MINERAL FERTILIZERS: AN ESSENTIAL AND EFFICIENT ELEMENT IN THE AGRI-FOOD CHAIN AND NUTRIENT CYCLE.

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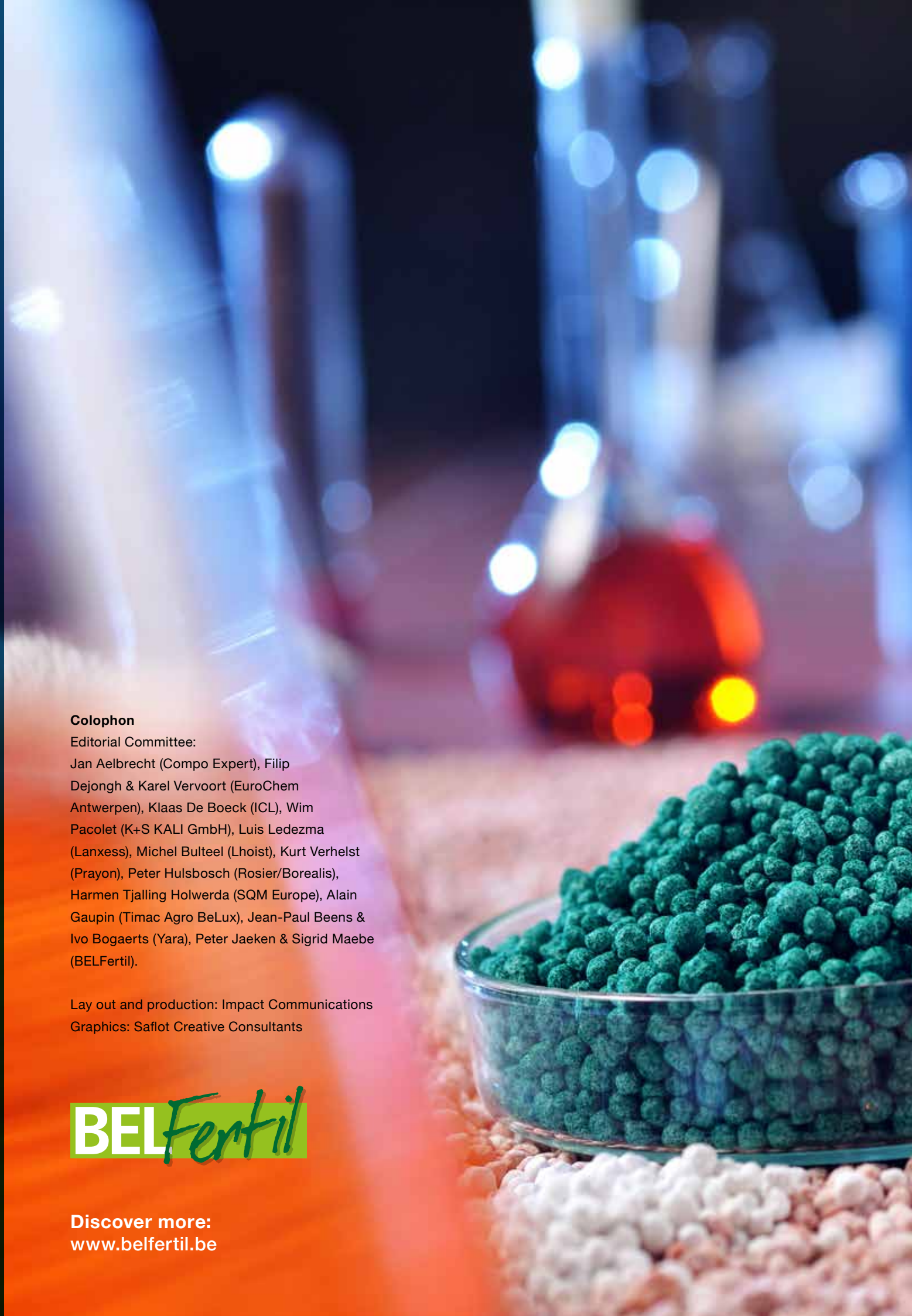

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PREFACE

To sustainably produce high quality food and biomass and to preserve agronomic diversity, we need specific solutions for balanced plant nutrition as part of an integrated approach to soil fertility. Mineral fertilizers play a major role in achieving these goals.

The mineral fertilizer industry became active in Belgium more than 150 years ago. Even then, Europe was densely populated and agriculture needed nutrients to compensate for the net removal of plant nutrients from the soil by crop production. The mineral fertilizer sector was relevant then and is still relevant today, making an essential and efficient contribution to sustainable food and biomass production through balanced plant nutrition.

Terms such as the circular economy, nutrient recovery and reuse, raw material efficiency, greenhouse gases and bio-based economy have become part of the standard vocabulary of policy makers and society in recent years.

Although mineral fertilizers enable farmers to replenish soil with the nutrients that are necessary for life, their role and importance in some key global challenges is not widely known. This also holds true for the industry's efforts and progress in these areas.

The global challenges, as defined in the United Nations' Sustainable Development Goals, are significant: hunger, poverty, climate, the environment. Agriculture has an important role to play in offering solutions to many of these challenges and it has a crucial partner in the mineral fertilizer sector.

For members of BELFertil, the Belgian and Luxembourg Fertilizer Industry Association these concepts are not just "terms", but a key part of our specific daily challenges and opportunities. The Association comprises a very diverse group of outstanding mineral nutrient producers with strong local roots but who operate internationally.

This local anchoring is often reflected in far-reaching synergies and integration, both upstream and downstream in the chain, which enable our members to successfully meet customer needs.

This brochure offers a wide-ranging overview of specific accomplishments over the past decade.

