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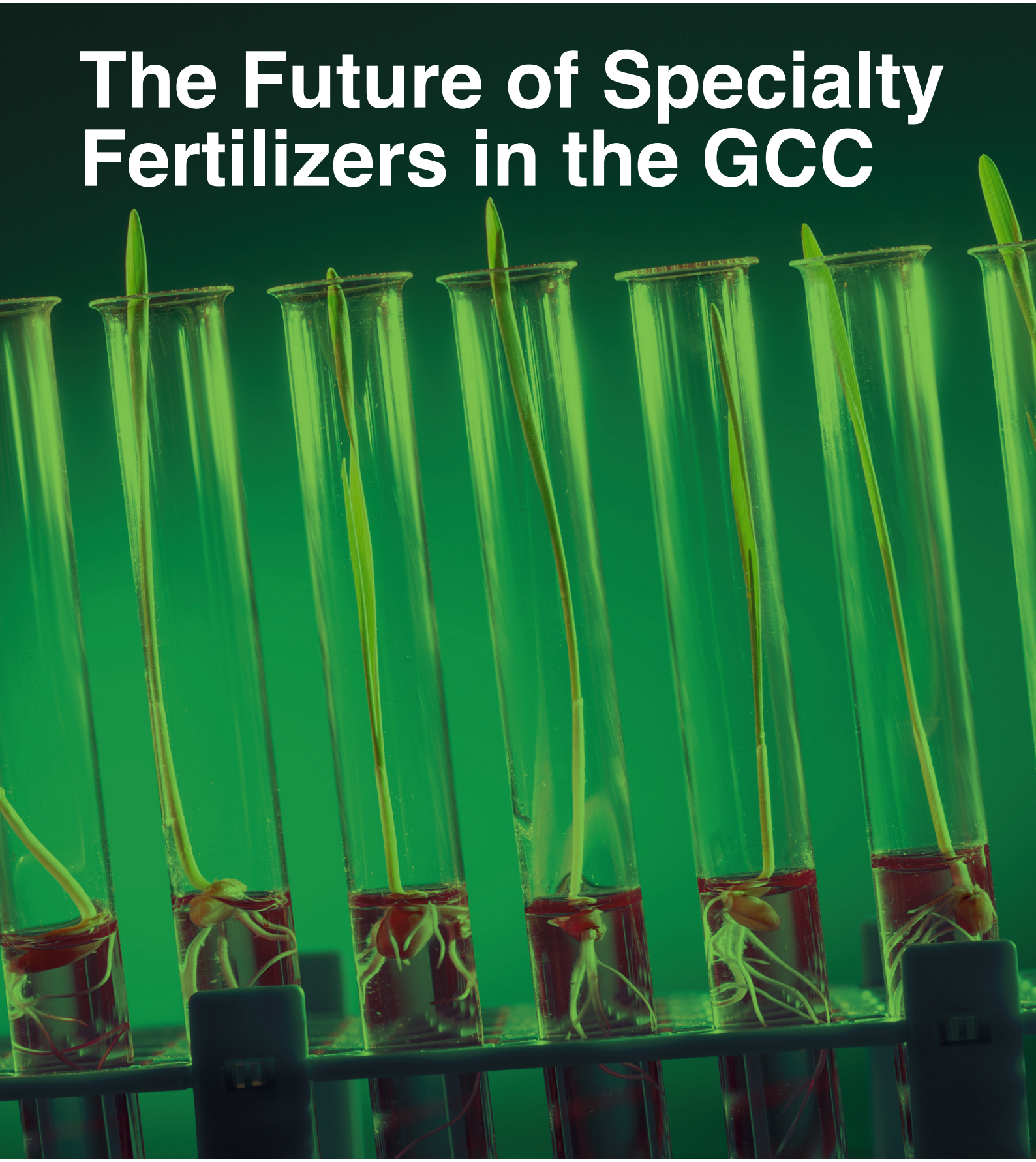
The Future of Specialty Fertilizers in the GCC



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1. Introduction to specialty fertilizers

Speciality fertilizers are a fast growing and diverse group of products with different characteristics containing one or more of the essential primary, secondary or micro-nutrients. There are around 12 plant nutrients which are essential for maximizing plant yield. These are shown in the table below with typical amounts required in kg/ha.

Primary nutrients 100's kg/ha required by crops	Nitrogen (N), phosphorus (P), potassium (K)
Secondary nutrients 10's kg/ha required by crops	Calcium (Ca), magnesium (Mg), sulfur (S)
Micronutrients* 1kg's/ha required by crops	Iron (Fe), zinc (Zn), manganese (Mn), copper (Cu), boron (B), molybdenum (Mo)

*We reference the main micronutrients; others are: vanadium, cobalt, nickel, chlorine, sodium, and silicon

Although secondary and micronutrients are required in smaller quantities than the primary nutrients they are equally important for crops to ensure balanced fertilization for optimum crop yield and quality.

