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DRUM COMMODITIES LIMITED (DCL)

REPORT ON FERTILIZERS

CONTENTS

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1. EXECUTIVE SUMMARY

1.1 This report provides an introduction to fertilizers. Starting with the basic origins of fertilizers, it then examines the supply chain and the markets they are traded in. The report is directed at informing readers without previous knowledge of fertilizers and the industry accompanying them.

1.2 With a forecasted need to produce more food over the next 50 years than has been consumed in the last 10,000 years, fertilizers offer a part in the solution for easing this food shortage. Humans, animals and plants all need nutrients to survive. Fertilizers contain nutrients that are applied to soils in various ways: rate, amount, mixture and timing of application all being important components. Use of fertilizers is therefore important to human diets and food security. It is estimated about 30 to 50% of the world's current population is fed due to the use of fertilizers, in particular, being the world's most consumed nutrient, Nitrogen fertilizers.

1.3 As the share of arable land per capita is declining, 77% of future food production must originate from increased yield on existing croplands. This could be accomplished solely through sustainable use of fertilizers. In Sub-Saharan Africa, fertilizer use is at unsustainably low levels; the continued underdevelopment of this sector means that increased use of fertilizers in the region is a must for both regional and global food security. Knowledge of soil types, as described in this report, is necessary for improving the poor state of Africa's arable lands.

1.4 This report looks at Nitrogen (N), Phosphorus (P) and Potassium (K) fertilizers. These usually contain other macronutrients and micronutrients, however, the industrial standard is to use NPK to describe and analyse information.

1.5 Drum Commodities Limited (DCL) has been handling fertilizer stock in Africa since 2009. The supply chain takes fertilizer from its raw state, through its trade, on to usage by farmers, and also includes its storage. Following the production of fertilizers, using gases and sometimes mined elements in specific chemical processes, many are exported to countries in need of nutrients. After importation, and the bagging of fertilizer bulks at port discharge, stock is usually transported to warehouses, in the port or nearby, to await further inland distribution by wholesalers.

1.6 Fertilizers, in the global market, are interdependent with other agro-commodities and the overall state of the economy. Global consumption of fertilizers has steadily risen over the past decades and, although demand stagnated in 2013, forecasts portray a favourable atmosphere for traders with demand projected to rise over the coming years. This stagnation was mainly due to the Green Revolution's giant, Asia, where demand contracted in 2013, coinciding with delayed harvests and other incidents in this volatile market.

1.7 The key players in the fertilizer market are China, Russia, USA, India and Canada. The only comparatively noticeable exporters on the African continent are the North-African countries, Morocco, Algeria and Egypt. Togo is the only significant exporter in sub-Saharan Africa, but it does not export at the same level as these countries.

1.8 Demand in African markets is growing very slowly, but is projected to show relatively higher growth rates as development initiatives by global and regional stakeholders, such as the African Development Bank (AFDB), continue. While the current state of Africa's market does constitute a trend, consumption rose to pre-crisis levels in 2011.

DRUM commodities

2. INTRODUCTION

2.1 This report provides an introduction to fertilizers, exploring the basic background of various fertilizer types and following through to the markets that trade them. It concentrates on fertilizers with regard to Africa as well as highlighting current DCL operations. It is important to note a distinction between organic and inorganic fertilizers[1]. Inorganic fertilizers are more commonly traded on a global level compared to their organic[2] counterpart.

2.2 The world population is increasing at a rate 150 persons per minute[3] but, at the same time, the share of land given over to arable farming is slowly declining (37.6% of total land area having been arable in 2011[4]), and there is a need to produce more food over the next 50 years than has been produced in the past 10,000. So the fertilizer industry is considered an essential element of the increasing need to feed our growing population. The importance of fertilizers, both to the world and to the development of the agronomy and agriculture in Sub-Saharan Africa, will be elaborated further in section 3.3 of this report. Section 3 will also include information on soils, soil management and basic information on the origin and composition of fertilizers.

2.3 The fourth section of this report examines the route fertilizer makes to become a commodity in the supply chain. Section 4.7 highlights the operations which DCL currently undertakes in managing the storage of specific fertilizers. An analysis of both the global and African markets for fertilizers will be provided in the final informative section of this report. Section 6.0 concludes the report and will be accompanied by some general recommendations with regard to regional Sub-Saharan Africa trade volumes, improving storing practices and the optimal geographical locations to trade and store fertilizers.