Photo Boerenbond

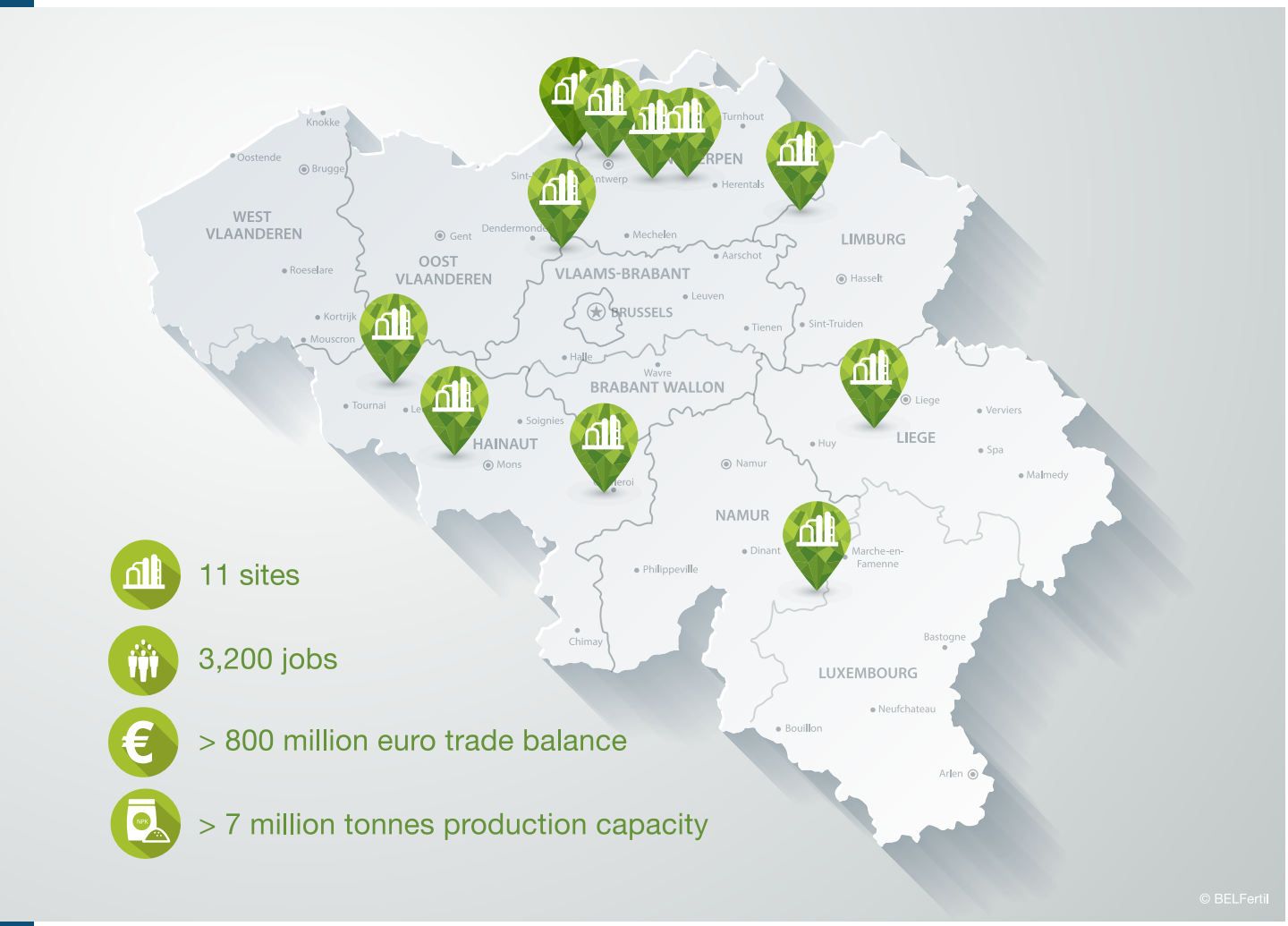
It highlights the progress made as well as some of the breakthroughs achieved in meeting some of the aforementioned challenges. The brochure also reflects the involvement and commitment of our employees and boardrooms. Resting on our laurels is not an option and we have no intention of doing so.

That is why we are outlining some of the short, medium and long- term developments we plan and explore.

Progress comes at a price. Apart from the wide-ranging skills and substantial investments in time, effort and funding required at a corporate level, we are also calling for an enabling policy and innovation framework, particularly in today's highly competitive global business environment. The time when everything could be developed in-house has long since passed, as has the time when one sector alone was able to solve a major societal problem. Today, mineral fertilizer producers have extensive networks of public and commercial R&D centres at their disposal. A model in which stakeholders from the academic world, the business community, regulators and government can come together and work to find realistic, scalable and above all sustainable solutions is essential. We hope this overview will encourage constructive dialogue between all these relevant stakeholders. Our sector has been committed to sustainability for decades and will remain so in the future.

Jean-Paul Beens,
President BELFertil

CHAPTER 1: THE MINERAL FERTILIZER INDUSTRY IN BELGIUM



"Today, mineral fertilizers account for up to 50% of the food needed for our daily diet. ***The Belgian mineral fertilizer industry contributes to the production of food for 50 million people****." Filip Dejongh (EuroChem Antwerpen)*

The mineral fertilizer sector has been active in Belgium since 1850. Today, the fertilizer market is of course a global one, and Belgium's outstanding high-quality products find their way to all corners of the world. Our location and our know-how are huge factors in the industry's global success. The mineral fertilizer sector is, therefore, a vital player in the Belgian agri-food sector.

