fertilizers europe

Infinite product stewardship

INFINITE FERTILIZERS

Continuing to feed the world


INFINITE
FERTILIZERS
Continuing to feed the world

About this publication

THIS BROCHURE AND ITS SISTER PUBLICATION "INFINITE NUTRIENT STEWARDSHIP" ARE INTENDED TO PROVIDE A GENERAL GUIDE TO FERTILIZER PRODUCTION, DISTRIBUTION AND USE IN MEETING THE DEMANDS OF "SUSTAINABLE AGRICULTURE".

The brochure describes the European fertilizer industry's vision of Infinite Fertilizers and the importance of the interaction between all those involved in food production chains in increasing the efficiency of agriculture and in reducing its environmental footprint.

Product stewardship for fertilizers is defined as the management of the quality, safety, security and environmental aspects of a fertilizer throughout its life cycle, respecting relevant legislation and the best industry and agricultural practice. For mineral fertilizers, the product life cycle includes:

- Product development
- Sourcing of raw materials, intermediates and additives
- Fertilizer production, including recycling and disposal of production materials
- Product distribution and storage: packaging, handling, transportation
- Marketing and sales
- Product application and use
- Materials recycling.

The last two stages of the life cycle - product application and use and materials recycling - are covered by Fertilizers Europe's nutrient stewardship activities.

Although the main focus of Fertilizers Europe's Product Stewardship Program is on the safety, health and environmental impact of fertilizers, the program also deals with other important issues concerning fertilizer use.

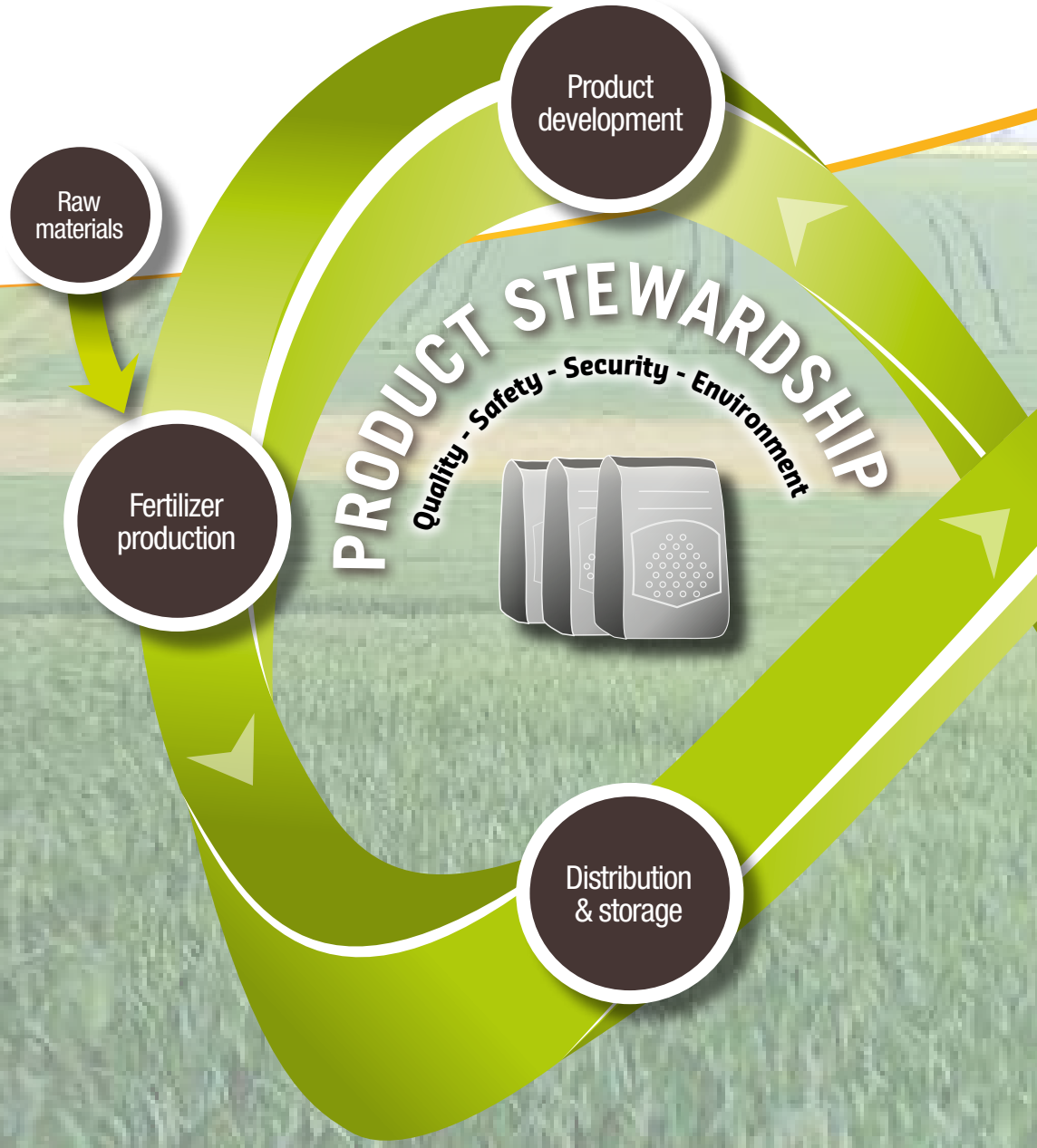
Fertilizers Europe
September 2016

Contents

INFINITE FERTILIZERS
Continuing to feed the world

Infinite fertilizers

FERTILIZERS ARE AN INTEGRAL PART OF FOOD PRODUCTION. THE EUROPEAN FERTILIZER INDUSTRY IS COMMITTED TO COLLABORATING WITH ALL THOSE INVOLVED IN FOOD PRODUCTION CHAINS TO INCREASE THE EFFICIENT USE OF NUTRIENTS AND REDUCE THE ENVIRONMENTAL FOOTPRINT OF FOOD PRODUCTION.



INFINITE FERTILIZERS GUIDES THE INDUSTRY'S PRODUCT AND NUTRIENT STEWARDSHIP ACTIVITIES. THESE ENSURE THAT EUROPE'S FARMERS HAVE ACCESS TO A VARIETY OF HIGH QUALITY, LOCALLY PRODUCED PRODUCTS, AS WELL AS INFORMATION ON THEIR CORRECT USE, ENVIRONMENTAL IMPACT AND NUTRIENT RECYCLING OPPORTUNITIES.

INFINITE FERTILIZERS
Continuing to feed the world

Fertilizer basics

- Why we need fertilizers
- Where fertilizers come from
- How fertilizers work
- How fertilizers are used

Why we need fertilizers

FOOD PRODUCTION MUST INCREASE SIGNIFICANTLY BY 2050 TO ENSURE GLOBAL FOOD SECURITY.

The United Nations' Food and Agriculture Organization (FAO) predicts that the world's population will reach 9.1 billion people by 2050 and that global food production will have to increase by some 60% above 2005/2007 levels to keep pace with demand.

This increase could be achieved by devoting more land to agriculture. However, this land is not readiliy available and the negative impact on the environment and bio-diversity of further converting the planet's natural forests and wild areas is well documented. Changes in land use account for some 12% of the greenhouse gas emissions that lead to global warming.

The more sustainable option is to make better use of land currently used for agriculture. This faces challenges of its own, however, in the form of increasing urbanisation, soil erosion and nutrient exhaustion, as well as increasing water scarcity. Since the "green revolution" of the 1960s and 1970s, growth in agricultural productivity has started to slow down in many regions and recent climate change studies predict that this slowdown will continue.

Global food security rests on reversing this trend through better agricultural efficiency, including more effective crop nutrition.

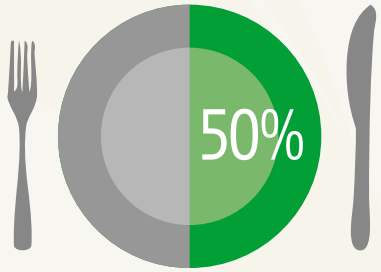
Food security in Europe

Europe is fortunate in that it has both the climate and enough farmland to be potentially self-sufficient in food production. Food imports, however, have increased by some 40% over the past 10 years and agricultural land area outside the EU the size of Germany is now devoted to producing these. Given the increasing global food demand, this land could be more effectively used to support local food needs.

European agricultural policy has a decisive role to play in ensuring that Europe maintains a strong and diverse agricultural sector. It must encourage European farmers to optimize their production at the same time as reducing their environmental impact.

This "sustainable intensification" of European agriculture requires more widespread adoption of the best agricultural practice, as well as the best soil management and cultivation techniques.

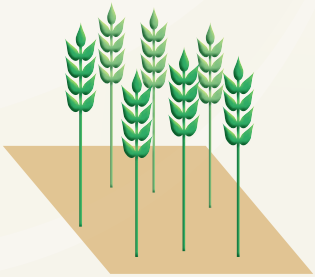
European agriculture must also be economically viable so that Europe's farmers can invest in their operations. Mineral fertilizers have helped European agricultural productivity to become the highest in the world. Every euro invested in a fertilizer in Europe provides, on average, a five-fold return for the farmer, assuring increased food production and his or her financial security.



Today, fertilizers* account for **50%** of global food production

in 1960
2 people
were fed from
1 hectare
of land

in 2025
5 people
will need to be fed
from 1 hectare
of land



*mineral-based fertilizers

Where fertilizers come from

FERTILIZER PRODUCTION TRANSFORMS NATURALLY OCCURRING RAW MATERIALS INTO PRACTICAL PRODUCTS THAT SUPPORT PLANT GROWTH.

Each year, the European fertilizer industry transforms millions of tons of naturally occurring raw materials such as air, natural gas and mined ores into products primarily based on the three essential nutrients nitrogen, phosphorus and potassium, which plants need to grow to their full potential.

For nitrogen-based fertilizers, the largest product group, the process starts by mixing nitrogen from the air with natural gas at high temperature and pressure to create ammonia. Approximately 65% of the natural gas is used as the raw material for sourcing hydrogen, with the remainder employed to power the production process.

The ammonia is then used to make nitric acid, with which it is subsequently mixed to produce nitrate-based fertilizers such as ammonium nitrate. Ammonia may also be mixed with carbon dioxide to create urea fertilizers. Both these fertilizers can also be further mixed with water to form UAN (urea-ammonium nitrate) solution.

Phosphorus and potassium-based fertilizers are both produced from mined ores. Crushed phosphate rock is primarily converted into phosphoric acid, which is then either concentrated or mixed with ammonia to make a range of products. By-products of phosphoric acid production include the fertilizers calcium sulphate or calcium nitrate.

Muriate of potash (potassium chloride) is separated out of crushed potash ore. This potassium fertilizer may then be further treated with nitric or sulphuric acid to produce potassium nitrate or sulphate of potash.

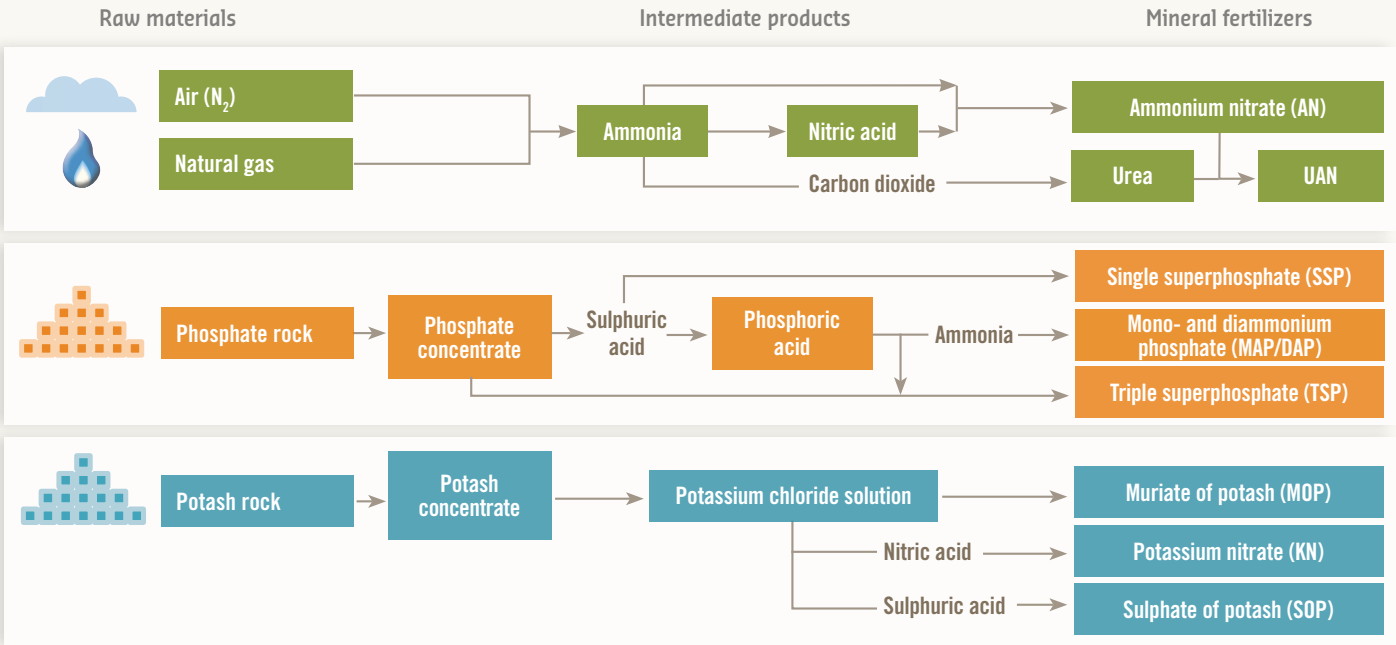
Environmental efficiency

While the basic ammonia synthesis process (Haber-Bosch) has remained unchanged since its invention 100 years ago, process efficiency, control systems and production skills have changed dramatically.