3. FERTILIZERS

3.1.1 As humans need nutrients to survive, so do their crops. The elements essential to humans such as proteins, fats, carbohydrates, vitamins and minerals, mostly come from our nutrition derived from animals, crops, fruits, seeds, etc[5]. Both domestic food animals and humans consume crops, while in turn crops and plants will receive most of their nutrient requirements from soils. This cultivation process and nutrient intake is enhanced by adding either organic or inorganic fertilizers of natural or synthetic origin to the soil in order to make up for any nutrient deficiencies on degraded lands. The most prevalent nutrients consist of 6 macronutrients, so called due to the necessity to use them in higher volumes, and 8 micronutrients. These nutrients are often referred to using their chemical symbols from the Periodic Table:

Table 5.1 Macronutrients	
N	Nitrogen
P	Phosphorus
K	Potassium
Ca	Calcium
S	Sulphur
Mg	Magnesium

Table 5.2 Micronutrients	
B	Boron
Cl	Chlorine
Cu	Copper
Fe	Iron
Mn	Manganese
Mo	Molybdenum
Zn	Zinc
Ni	Nickel

3.1.2 In addition to these nutrients, which can be added to the soil through the use of fertilizers, there are 3 more macronutrients that are required by crops and plants to grow: carbon (C), hydrogen (H) and carbon dioxide (CO_2). These are predominantly supplied through rainfall or irrigation (water management is extremely important when applying fertilizers to soils, see 3.7) and CO_2 in the atmosphere. With the increased use of under-cover crop cultivation in greenhouses and poly-tunnels, these macronutrients are often increasingly

[1] Also referred to as: synthetic commercial, manufactured and mined inorganic fertilizers.
[2] For example, animal and plant based organic fertilizers; animal-based organic fertilizers; compost fertilizers; mineral-based organic fertilizers; plant-based organic fertilizers; other organic fertilizers.
[3] US and World Population Clock at: http://www.census.gov/popclock/.
[4] World Bank, 2013.
[5] IFA, 2013.

manageable as well. These nutrients are also used throughout the production processes of inorganic fertilizer (see 4.3 production).

3.2 **Composition and Types**.

3.2.1 Fertilizers contain one or more nutrients and can take solid, liquid and gaseous forms. The number of nutrients in a fertilizer (ie. fertilizer grade[6]) is decided according to what a specific soil needs to yield crops. Fertilizer grades are often expressed in the following order N – P – K (eg. 0 – 46 – 0) and can be either single-nutrient (straight) or multi-nutrient (compound). Urea, also known as carbamide, and normally produced organically as waste by the human body after metabolizing proteins, is an example of a straight fertilizer with a grade of 46 – 0 – 0. This means that Urea, first produced synthetically in 1882, comprises of 46% N and is therefore regarded as a straight N fertilizer. An example of a compound fertilizer would be DAP (Diammonium Phosphate) with an 18 – 46 – 0 grade, translating into 18% N and 46% of P_2O_5 (Phosphorus Pentoxide). The last percentage in a standard fertilizer grade represents K_2O (Potassium oxide)[7].

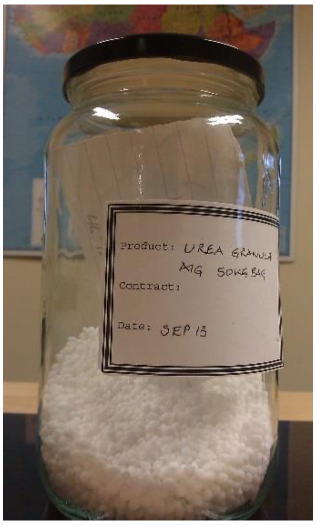

Image 1: Urea granules

3.2.2 There are 2 combinations of fertilizers: firstly, mixed fertilizers or bulk-blends, which essentially constitute a physical mixture of 2 or more straight or multi-nutrient fertilizers. And, secondly, complex fertilizers, in which 2 or more nutrients are joined chemically (eg. NPK, DAP, etc.). A list of all common fertilizers, their abbreviations and descriptions is in Appendix 2.

3.2.3 Fertilizers have 4 types of nutrient release rates:

- Quick-acting: The fertilizer would be soluble in water and immediately available to the soil.
- Slow-acting: Requires a transformation into a soluble substance (eg. phosphate rock that is directly applied to the soil).
- Controlled-release: Through the use of coating.
- Stabilized: Delays the release of nutrients through inhibitors[8].