Specialty fertilizers are distinct from the commodity fertilizer products like urea, diammonium phosphate (DAP) and muriate of potash (MOP) or blends of these in that they are generally less commoditized, have "designer" characteristics and are of higher unit value. Specialties command a higher premium to producers and distributors over commodity products, which explains the great interest now being seen in them.

Specialties include products ranging from single nutrient containing micronutrients or coated nitrogen to control its release, to complex multi-nutrient solubles, 'designed' for specific crops. The object of this publication is to describe these products, their position in the global fertilizer market and highlight current participation and future opportunities in this business for Gulf Cooperation Council (GCC) countries and Gulf Petrochemicals & Chemicals Association (GPCA) members.

Specialty fertilizers are by nature bespoke but they can be grouped together in broad categories according to their product characteristics, though there is crossover in many cases.

- Compound fertilizers containing at least two of the essential elements

- Water-soluble fertilizers excluding chloride which can be applied using fertigation systems or as foliar sprays

- Fertilizer nutrient use efficiency promoters - products which either allow slow release or control the release of nutrients, using coatings or act as inhibitors which 'stabilize' nitrogen in the soil reducing losses to the environment

- Micronutrients in chelated or non-chelated form

We will look in more detail at these products in the sections which follow in this publication.

The main driver for fertilizer products is the need to supply a growing population, with increasingly diverse and crop-intensive diets, with more food from limited resources of land. To achieve this in future will increasingly require more balanced nutrition as crop yield and quality requirements increase.

However, with commodity fertilizer products it is harder to precisely match and balance crop nutrient requirements and prevent losses of fertilizer nutrients. For instance, significant quantities of the nutrients from the application of urea, DAP and MOP are lost to groundwater and the atmosphere by soil

biological activity or converted into forms which plants cannot access by soil conditions. Through improved technologies in formulation, production and application, and a more precise focus on plant nutrient needs, specialty fertilizers can overcome many of these constraints.

The main focus of the commodity fertilizers are the primary nutrients – nitrogen, phosphorus and potassium, applied in relatively large amounts. However, as explained above, there are 12 essential fertilizer nutrients required to maximize crop yield and quality and to improve a crop's ability to use the primary nutrients efficiently.

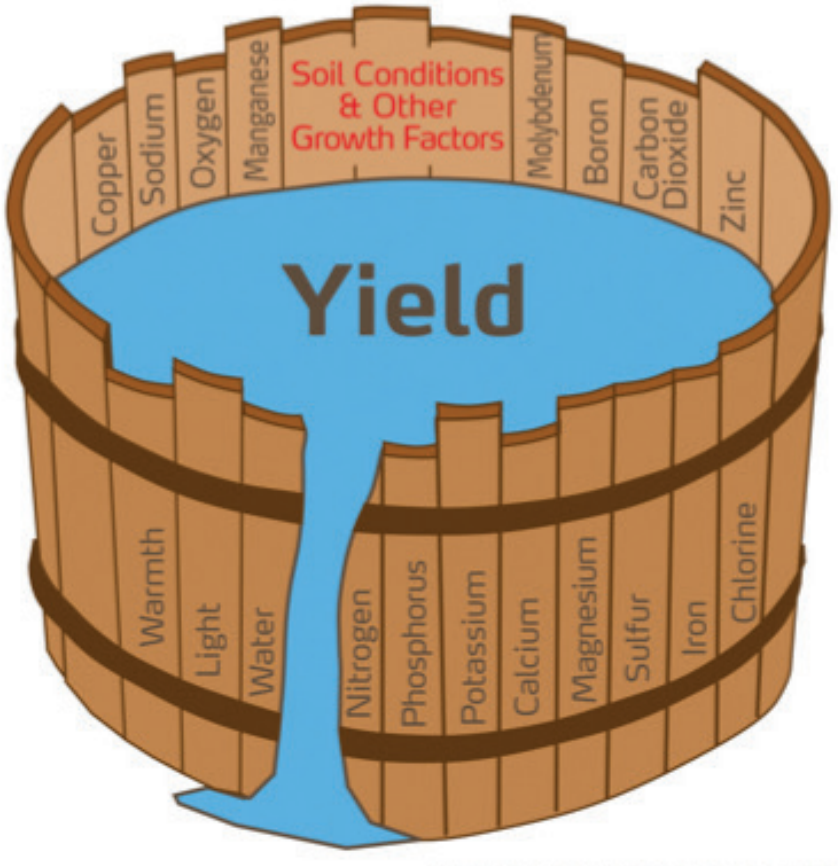
Many specialty products contain some of the secondary nutrients and micronutrients. Though these are required in relatively smaller quantities, they are essential for balanced crop nutrition, and simply increasing the rate of primary nutrients alone will not necessarily increase yield. The importance of balanced nutrition in ensuring maximum yield and quality was described in Justin Von Liebig's "Law of Minimum". The law states that the potential yield is not limited by the total amount of resources, but by increasing the amounts of the limiting nutrient, and this is illustrated in the barrel analogy below.