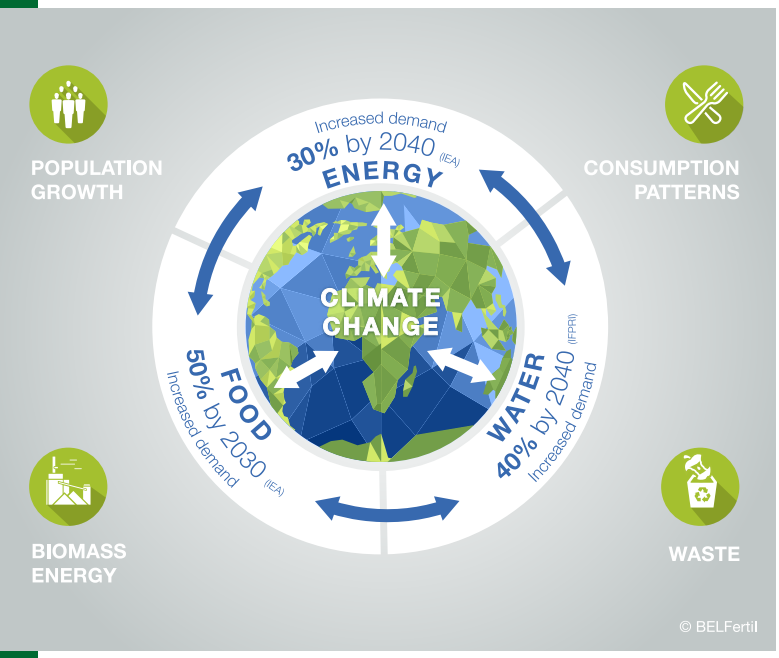
BELFertil, the Belgian and Luxembourg Fertilizer Industry Association, has formal roots dating back to 1971. The mineral fertilizer industry is a part of essenscia, the Belgian chemical and life sciences industries umbrella organisation. The fertilizer industry requires a high level of technical knowledge and capital investment. BELFertil represents its members in discussions with government bodies, public authorities, and other relevant organisations and the general public on a regional, national and European level. Its member companies represent the vast majority of fertilizer companies in Belgium and Luxemburg.

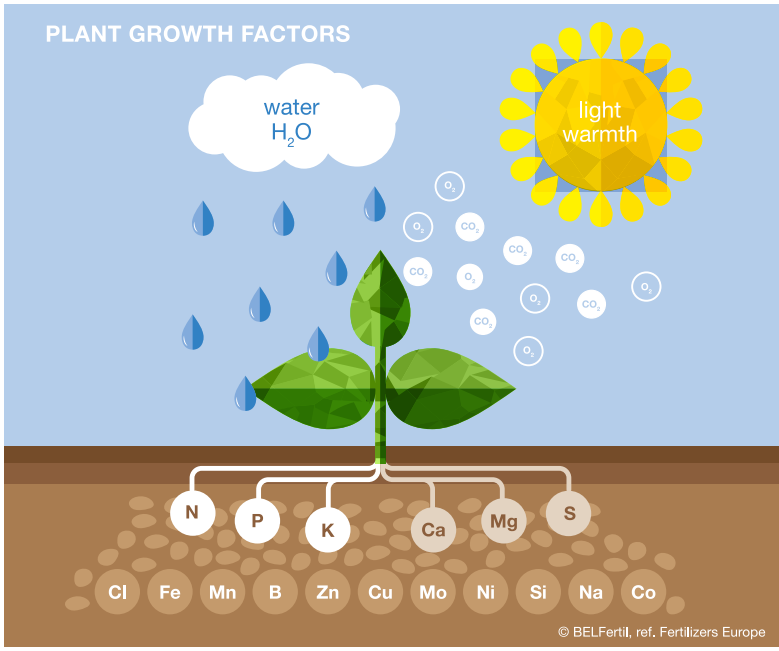
Our members work closely with regulatory authorities and other relevant bodies in the agro-food chain across all areas of mutual interest and concern in the fertilizer business, from production, technology, and the economy, to ecology, logistics, and of course agriculture.

Members are committed to producing responsibly and to putting only the highest quality products on the market. They not only strive for science-based innovation, but also work to provide continuous support to customers and ensure product stewardship for a safe, sustainable and efficient use of their products.

All the members of BELFertil contribute in their own way to various societal challenges, such as ensuring a sufficient high-quality food supply, local employment, and the efficient use of raw materials, water, energy and minerals, resulting in top-class products and smart solutions. One of BELFertil's objectives is to combine these good practices to help shape the nutrient cycle of tomorrow, for example by collaborating with academics, experts and other stakeholders. The fertilizer industry is also working to achieve a circular model in which the various cycles in both production and use are closed as much as possible.

CHAPTER 2: FOOD, PLANT NUTRITION AND THE NUTRIENT CYCLE





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"Mineral fertilizers can optimise plant nutrition and can be used flexibly. They meet the needs of all cultivation systems and all types of farming. Their use is an integral part of modern-day farming and fits well with all the latest technological innovations such as precision agriculture and farming." ***Wim Pacolet (K+S KALI GmbH)***

Food production also requires "food", in the form of plant food. Just as humans do, plants require a healthy balance of nutrition. Shortages of particular nutrients lead to hunger and deficiency symptoms, yet too much can impair the quality of the agricultural product and environment.

Everything starts with soil – plants need healthy soil that takes into account the specific nutrient needs of the cultivation system. But soil alone is not enough – the air, vegetative and animal waste streams are all potential sources of nutrients and play a complementary role, each in their own way in ensuring soil health. The nutrition of plants, humans and animals generates organic material that can be reused in the nutrient cycle.

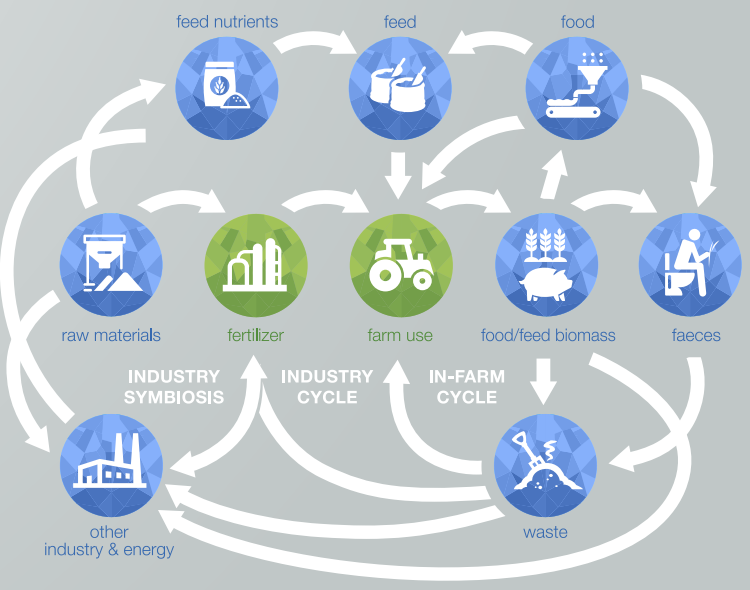
This alone is not sufficient, however, to ensure plant nutrition and relying solely on it can lead to imbalances.