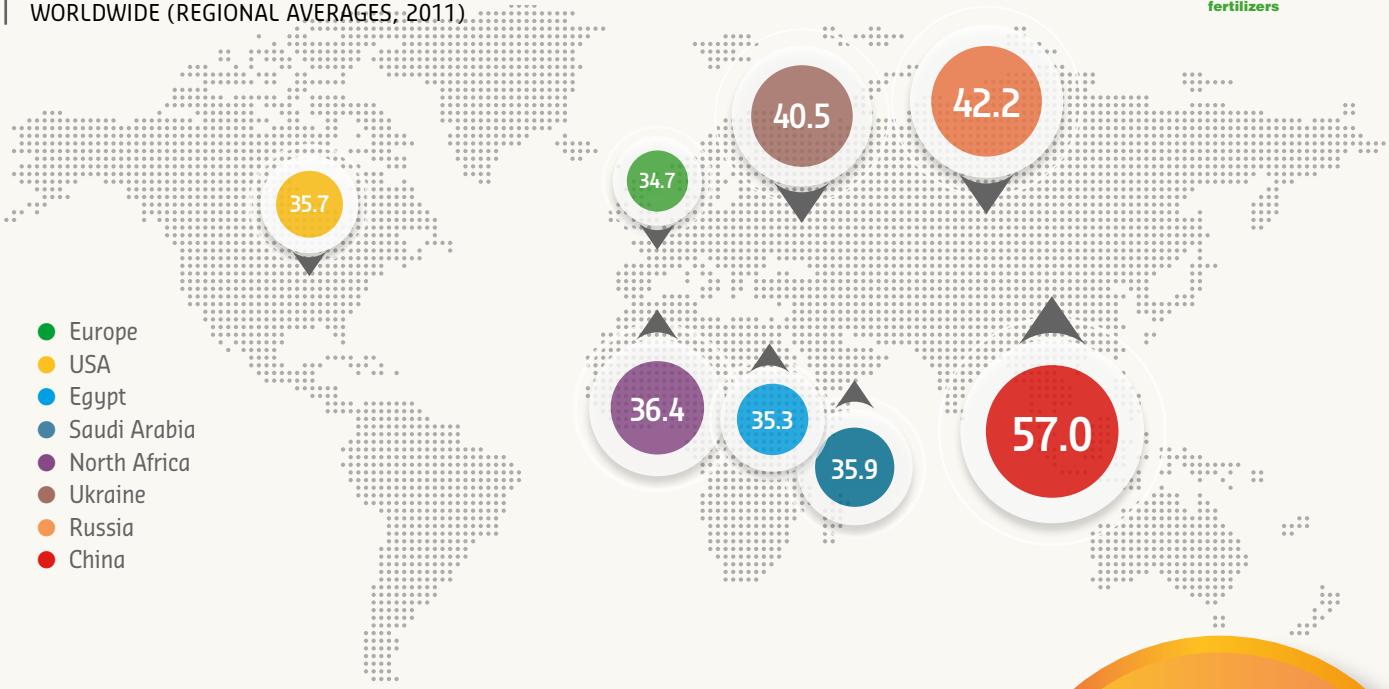
Due to innovative advancements in technology, the European fertilizer industry's ammonia plants are among the most energy efficient worldwide, with the lowest greenhouse gas (GHG) emissions. Its nitric acid plants are also equipped with advanced greenhouse gas emissions reduction technology.

Europe's strict environmental legislation has meant that over the past few years the fertilizer industry has invested steadily to increase its efficiency and reduce GHG emissions.

PRODUCTION OF MAIN FERTILIZER PRODUCTS



ENERGY CONSUMPTION (GJ PER TONNE OF PRODUCT) IN AMMONIA PLANTS WORLDWIDE (REGIONAL AVERAGES, 2011)



Industry competitiveness

While deposits of natural gas, phosphate and potash rock are all relatively abundant globally, they can only be found to a limited extent within Europe. The European fertilizer industry is therefore highly dependent on the quality and availability of imported raw materials.

This challenges the industry to be highly efficient in its raw materials use but also makes it vulnerable to the supply and pricing policies of countries outside Europe.

In particular, the high price of gas in Europe makes it very difficult for the industry to remain cost-competitive in a global market. Europe's energy cost-competitiveness is a priority for fertilizer industry profitability, as well as for safeguarding jobs.

Competitive energy costs are essential for a vibrant fertilizer industry in Europe.

Product stewardship

The fertilizer industry's aspirations for efficient, safe and environmentally-friendly fertilizer production has led Fertilizers Europe to develop an industry-wide management system to ensure its advanced production controls are consolidated and maintained.

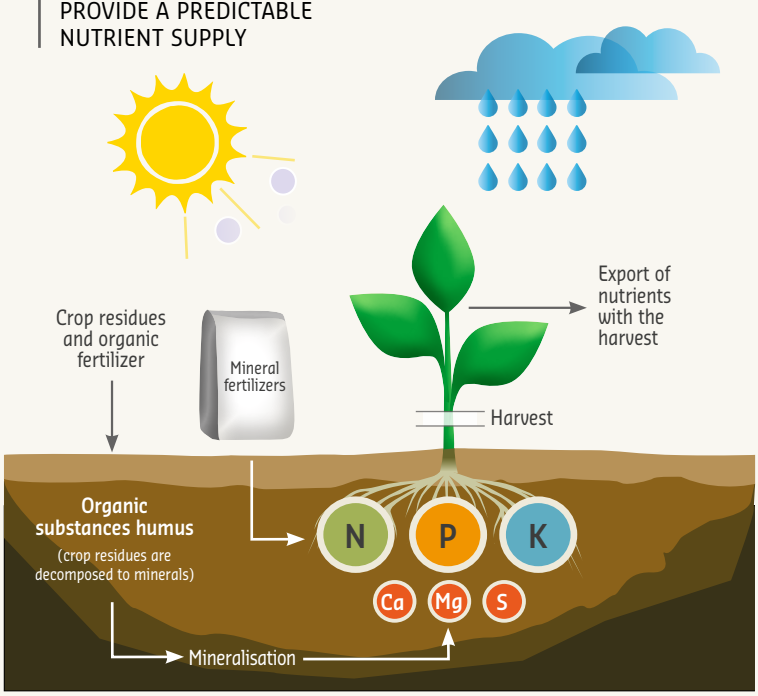
The Fertilizers Europe Product Stewardship Program is compulsory for all members of the association and sets the highest global standards for programs of this type.

The program (www.productstewardship.eu) also ensures that the industry oversees the transport, distribution and storage of its products, working closely with the supply chain to ensure the secure handling of fertilizers on their way to Europe's farmers.

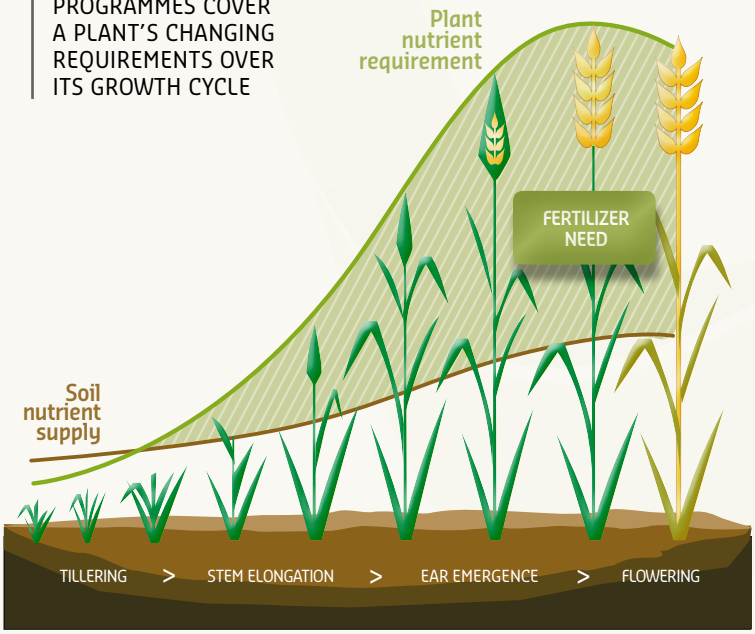
How fertilizers work

EFFECTIVE CROP NUTRITION IS THE KEY TO INCREASING CROP YIELDS AND OPTIMIZING PRODUCTION.

MINERAL FERTILIZERS PROVIDE A PREDICTABLE NUTRIENT SUPPLY



EFFICIENT FERTILIZATION PROGRAMMES COVER A PLANT'S CHANGING REQUIREMENTS OVER ITS GROWTH CYCLE



Crop growth requires sunlight, carbon dioxide (CO_2), water and a balanced supply of the primary nutrients nitrogen, phosphorus and potassium, as well as secondary and micronutrients. These nutrients support a plant's essential metabolic functions.

The water and nutrients are primarily absorbed from the soil via the plant's root system to allow it to develop to its full potential and provide the maximum nutritional value. When the plant is harvested, the nutrients it has absorbed are therefore lost from the soil.

Unless the nutrients are replenished, the soil's productive capacity declines with every harvest. Natural processes that break down crop residues and organic material in the soil replace, on average, about half of the required nutrients. The remainder needs to be provided by mineral fertilizers and other organic sources such as manure.

Predictable nutrient supply

The main mineral fertilizers are based on one or more of the essential nutrients, which are delivered in a form that can be readily taken up by the plant.

They enable farmers to offer a specific crop a predictable, balanced supply of the primary nutrients, as well as important secondary elements such as calcium, magnesium and sulphur, and other micro-nutrients. The nutrient content of manures and other organic sources are far less predictable.

Effective fertilization programmes aim to closely balance the composition and availability of the nutrients in the soil with a plant's changing requirements over its growth cycle.

Mineral fertilizers close the gap between the nutrient supply from the soil and organic sources and the plant's nutrient requirement for optimum development. Targeted application maximizes plant nutrient uptake and ensures healthy and productive growth. It also minimizes nutrient losses from the soil, either to the atmosphere or waterways.

Main fertilizer types

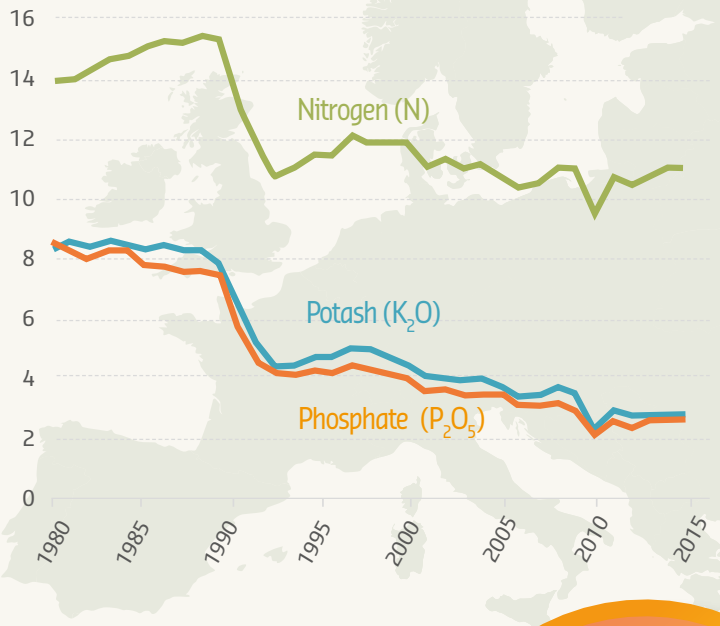
Nitrogen-based fertilizers account for the vast majority of fertilizer use (67% of total consumption in Europe). Phosphate and potash fertilizers account for some 16% and 17% of European fertilizer consumption respectively and can be applied in combination with nitrogen fertilizers.

Most European farmers consider ammonium nitrate (AN) and calcium ammonium nitrate (CAN) to be the most effective sources of crop nitrogen with European climatic conditions. By combining ammonium and nitrate, the two forms of reactive nitrogen that are directly absorbed by the plant roots, they offer the highest nitrogen-use efficiency.

Other nitrogen fertilizers, such as urea and urea-ammonium nitrate solution (UAN), are also available in Europe and are widely used in other parts of the world.

However, unless preventative measures are taken, nitrogen losses to the atmosphere can occur when these latter products are progressively transformed into the nitrate form in the soil. This increases emissions from the field and also reduces their nitrogen-use efficiency.

ANNUAL FERTILIZER USE IN EUROPE (MILLION TONNES)



Source: Fertilizers Europe

Ammonium nitrate and calcium ammonium nitrate are the preferred choice of European farmers.

How fertilizers are used

THE CORRECT USE AND APPLICATION OF FERTILIZERS ARE KEY TO SUSTAINABLE AGRICULTURE AND EUROPE'S FOOD SECURITY.

Sustainable agriculture relies on providing the necessary growing conditions for optimal crop production over the long term. It requires Europe's farmers to adopt the best agricultural practice to optimize crop yields and reduce the environmental impact of agriculture. Fertilizer selection and use are an integral part of this process.

Agricultural experts, legislators and providers of agricultural inputs all have a role to play in ensuring the availability of suitable fertilizers and in promoting good agricultural practice. The European fertilizer industry plays an active role in explaining the specific attributes of its products and in the development of advanced farm management strategies.

Techniques such as crop rotation, minimum tillage and cover crops can help maintain the structure and fertility of the soil, while the basic rule for the correct selection and application of fertilizers is provided by the four principles - the right product, at the right rate, at the right time, at the right place.

Best practice

Modern fertilizer products and application technology are increasingly tailor-made to meet specific crop requirements and cater for different locations and soil types, as well as for the different weather conditions encountered in Europe. Best practice in fertilizer application takes advantage of these characteristics to optimize nutrient-use efficiency.

Modern application machinery is often equipped with new technology such as GPS soil and biomass mapping, which can define nutrient demand down to within a few metres on a particular field. Smart sensors enable highly targeted application patterns, with small coefficients of variation, improving crop productivity and reducing nutrient losses.

While investment in the very latest farm equipment takes time before it becomes mainstream, the fertilizer industry continues to focus on developing practical tools, including GSM-based mobile applications, for improving on-farm nutrient management. Over the years, it has also built up a comprehensive range of information for farmers that addresses the issues of productivity, energy efficiency and the management of emissions.

Reducing environmental emissions

Climate change predictions and the continued focus on the environment mean that reducing atmospheric and water-borne emissions from agriculture remain a priority.

product stewardship fertilizers

Best practice in fertilizer application takes advantage of product characteristics to optimize nutrient-use efficiency.

Atmospheric emissions include ammonia and greenhouse gases (GHGs) such as methane, nitrous oxide and carbon dioxide. They primarily result from livestock production, organic sources of nitrogen and the application of certain types of fertilizer.

Ammonia emissions can directly affect human health, as well as cause soil acidification and the eutrophication of waterways. Mitigation measures include a variety of techniques such as low-nitrogen feeds, low-emission housing for livestock, covered slurry storage and more targeted application of manures.

Techniques for the reduction of atmospheric emissions resulting from mineral fertilizer use include application measures and the use of inhibitor technology, as well as recommendations for fertilizers outlined in the UN's Gothenburg Protocol and EU Air Quality legislation. With the availability of new fertilizers that limit emissions, the main focus of current GHG mitigation efforts is on the promotion of nitrogen-use efficiency. This has increased by 45% in Europe since 1985, but there is still further scope for improvement.

Fertilizer leaching

Leaching of excess nitrate or phosphate run-off from the soil can also lead to the eutrophication of waterways and excessive algae growth. This normally occurs when the soil is saturated with water and nitrate is washed beyond the plant root zone or phosphate moves with run-off and soil erosion.