3.3 **Importance of Fertilizers**.

3.3.1 By increasing nutrients in soils, fertilizers compensate for deficiencies in nutritional values of soils for crops and plants as well as humans. Appendix 4 provides an example using Zinc balances in both soils and

[6] Also referred to as the NPK ratio.
[7] IFA 2013.
[8] Inhibitors: Elements that 'block or…delay the action of biochemical or biological processes that transform fertilizers' (Watson 2013).

humans. Use of fertilizers is important to food security and human diets as well as to preventing or easing the food shortage that is expected to soar over the coming decades. At present, between 30 to 50% of the world's population is said to be fed due to the use of fertilizers in agriculture. Being a crucial component of metabolic, genetic and structural compounds in the cells of plants, and therefore playing an important role in the cultivation of crops, Nitrogen is the world's most consumed nutrient[9]. Some research suggests that 50% of the world population is fed solely due to the use of N fertilizers[10]; it is therefore one of the most widely used fertilizers. The map in Figure 2 shows nitrogen (N) balances within soils throughout the world. The high deficiencies visible in countries of Sub-Saharan Africa are in line with negative trends seen throughout other data analysed in this report.

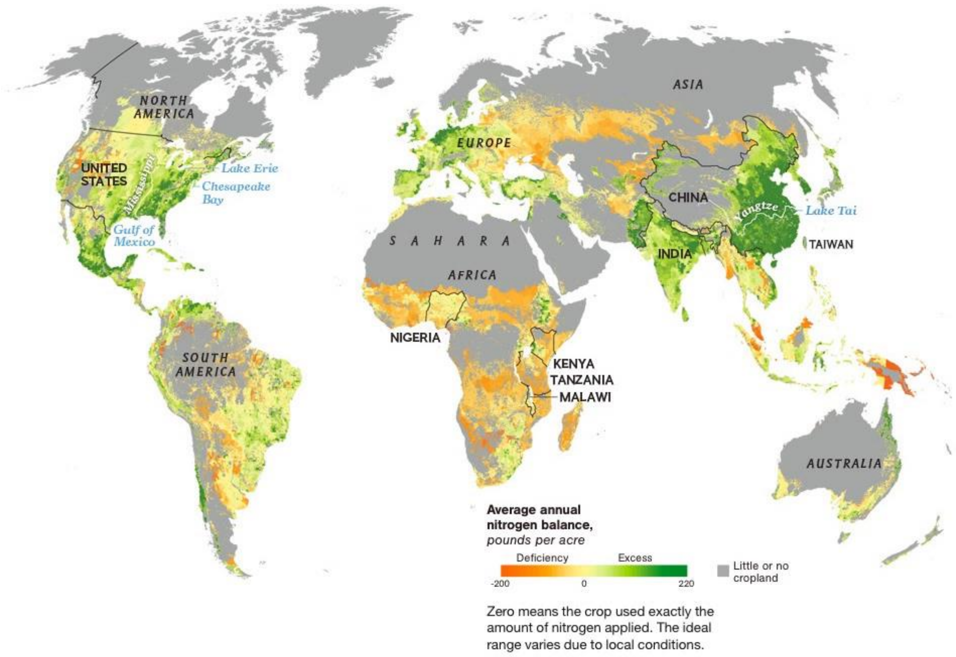

Figure 2: Average Annual Nitrogen balances
Source: National Geographic

3.3.2 Fertilizer use plays an important role in the economic growth of developing nations and so this applies in most nations of Sub-Saharan Africa. The agricultural sector is seen as the 'kick-starter' for a nation on its road to economic advancement. An increase in fertilizer use can help yield a higher agricultural output from soils and therefore assist in developing a region or country's agronomy. Many policies are currently being implemented to prevent projected food shortages, and the declining share of arable land per capita (77% of future output for necessary food production will have to come from increasing yields from existing farmlands). Figure 3 portrays the relative potential of these methods of increasing food production. In order to increase yields from existing lands under cultivation, the use of fertilizers needs to be increased and improved.