The use of many specialties is also associated with more sophisticated application methods. Commodity fertilizers are typically broadcast by hand, spinner or spreader, but these methods often lead to significant losses to the soil, water table or the atmosphere due to inaccurate application rates, placement or timing.

Specialty fertilizers can reduce these losses by applying nutrients, in combination with essential water through irrigation systems (fertigation), by coating fertilizers or adding inhibitors/stabilizers, by foliar sprays or treating seeds with nutrients. The technologies used to achieve both balanced crop nutrition and to improve fertilizer, crop and labour efficiencies are the key differentiators of specialties in comparison to commodities.

Production of specialty fertilizers in the GCC region is in its infancy but there are several successful businesses, some of which we profile in this publication.

With a substantial base in primary nutrients, GPCA members are well positioned to develop interests in specialty fertilizers in the future and we explore some of these developments.



Source: http://kemnovation.com/crop-nutrition/

2. Specialty compound NPKs and other products

As described in the introduction, specialty fertilizers is a general term used to describe a broad range of differentiated products, including some variations upon straight and compound commodity products. We describe some of these specialty/commodity crossover products in this section. Many have relatively simple formulation but have special characteristics, scarce raw materials or complex production processes.

Nitrogen compounds

Calcium nitrate (CN) contains two essential plant nutrients: calcium and nitrogen, the latter in plant-available nitrate form. It is produced by reacting limestone with nitric acid and can be manufactured in water-soluble form and is therefore suitable for fertigation. Yara International is a leading producer with a large production facility located in Porsgrunn, Norway.

Ammonium thiosulfate also contains two essential plant essential nutrients, nitrogen and sulfur, and is water soluble. Tessenderlo Kerley is a leading producer of this product under the brand "THIO-SUL". Besides supplying nutrients, "THIO-SUL" also acts to slow the hydrolysis of urea, effectively acting as a slow-release product. It is commonly mixed with urea ammonium nitrate (UAN) solutions which are widely used in the broad acre crop markets, primarily in North America and Europe.

Phosphate compounds

Granular **monoammonium and diammonium phosphate (MAP and DAP)** are used worldwide and are the leading commodity phosphate-containing products. Soluble versions of these products, more commonly MAP, are produced by using a purer phosphoric acid as a raw material.

Superphosphoric acid (SPA) is widely used to produce **ammonium polyphosphate (APP)**, a liquid fertilizer which can be applied directly or mixed with UAN and other fertilizer solutions. Typical grades are 10-34-0 and 11-37-0. This product is widely used in North America.

Many producers of commodity grade DAP and MAP are adding secondary and micronutrients to respond to increasingly sophisticated demands of buyers for specialties. Both OCP and Mosaic produce significant quantities of DAP and MAP with sulfur in different ratios. Mosaic has a range of variations which are branded as "Microessentials" (N, P, S and Zn) and a new product called 'Aspire' (K and B).

Potash compounds

Straight potassium chloride (muriate of potash [MOP] or KCl) is the most widely used source of potash fertilizer and can be applied either directly in a blend or as a raw material in a NPK complex. In addition there are several dry potash products with special properties.

Potassium sulfate (SOP) contains two essential nutrients, potassium and sulfur, but also has some important niche applications. For certain crops, notably many fruits and vegetables, an excessive supply of chloride is undesirable as it negatively affects yields. This is prevented by using potassium sulfate.

K+S in Germany is a leading supplier of potassium sulfate which is produced from the naturally occurring mineral form, but it can also be produced by reacting MOP and sulfuric acid. Similarly, Mosaic produces significant quantities of its brand "KMag" with various grades containing ratios of potassium, magnesium and sulfur.

Potassium nitrate (NOP) offers similar benefits to SOP providing two essential nutrients, nitrogen and potassium, without chloride. In some situations NOP

is preferred to SOP because of its balanced ratio of the two nutrients it contains in fertigation systems. The world's largest producer of NOP is SQM of Chile followed by HAIFA of Israel and Kemapco of Jordan although Kingenta of China is growing fast in NOP production.

NPK compounds

The boundaries between commodity grade and specialty complex NPKs are blurry. There are a potentially limitless number of alternative grades of product which can be manufactured from the basic commodity fertilizers such as urea, ammonium sulfate, DAP, and MOP, as well as secondary and micronutrient materials to make custom grades.

Some NPK compound products though have clear specialty features, for example those based on potassium sulfate or potassium nitrate, which are therefore chloride free, and give a final product which is fully soluble. NPK compound products containing faster release nitrate nitrogen produced by chemical granulation (ODDA process) rather than urea-based produced by physical (steam) granulation are strongly preferred in some markets.

3. Water soluble fertilizers (WSFs)

Water soluble fertilizers are applied to crops using a number of different application methods but all rely on a high and quick dissolving formulation for application with irrigation water in fertigation, and foliar application, where the fertilizer solution is sprayed onto crop foliage. Blockage of fertigation or sprayer systems by even small amounts of insoluble will not be tolerated so the technical requirements for WSFs are high.