As most losses occur outside the cropping period, good agricultural practice aims to minimize excess nutrient concentrations in the soil after crops are harvested.

For winter cereals, application of nitrogen fertilizer at the economic optimum rate has been shown to not only maximize nutrient-use efficiency and crop productivity but also to significantly decrease excess nitrate concentrations in the soil after the harvest.

Other agricultural practices to limit soil erosion and nutrient run-off include maintaining a porous soil structure, using cover crops to catch residual nitrogen and protect the soil against erosion, and better synchronization of nutrient availability with crop demand through split fertilizer applications or by using nitrification inhibitors. More appropriate application methods for spreading manure and slurry, such as soil injection, can also have a significant impact.

CARBON FOOTPRINT OF FERTILIZERS

CFT COOL FARM TOOL

Caculation of the environmental impact of fertilizer application used to be a complicated process. Increasingly, however, European farmers now use electronic applications like the 'Cool Farm Tool' carbon footprint calculator to check the overall environmental impact of their operations. More on this tool can be found later in this publication.

Nutrient use and recycling

Recent attention has focused on "closing the fertilizer loop" through the more effective use of on-farm waste and nutrient recycling. Techniques primarily involve recycling crop waste through composting, anaerobic digestion of manure for energy or fuel generation, and the more efficient use of manure within the overall fertilization strategy.

On an industrial scale, incineration of meat and bone waste and sewage sludge, with the resulting ash being recycled as a raw material for fertilizers, has been successful in several regions. Research continues into other viable nutrient recycling schemes. These contribute to better nutrient-use efficiency, leading to major improvements in resource use.

Product innovation

European fertilizer producers continuously improve their products and processes based on feedback from farmers and explore any possibilities that open up within the food and energy production chain. The focus is on new fertilizer compositions and structures, as well as application technology, to enable more efficient crop nutrition.

Specific fertilizers and application technologies such as fertigation and foliar spraying are increasingly targeted at individual crops to make the most productive use of both nutrients and water.

Infinite Fertilizers

In line with its vision of Infinite Fertilizers, Fertilizers Europe cooperates closely with farmers organizations and other stakeholders within the food chain to develop a coherent approach to Europe's agricultural, environmental and economic challenges and to advancing best agricultural practice within its farming community

New fertilizers are increasingly being targeted at specific crops and offer a variety of release profiles.

Product stewardship

- Ensuring safe, efficient products

Ensuring safe, efficient products

LIKE ANY OTHER PRODUCT, THE IMPACT OF A FERTILIZER NEEDS TO BE MANAGED WITH REGARD TO SAFETY, HEALTH AND THE ENVIRONMENT, AS WELL AS SECURITY.

Fertilizers Europe's Product Stewardship audits need to be carried out every three years.

The European fertilizer industry's aspirations for efficient, safe and environmentally-friendly fertilizer production has led Fertilizers Europe to develop a product stewardship management program for fertilizers to maintain and consolidate the industry's advanced production techniques and safety procedures across Europe.

Product stewardship for fertilizers covers the development of fertilizers, their raw materials and production processes, and how the resulting products are distributed, stored and used. The program ensures that the industry also works closely with its supply chain to oversee the transport, distribution and storage of fertilizers, and their secure handling on their way to Europe's farmers.

The Fertilizers Europe Product Stewardship Program (www.productstewardship.eu) is compulsory for all Fertilizers Europe members and sets the highest global standards for this type of program. It addresses everyone involved in the product chain, including suppliers, contractors, distributors and customers, and actively promotes their participation.

Compliance with the program is regularly validated through an audit process covering specific day-to-day operations. The process is designed to assist members identify gaps in their product stewardship activities and identify possible improvements. It can be used for self-assessment and as a basis for an independent third-party inspection. Inspection checklists also cover topics of importance to the industry that are not necessarily included in international standards such as ISO and IMAS.

Members' implementation of the product stewardship program is checked regularly by an independent third party and the audit results assessed by the Board of Fertilizers Europe. Companies not meeting its standards are required to develop an improvement program. Product stewardship audits are undertaken every three years.

Companies not located in Europe can also qualify for European product stewardship accreditation under the International Fertilizer Industry Association's (IFA) Protect & Sustain scheme, with which the "Infinite Product Stewardship" program is integrated at the highest level.

Product development

- Product assessment
- Product dossier
- Business impact

Product assessment

BEFORE THEY CAN BE COMMERCIALIZED IN EUROPE, ALL FERTILIZERS, WHETHER NEW OR IMPROVEMENTS TO EXISTING PRODUCTS, MUST COMPLY WITH VARIOUS LEGAL REQUIREMENTS.

The requirements primarily relate to product composition, levels of impurities, and the safety, security, health and environmental (SHE) impact of the production, storage and handling of the product.

During the product development stage, an assessment is made of the potential impact of the manufacturing, distribution, intermediate storage and handling of the product from the factory to the farm, as well as of its storage and use by farmers. A product dossier and a safety data sheet (SDS) provide information to all those involved, including employees, customers, the supply chain and end-users. A business impact assessment is also carried out when considered appropriate.

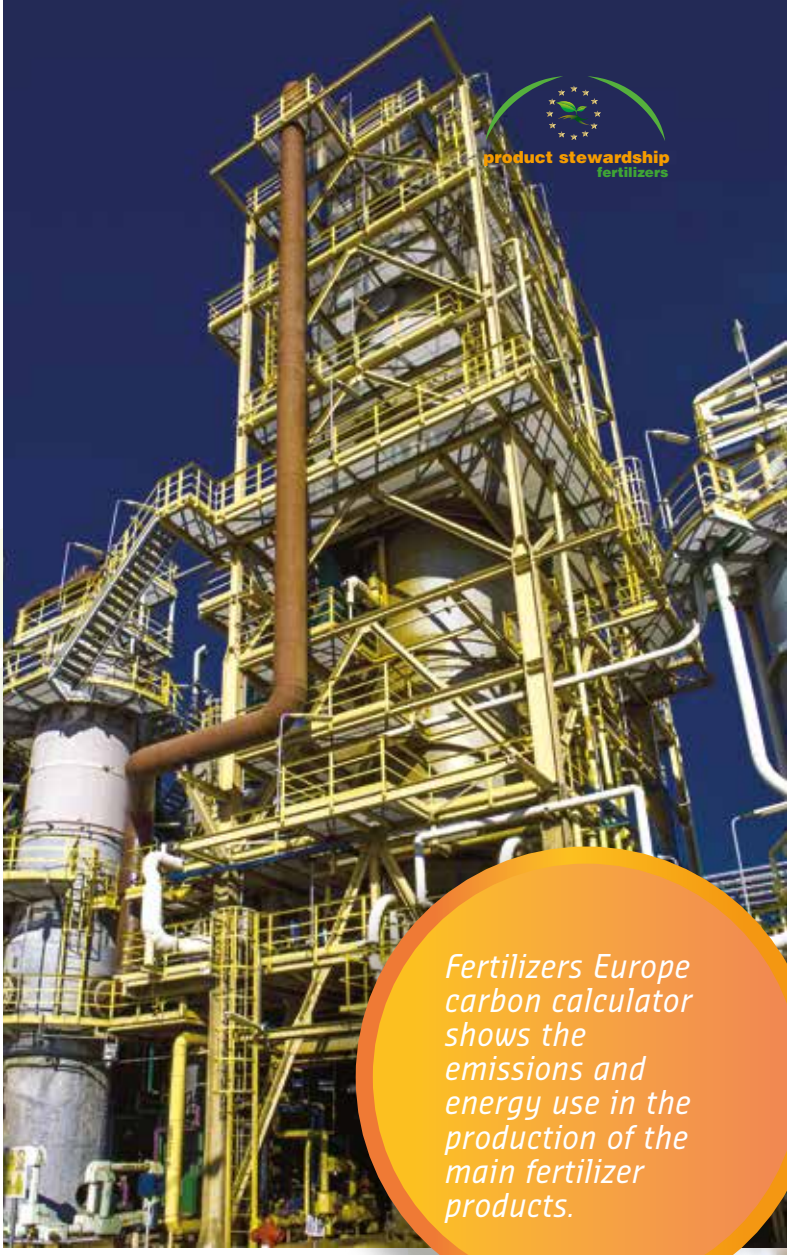
The product development process essentially involves three phases - generation of ideas, feasibility assessment, and product commercialization (or change). A simple matrix of information is established for each, with every item of information assessed for its effect on the overall impact of the product, as well as for its manageability. The acceptability of the product is established before moving to its manufacture, marketing and sale. The example checklist below demonstrates the general procedure.

ACTION	PRODUCT SPECIFICATION	PRODUCT MARKETING	PRODUCT UTILIZATION
Phase 1: Generation of ideas			
Identify	New ingredients or components	Potential selling regions	Broad nature of potential product use
	Any new chemistry for raw materials, additives, coatings, and materials processing		
Consider	Inherent SHE issues in the manufacturing process	Marketing issues	Product SHE concerns
Phase 2: Feasibility assessment			
Define	Product composition	Countries for which approvals are required	Prime and other possible applications
Develop	Technical and physical properties. Any new data required due to: ➤ new substances (inventory check) ➤ composition changes (from classification changes/SDS) ➤ new ingredients Core Safety Data Sheet REACH compliance Containment/packaging options Process SHE issues	Understanding of national inventory, classification, application regulations for ingredients/product Transport and storage regulations Regulatory approvals for releasing product on the market Ability to provide SDS in relevant languages Any new data required for national inventory check	Understanding of customer issues in use and potential for misuse and abuse Risk assessment in use Understanding of waste concerns and waste minimization Handling and use information
Phase 3: Commercialization (or product change)			
Define	Product name and specification	Countries for sale and those for which approvals are needed	Intended applications and any exclusions
Complete and integrate into business	All actions in Phase 2 (reviewing assumptions) Establish Safety Data Sheet	Establish Product Dossier and submit for regulatory approval	Carry out a Business Impact Assessment

Environmental footprint of fertilizers

The specific environmental impact of a particular fertilizer involves assessing its carbon footprint over its entire life cycle. This not only includes the environmental impact of the emissions, losses and energy used in the fertilizer's production, distribution and use, but also of that of the production of its raw materials, intermediate products and additives.

Fertilizers Europe has developed an online carbon calculator for fertilizer manufacturers. The application calculates the greenhouse gas (GHG) emissions and energy used in the production and distribution of the major fertilizer products. The calculator is the first of its kind globally and is available to everyone on request and after accreditation.



Fertilizers Europe carbon calculator shows the emissions and energy use in the production of the main fertilizer products.

Product dossier

THE PRODUCT DOSSIER BRINGS TOGETHER ALL THE SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION THAT A COMPANY HOLDS ON A FERTILIZER OR A "FAMILY" OF FERTILIZERS.

The product dossier forms a useful checklist to ensure that all aspects of the product life cycle have been adequately considered. It is usually updated at regular intervals or whenever new information becomes available.

Information required for the dossier will typically be available from different parts of an organization and, if not physically combined into one file, then clear signposts need to be put in place to show how it can be retrieved and examined.

A typical product dossier for fertilizers is generally organized under the headings below:

The product dossier needs to be updated on a regular basis.

Product dossier

- Product specification
- Hazard assessment, classification and labelling
- Product uses/applications
- Agronomic data and environmental fate
- Packaging
- Safety and security precautions
- Information to distributors, logistics operators and farmers
- Market information
- Specific market regulations
- Product improvement plans
- Review process
- Registration for EU approval

Safety data sheets

In Europe, extended Safety Data Sheets (eSDS) need to be established for all products that are classified as hazardous before they can be put on the market. Fertilizers Europe recommends that an eSDS be established for all fertilizers, even if they are not classified as hazardous.

The eSDS specifies the Safety, Health and Environmental (SHE) properties of the product and provides best practice information on its correct handling and storage. Furthermore, it specifies the classification of the product according to national and international transport regulations.

Suppliers are legally obliged to provide an eSDS to their customers, prepared in accordance with the regulations of the country concerned.

The supplier must ensure that the information in the eSDS is accurate and consistent with reliable information on correct product handling. The information should be provided in the language of the customers, supply chain operators and end-users of the product. In the case of non-classified products the eSDS can be handed over on request.

Business impact

A STRUCTURED BUSINESS IMPACT ASSESSMENT PROVIDES INFORMATION ON A FERTILIZER'S POSSIBLE POSITIVE AND NEGATIVE EFFECTS ON A MANUFACTURER'S BUSINESS AND HIGHLIGHTS ANY AREAS THAT NEED IMPROVEMENT.

The assessment uses available data and the results of hazard assessments to identify where further detail or technical risk assessment might be warranted. It combines the conclusions of technical risk assessments with value judgments on the risk perception of end-users, customers and the general public in order to arrive at the overall implications for the business. The output is primarily a prioritized list of risks and opportunities which can be addressed by the company's business plan.

The impact assessment is usually best accomplished as a team activity involving various disciplines within a company. The following steps serve as guidance:

1. Definition of the product range

Description of the product under consideration:

- specification: chemical, physical and packaging
- market: region or countries, industry or public
- use: broad area of use or specific application.

Identification of competing products (own, third-party and competitors' products) and the importance of each product by volume and profit contribution.

2. Identification of threats and opportunities

Identification of risks that can occur at each stage of the product lifecycle, both at the company's locations as well as those of contractors and customers. For example, consideration of how the product is stored, handled and used, the number of people involved, and their competences. Identification of situations that have significant potential for causing harm to people, property or the environment, or to commercial and financial business operations and the public image of the company.

Comparison with the impact of competitors' products and operations and also the expectations of customers and the general public. Identification of positive safety, health and environmental attributes of the product.

3. Estimation of consequences

Rating of each risk identified according to the magnitude of its impact:

- Disastrous: loss of business; loss of major part of the market for several years
- Damaging: major business image concern; significant sales loss; prosecution by authorities
- Costly: significant business cost; threat to business growth; loss of customers, poor image
- Minor: modest business cost; operational concern; action that is not good practice
- Beneficial: enhanced business direction; improved business image.

4. Identification of potential causes and their likelihood

Decisions on the likelihood of each event that could lead to harm or create opportunity. Also, consideration of the likelihood that, should the event happen, harm or opportunity will actually occur. It may be difficult to quantify these probabilities - evaluating them as high, medium or low may be sufficient.

An impact assessment identifies the risks and opportunities to be addressed in the business plan.