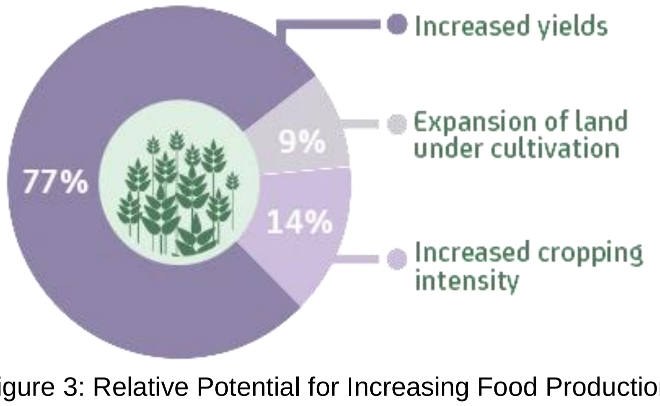

Figure 3: Relative Potential for Increasing Food Production
Source: FAO, Roots for Growth

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9 IFA, 2013.
10 Erisman *et al.* 2008.

3.3.3 Africa, Sub-Saharan Africa in particular, lacks long-term sustainable fertilizer practices with policies often outdated or non-existent. This leads to a nutrient deficiency in soils (see paragraph 3.5), underdeveloped agronomic fertilizer practices and increased levels of deficiencies in local diets. It is therefore important to use fertilizers more widely in the region. In terms of the global importance of an increased use of fertilizers in Africa, the achievement of 2 out of the 8 MDGs[11] devised by the United Nations can be enhanced by developing sustainable use of fertilizers on African soils. A further concern is that the available arable land in Africa is necessary to fill the supply-demand gap for crop cultivation beyond regional limits in the future. If all arable agricultural lands are not engaged to their full potential, the food shortage will reach far beyond just the countries of Sub-Saharan Africa in 2050. Due to unsustainable subsistence farming activities, arable lands in Africa lose many of their necessary nutrients and become badly degraded (see section 3.5). They need the effective usage of arable land to be improved for both global and local causes.

3.4 **Soil Types**.

3.4.1 Knowledge of the types of soils prevalent in an area, in combination with the climate, is of high importance to the correct and efficient application of fertilizers (see paragraph 3.7). Most countries have their own soil classifications or soil taxonomic systems. The World Reference Base for Soil Resources WRB classifies soil types into 32 reference soil groups that are themselves classified into ten main groupings (eg. soils with strong human influence, etc.)[12]. A simplified table of the 32 soil groups, as extracted from the IUSS report is in Appendix 5.

3.4.2 Analysis of specific soil types is crucial to determine the type of nutrients that local soils need in order to increase their fertility. Combining this knowledge of nutrients and soil types enables agribusiness to manage soil fertility effectively. Within this field, the selection of fertilizer type, timing and method of application can be established in a manner appropriate to local conditions. Due to the study of soils, or pedology, farmers are now increasingly aware of soil structures and soil fertility requirements. Knowing the density, structure, etc. of local soils helps farmers to cultivate in a sustainable manner.

3.5 **African Soils**.

> "*To feed our people, we must feed our soils.*"
>
> Olusegun Obasanjo
>
> [Former president of Nigeria]

3.5.1 African soils are diverse or, in scientific terms, have a high degree of pedodiversity[13, 14]. Soil fertility management in Africa has not been developed sufficiently to stop inefficient practices on many local soils. This means many hectares of arable land are increasingly being degraded. While South East Asia has benefited from the 'Green Revolution' since 1961, African soil fertility has declined in the past 50 years. In the Asian region there is a sustainable excess of crucial nutrients in soils, a direct result of sustained development.

[11] United Nation's Millennium Development Goals: www.un.org/millenniumgoals/
[12] IUSS Working Group 2007
[13] The (study of) variation of soil properties in an area/region (classified in the WRB/FAO soil groups).
[14] Yaalon 1998

Figure 4: Yields from Degraded Soils in Sub-Saharan Africa
Source: UN, Roots for Growth

3.5.2 Although Africa's slow agricultural development can be attributed to many causes, ranging from unsustainable practices to under-investment[15], the soils are themselves suitable for cultivation. Sub-Saharan Africa soil practices lack implementation on a continental level so degradation continues. Figure 4 demonstrates the poor state soils and farmers are currently in. Essentially 75% of soils are degraded, resulting in an average annual nutrient loss of 39.5kg per hectare. Consequently farmers are estimated to miss out on $4 billion revenue from reduced yields.