Spray application equipment and irrigation systems are significant investments and the market for the latter is growing at a phenomenal rate globally with more and more advanced irrigation systems appearing to increase water use efficiency.

This demonstrates the huge growth potential for WSFs particularly in water scarce regions. Yara of Norway, SQM of Chile, ICL and HAIFA of Israel and Kingenta and Hebei Monband of China are the largest global producers of water soluble compound NPKs. Yara is currently up-grading production of these at its main plant at Porsgrunn, Norway.

Many fertilizer products are naturally water soluble from their straight commodity ingredients such as UAN solutions, to more specialist 'crossover' commodity compounds like calcium nitrate, super phosphoric acid, potassium sulphate and potassium nitrate, through to more complex granulated and prilled NPK compounds containing secondary and micronutrients. With regard to the latter product type it is important to note that fertilizer nutrients and their combinations have varying degrees of internal compatibility which need to be considered in order to avoid formation of insolubles and undesirable reactions during and following production. Furthermore, variations in solubility and internal compatibility depend on each manufacturer's production process and any additives, conditioners and raw materials used. For example, the phosphoric acid used to produce phosphate-based water soluble fertilizers must be of significantly higher purity than that used to make granular MAP and DAP to avoid undesirable organic material ending up in the final product.

Fertigation is the application of fertilizers through irrigation systems, which is a rapidly growing area, in line with the growth in production of cash crops like fruits and vegetables where water requirements are high and/or water scarcity is high. These irrigation systems are commonly seen in industrial-scale glasshouses and in furrow, drop and pivot irrigation in open fields or under cover (polytunnels).

Fertigation systems generally require sizeable up-front investment but they offer significant advantages over more traditional fertilization methods, allowing more accurate and consistent application, with greater precision which is more closely matched to the irrigated crop's needs, and sometimes referred to as 'prescription' feeding. The investment does pay back because labour costs can be reduced, nutrient losses minimized and water use efficiency increased significantly. Nutrient uptake improves because the ratio of nutrients can be adjusted and delivered in immediately available form as the plant's needs evolve at different stages of growth.

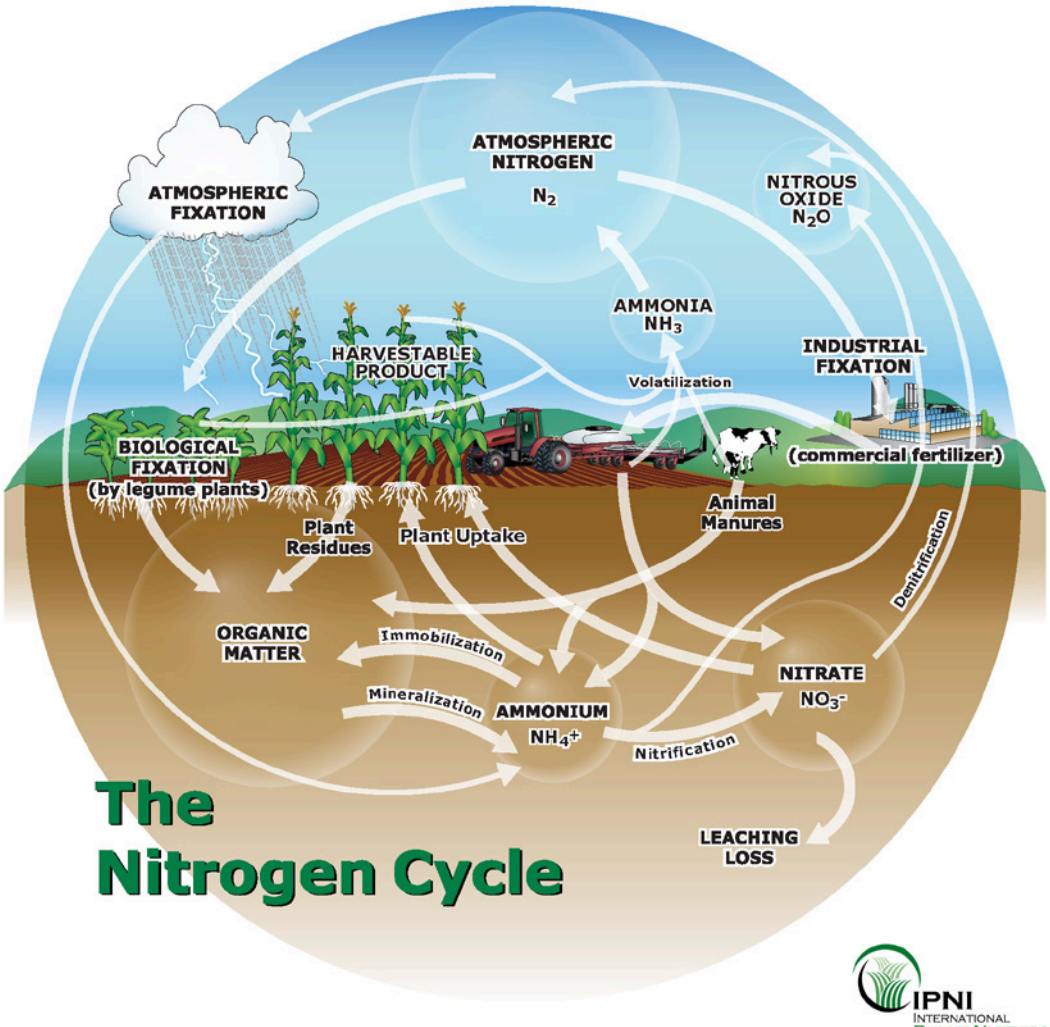
Foliar application is when fertilizers are applied as a nutritional top-up fertilizer once the plant has developed foliage. The major source of nutrient uptake occurs through the plant roots and adequate nutrient application to the soil or growing medium is essential. However, foliar nutrient application can be used to correct occasional nutrient deficiencies or ensure that the plant's nutrient needs are 'topped up' during critical stages of growth, when soil nutrient supply is insufficient, or during periods of stress such as heat or drought. Foliar applications of micronutrients to top up levels in crops can be particularly helpful because of their lower but essential requirement by crops.