5. Rating of business risks and agreement on action plans

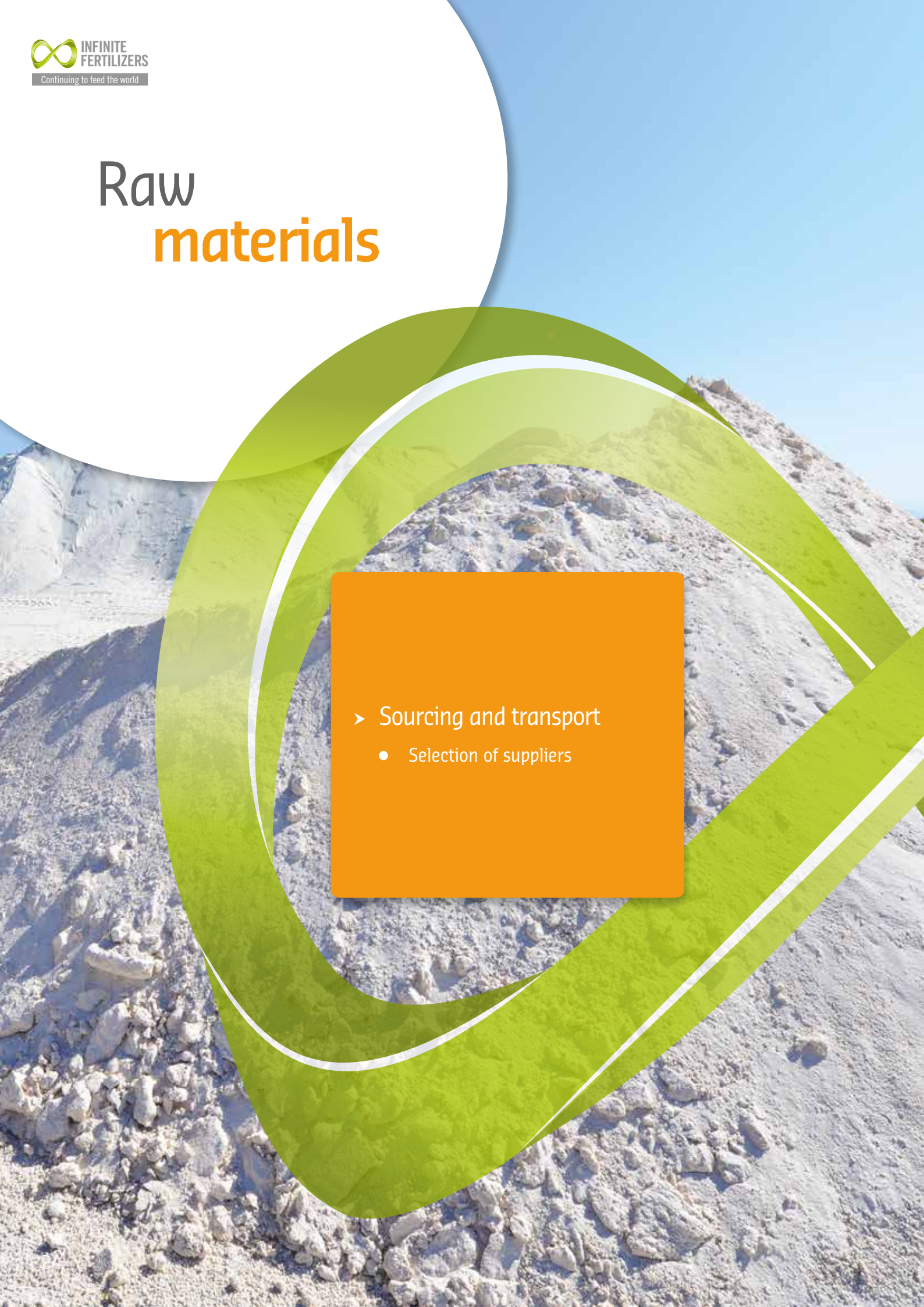
By subjectively combining the severity of different events (Step 3) with the likelihood of their occurrence (Step 4), the various business risks can be rated and a priority list of action for improvement established. In addition, potential commercial opportunities relevant to the product which might arise from the SHE scenarios foreseen can be identified.

6. Review

The assessment will need to be reviewed after any changes to product specification, market or use.

INFINITE FERTILIZERS
Continuing to feed the world

Raw materials



- Sourcing and transport
  - Selection of suppliers

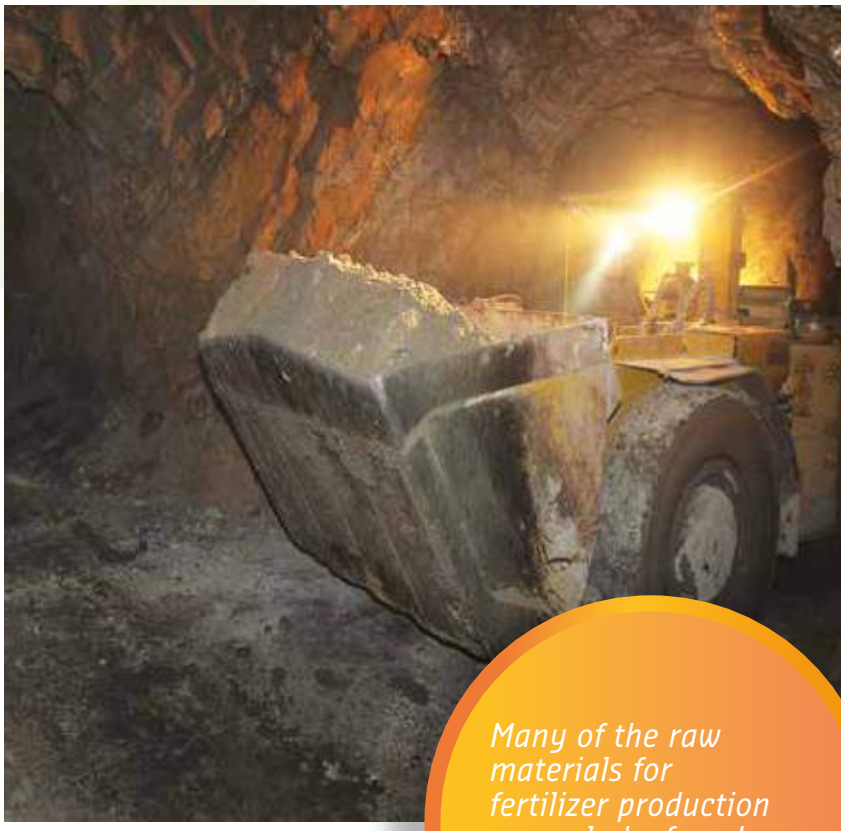
Sourcing and transport

PRODUCTION OF A WIDE VARIETY OF FERTILIZERS REQUIRES THE SOURCING AND TRANSPORT, OFTEN OVER LONG DISTANCES, OF SUBSTANTIAL QUANTITIES OF RAW MATERIALS. IT ALSO INVOLVES THE USE OF A SIGNIFICANT AMOUNT OF ENERGY.

For nitrogen-based products, the main raw materials are nitrogen from the air and natural gas (methane), which is also used to provide energy. These are processed into ammonia using mineral and ceramic support materials and a variety of catalysts containing chromium, nickel, iron and copper. Platinum/rhodium and vanadium based catalysts are used for nitric and sulphuric acid production respectively. Phosphorus and potassium-based products require crushed phosphate and potash ores and sulphuric and nitric acids.

The majority of the materials used - natural gas, phosphate and potash ores - can only be found to a very limited extent within Europe. The industry is therefore highly dependent on the quality and the availability of materials sourced from outside the continent, typically from the major producing countries of Morocco, Russia, the Middle East, and North America.

Natural gas is primarily produced in large gas fields from where it is transported through several large international pipelines to the European gas network. Phosphate and potash ores are predominantly mined, crushed and concentrated by techniques like flotation, washing and screening on-site and then shipped in bulk to major European ports such as Antwerp, Rotterdam and Marseille.



Many of the raw materials for fertilizer production can only be found to a limited extent in Europe.

From a product stewardship standpoint, the sourcing of these raw materials, as well as intermediate products, chemical additives, coating materials and other third party goods and services, needs to be based on an assessment of each one's safety, security and environmental impact.

This principally involves verifying that the goods and services comply with Fertilizers Europe's safety management principles and the EU best available production techniques BREF references (BAT-BREFs) with regard to environmental impact.

The assessment also ensures that the materials satisfy the requirements of the European Union's REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) and Safety, Health and Environmental (SHE) legislation.

Heavy metal impurities can be an issue with some phosphate fertilizers. The impurities originate from the rock phosphate raw material and the heavy metal content of the end product can only be controlled by the selection of suitable rock.

The entire supply chain, including all those involved in the transport and intermediate storage of materials, must satisfy the relevant requirements regarding product security.

Recycling of packaging materials and pallets at manufacturing sites and distribution warehouses can usually be raccomplished through waste handlers, while advice on national recycling schemes can be provided at customer locations.

Selection of suppliers

Selection of raw materials suppliers and transporters takes account of their safety records and their SHE management systems through a structured evaluation and selection procedure.

Safety Data Sheets should be available from the supplier and the requirements of SHE and security legislation are usually part of purchase and supply contracts. The company responsible for sourcing any product is required to organize the necessary assurances and controls to ensure all SHE and security requirements are met.

Fertilizer production

- Production processes
  - Nitrogen fertilizers
  - Phosphate fertilizers
  - Potassium fertilizers
- Additives and treatments
- Environmental controls
- Best practice guidelines
- Safety management
- Production recycling and waste

Production processes

THE EUROPEAN FERTILIZER INDUSTRY USES LARGE INDUSTRIAL PROCESSES TO TRANSFORM MILLIONS OF TONS OF NATURALLY OCCURRING RAW MATERIALS OR SECONDARY RAW MATERIALS INTO A VARIETY OF PRODUCTS.

The main fertilizer product groups are based on the essential plant nutrients nitrogen, phosphorus and potassium. Nitrogen-based fertilizers are by far the most important, accounting for some 10.5 million tons of product, followed by potassium and phosphate fertilizers, with annual usage of approximately 2.5 - 3 million tons each.

Nitrogen fertilizers

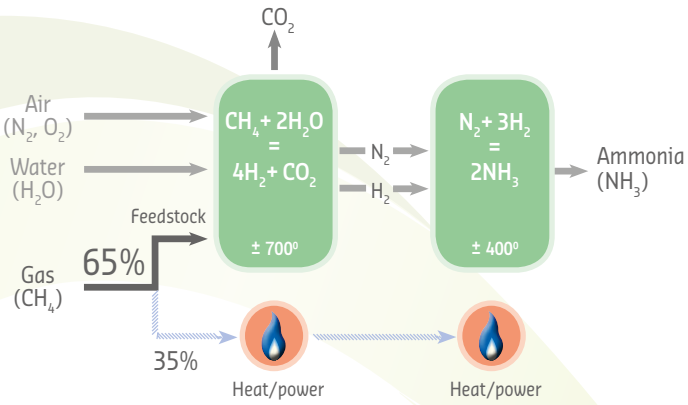
For nitrogen-based fertilizers, the production process starts by mixing nitrogen from the air with the hydrogen from natural gas at high temperature and pressure to create ammonia using the Haber- Bosch process.

Nitrogen fertilizers are based on the production of ammonia and nitric acid.

Although the process, which saw Haber and Bosch both receive the Nobel prize, was first introduced some 100 years ago, it has since been continually refined with the addition of new technology, so that European ammonia producers now lead the world in process efficiency. Approximately 2/3rds of the natural gas employed is used as raw material, with the remainder used to power the production process.

For the production of nitrate-based fertilizers, some of this ammonia is used in a second stage to make nitric acid.

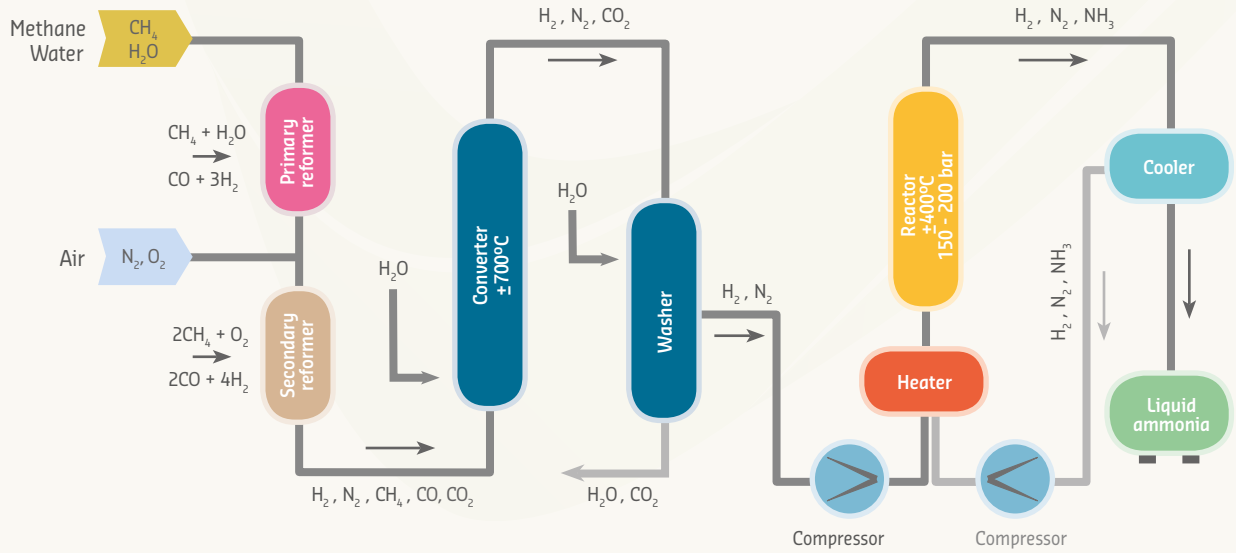
BASIC AMMONIA PRODUCTION PROCESS



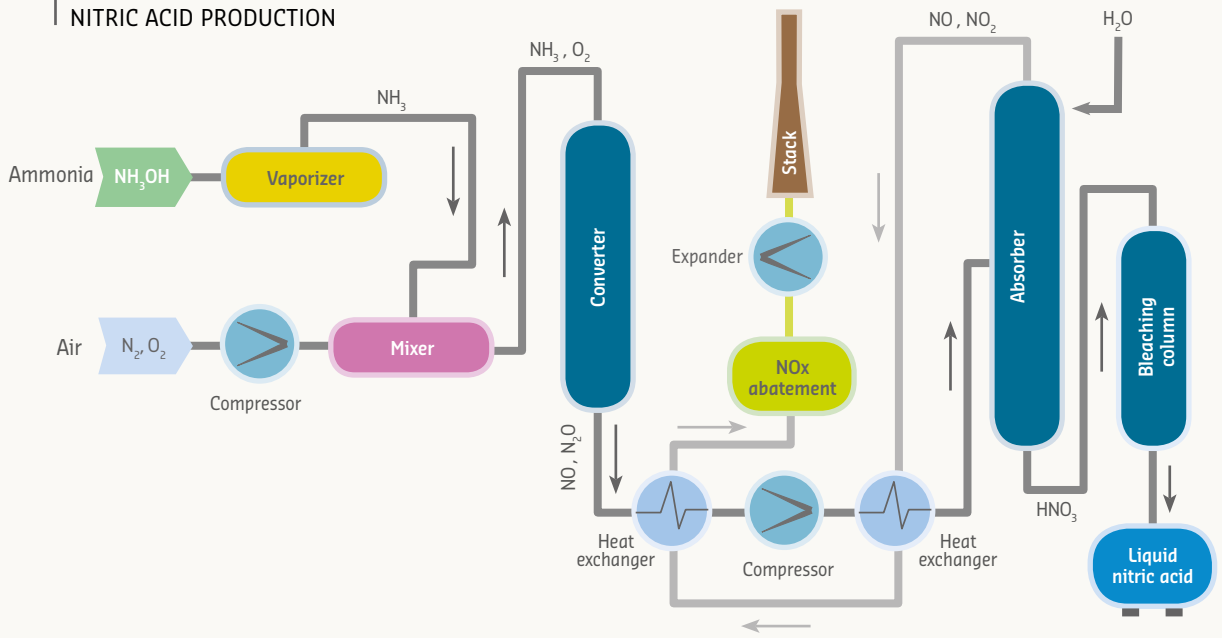
The remainder is then reacted with the nitric acid to form a concentrated melt that is subsequently solidified in a prilling or granulation process to produce solid nitrate-based fertilizers such as ammonium nitrate (AN) and calcium ammonium nitrate (CAN). CAN is produced by mixing calcium and/or magnesium carbonate with ammonium nitrate solution before the solidification process. Ammonium nitrate is water soluble and used in various fertilizer solutions.