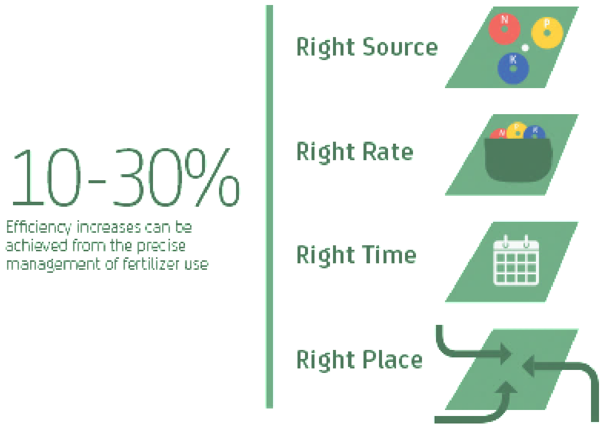

Figure 5: Fertilizer Application Efficiency
Source: FAO, IFDC, Roots for growth

3.6 **Fertilizers in Action**.

3.6.1 As established previously in the report, there are many soils types with varying levels of nutrients all over the world. In order to introduce universal standards for the correct application of fertilizers, with the suitable amount of nutrients and at the appropriate time and rate, Fertilizer Best Management Practices (FBMPs) have been adopted throughout the fertilizer industry. These best management practices are adapted to local conditions and aim to help improve food supply, farmer income, mitigate the environmental footprint of the fertilizer industry and reduce negative reaction to using fertilizers from industry stakeholders[16]. Figure 5 shows the efficiency increases achievable from applying fertilizers using the correct nutrients, rate, time of the year (eg. spring for N fertilizers), and location. These will help reduce, or even prevent, the misuse, overuse or underuse of fertilizers globally, permitting the Fertilizer Best Management Practices are adopted widely throughout the industry. Stakeholder institutions (IFA, ANDA, Fertilizers Europe, CFI, ECOWAS etc.) are

[15] Brenton and Isik 2012.
[16] Lammel 2007; Ryan 2007.

advocating this through the initiation of multiple internal and collaborative initiatives (eg. Roots for Growth, Africa Forum, etc.) and are expected to continue in future.

3.7 **Utilisation Hazards**.

3.7.1 The many hazards involved with using fertilisers can be and are mitigated through their correct application. The main risks are mostly manageable and are predominantly due to previously mentioned misuse, overuse, or underuse. These hazards often directly endanger the lives of humans, in particular infants. The main issues that arise are leaching, runoff and eutrophication (stimulated excessive plant growth, particularly algae, leading to poor water quality), all issues that overlap each other and are generally due to mismanagement of water.

4. FERTILIZERS: FROM MOLECULE TO COMMODITY

4.1.1 This section examines the process inorganic fertilizers go through during their life as a commodity, ie. the fertilizer supply chain. DCL undertakes activities at storage facilities in more than 17 countries across the Sub-Saharan Africa and MENA regions, dealing with a broad portfolio of stock types. Fertilizers have been under contracts with DCL since 2009. Section 4.7 provides more information on DCL's current operations with fertilizers.

4.2 The fertilizer supply chain:

Production

- (Raw) Inorganic fertilizer
- Mined and processed or otherwise synthetically produced
- Exported to destination country

Importation

- Goods imported via various channels
- Port discharge (occasional involvement DCL)
- (Rarely: procurement importer > trader)

Distribution

- Pre-procurement storage at port warehouse or warehouse in close proximity of port (DCL involvement)
- Distribution trader to off-takers (wholesalers) who provide to retailers (ie. agro dealers) or transport to storage facilities in landlocked regions.

Agro Dealer

- Purchase from wholesaler
- Retail-level operations (Sales to farmers and 'stockists')
- Distribution to retailers (ie. agro dealers) or transported to further inland storage facilities

Farmer

- Purchase from agro-dealer (often accompanied by application intelligence)
- Onsite application procedures
- Appropriate use of technology
- Output marketing

Output

- Storage of output produce (DCL involvement)
- Marketing and processing of cereals (or other crops, eg. fruits and vegetables, sugar crops, cotton, etc.)
- Export

4.2.1 Inorganic fertilizers are produced through specific chemical processes. In most cases, fertilizers (in raw gaseous or solid forms) are mined from deep within the upper crust of the earth, before being processed into a final form for sale. An example recovery process, conducted in Madagascar, is the hydrometallurgical process recovering micro-nutrients Nickel and Cobalt. This produces the by-product, Ammonium Sulphate[17].

[17] Wanzala and Groot 2013.