Mineral fertilizers can complement crop cultivation needs, thus satisfying nutrient demand and resulting in a net increase in agricultural and biomass production. To put it simply, we could say that mineral or “inorganic” fertilizers contain plant nutrients in their basic salt form. The vast majority of mineral fertilizers used today are products that also occur in nature, but which are processed in factories to deliver a balanced diet for agricultural crops and an efficient crop nutrient uptake, ensuring food safety, environmental protection and other operational requirements. The demand for efficient and balanced nutrients is central to the production and the use of mineral fertilizers.

The United Nations projects that the global population will reach 9.7 billion people by 2050. This population growth and its associated drivers will lead to enormous increases in demand for energy, food and water. Meeting this demand poses a huge challenge for all of us in the coming years, not least those of us working in the agricultural sector. Sustainable agriculture will contribute in delivering solutions. Circular thinking and new approaches to how we work will be crucial if we are to meet these major societal challenges head on.

“Circularity” covers many aspects of modern industrial practices, and the mineral fertilizer sector is making an active contribution to this process. It is a key player in the increasingly efficient production of biomass and in agriculture’s most important ecosystem service: sustainable food production for humans and animals.

But the mineral fertilizer sector is also a crucial part of the nutrient cycle with many complex interactions. Its activities include the recycling of nutrients from both mineral and organic streams, and the effective levelling out of geographical imbalances in nutrients.



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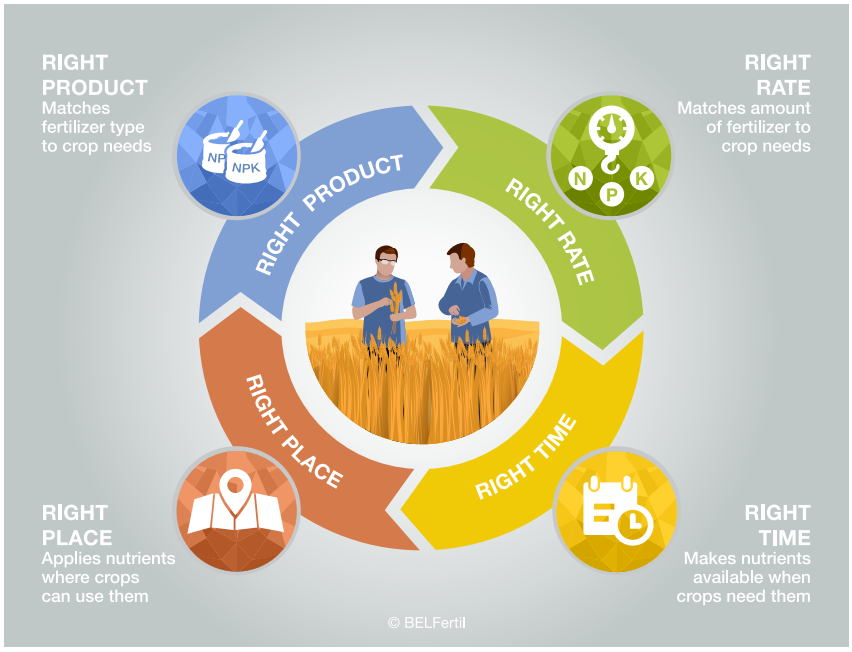
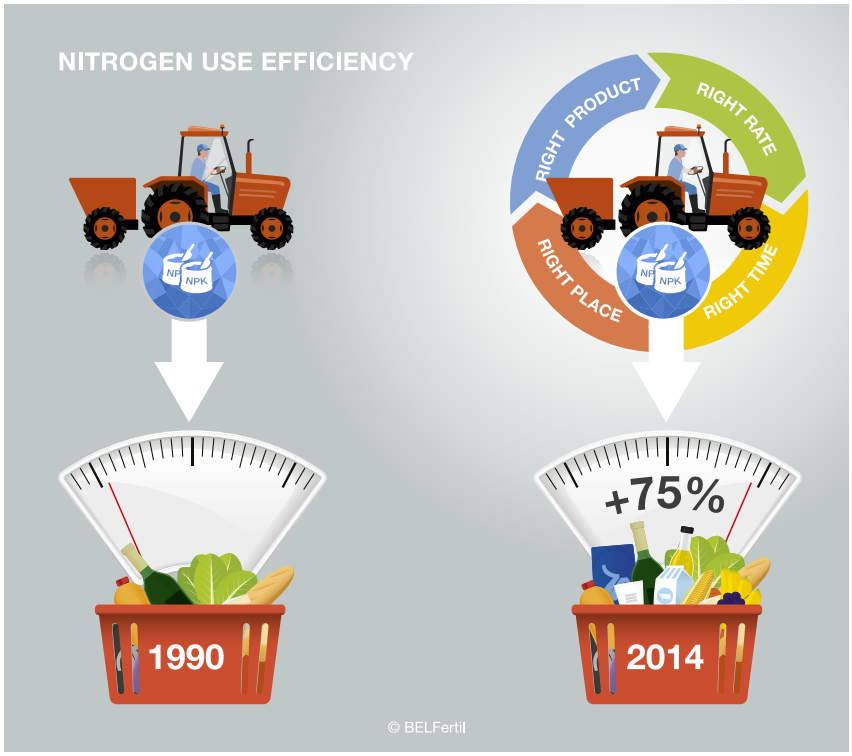
“The notion of the circular economy is that it enables society to extract maximum value from resources and adapt resource consumption to actual and future needs. Waste prevention, remanufacturing or reuse, recycling or recovery (material and energy) enable society to extract maximum value from resources and adapt consumption to actual needs. In doing so, it optimises the demand for primary resources and mitigates related energy use as well as environmental impacts.” ***(Business Europe)***

CHAPTER 3: THE ROOTS OF THE AGRI-FOOD SYSTEM: THE 4 RS





Sustainable fertilization is based on the needs of both the soil and the crop and on the principle of the 4 Rs: the Right product applied in the Right dose at the Right time in the Right place. Plant nutrition and soil fertility are a complex whole. In order to tackle this properly and efficiently, many local parameters must be taken into account.