Ammonia may also be mixed with carbon dioxide to create urea fertilizers. Both these fertilizers can also be further mixed with water to form UAN (urea-ammonium nitrate) solution.

HABER-BOSCH PROCESS FOR AMMONIA PRODUCTION



OSTWALD PROCESS FOR
NITRIC ACID PRODUCTION



Phosphate fertilizers

Phosphorus fertilizers are produced from mined phosphate ore. Phosphate rock is usually found 10-40 metres beneath the ground in a mixture of rock, sand and clay. Diggers, or draglines equipped with large buckets, excavate the rock, depositing it into a shallow containment area.

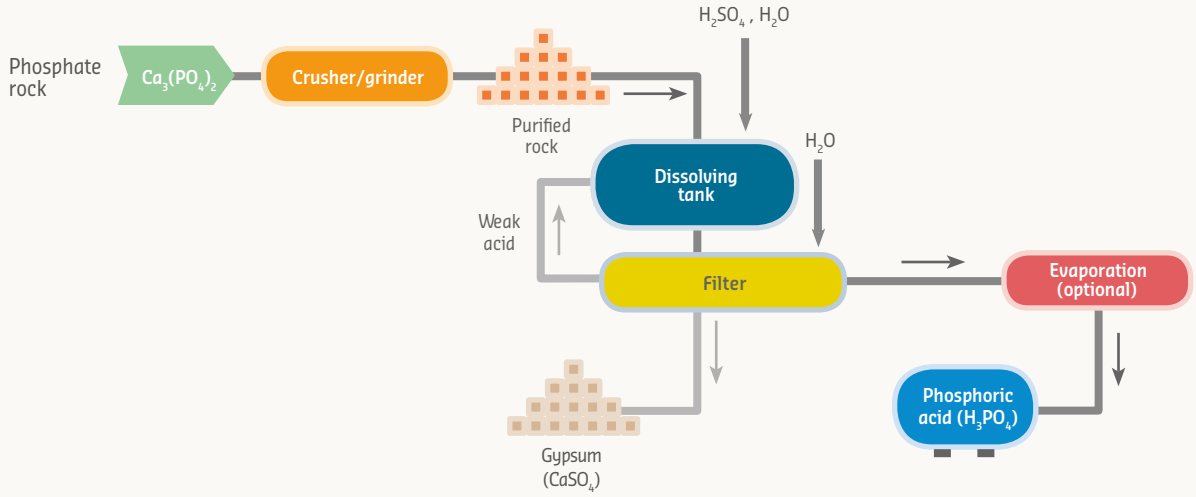
A beneficiation step is often necessary. In such case the material is turned into a slurry, which is piped to a beneficiation plant where the rock is physically separated from the sand and clay.

The slurry is then passed through a series of washing stations and vibrating screens that physically separate out the phosphate particles. These then pass through dewatering tanks to an inventory pile, from where they are transported by ship, rail and truck to fertilizer manufacturing plants to make finished products.

The crushed phosphate rock is treated with sulphuric acid to produce single superphosphate (SSP) or phosphoric acid. The resulting phosphoric acid is either reacted with more phosphate rock to make triple super phosphate (TSP) or mixed with ammonia to make a range of ammonium phosphate products such as mono- or di-ammonium phosphate (MAP or DAP).

Alternatively, and frequently the case in Europe, the phosphate can be reacted with nitric acid in a nitrophosphate process to produce a variety of NPK fertilizers.

PRODUCTION OF
PHOSPHORIC ACID



Potassium fertilizers

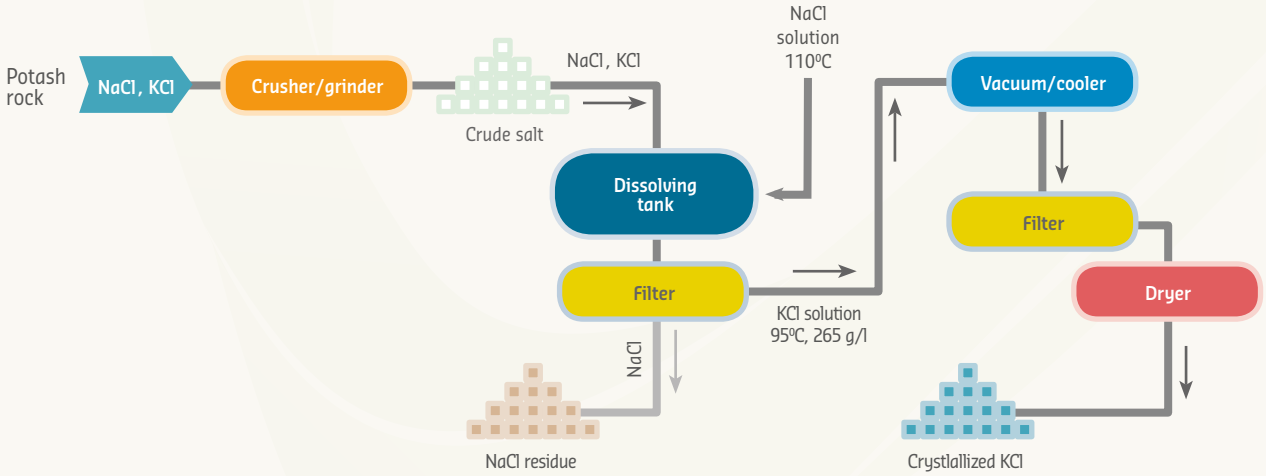
Potassium-based fertilizers are produced from mined potash ores, which are usually rich in salts of both potassium and sodium chloride. These different components first have to be separated to produce fertilizers of the required composition.

Three methods are commonly used: thermal dissolution, flotation and electrostatic beneficiation. In the widely used dissolution process (see diagram) the finely ground, crude salts (mainly sodium and potassium chlorides) are added to a hot, sodium chloride saturated solution.

Potassium chloride dissolves in this solution and the sodium chloride and other salts can be removed by filtration. The hot, potassium chloride-rich solution is passed into vacuum coolers where the potassium chloride crystallizes selectively as muriate of potash (MOP). It is then removed and dried.

The crystallized MOP may then be further treated with sulphuric or nitric acid to produce either sulphate of potash (SOP) or potassium nitrate (KN) fertilizers.

THERMAL DISSOLUTION PROCESS FOR MOP (KCl) PRODUCTION



Additives and treatments

FERTILIZER MANUFACTURERS USE A VARIETY OF ADDITIVES AND TREATMENTS TO PROVIDE A PARTICULAR PRODUCT ATTRIBUTE OR TO ENHANCE A FERTILIZER'S PHYSICAL PROPERTIES.

Many different additives may be mixed with nitrogen, phosphorus or potassium fertilizers to enhance the growth of a specific crop. These can include other nutrients, such as calcium, sulphur and magnesium, and micronutrients, such as boron, copper, iron, manganese, molybdenum and zinc.

Additives are also used to improve the agronomic efficiency of fertilizers, for example by reducing nitrogen losses (through nitrification or urease inhibitors). Fertilizers are also treated with different coatings to improve the granule quality for better handling, storability and spreading on the farm.

Knowledge and understanding of any harmful properties of the additives used is essential. Every material used must satisfy the requirements of the European Union's REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) guidelines and other safety, health and environmental (SHE) legislation.

A variety of additives are used to increase fertilizers' agronomic efficiency.

Environmental controls

ALL FERTILIZER MANUFACTURING FACILITIES IN EUROPE ARE REGULATED BY ENVIRONMENTAL PERMITS UNDER THE INDUSTRIAL EMISSIONS DIRECTIVE (IED).

Environmental permits are based on the concept of Best Available Techniques (BAT). The reference for the fertilizer industry is the EU Best Available Techniques Reference document for Large Volume Inorganic Compounds, Ammonia, Acids and Fertilizers (BREF LVIC-AAF August 2007).

Fertilizers Europe has also issued eight reference documents on Best Available Techniques in the fertilizer industry, covering all essential processing operations:

Fertilizer Europe BAT reference documents

- Production of Ammonia
- Production of Nitric Acid
- Production of Sulphuric Acid
- Production of Phosphoric Acid
- Production of Urea and Urea-Ammonium Nitrate
- Production of Ammonium Nitrate and Calcium Ammonium Nitrate
- Production of NPK Compound Fertilizers by the Nitrophosphate Route
- Production of NPK Compound Fertilizers by the Mixed Acid Route.

Best practice guidelines

THE INDUSTRY'S HARD-EARNED SAFETY RECORD IS BASED ON THE APPLICATION OF ITS BEST PRACTICE GUIDELINES.

Fertilizer production is extensively regulated. In addition, fertilizer manufacturers are expected to follow the industry's best practice guidelines. These cover safety management standards and risk assessment, product specification, emergency plans, and safety training.

Implementation of best practice safety management is based on Fertilizers Europe's Basic Principles for Safety Management. Extensive reference documents are published on page 53.

Product specification

Establishing specifications for end-products as well as corresponding raw materials, additives and coating materials take into account:

- Product requirements (nutrient content, efficiency, levels of impurities, quality requirements for dust formation, caking, particle size, etc.)
- Product regulatory requirements in destination countries and for transportation
- Purity requirements for input materials for food production and animal feedstuffs
- Processing constraints
- SHE restrictions in handling raw materials, in processing and in handling the final product
- Safety hazards in product production and storage
- Product properties to avoid potential misuse.

Regular testing and controls during production checks that products conform to specified quality criteria.

Emergency plans

Establishing emergency plans and informing company employees, contractors, local authorities and the public about them includes the dissemination of regular information regarding hazards and emergency actions.

Qualified personnel need to be nominated to respond to internal and external enquiries on product and process related emergencies and a procedure put in place for reporting and investigating incidents which occur at a manufacturing site. Large manufacturing sites may have to comply with the SEVESO directive.

Safety training

Undertaking and documenting safety training for company employees and contractors includes training on the hazardous properties of the materials and chemicals handled, process and occupational safety risks in manufacturing, correct product handling, handling of spillages and non-conforming materials, and emergency procedures.

Guidelines cover safety management, risk assessment, training and product specification.

Manufacturers are required to participate in Fertilizers Europe's performance benchmarks on safety, emissions and energy efficiency and in evaluating the need for improvements.

The Fertilizers Europe accident reporting scheme provides members with information to avoid similar incidents recurring.

A further element, Fertilizers Europe's "Safety Seminar" provides a platform for free discussion of safety and related issues. It also allows for the exchange of local experience and provides learning opportunities. The seminar is an integral part of the work Fertilizers Europe does in promoting best safety practices.

Safety management

FERTILIZERS EUROPE HAS ESTABLISHED 10 PRINCIPLES FOR GUIDELINES ON THE MANAGEMENT OF SAFETY DURING FERTILIZER PRODUCTION AND STORAGE AT MANUFACTURERS' PRODUCTION SITES.

The principles apply to guidelines for site employees as well as to those for contractor personnel. Support from site line management is essential for them to be successfully implemented.

Guideline principles

1. Every production site should have a high standard of housekeeping.
2. All sites should establish annual safety targets and action plans to achieve them.
3. Every site should have a safety committee comprising the site manager and members reflecting all levels within the organization. All employees should participate in safety meetings on a regular basis.
4. All jobs should be evaluated with respect to safety and a job safety analysis carried out for those that are considered critical. Critical jobs should be described in job procedures, including the prescription of any special personal protective equipment, and employees should be trained accordingly.
5. A preventive maintenance system should be in place.
6. Modifications of process systems and process equipment should be approved based on a systematic safety review.
7. For all work, a work permit system should be in place.
8. An approval system for contractors should be in place.
9. All accidents and near misses should be reported and investigated, with subsequent implementation of corrective actions.
10. Every production site should have an emergency plan, which should be tested at least once a year. The plan should be developed in cooperation with the external emergency services.

Management of contractors

The guidelines require contractor qualification, training and safety to be in place in its member companies for all on-site activities. Evaluation of a contractor company's safety system and safety performance is part of the selection process. Satisfactory assessment of the contractor is considered a pre-qualification for work and subject to periodic renewal.

Selected contractors must demonstrate that their employees have been given appropriate training for compliance with local legislation. They must also demonstrate that appropriate site-specific training for hazards related to the job in question have been reviewed and understood by their employees.

Safety passport

In order to be allowed to work at a site, contractor's employees need to hold a safety passport. The passport is only to be issued after an orientation on the safety hazards, safety rules and emergency plan for the site, and after successful completion of a relevant knowledge test organized by the site. The passport is a personal certificate and needs to carried at all times by the contractor employee when on site.

The passport is valid for a limited period, (e.g. 2 years), after which a new test has to be passed and the passport renewed. When issuing work permits, the validity of the passport is checked.

For contractors not yet in possession of a safety passport, the site will provide appropriate safety guidance to the contractor before work starts and special supervision of the work.

All contracted work has an assigned site employee to act as the contact between the contractor and the site manager. The contact person is responsible for checking out and documenting whether the order is sent to the contractor, whether the contractor can start work and whether the contractor can be selected for later work.