4. Slow and controlled release and stabilized fertilizers

Under some circumstances, losses from fertilizer applications can be significant, particularly for nitrogen. Beside the economic losses, the applied nitrogen is lost to the atmosphere by volatilization (usually as ammonia-N) or through the soil by leaching in to groundwater (usually as nitrate-N), with the latter potentially leading to significant environmental problems.

For example, in temperate climates, seeds are planted in the spring when soil tends to be cool and wet. Commodity nitrogen products may become available almost entirely during the first weeks after planting when root growth is quite slow and uptake limited, leading to potential environmental losses through volatilization and leaching.

Although the size of the nitrogen losses depends on climate, soil types and conditions and the type and amount of nitrogen product used. Most of the world uses urea, with Europe preferring nitrates, and



North America a mix, including direct application of ammonia. All are relatively simple commodity nitrogen products which are prone to volatilization and leaching. In recent decades a number of specialty products have been developed which can help address these losses by slowing, controlling or stabilizing the rate at which nitrogen is released or converted to plant available form, consequently improving the efficiency of nutrient application and reducing negative environmental impact.

Slow and controlled release and stabilized fertilizers are currently a relatively small part of the overall fertilizer market, but their production and usage are growing at very robust rates particularly in Asia. The decision point of whether to choose commodity or specialty products is whether the higher cost of a more nutrient efficient specialty fertilizer, with lower rate and reduced labour requirement, outweighs lower initial cost of a commodity fertilizer, with higher rates because of lower nutrient efficiency and frequently higher labour requirement from probable repeat applications.

We will look at slow and controlled release fertilizers and stabilized fertilizers in turn.

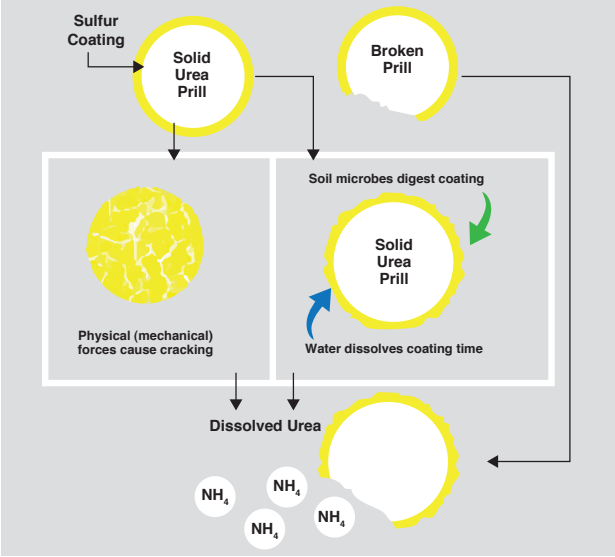
Slow and controlled release fertilizers (SCRs)

Slow release fertilizers (SRFs) and controlled release fertilizers (CRF's) seek to slow or control the rate and timing of nutrient release to more closely match the plant's nutrient requirement.

There are several different types of product in this category.

Slow and controlled release fertilizers are typically coated with sulfur and/or polymers on the surface of the fertilizer granule. The coatings are usually either sulfur, polymer or both and the rate of nutrient release is then a function of the type and thickness of the surface coating and how consistently it is applied to the granule.