Our industry helps farmers to increase nutrient efficiency and reduce losses to the environment.

It was, therefore, possible that grain harvests in Europe had tripled since the 1950s, while mineral phosphorus and potassium consumption on European fields had returned to the same level as in those days.

"Between 1990 and 2014, the efficiency of the nutrient use of nitrogen increased by as much as 75% while maintaining the quality of the food products and increasing productivity!" ***Peter Jaeken (BELFertil)***

Photo Boerenbond

"The mineral fertilizer sector in our country has evolved into a sector with quality products aimed at getting the right nutrients in the right place at the right time and at the right dose."

Peter Hulsbosch (Rosier/Borealis)

The introduction of mineral fertilizers has contributed in tripling the size of grain harvests in Europe since the 1950s while the use of phosphates and potassium on European fields has returned to the levels seen at that time.

CHAPTER 3:
SOME EXAMPLES

1 Lime is a miraculous product that is a basic element as well as a nutrient and soil improver. Today, applications are increasingly switching to semi-wet unburnt products because of the advantages they offer in terms of storage, dust formation, ease of mixing and spreading efficiency. “By developing granulated dolomite products and dolomite suspensions, we are able to meet the demand for precision liming. It is also increasingly becoming a tool in the recycling of organic waste or phosphorus. 43% of the lime used in agriculture comes from by-products.” says **Michel Bulteel (Lhoist).**

Photo Boerenbond

2 During seedling establishment of maize and sugar beet, the developing root system is very delicate. The presence of the right nutrients close to the developing roots is important for a good start of the crop and for preventing losses. “Placing localised and ultra-localised fertilizers containing biostimulants close to the roots is an essential way of guaranteeing better absorption of the mineral elements by the plant, thus ensuring the growth and development of the roots.” says **Alain Gaupin (Timac Agro BeLux).** Another advantage: sowing and starter fertilization are carried out in a single operation (which means less labour and less fuel) and the fertilizer is immediately available to the plant when growing conditions are good.

3 To optimise the efficiency of applied mineral fertilizers, specific slow-acting products have been developed called Controlled Release Fertilizers (CRF), and Slow Release Fertilizers (SRF). CRF fertilizers have a coating that ensures nutrients are released in a controlled manner depending on the growing conditions. SRF fertilizers are not coated but contain a complex nitrogen source which degrades slowly in the soil. “Because the mineral nutrients are released slowly according to the needs of the plants, the dose can be reduced, which also significantly reduces the risk of leaching.” say **Jan Aelbrecht (Compo Expert)** and **Klaas De Boeck (ICL).**

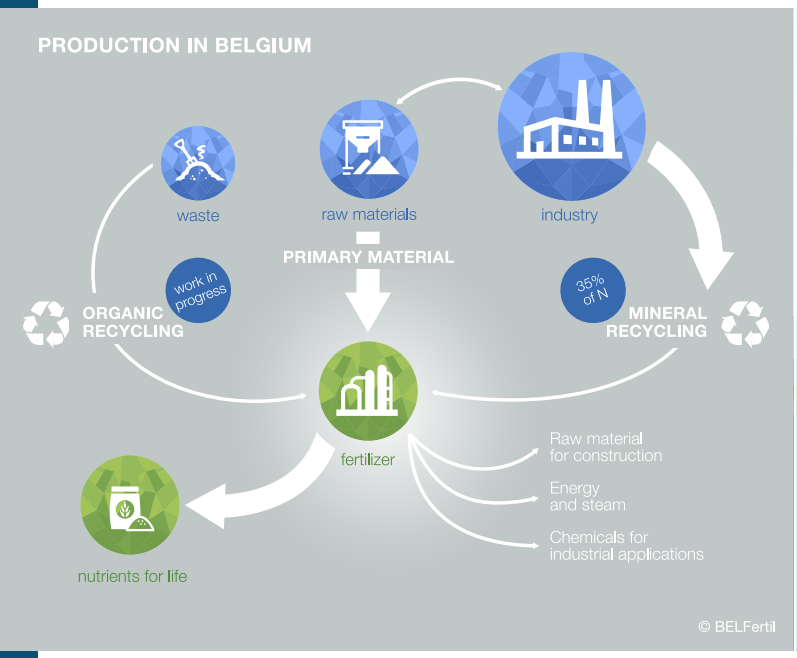
4 In the 1980s, the majority of vegetable and fruit production in glasshouse horticulture, such as tomatoes, peppers and cucumbers, switched to growing on substrate and horticulturists began recycling their drain water. Sodium is barely absorbed by a plant and can thus accumulate in drain water at concentrations that are harmful to roots. The fertilizer industry has developed new fertilizer salts with a very low sodium content and some without any altogether. This helps spare the environment from unwanted surplus sodium. “This recirculation led to a drop of approximately 25-30% in the use of nutrients and an even greater reduction in emissions of nitrogen, phosphate and other nutrients into the environment, as well as considerable cost savings for the farmer.” says **Harmen Tjalling Holwerda (SQM Europe).**