Safety guidelines should cover both company employees and contractors.

Production recycling and waste

ONE OF THE OBJECTIVES OF PRODUCT STEWARDSHIP IS TO MINIMIZE SAFETY AND ENVIRONMENTAL ISSUES IN RELATION TO PRODUCTION WASTE AND NON-CONFORMING MATERIALS.

This involves the re-use, recycling and proper disposal of solid and liquid wastes, as well as packaging materials, and the correct treatment of any product that is off-specification or refused by customers. Many of these materials can also be found in the supply chain and at users' locations. Typical waste materials include metal catalysts, organic resins, various additives and coatings, gypsum, lubricating oils and waste water.

Recycling of materials is encouraged at all stages of the production chain.

The main catalysts for ammonia production contain chromium, nickel, iron and copper, as well as mineral/ceramic support materials. Those for nitric and sulphuric acid production are based on platinum, rhodium and vanadium. For environmental and cost reasons these catalysts are returned to the catalyst producers for rework or are handled as dangerous waste.

Resins from boiler feed water treatment in ammonia production are returned to the resin producer, while water treatment resins used in nitric acid production are regenerated and recycled.

Additives and coatings are treated by recycling operators and disposal of gypsum from phosphoric acid production is agreed with local authorities. Gypsum from new plants can generally be disposed of in landfill but the landfill system needs to be designed to prevent any contamination reaching the surrounding groundwater.

Lubricating oil for rotating machines such as compressors, turbines and pumps and used oil can normally be returned to recycling operators. Waste water from the production process is generally recycled or treated in on-site physical/chemical or biological waste water treatment facilities.

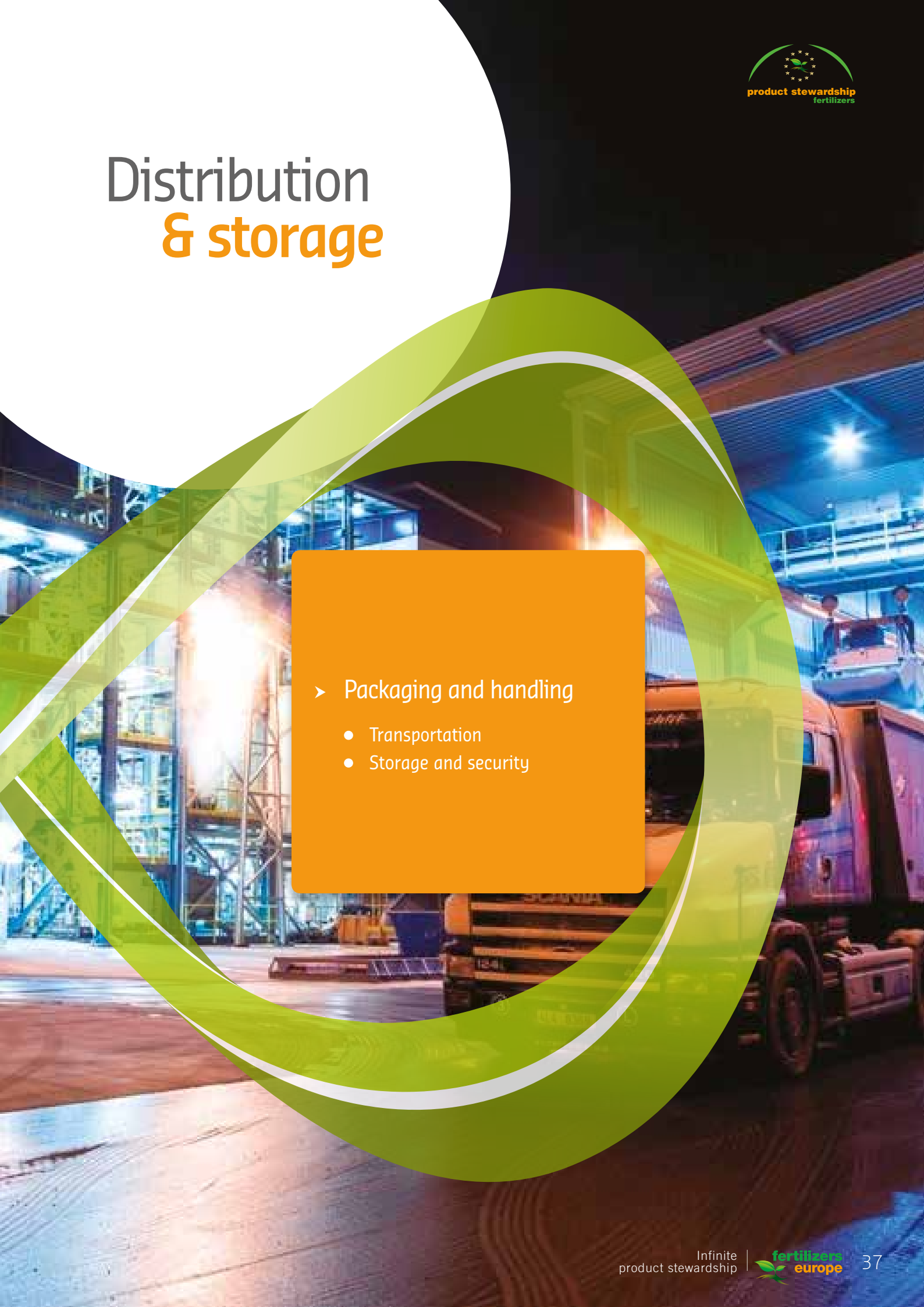
With modern fertilizer application systems, there is little left-over end-product. Any such material can usually be returned to suppliers for disposal in an environmentally friendly way. Contaminated material must be handled safely.

Fertilizer manufacturers are encouraged to establish a waste management strategy to provide advice for service providers and customers. Specific guidance on the re-use and recycling of non-conforming materials is provided in several Fertilizers Europe publications aimed at producers, fertilizer importers, distributors and merchants, and end-users.

The use of raw materials, such as sewage sludge ash and struvite (magnesium ammonium phosphate), in the production of mineral fertilizers opens the way to at least partially closing the nutrient loop in order to contribute to common sustainability ambitions. Care should be taken to address any health and safety issues associated with secondary raw materials and such materials should also comply with legal requirements.

product stewardship fertilizers

Distribution & storage



- Packaging and handling
  - Transportation
  - Storage and security

Packaging and handling

AFTER PRODUCTION, MOST FERTILIZERS ARE STORED IN SMALL BAGS, BIG-BAGS OR IN BULK, BEFORE BEING TRANSPORTED TO DISTRIBUTORS, WHERE THEY CAN ALSO BE PACKAGED.

Legislation often governs fertilizer packaging, depending on the product classification and resulting packaging group. From a practical standpoint, packaging materials obviously need to be compatible with the particular fertilizer to avoid any chemical or physical reaction. The design and construction of fertilizer bags must be such as to protect the product from any adverse conditions like water ingress and direct sun exposure and provide resistance when the product is lifted, stacked or dropped.

The transport of fertilizers and their raw materials is regulated by EU legislation.

Most product stewardship schemes ensure that information on the packaging is accurate with respect to product name, nutrient content, identity of the manufacturer, batch identification and storage recommendations, and legally required SHE information on transport and storage, including a Safety Data Sheet (SDS).

Safe loading of fertilizers, - whether bagged or in bulk - onto trucks, rail wagons, ships and barges is required to satisfy Fertilizers Europe's Best Practice Guidelines. The same applies to the handling of input materials, intermediate products and chemicals involved in the production process.

Transportation

The transport of fertilizers and their raw materials is regulated by both UN and EU legislation. In order to keep the risk of accidents to a minimum, transport operators need to follow best industry practice. The Fertilizers Europe Product Stewardship Program calls for the selection of transport operators based on SHE performance and competence, adherence to best industry practice in their loading and unloading operations, and attention to security during transport.

This primarily involves making a SHE risk assessment of risks and security concerns during loading, unloading and transport, evaluating alternative means of transport, as well as transport routes and intermediate storage locations, and selecting transport operators based on an assessment of their past SHE performance.

Instructions to transport operators specify required transport equipment, procedures and protective equipment for loading and unloading, special competences and emergency and security preparedness and response. They also cover establishing the role of a dangerous goods safety advisor, classifying and labelling products for transport and providing Safety Data Sheets, establishing safe loading and transport procedures, and ensuring that drivers and shippers are trained in handling products and any emergencies that may arise.

The above requirements relate to fertilizer end-products as well as to raw materials and chemicals. Several Fertilizers Europe publications provide the necessary guidance on the storage, handling and transportation of solid and liquid fertilizers, chemicals and intermediate products.

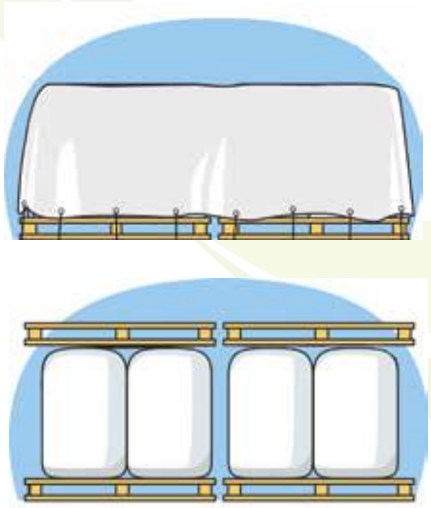
Fertilizers Europe also recommends use of the Safety and Quality Assessment Systems (SQAS) issued by CEFIC, the European Chemical Industry Council. These are well suited to the evaluation of a particular mode of transport or logistics operation (road, rail, intermodal, cleaning stations, marine packed cargo, bulk marine shipping, bulk storage terminals and barges).

Storage and security

Fertilizers need be stored and handled with care. The aim is to maintain the physical and chemical qualities of the product, to prevent incidents, such as fire, product decomposition or explosion, and to avoid product theft.

For storage at company or rented warehouses, at distributors or on the farm, the same general guidelines apply:

- Nitrogenous fertilizers should be stored away from water and drains so that spillage cannot cause contamination
- Solid fertilizers should be kept dry, and all fertilizers stored out of direct sunlight and protected from exposure to wide variations in temperature



Guidelines for the correct storage of fertilizer big-bags.

- Fertilizers with oxidizing properties should be stored away from organic materials and fuel sources and local fire authorities should have access to the type and quantity of fertilizers being stored
- Care should be taken to stack bagged fertilizers according to manufacturers' instructions and big bags should be handled with the appropriate machinery.

Fertilizers Europe's Best Practice Guidelines provide manufacturing companies with the procedures to follow. The guidelines can also be used when renting storage and for selecting distributors and their warehouses. External warehouse selection needs to be based on an assessment of the operator's SHE performance and the SHE management and security systems in place.

Fertilizer manufacturers provide product information to distributors and customers so they have a good knowledge of the SHE aspects of the products (e.g. by means of Safety Data Sheets and Best Practice Guidelines).

These ensure safe housekeeping and separation of products, correct handling of non-conforming materials and waste, risk assessment of the storage facilities, necessary measures to prevent accidents and criminal acts, the establishment of emergency plans, and the provision of information and training to storage operators.

Safety Data Sheets and Best Practice Guidelines promote safe housekeeping of products.

The traceability of products is usually covered by procedures for attending to customers and registration of the amount of product in store at any time.

Fertilizer use

Customer assistance

- Customer advice
- Fertilizer blending
- Fertilizer application

Customer assistance

FERTILIZER MANUFACTURERS' CUSTOMER ASSISTANCE SYSTEMS COVER PRODUCT QUALITY AND TRACEABILITY, CUSTOMER COMPLAINTS AND PRODUCT RECALL PROCEDURES.

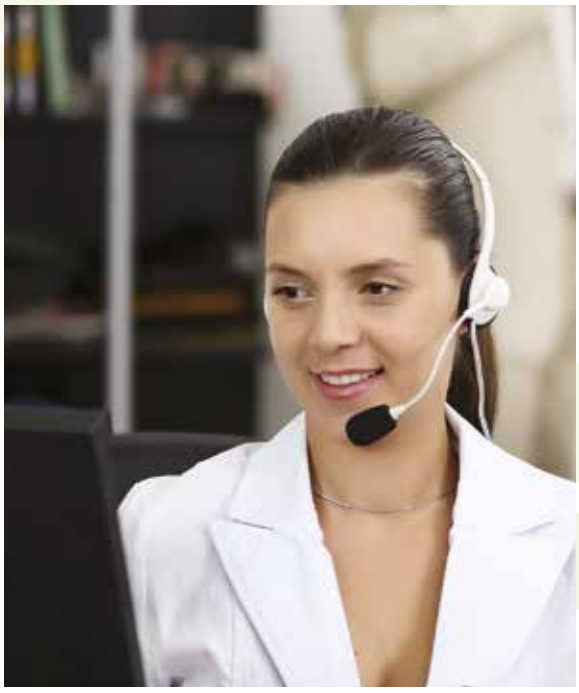
All fertilizer products on the European market must conform to specific quality requirements described in EU regulations on fertilizers. In addition, fertilizer end-users, Europe's farmers, often have their own preferences for product purchase based on nutrient content and quality characteristics.

Fertilizer manufacturers have quality assurance systems in place, therefore, to document required product characteristics and carry out regular product sampling and laboratory quality analyses. These systems often include best practice handling procedures to avoid any deterioration in product quality along the distribution chain.

The systems also cover procedures to rapidly respond to complaints from customers, distributors and service providers. Batch traceability enables identification of products at all stages within the distribution chain, while product recall systems cover procedures for the removal of products from the market and handling of emergency calls from customers, service providers and the general public.

Customer advice

With the closest contact with customers, the fertilizer manufacturer's marketing and sales department often plays an important part in product stewardship.



Marketing and sales teams are trained to provide assistance on product related issues such as the agronomic aspects and correct application of a fertilizer, its properties as given in Safety Data Sheets and other SHE-related information, the identification of risks from intended product use and possible misuse, and correct product handling and storage.

They also provide information and guidance to customers on product quality and SHE-related issues such as the handling of spills, contaminated products, complaints, product recalls, incidents and emergency calls, as well as security issues and regulatory requirements. Companies can also often offer specific training on the correct use, storage and handling of products.

Customer advice should include information on product handling and use.

SHE-related information to distributors and farmers to prevent any adverse SHE-related incident generally includes information on:

- Correct product application
- Safe handling, storage and transportation of products
- Safe storage of products on the farm
- Safe handling of spills and contaminated products
- Emergency preparedness and response
- Security measures for fertilizers.

Several Fertilizers Europe Best Practice Guidance documents provide further details.

Fertilizer blending

Instead of distributing single-nutrient fertilizers separately or making use of factory-manufactured multi-nutrient complex fertilizers, distributors or farmers may well wish either to mix the fertilizers themselves or make use of the services of a retailer with a blending unit.

