| Ammonia | 82 | 0 | 0 | 0 | 0 |
| Ammonium sulphate | 21 | 0 | 0 | 23 | 0 |
| Ammonium nitrate | 33-34.5 | 0 | 0 | 0 | 0 |
| Calcium ammonium nitrate | 20.4-27 | 0 | 0 | 0 | 0 |
| Urea | 45-46 | 0 | 0 | 0 | 0 |
| **Phosphate Fertilizers** | | | | | |
| Single superphosphate | 0 | 16-20 | 0 | 12 | 0 |
| Triple superphosphate | 0 | 46 | 0 | 0 | 0 |
| Diammonium phosphate | 18 | 46 | 0 | 0 | 0 |
| Monoammonium phosphate | 11 | 52 | 0 | 0 | 0 |
| Ground rock phosphate | 0 | 20-40 | 0 | 0 | 0 |
| **Potash Fertilizers** | | | | | |
| Muriate of potash (potassium chloride) | 0 | 0 | 60 | 0 | 0 |
| Sulphate of potash | 0 | 0 | 50 | 18 | 0 |
| Sulphate of potash magnesia | 0 | 0 | 22-30 | 17-22 | 10-11 |
| **Magnesium Fertilizers** | | | | | |
| Kieserite | 0 | 0 | 0 | 20-22 | 25-27 |
| Epsom salt | 0 | 0 | 0 | 12-13 | 15-16 |
| **Complex Fertilizers** | | | | | |
| NPK fertilizers | 5-25 | 5-25 | 5-25 | * | * |
| NP fertilizers | 15-25 | 15-25 | 0 | * | 0 |
| NK fertilizers | 13-25 | 0 | 15-46 | * | 0 |
| PK fertilizers | 0 | 7-30 | 10-30 | * | * |
| ** Some with S and/ or Mg and/or micronutrients* | | | | | |

# Annex 3. Conversion factors

| Area and distance | | |
|---|---|---|
| 1 hectare (ha) | = | 2.471 acres |
| 1 meter | = | 1.0936 yards |
| 1 acre | = | 4480 sq. yards<br>0.4047 hectare |
| 1 yard | = | 0.9144 metre |
| **Weight** | | |
| 1 kilogram (kg) | = | 2.2046 pounds |
| 1 kg/ha | = | 0.9822 lb/acre |
| 1 metric tonne | = | 1.1023 short ton (2000 lb)<br>0.9842 long ton (2240 lb) |
| 1 pound (lb) | = | 0.4536 kg |
| 1 lb/acre | = | 1.1208 kg/ha |
| **Cereals** | | |
| 1 bushel wheat (U.S.) | = | 60 lb = 27.215 kg |
| 1 bushel maize (U.S.) | = | 56 lb = 25.410 kg |
| **Fertilizers** | | |
| **Phosphorus** | | |
| To change $P_2O_5$ (phosphate) to P | multiply $P_2O_5$ by 0.4364 | |
| To change P to $P_2O_5$ | multiply P by 2.2914 | |
| **Potassium** | | |
| To change $K_2O$ (potash) to K | multiply $K_2O$ by 0.8302 | |
| To change K to $K_2O$ | multiply K by 1.2046 | |

# **Join the** International Fertilizer Industry Association

## What is IFA?

- IFA is an industry association representing the fertilizer industry globally.
- IFA has 534 members in 83 countries - with 50 percent based in developing economies.
- IFA member companies deal with all activities related to the production, trade, transport and distribution of every type of fertilizers, their raw materials and intermediates.
- Membership also includes organizations involved in construction, engineering, consulting, agronomic research and training, among others.

## What are the benefits of joining IFA?

- Knowledge sharing and networking opportunities;
- Assistance in managing global policy issues and enhancing your company's profile;
- Information to assist decision-making while enhancing company standards.

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