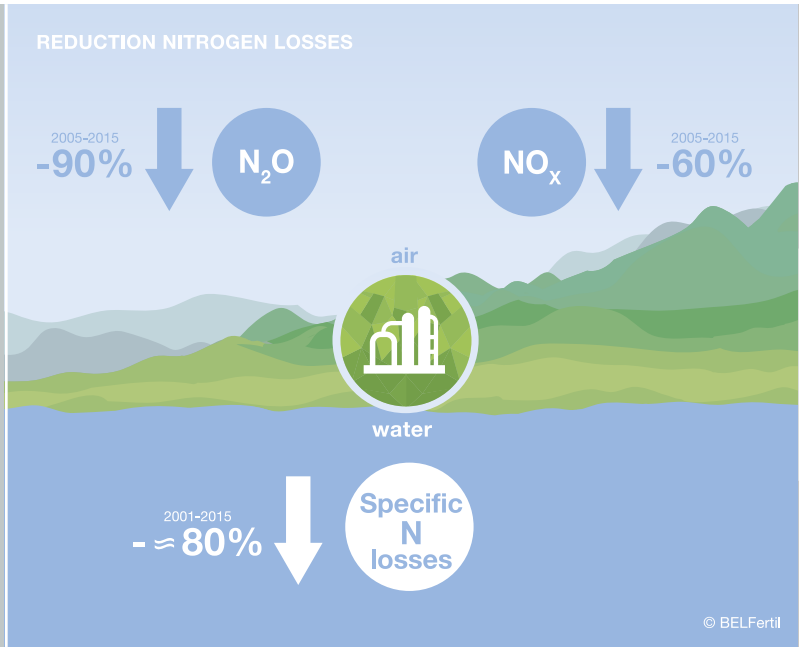
Photo Boerenbond

5 With the introduction of hydroponics, food production shifted from quantity-driven to quality-driven. To meet the high standards required for this new horticultural production system in a sustainable way, the fertilizer industry had to adapt and develop new water soluble fertilizers. Through the use of new techniques and processes, the primary material is transformed into a very pure, high quality final product. “As an example, polyphosphates have been introduced into hydroponics to replace carrier molecules, mainly to enhance micronutrient uptake and to improve the efficiency of the technical installations,” says **Kurt Verhelst (Prayon).**

All these efforts contribute to improved nutrient management and more sustainable agriculture by reducing the proportion of nutrients lost to surface and ground waters through leaching and run-off.

CHAPTER 4: RESOURCE EFFICIENCY IN PRODUCTION





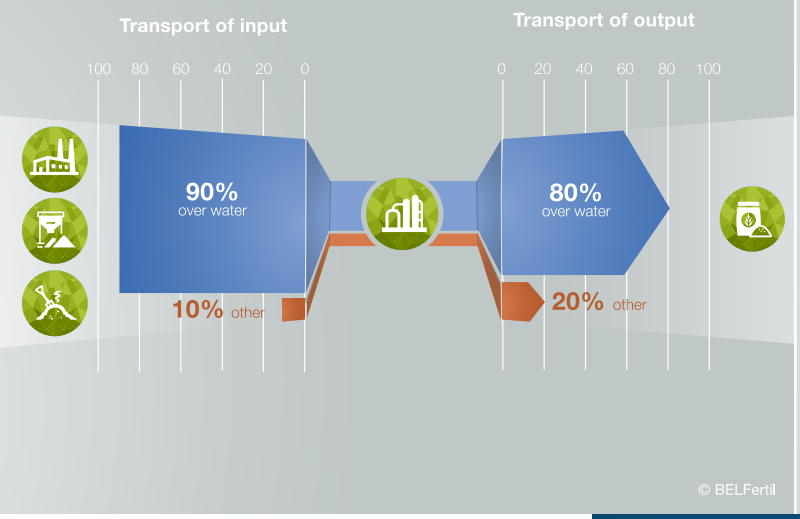
Circularity is not a new concept. The mineral fertilizer industry plays a crucial role in integrated or interlinked production processes. Nutrients that become available from other processes are used as intermediate raw materials for high-grade fertilizer products.

Efficient use of raw materials is a key concept at mineral fertilizer production sites. Research is underway into the extraction and reuse of minerals from organic co-produced streams from diverse industrial processes and testing in the field is also in progress. All in all, this is still rather limited due to the many technical and economic obstacles that need to be addressed but, the principles of mineral recycling are well established.

"More than 30% of the mineral nitrogen fertilizer production in Belgium results from integrated processes of various industrial sectors." ***Luis Ledezma (Lanxess)***

LOGISTICS

Transport in- and output



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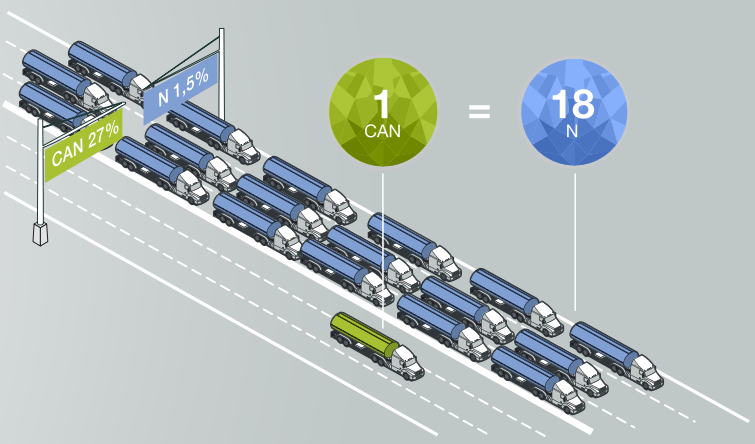
LOGISTICS

Comparison of transport effeciency between



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The higher the nutrient content of mineral fertilizer, the more efficiently product can be delivered to customers. For instance, one truck loaded with the popular fertilizer “CAN-27%” will deliver the nutrient equivalent of 18 trucks loaded with a 1.5% nitrogen fertilizer solution.