This provides the opportunity to prepare special blends with particular nutrient ratios to suit a farmer's soils and crops.

Fertilizers which are to be mixed together need to be chemically and physically compatible so that there are no gaseous losses or decreases in nutrient availability or caking and/or physical interactions.

Special care needs to be taken when mixing ammonium nitrate-based fertilizers with other materials such as potassium chloride and trace elements. A risk assessment should be made to ensure that the blended products satisfy regulatory requirements with respect to composition and resistance to decomposition and detonation.

Physically blended materials should be of similar granule size (normally 2-4 mm in Europe) and density to prevent segregation during storage, transport and spreading.

Reference can be made to Fertilizers Europe's Guidance for Compatibility of Fertilizer Blending Materials and input materials and the blended products should be handled and stored in line with its guidance for the storage, handling and transportation of solid mineral fertilizers.

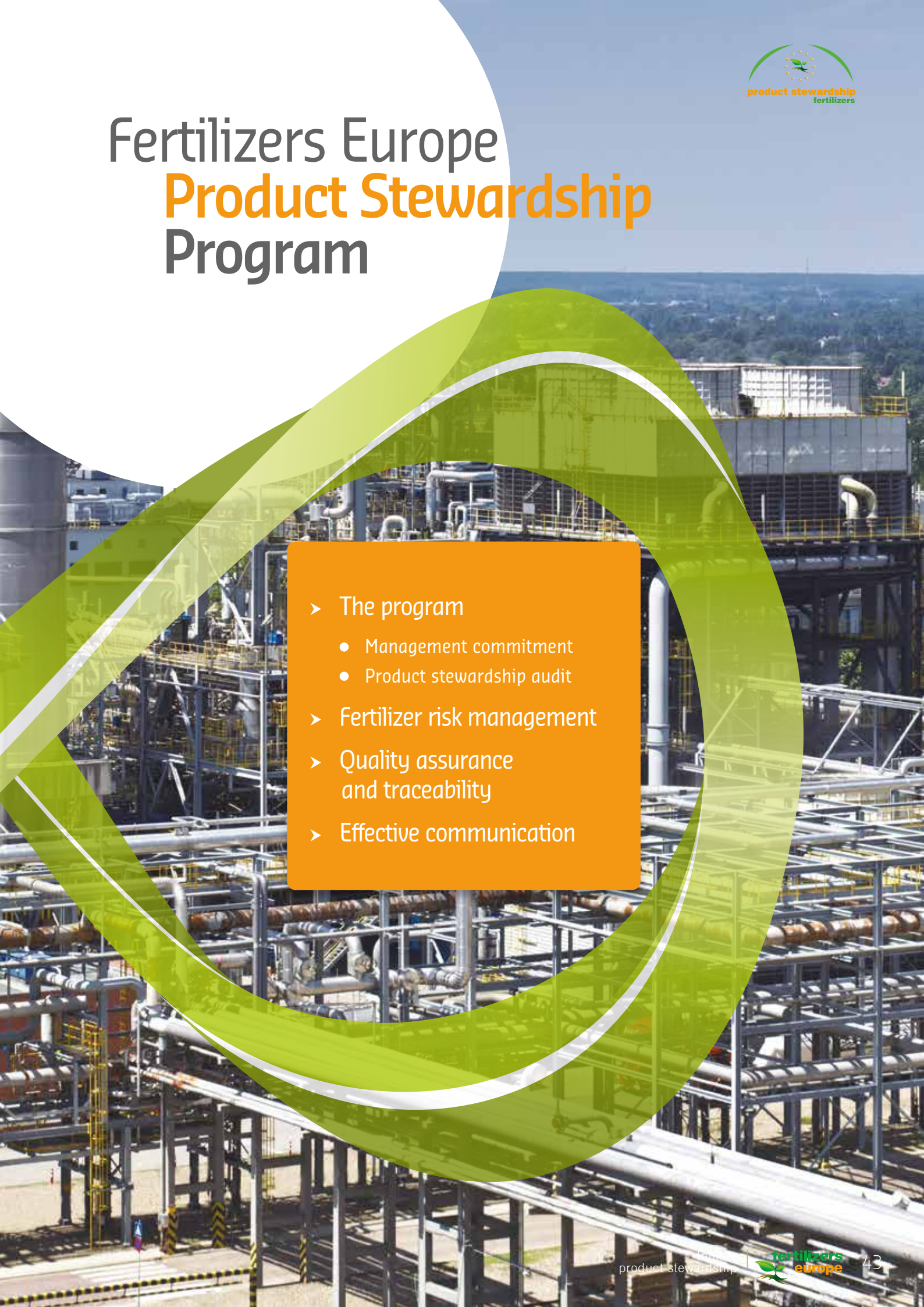
Fertilizer application

Fertilizers Europe promotes correct fertilizer use according to the principles of Good Agricultural Practice.

Advice to farmers on the application of fertilizers is based on Fertilizers Europe's four principles - right product, right rate, right time and right place. This governs the most appropriate type of fertilizer to be applied for a particular crop, the amount of fertilizer to be applied, the timing and number of applications, and areas where the fertilizer should, or should not, be applied.

Manufacturers' advice also includes information on the physical quality of products, appropriate setting of spreading equipment, precision farming techniques, handling of product waste and emergency procedures. Reference should be made to Fertilizers Europe's Nutrient Stewardship brochure which describes the activities in further detail.

Fertilizers Europe Product Stewardship Program



- The program
  - Management commitment
  - Product stewardship audit
- Fertilizer risk management
- Quality assurance and traceability
- Effective communication

The program

THE FERTILIZERS EUROPE PRODUCT STEWARDSHIP PROGRAM COVERS ALL TYPES OF MINERAL FERTILIZERS, AS WELL AS RAW MATERIALS AND INTERMEDIATE PRODUCTS.

The program specifies procedures for best practice management of the safety, health, environmental and security aspects of sourcing fertilizer raw materials, fertilizer production and storage, and supplying fertilizers to Europe's farmers. In addition, Fertilizers Europe issues advice on the correct application and use of fertilizers under the banner of nutrient stewardship.

The Fertilizers Europe program provides a practical structure for establishing product stewardship in a company based on best practice guidelines, and offers an overview of relevant national and international fertilizer legislation. Fertilizers Europe requires its member companies to implement its Product Stewardship Program and Best Practice Guidelines and their implementation is verified by regular independent third-party audits.

The European program qualifies as being at the most advanced level of the product stewardship programs established by the International Fertilizer Industry Association (IFA), the global industry body.

Company management is expected to actively demonstrate its commitment to product stewardship.

Management commitment

For the overall management of a product stewardship program at company level, each member company is expected to have a company policy statement and a program structure which reflects its commitment to product stewardship and product stewardship improvement targets, as well as action plans for achieving these. It must also allocate sufficient resources for product stewardship activities and set clear lines of responsibility for the various elements of product stewardship, with a single person nominated as the overall facilitator.

The company is also expected to provide training, monitor and evaluate performance, initiate corrective actions that hold people accountable according to their roles and responsibilities, and actively encourage employees and the supply chain to raise their awareness of product stewardship and its importance for the industry.

Various systems can be put in place for controlling the documentation of operational requirements for product stewardship, such as handling non-conformities and

complaints and to trace and retrieve products in the supply chain. These also enable decisions to be made on product risks across the entire supply chain and the assessment of alternative raw materials and chemicals, alternative means of transport and transport routes, type of storage, etc.

Appropriate systems enable compliance with product stewardship to be checked and the initiation of improvements and regular company management reviews of progress, as well as the initiation of any corrective actions.

Product SHE-risks

Fertilizers Europe Product Stewardship Program is based on the application of the 'Plan-Do-Check-Act' principles for the management of product SHE-risks. This involves developing a comprehensive understanding of the risks to people, property and the environment throughout the lifecycle of a product and establishing a management system to reduce and control them.

Senior management are required to take ownership of the activities and be the "driver" of change. Periodic reviews or audits of implementation are required. These should be initiated by senior management and clear feedback to the organization on the reviews is expected.

Fertilizers Europe Product Stewardship Program is structured to follow the product life cycle (i.e. from sourcing of raw materials, fertilizer production, storage and transport through to product delivery and storage on farms).

Each step of the product life cycle contains a number of product stewardship requirements, which Fertilizers Europe's member companies are expected to fulfil. The application, use and recovery of fertilizers are covered by Fertilizers Europe's nutrient stewardship activities.

Product stewardship audit

Fertilizers Europe's member companies are required to have an internal system in place for auditing their product stewardship program. The self-auditing procedure includes an audit plan, the training and qualification requirements for internal auditors, and procedures for conducting audits and implementing recommendations and follow-up.

The audits are based on an audit manual and a questionnaire designed to assist members identify gaps and possible improvements to be made in their current product stewardship activities. A weighting is introduced to facilitate simple progress reporting and for establishing improvement targets.

Every three years, Fertilizers Europe organizes compliance audits of program implementation in member companies by a qualified independent third party. These build on the self-audits carried out by member companies. Verification is undertaken by the independent auditor using an inspection checklist as a supplement to the audit questionnaire.

The results of the third-party audits are assessed by the Board of Fertilizers Europe. A certificate is issued to those companies that pass the audit.

Fertilizer risk management

THE CORE OF THE FERTILIZERS EUROPE PRODUCT STEWARDSHIP PROGRAM IS A COMPREHENSIVE UNDERSTANDING OF PRODUCT RISKS AND TAKING APPROPRIATE STEPS TO REDUCE OR PREVENT THEM.

Fertilizer risk management evaluates, as far as is possible, actual and potential risks to human life, property, and the environment at each stage of a product's life-cycle, mainly through hazard identification and an estimation of possible exposure.

Prioritization of risks, based on an informed judgment as to their severity and consequences, is important before deciding on suitable action.

The purpose of the risk management is to ensure that no chemical or process related to the manufacturing, storage, transport, use or disposal of fertilizers, or circumstances of possible criminal acts, presents any unacceptable risks and that any risks that do exist are reduced to the lowest practical level.

The process consists of five major parts, which need to be integral to a company's product stewardship program:

Fertilizers risk management process

1. Determine product properties

Obtaining a thorough understanding of any potential harmful properties of the product. This applies not only to products which are formally classified as hazardous, but also to any other products with properties which could foreseeably cause harm.

2. Identify exposure and assess risks

Determining the potential exposure of people, property and the environment to the product. Both normal and abnormal circumstances should be considered. Abnormal circumstances include accidents, spillages and criminal acts. Identify specific risk scenarios based on the product properties and potential exposures: what exposure can take place during normal manufacturing, storage and handling operations, what kind of abnormal events could take place, and what are the consequences for people, property and environment?

3. Prioritize risks

Prioritizing any risks to taking corrective action, taking account of the likelihood of events, the consequences, and the ability of the organization to influence these factors.

4. Design and implement controls

After evaluation of the actual and potential risks at each stage of the product lifecycle, developing and implementing appropriate actions to minimize and control them. The following basic principles apply:

- Develop/modify products to meet customer's needs while striving to minimize SHE impact
- Evaluate risks resulting from the unintended and intended use and possible misuse of products and periodically update the evaluation

It may not be possible for a fertilizer company to manage all the risks on its own, since many service providers are usually involved in the supply chain. Fertilizers Europe's member companies are encouraged, however, to influence the whole supply chain to follow its product stewardship principles.

All suppliers must recognize that they are part of a chain and that they should make all reasonable effort both to manage risks over which they have direct control and to work with others in the chain to help them manage risks within their control.

Evidently, the purchasing contract should include relevant specifications to SHE, whether this is a contract for purchasing raw materials, for maintenance work, for storage operations, or for transport companies.

Any change in organization, raw materials, manufacturing process, distribution, use, etc. may have an impact on product risk. All such changes should be specifically reviewed as part of the overall risk management activity.

Risk management is an integral part of any product stewardship program.

- Establish and maintain information on foreseeable SHE hazards from exposure to new and existing products
- Whenever technically and economically feasible, continuously develop and improve processes for minimizing waste, reducing emissions, and for the reuse, recovery, recycling and disposal of products
- Develop and implement appropriate actions to control or minimize risks. Such actions could include reformulating a product with less hazardous components; safe storage or disposal; labelling; training; engineering controls; protective equipment; emission controls; incident monitoring; controls in raw material purchasing, product sourcing, and storage and distribution; auditing of operators, hauliers, contractors, suppliers; responsible advertising or after sales support.

5. Monitor progress and implement necessary corrective actions

Quality assurance and traceability

ALL FERTILIZERS ON THE EUROPEAN MARKET MUST CONFORM TO SPECIFIC QUALITY REQUIREMENTS SET BY THE AUTHORITIES. THESE ARE DESCRIBED IN EU FERTILIZER REGULATION.

Customers also set requirements for their purchases in relation to product nutrient content and product quality characteristics. Companies should have quality assurance procedures to document the required characteristics, and to carry out the necessary sampling and laboratory analyses.