Slow release products, typically sulfur coated urea (SCU) is generally the lowest cost compared to other types of coating, and its lower price generally makes SCU the most widely used product in this category. The sulfur coating is initially impermeable but it gradually breaks down by various microbial and chemical processes in the soil thus releasing the nitrogen more gradually to meet increasing crop growth demand. Sulfur itself is of course a secondary nutrient offering additional benefit to crop nutrition. A downside of SCUs is that the thickness of the coating determines the product grade, for example an SCU would typically have the following grade 35-0-0, whereby the 46% nitrogen content of commodity



urea has been reduced to 35% by the sulfur coating. Another downside of SCUs is that it is generally harder to control the rate of nitrogen release compared to the more precise polymer coatings which have been developed to improve performance. As a consequence polymer coated urea (PCUs) and in combination with sulfur (PCSUs) are becoming increasingly common.

Controlled release (polymer) coated products employ a barrier coating which is generally impermeable or semi-permeable depending on the type of coating material used. Nutrient release takes place depending primarily on the soil temperature which means it more closely matches the crop's nutrient requirement in terms of quantity and timing during the main growth season. Furthermore this group of specialties frequently contains several primary, secondary and micronutrients with a much higher degree of predictability than slow release types for which variables like moisture, salinity and pH can unpredictably increase the rate of nutrient discharge independently of soil temperature. An upside to polymer coatings is that they are generally thinner than those based on sulfur so the grades can be higher. The downside to controlled release products is that the cost of coatings is relatively high even compared to sulfur coatings but this must be off-set by reduced rates, greater nutrient and labour efficiency and environmental impact. In many countries particularly developing ones these advantages are becoming ever more relevant at local, regional and governmental levels.

Use of slow and controlled release fertilizers has been previously confined to the high-end horticulture, amenity and golf course markets where end-users generally have bigger budgets to support the higher costs but equally realise the advantages of the better performance. However their use is now beginning to spread into the broad-acre crops such as maize and

potatoes particularly in Asia where the agricultural development issues raised above are very pressing.

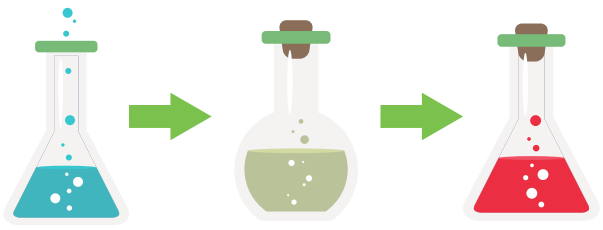
Currently the largest and fastest growing global producer of SCRFs is Kingenta of China with a wide range of SCUs, PCUs, PCSUs and polymer coated NPK-based controlled release fertilizers. Other large global players include Agrium of North America with their very well established global product ESN (Environmentally Smart Nitrogen), HAIFA of Israel, COMPO of Germany and SQM of Chile. Notably in 2015 HAIFA opened a 16,000 Mt/pa SCRF plant in France and will open a similar facility in Georgia, USA in 2016 which is a clear indication of the global confidence in this group of specialties for the future.

Stabilized fertilizers (containing 'Inhibitors' of nitrogen breakdown)

Stabilized fertilizers are so-called because they contain or are treated with inhibitors which reduce the process by which nitrogen is broken down (in the natural Nitrogen Cycle) by specific groups of soil micro-organisms, and thereby 'stabilizing' the main forms in which nitrogen is present in soils (as ammonium-N and nitrate-N) consequently reducing their losses at key crop growth stages.

Nitrification Inhibitors

Urea, anhydrous ammonia and UAN solutions react in the soil to form the ammonium form of nitrogen (ammonium-N) which is generally quickly absorbed onto the soil particles and losses are relatively small in the short term. However soil bacteria gradually convert the ammonium-N to nitrate form (nitrate-N),in a process called bacterial nitrification, which is very plant available but is also subject to losses either by leaching in to the soil, or further breakdown by denitrification bacteria to nitrogen oxide gases (Nox 's which are greenhouse gases) and nitrogen to the air. The schema below shows the steps by which specific soil bacteria convert ammonium-N to nitrate-N during the initial nitrification process.



Ammonium (NH_4) Nitrosomonas

Nitrite (NO_2) Nitrobacter

Nitrate (NO_3)

Nitrification inhibitors work by subduing the soil bacterial activity and thereby preserving more of the applied urea-based fertilizer nitrogen in the ammonium form for later conversion to nitrate-N.

Two of the major global suppliers of Nitrification Inhibitors are EuroChem of Russia with 'ENTEC' and COMPO of Germany with 'NovaTec'.

Urease Inhibitors

Applications of urea and UAN onto soil can also result in nitrogen losses as they are converted by hydrolysis to gaseous ammonia which is volatilized into the atmosphere. This process is catalysed by an enzyme called urease which is ubiquitous in soils and natural systems and its activity is independent of temperature so it works at both low and higher natural temperatures on urea and UAN. The schema below shows the conversion process.

Urea $(NH_2)_2CO + 2H_2O)$

Ammonium bicarbonate $(2NH_4HCO_3)$

Ammonia gas $2NH_3 + H_2O + CO_2$

Urease inhibitors can reduce these losses by blocking the urease enzyme dramatically slowing the rate of ammonia production.