CHAPTER 4:
SOME EXAMPLES

Photo Boerenbond

1 The fertilizer industry has been very successful in investing in emission reductions over the past two decades. “Remarkable reductions have been achieved. In the air, a 90% drop in nitrous oxide (N_2O) emissions was achieved while the comparable figure for nitrogen oxide (NOx) was 60%. Similarly impressive reductions in leaching were achieved with specific nitrogen (N) losses to surface water down by 80%” says **Karel Vervoort (EuroChem Antwerpen).**

2 Within production facilities, 100% nutrient recovery is essential, and this can be achieved by, for instance, reprocessing products of insufficient quality back to top quality or by recovering nutrients from a variety of sources on site.

3 Major investments have been made to maximise energy saving. Belgian nitrogen production plants rank among the top 10% most energy efficient companies in Europe. Between 2010 - 2015, 20% less energy was used per tonne of finished product. This trend in production is likely to slow down as further efficiency gains in the field often require more complex products but producers are working to improve these figures still further.

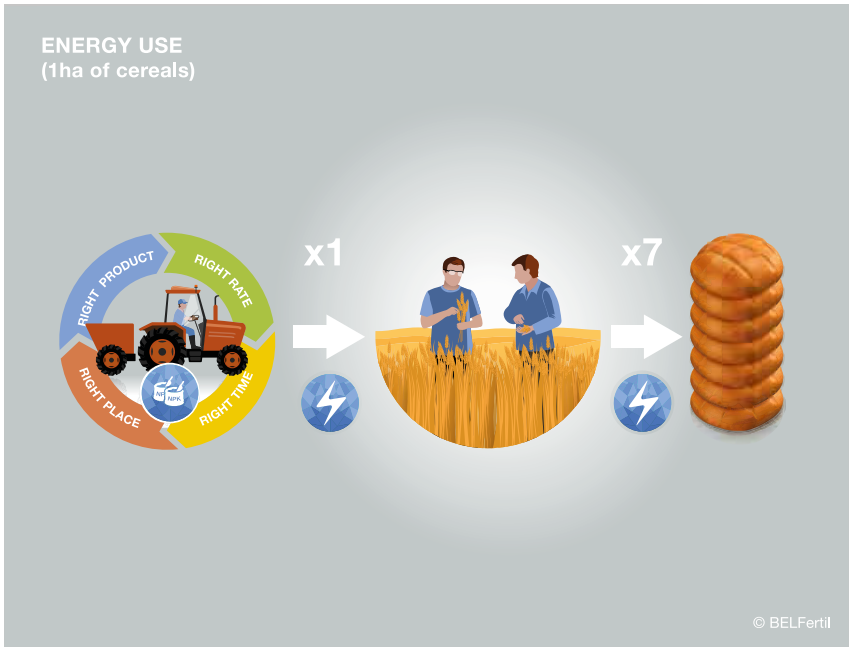
4 Some installations have successfully invested in green energy and achieved a 50% reduction in the amount of natural gas they consume as heating source.

5 The circular economy increasingly involves the use of smart industrial symbiosis models. An inspiring example of this is a project run by both the fertilizer industry and the horticultural sector in the North Sea Port area. Excess heat and CO_2 from a fertilizer plant is supplied to a nearby 170 ha greenhouse complex. Greenhouse crops require more CO_2 for their growth than ventilation from outdoor air can supply. “This unique public-private venture supports horticultural growers and has created hundreds of new jobs. These positive outcomes have avoided the additional burning of natural gas, an amount equivalent to the yearly consumption of 35,000 households, as well as achieving a reduction of some 135,000 tonnes of CO_2 emissions”, says **Koen Van Keer (Yara).**

Photo Eurochem

6 Finally, a great deal of attention is being paid to the development of more climate-friendly and efficient transport and logistics systems. The transport of mineral fertilizers, both in terms of the supply of raw materials and the transport of finished products, is largely carried out by ships rather than by road. One of the reasons for this is the unique logistical location of the production sites near waterways.

CHAPTER 5: HOW COOL ARE MINERAL FERTILIZERS?



"Good practice and more complex high quality nutrient products can support agriculture in its efforts to find solutions to climate and greenhouse gas emissions. This will only really succeed if such products are successfully incorporated into strategies of integrated soil fertility management adapted to each local situation." ***Sigrid Maebe (BELFertil)***

In order to understand the climate impact of mineral fertilizers, the entire chain must be taken into account. The European Emissions Trading System (ETS) is the cornerstone of the European Union's industrial climate policy. The mineral fertilizer sector is directly involved in development of the ETS through ammonia and nitric acid, both key building blocks in the production of almost all mineral fertilizers. Greenhouse gas emissions from production have fallen by half since 2005, already achieving the EU emission target set for 2030. Currently, approximately 3% of the world's gas consumption and about 1% of the world's total energy consumption is used to produce mineral fertilizers.

The sector is also indirectly involved in climate policy, via agriculture, which is a so-called "non-ETS" sector. Such sectors must also contribute to greenhouse gas mitigation efforts, but they are not

part of the emissions trading system. In applying the “4 R”-strategy, outlined above, per unit of energy invested in the production, transport and the application of mineral fertilizers, 7 units are generated in terms of calories in the form of grain. It is an energy leveraging effect of approximately a factor of 7.

If we add to this the inedible biomass, the balance is even more favourable. This part can be used, for example, as a source of organic matter for soil fertility or for other applications (bioplastics, building materials or fuel).