Operations should include best practice handling routines to avoid any deterioration of product quality along the distribution chain. These procedures should also cover complaints, traceability, product recalls and emergencies:

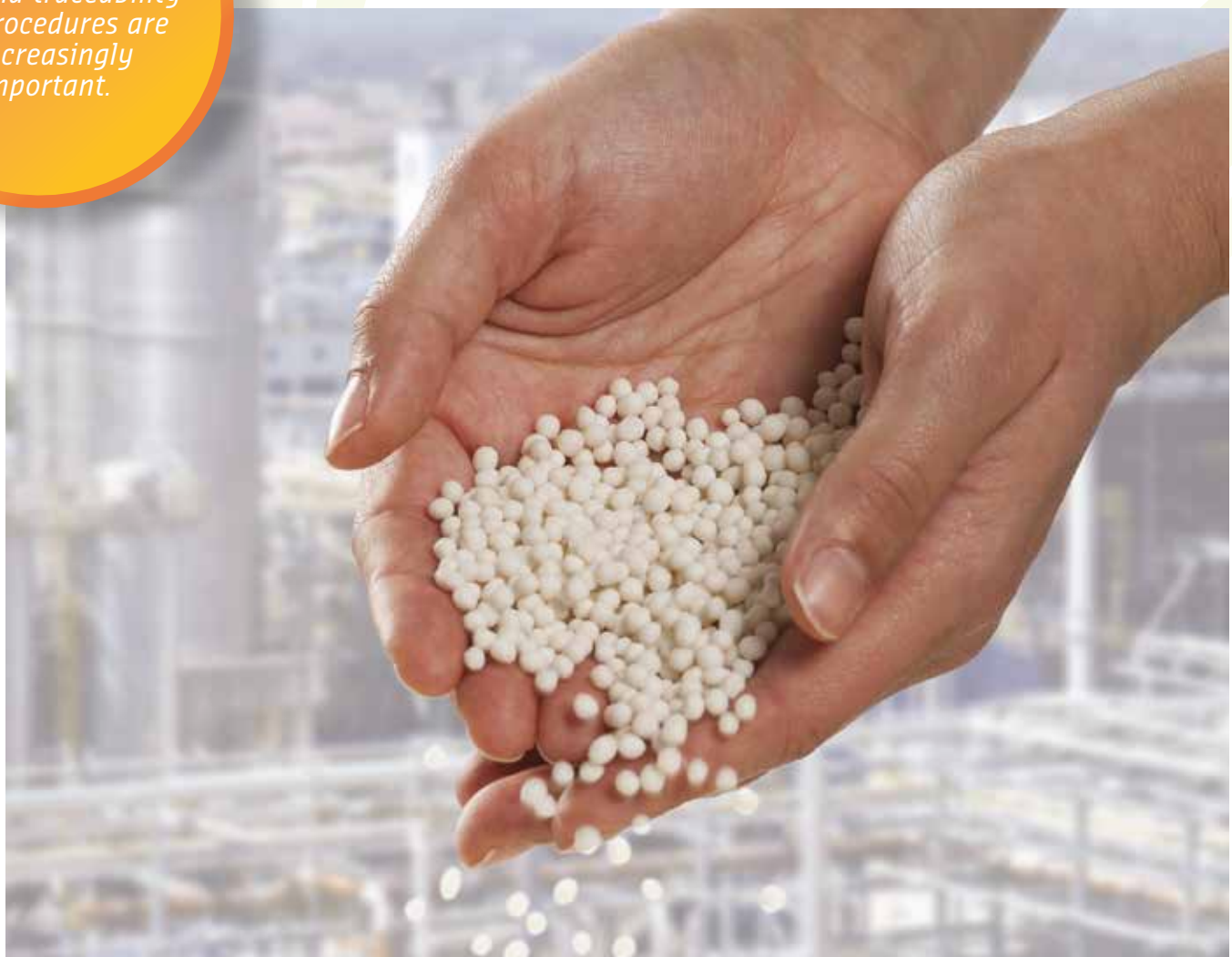
- A complaints handling system to respond to complaints from customers, distributors and service providers
- A batch traceability system to enable tracing of a batch of manufactured product at all stages of the product life chain
- A product recall system for recalling of products from the market if necessary
- Handling of emergency calls from customers, service providers, and from the public at large.

Security

In response to the increased concern related to terrorism and misuse of fertilizers, Fertilizers Europe recognizes the need to address security in production, storage, transportation and sales of fertilizers. Hence, the Fertilizers Europe Product Stewardship Program covers this important topic, taking account of the risk of theft, possible misuse of products and criminal acts.

Fertilizers Europe's recommendations regarding security measures are available to member companies and the recommended security measures are part of Fertilizers Europe's auditing system for product stewardship.

Product quality and traceability procedures are increasingly important.



Effective communication

AN EFFECTIVE COMMUNICATION PROCESS IS AN IMPORTANT ELEMENT OF ANY PRODUCT STEWARDSHIP PROGRAM.

Comprehensive SHE information needs to be targeted at all those involved in the product life-cycle and measures need to be put in place to ensure that the information is understood and implemented. This involves communicating the Fertilizers Europe Product Stewardship Program to member companies, ensuring that the program is understood and verifying that it is implemented at a company level.

Fertilizers Europe's member companiesare required to comply with its Product Stewardship Program and disseminate SHE information to its employees, relevant partners in the supply chain and to customers and to ensure that the information is understood and implemented.

The outline of the Fertilizers Europe Product Stewardship Program is given in this brochure. General information can also be found in the Questions and Answers section of the Fertilizers Europe website. The program is described in more detail on the website, although some sections, (i.e. those relating to security and auditing), are available to members only.

Fertilizers Europe's Best Practice Guidance documents, recommendations and brochures are available for everyone interested in product stewardship for fertilizers and links to this information are provided on the website. A reference list is also provided for relevant EU and international regulations. Fertilizers Europe expects member companies to cover the relevant issues in its Product Stewardship Program in contracts with customers.

An important part of Fertilizers Europe's work is to share information on product stewardship activities between its member companies as well as with business partners, the regulators and with the community at large. Fertilizers Europe organizes training programs to introduce the program to member companies. The member companies who are expected to train their employees on the product properties, safe handling and storage, use and disposal of products.

Partnerships

The building of effective partnerships between a fertilizer supplier and its customers, suppliers, hauliers, distributors, and others involved in the supply chain is a key aspect of product stewardship. The ultimate objective is to extend the recognition of its positive contribution to all those involved.

This also applies to the contacts with the authorities and regulators, and with the scientific community, to ensure that the information being used for the development of regulations and information to the general public are based on science and correct risk assessment.

Fertilizers Europe recommends that its members collaborate actively with all external parties involved in supplying, handling and using fertilizers and with authorities and the scientific community.

Major partners include the emergency services, suppliers, contractors, customers, resellers and other downstream users, haulage companies, industry associations, such as the International Fertilizer Industry Association (IFA) and the European Chemical Industry Council (CEFIC), and authorities such as the European Commission, EU Member States and Members of the European Parliament.

Fertilizers Europe seeks a well balanced legislation where the community takes proper account of the safety, health and environmental aspects of fertilizers, as well as their social and economic impact.

INFINITE FERTILIZERS
Continuing to feed the world

Infinite fertilizers

At the forefront of change

- Product Stewardship
- High quality raw materials
- Nutrient Stewardship
- Nutrient-use efficiency
- Life cycle analysis
- Continued dialogue

At the forefront of change

ENSURING THAT EUROPE'S AGRICULTURE SECTOR MEETS INCREASING PRODUCTION AND ENVIRONMENTAL DEMANDS REQUIRES CHANGE. THE EUROPEAN FERTILIZER INDUSTRY IS HELPING TO SPEARHEAD THIS CHANGE.

Global food production needs to increase to keep pace with projected food needs. The "sustainable intensification" of European agriculture will enable Europe's farmers to play their part while, at the same time, reducing their environmental footprint.

The European Fertilizer industry supports sustainable intensification and believes that it can practically be achieved through more widespread adoption of the best agricultural practice, precise crop nutrition, and the latest cultivation and soil management techniques.

As part of this process, the industry has the responsibility not only to provide, safely and efficiently, Europe's farmers with a variety of high quality fertilizers, but also to inform them in their correct selection and use. This belief is exemplified by our vision of Infinite Fertilizers.

Product Stewardship

Mineral fertilizer production is based on large numbers. Each year, the industry transforms millions of tons of air, natural gas and naturally occurring mineral ores into easy-to-use nutrients that support crop growth.

European fertilizer manufacturers increasingly draw on the experience of the entire food production chain when developing their products. Today, these are often targeted at specific crops, with a variety of release profiles that take into account limited resources, such as water, or other environmental factors.

The scale and scope of the industrial processes to produce fertilizers requires us to focus closely on providing a safe and secure environment at our plants and in their neighbouring communities, as well as on safeguarding those beyond the factory gates who store and distribute our products.

Fertilizers Europe has developed a management system within Infinite Fertilizers to ensure that European fertilizer producers live up to this challenge and that their advanced production and distribution controls are consolidated within the industry and updated with the introduction of new technology.

Fertilizers Europe's Product Stewardship Program embodies the industry's aspirations. The program is compulsory for our members and their compliance with it is regularly verified by independent auditors. The program sets the highest global standards for programmes of its type.

High quality raw materials

Our production cycle begins with our raw materials. Apart from the air and natural gas used to produce nitrogen fertilizers, key raw materials are mined deposits of phosphate and potash-bearing rock. While these materials are relatively abundant globally, they can only be found to a limited extent within Europe.

This means that the European industry is highly dependent on imports and the trade, pricing and environmental policies of countries is beyond Europe's control. It challenges us to be highly efficient in the selection and use of our raw materials. Industry quality standards are especially relevant as far as phosphate and potash fertilizers are concerned.

While the basic processes for producing the main types of fertilizer were invented some 100 years ago, the skills, efficiency and control systems we use today have changed beyond all recognition. These enable European nitrogen fertilizer plants to be among the most energy efficient in the world, as well as to have the lowest environmental impact. Investment in our production processes and procedures is continuous.

Beyond the plant gate, we work closely with the fertilizer supply chain to ensure the efficient and secure transportation and storage of our products on their way to Europe's farmers.

Nutrient Stewardship

On the farm, mineral fertilizers offer a predictable, well-balanced supply of nutrients to meet the changing requirements of individual crops over their growth cycle and ensure productive growth. They also help replace the nutrients removed from the soil when the crops are harvested and so help maintain fertile soils.

New technologies such as GPS and sensor-based soil and biomass mapping, which precisely define nutrient demand at field level, enable highly targeted fertilizer application, increasing nutrient-use efficiency and reducing the risk of environmental losses.

The industry's activities promoting the correct selection and use of our products fall under the umbrella of nutrient stewardship. Their main objective is to encourage good agricultural practice by increasing farmers' knowledge of our products and their application.

We focus on developing practical guidelines for sustainable nutrient management on the farm and, over the years, have built up a range of publications that address specific issues such as productivity, energy efficiency, air quality and the management of emissions.

Nutrient-use efficiency

The main thrust of our current efforts is on the promotion of nutrient-use efficiency. To optimise crop yields and minimize environmental impact, our basic rule of thumb is application of the right product, at the right rate, at the right time, at the right place. To help maintain the nutritional quality of the soil, we also encourage the use other agricultural techniques such as crop rotation, minimum tillage and catch crops.

Our campaign explaining the benefits of different types of nitrogen fertilizer was well received by farmers across Europe. The campaign was part of our response to reducing environmental emissions from agriculture, where the application of different types of fertilizer has an impact.

Life cycle analysis

Life cycle analysis of fertilizer products, including their production, transportation and use, is an integral part of assessing agriculture's environmental footprint. Farmers can now use Fertilizer Europe's carbon footprint calculator for fertilizer production in conjunction with applications such as the Cool Farm Tool to check the overall environmental impact of their operations.

The reduction of waste and the recycling of nutrients derived from non-renewable resources are becoming increasingly important globally. To date, the primary focus within European agriculture has been on on-farm measures such as composting crop waste, anaerobic digestion of manures and the more efficient use of organic material in the overall fertilization strategy.

On an industrial scale, several regional projects to capture and concentrate nutrients have been successful. Industry research continues into sourcing viable streams of recycled raw material to close the fertilizer loop.

Continued dialogue

The industry works increasingly closely with all those involved in the food production chain to help create a modern, productive and profitable agricultural sector in Europe. Continued dialogue with policymakers, scientists and other stakeholders ensure the conditions for the European fertilizer industry to continue to develop and innovate.

Fertilizers Europe Product Stewardship publications

Transport

- Guidance for UN Classification of Ammonium Nitrate Based Substances
- Transporting Ammonia by Rail
- Sea Transport of Ammonium Nitrate Based Fertilizers
- Transporting Nitric Acid in Tanks

Storage

- Safe and Secure Storage of Fertilizers on Farms
- Storage, Handling and Transportation of Solid Mineral Fertilizers
- Storage of Hot Ammonium Nitrate Solutions
- Inspection of Atmospheric Refrigerated Ammonia Storage Tanks
- Guidance for the Compatibility of Fertilizer Blending Materials
- Safe Handling and Utilization of Non-conforming Solid Fertilizers and Related Materials for Fertilizer Importers, Distributors and Merchants
- Short version of Guidance for Handling Non-conforming Ammonium Nitrate Based Fertilizers in the Distribution Chain
- Safe Handling and Use of Non-conforming Fertilizers and Related Materials for Producers
- Do's and Don'ts for Safe Storage of Fertilizers containing AN
- Stress Corrosion Cracking leaflet
- Guidance for Fighting Fires and/or Decomposition involving Solid Mineral Nitrogen-based Fertilizers

Production

- Inspection of and Leak Detection in Liquid Ammonia Pipelines
- Booklet nr. 1: Production of Ammonia
- Booklet nr. 2: Production of Nitric Acid
- Booklet nr. 3: Production of Sulphuric Acid
- Booklet nr. 4: Production of Phosphoric Acid
- Booklet nr. 5: Production of Urea and Urea-Ammonium Nitrate
- Booklet nr. 6: Production of Ammonium Nitrate and Calcium Ammonium Nitrate
- Booklet nr. 7: Production of NPK Compound Fertilizers by Nitrophosphate Route
- Booklet nr. 8: Production of NPK Compound Fertilizers by Mixed Acid Route

All Fertilizers Europe Product Stewardship publications are available at: www.fertilizerseurope.com

INFINITE FERTILIZERS

Continuing to feed the world

Fertilizer Europe's Product Stewardship Program sets the highest standards for product quality and the safety, efficiency and environmental impact of fertilizer production and distribution, including the effective use of raw materials. The program is compulsory for all Fertilizers Europe members.

Fertilizer Europe's Carbon Footprint Calculator enables fertilizer producers to better measure and manage the energy use and emissions from the production of major fertilizer products.

Fertilizer Europe's fertilizer family spearheads our activities to encourage the best agricultural practice among Europe's farming community and the correct selection and use of fertilizers. Our DAN campaign promotes nutrient-use efficiency and the benefits of directly available nitrogen fertilizers.

Fertilizers Europe supports and promotes the use of the Cool Farm Tool which enables farmers to simply measure the environmental emissions from their operations and food production companies to evaluate and reduce emissions in their supply chains.

INFINITE FERTILIZERS

Continuing to feed the world

Infinite fertilizers guides the European fertilizer industry's initiatives to ensure that Europe's farmers have access to a variety of safe, high quality, locally produced products, as well as information on their use, environmental impact and nutrient recycling opportunities.

fertilizers europe

Fertilizers Europe represents the majority of fertilizer producers in Europe and is recognized as the dedicated industry source of information on mineral fertilizers. The association communicates with a wide variety of institutions, legislators, stakeholders and members of the public who seek information on fertilizer technology and topics relating to today's agricultural, environmental and economic challenges. The Fertilizers Europe website provides information on subjects of relevance to all those interested in fertilizers contribution to global food security.

Fertilizers Europe asbl
Avenue E. Van Nieuwenhuyse 4/6
B-1160, Brussels, Belgium
Tel: +32 2 675 3550
Fax: +32 2 675 3961
main@fertilizerseurope.com

www.fertilizerseurope.com

www.facebook.com/fertilizerseuropepage

Group Fertilizers Europe

twitter.com/FertilizersEuro

www.youtube.com/fertilizerseurope

www.danfertilizers.com

www.productstewardship.eu

www.fertilizersforum.com