Probably the global leader in the production and supply of urease inhibitor is KOCH of North America with its 'AGROTAIN' product.

As with SCRFs the global market for the use of inhibitors to stabilize fertilizers is relatively small but is growing at a very fast rate in both developed and developing agricultural regions with the concerns over nitrogen use efficiency and environmental impact of commodity nitrogen products.

Interestingly the Indian Government has recently mandated that all urea applied must be coated with Neem extract (natural extract of the Neem tree) which has been shown to have some inhibitory effects which the authors cannot verify but at least this does illustrate an important global trend with this group of specialities.

Finally the use of combinations of nitrification and urease inhibitors together to stabilize nitrogen fertilizers is an increasingly common practice in Europe and North America which is helping to drive the markets onwards.

5. Micronutrients

Although they are required in much smaller volume by plants, micronutrients are as essential as their primary and secondary nutrient peers in achieving maximum crop yields and quality as illustrated in the essential nutrient table and barrel analogy diagram cited earlier in this document.

As yields and constant crop removal have increased over recent decades, micronutrient deficiencies increasingly have become limiting yield factors in many parts of the globe. Without sufficient amounts and availability in soils, many plant functions will misfire leading to lower yields or quality because crops cannot use the primary and secondary nutrients efficiently. Fortunately where deficiencies are recognized micronutrients are a versatile group of specialities which can be applied in many ways in liquid or dry form combined with dry or liquid primary and/or secondary nutrient products, sprayed on the plant foliage, or as fertilizer granule and seed coatings.

We can subdivide micronutrients into two categories:

Non-chelated micronutrients

Straight inorganics: these are usually commodity micronutrients, mined and traded as raw materials, comprising unrefined inorganic salts such as sulphates, oxides or carbonates. There is a risk with using micronutrients in this form because undesirable impurities can cause reactions when incorporated into compound fertilizers and they can be toxic to plant leaves when foliar applied.

Formulated specialty micronutrients: these products are high-grade, high-specification micronutrient sources, mainly inorganics such as oxides, carbonates and sulphates, borates and molybdates, which can be confidently incorporated (following 'internal compatibility' checks) into compound fertilizers. They incorporate co-formulants to ensure stability, optimum performance and plant safety during foliar application and seed coating. Also complexing agents are used to produce concentrated liquid micronutrients with exceptional liquid fertilizer mixing characteristics and safety.

This group of formulated micronutrients has grown in diversity and versatility over recent decades and is currently the fastest growing group of specialties of all globally for both incorporation into compound fertilizers and foliar treatments.

The largest producers in this group are Yara of Norway, Rio Tinto Borax of the USA, Agrichem of Australia, Cheminova (Headland) of Netherlands (UK), Brandt Chemical of the USA, COMPO of Germany and Valagro of Italy.

Chelated micronutrients

As the name implies, chelated micronutrients are speciality micronutrients group based on sophisticated chelating agent technologies. The chelating agent has a very intimate bond comprising two or more sites which donate electrons to 'sequester' a central micronutrient cation. The most common chelating agents used are EDTA, DTPA and EDDHA (the latter is sometimes referred to as 'Sequestrene'). Chelating micronutrients prevents their chemical conversion into insoluble forms (which precipitate) when included with concentrated fertilizer solutions particularly those with a high phosphate grade and are therefore the specialty micronutrient of choice for fertigation in combination with compound WSFs. Consequently the growth in chelated micronutrients is tracking the global increase in WSF and irrigation equipment markets.

The global current leader in chelated micronutrients is AkzoNobel of the Netherlands which are now almost exclusively marketed globally (apart from North America and China) by Yara of Norway and

note the match here with the latter's leading position in compound WSF production and distribution. Quite recently ADOB of Poland have become a leader in the new area of 'bio-degradable' chelates such as HBED and like Yara they combine the marketing of these with compound WSFs in Central Europe.

The significantly greater performance of chelated micronutrients means that they can command much higher market prices but their close association with more nutrient and water efficient fertigation is creating the value to justify this differential.

By nature of the relatively small amounts required by plants, the size of the micronutrients business is relatively small in volume produced and sold compared with primary nutrient compounds but the value and margins, particularly those from chelated micronutrients, make up for this and therefore they represent a very attractive global market which looks like it will grow at a very fast rate for the foreseeable future.

6. GCC specialty fertilizers activity and opportunities

The specialty fertilizer market in the GCC region is at a relatively infant stage but there are significant opportunities for their production and marketing. There are two existing producers and suppliers of note: ADFERT and RNZ Group, both of which are located in the United Arab Emirates (UAE).

Abu Dhabi Fertilizer Industries (ADFERT) is a producer of specialty fertilizers based in Abu Dhabi, UAE. It was established in 1995 as a joint venture between SQM, a leading global producer of specialty fertilizers headquartered in Chile, and International Technical and Trading Co (ITT), a large agricultural sales and marketing company.