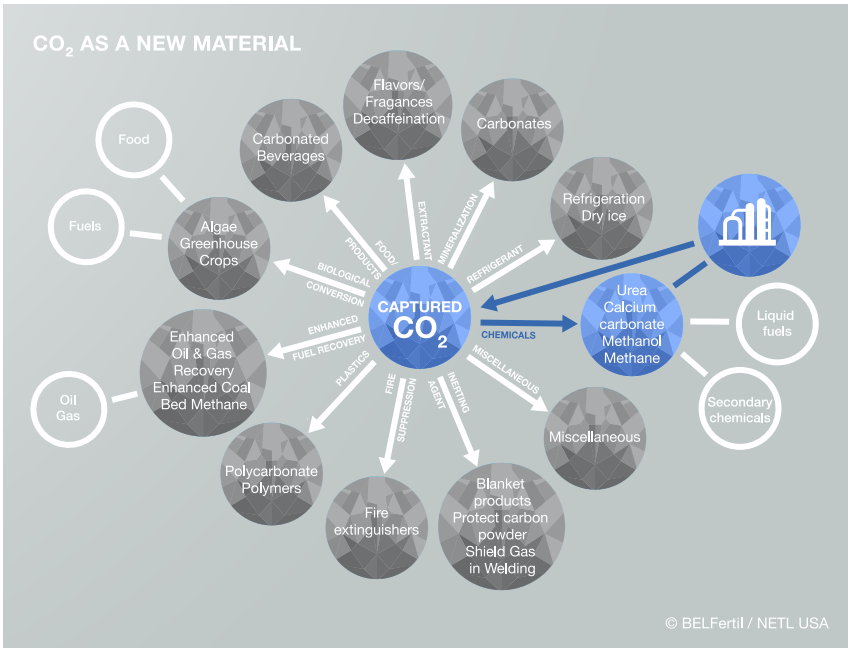
Synergies between other sectors, such as machine manufacturers and breeders and cooperation with end users and other service providers will become increasingly important. That’s why the fertilizer industry is involved in developing farm-level decision support software (www.coolfarmtool.org) to help reduce the carbon footprint of food production. The sector is also working on intelligent solutions in the field of precision agriculture, such as nitrogen sensors, foliar nutrition advice and knowledge support.

“Some producers invest a lot in research and development for tools and apps which help the farmer in making decisions. The solutions draw on decades of agronomic experience of research and combine them with new digital technologies, giving all professional farmers precise and easy access to nitrogen application advice without the need for additional investment. ***Ivo Bogaerts (Yara)***

CHAPTER 6: LOOKING TO THE FUTURE

In the short term

In recent decades, the fertilizer industry has invested heavily in efficiency gains in production and logistics and will continue to do so. It is also taking the lead in the pursuit of Nutrient Use Efficiency. The higher the nutrient efficiency of a fertilizer product, the higher the agronomic benefits and the more limited the impact on the environment will be. More complex products will sometimes require a trade-off between efficiency gains on the field or in production.



In the medium term

Biomass is a renewable resource, but its supply is not unlimited. Mineral nutrients will continue to play a leveraging role in biomass production and capturing solar energy. Part of the biomass will be reused for agricultural purposes. Indeed, within the field of nutrient recovery, it is important to put a value not only on

mineral flows, but on organic flows as well. The fertilizer industry is already developing expertise in using recovered minerals from organic sources as raw materials. Today this is mainly limited to pilot projects, and in a few cases also to some production. Technological innovation is likely to result in more options and improved economic viability in future.

At present, the reuse of CO_2 as a raw material still involves many legal and policy restrictions and technological hurdles with too few positive incentives to encourage take-up. CO_2 reuse will not solve the climate problem in itself but will undoubtedly make a more important contribution in the medium term.

The (re-)use of CO_2 as a raw material is already applied in various processes in the sector, such as in production of urea, calcium carbonate, greenhouse fertilization, and in the beverages industry.

Innovations in CO_2 reuse will gradually open new, market mature opportunities. This might become a worthwhile route to explore, in particular for the production of nitrogen-based fertilizer via the Haber-Bosch process. Even though Belgium has top class production facilities, CO_2 production remains an inherent part of this chemical process.

In the long term

The use of green hydrogen gas (H_2) to capture nitrogen from the air opens up new and interesting prospects. In this way, nitrogen and hydrogen can form a compound in a natural cycle without releasing carbon. However, the hydrogen economy is still in its infancy and a lot of research is still needed to better understand methods of achieving production efficiency, storage, transport and wider applications. A key element in this discussion is the availability of renewable energy that efficiently converts surpluses to H_2, and after that, ammonia.

CHAPTER 7:
CONCLUSIONS

The mineral fertilizer sector in Belgium is proud to have made continuous progress over the last few decades. This progress is based on technological innovation, major investment, many years of experience and the accumulation of a great deal of knowledge and expertise.

In recent years, the fertilizer industry has invested heavily in production processes, in the quality of its products to better meet the needs of smarter agriculture, and in energy savings measures and emission reductions, as illustrated in the previous chapters. Numerous steps have also been taken to limit environmental pressures.

By means of a chain approach and through life-cycle analysis, the fertilizer industry has also made a substantial contribution to increasing the efficient use of its products, while maintaining their efficacy and quality, but simultaneously reducing their impact on people and on the environment. Every day, fertilizers make an essential and efficient contribution to sustainable food and biomass production.

In addition to the standard products already available, the focus is also on innovation and the development of new services and products.

Our industry is making a substantial effort to expand research in order to enable farmers to make the best use of these new products and to implement precision agriculture. This offers farmers opportunities to improve yields without increasing their environmental footprint and to contribute to more sustainable agriculture. Farmers must have access to quality solutions and services. The key to sustainable fertilization is therefore also interrelated with a decent income for farmers.

Photo Boerenbond

The fertilizer industry is an indispensable link in the dynamics of the nutrient cycle. The sector has long looked into possible ways of recycling by-products in order to save on the use of virgin raw materials and promote the sustainability of the sector. Nutrient recovery and the reuse of less traditional sources is far from being a futuristic concept, but will still require a great deal of research, investment and a cooperative, partnership approach to reach maturity. To sustain progress and to continue our role in tackling the many challenges facing society, we welcome an enabling policy that fosters such partnerships.

World-class production techniques, combined with an end product that optimally meets nutrient demand, makes the mineral fertilizer sector an essential and efficient part of the agri-food chain and the nutrient cycle. It is the ambition of the fertilizer industry and of BELFertil to continue to play a leading role in the provision of nutrients for life and to help find sustainable solutions for the many challenges facing our planet, and hence affecting all of us.

Nederlandse versie

Version en français

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