ADFERT has the capacity to produce around 100,000 ton/year of specialty products, including granular and water soluble NKPs, liquids and suspensions, micronutrients and foliar products, and sulfur-coated urea (SCU). The company lists its capacity as follows:

- NPK water-soluble fertilizer capacity - 50,000 ton/year
- NPK granular fertilizer capacity - 40,000 ton/year
- Liquid and suspension capacity – 5,000 ton/year
- Micronutrients and foliar capacity – 2,000 ton/year
- Sulfur-coated urea (SCU) capacity - 24,000 ton/year.

ADFERT markets its products through a team of agronomists and sales people. The team works with its customers to create bespoke formulas, from relatively standard granular NPK formulas to products tailored to specific crops. The company has representatives in more than 44 countries, mostly focused around the Middle East, north and east Africa and the Indian sub-continent.

An important part of the company's approach is its relationships with key suppliers of raw materials, ensuring that its products are of the highest quality. The key suppliers are SQM, SQM Vitas (a joint venture between SQM and Roullier Group's Vitas business), Yara International and AkzoNobel.

RNZ Group is a specialty fertilizers producer and supplier which is a well-established business with a 35-year track record, headed up by industry expert Mr Raza Soomar. Its headquarters are in Dubai, where it also has the capacity to produce a multitude of water soluble NPK grades with a capacity of 36,000 ton/year.

RNZ is also a supplier of various other water-soluble fertilizers which it sources from its own production and third-party raw material suppliers. The company's key market is for water-soluble fertilizers in the Indian sub-continent, supported by trained agronomists.

The future of specialty fertilizers in GCC

There remains significant potential opportunity for GPCA members to increase their participation in this growing business of specialty fertilizers. Many GCC countries are seeking to increase crop production, including high value crops, to cater to growing and increasingly sophisticated food demands from the region.

This comes with obvious challenges, but when water resources are relatively scarce, specialty fertilizers are essential. Besides, on the supply side, the region is already one of the most important for production of nitrogen and phosphate raw materials, and many of the chemical companies in the region are seeking to add value by moving into more specialized and diversified chemistry and production. What distinguishes the specialty from commodity fertilizer businesses are the higher barriers to entry. In order to produce more sophisticated products, greater technical know how is required for the processes that coat commodity

products or produce stabilizers, solubles and higher value micronutrients. This knowhow can be acquired through research and development or by licensing existing technology. Some GCC members already have programmes following these routes.

The barriers to entry should not be seen by GCC-based companies as insurmountable. In recent years the traditional market leaders in the specialties business based primarily in North America and Europe have been joined by fast growing and innovative companies from China. For example, Chinese company Kingenta has quickly established itself as a leading supplier of slow and controlled release products, and other specialties.

As the demand for specialty fertilizers in the GCC region continues to increase at a faster rate than commodity products, the region's production of specialty products should also be increasing in line.

Authors and acknowledgments

This publication is a collaboration between the Gulf Petrochemicals and Chemicals Association (GPCA), Integer Research Ltd and ICIS, leading market intelligence suppliers to the fertilizer and chemicals industries.

• **Integer** is a specialist provider of commodity and specialty fertilizer industry research, data, analysis and consultancy services. Headquartered in London, UK, and with offices worldwide, the company offers a variety of information services: subscription products that enable benchmarking and competitor analysis, and help businesses better understand future industry developments; bespoke market research commissioned by individual clients; and industry events.

• **ICIS** is the world's largest petrochemical market information provider and has fast-growing energy and fertilizer divisions. Our aim is to give companies in global commodities markets a competitive advantage by delivering trusted pricing data, high-value news, analysis and independent consulting, enabling our customers to make better-informed trading and planning decisions. We have more than 30 years' experience in providing pricing information, news, analysis and consulting to buyers, sellers and analysts. ICIS is a division of Reed Business Information, part of RELX Group.

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We are grateful for the input to this publication provided by **Kemnovation.com** and its founder Dr Kevin Moran. Kevin has 35 years of international experience in the fertilizer industry and specialty fertilizers, with a focus on micronutrients, precision fertilizer application, speciality soil and crop conditioners and performance improvers.

The Gulf Petrochemicals and Chemicals Association (GPCA) represents the downstream hydrocarbon industry in the Arabian Gulf. Established in 2006, the association voices the common interests of more than 240 member companies from the chemical and allied industries, accounting for over 95% of chemical output in the Gulf region. The industry makes up the second largest manufacturing sector in the region, producing up to $US 102 billion worth of products a year.

The association supports the region's petrochemical and chemical industry through advocacy, networking and thought leadership initiatives that help member companies to connect, to share and advance knowledge, to contribute to international dialogue, and to become prime influencers in shaping the future of the global petrochemicals industry.

Committed to providing a regional platform for stakeholders from across the industry, the GPCA manages six working committees - Plastics, Supply Chain, Fertilizers, International Trade, Research and Innovation and Responsible Care - and organizes six world-class events each year. The association also publishes an annual report, regular newsletters and reports.

For more information, please visit **www.gpca.org.ae**

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