4.3 **Production**.

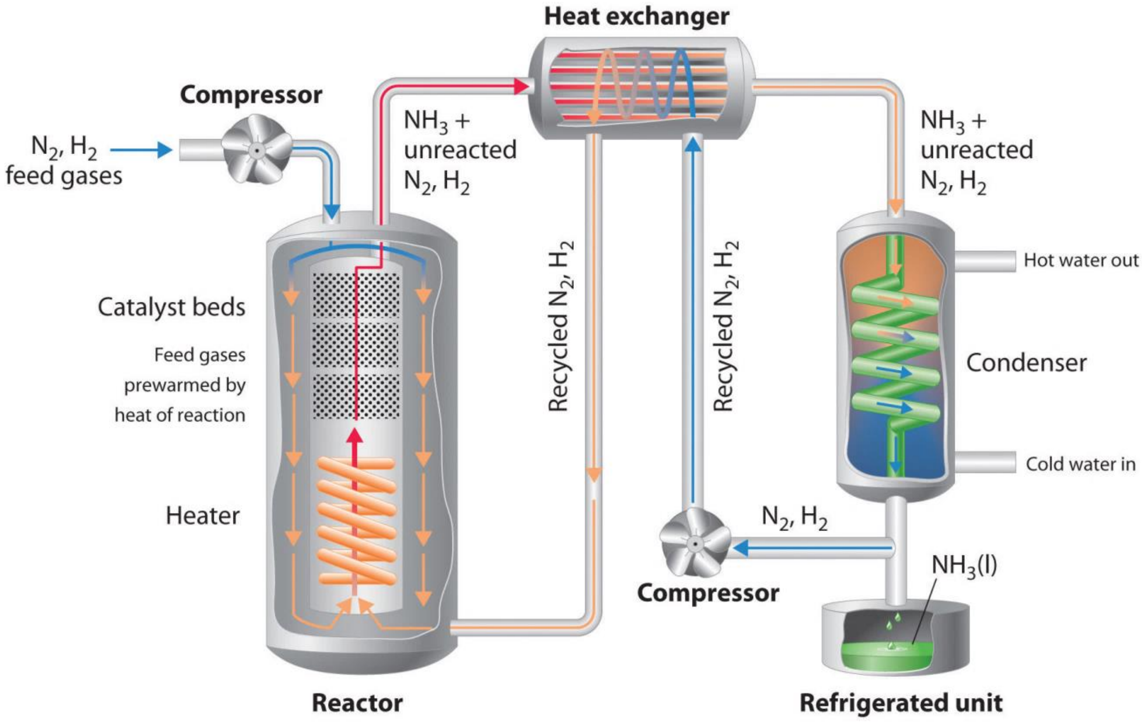

Image 6: The Haber Process
Source: Principles of General Chemistry

4.3.1 A wider known production model, which includes 3 production processes, is that of NPK fertilizer. The first process, the Haber process (Image 6), produces ammonia out of nitrogen and hydrogen. The nitrogen is extracted out of the air and hydrogen is added to the distillation process from natural gas. After the ammonia is produced, the Ostwald process is initiated to convert the ammonia into nitric acid. These processes involve 2 chemical reactions that result in nitric acid and nitrogen oxide; the latter is recycled and re-used in further repetitive processes.

Image 7: Nevinnomyssky Azot
Source: EuroChem

4.3.2 The final process, the nitrophosphate process, involves acidifying phosphate rock with the previously produced nitric acid. This produces a phosphoric acid and calcium nitrate mixture. If either potassium chloride or potassium sulphate is added to this, it finally produces the NPK fertilizer[18]. This lengthy and costly production process that NPK undergoes is one of the reasons it is referred to as a complex fertilizer. The production of all

[18] Horner et al. 2013.

N fertilizers involves one or more of these chemical processes in some form (eg. Urea is produced by reacting ammonia with CO_2). Image 7 depicts a nitrogen production plant in Russia, Nevinnomyssky Azot.

4.4 **Importation**.

4.4.1 After production, the fertilizer enters the supply chain, but before being shipped, the fertilizers are generally transported to main regional distribution centres which send-off shipments to destination countries.

Image 8: Port discharge activities in Lagos, Nigeria

4.4.2 On a regional level, the importation of fertilizers in Sub-Saharan Africa makes up a relatively small share of the global trade flow. Fertilizer traders or importers face various constraints including: high freight rates to most Sub-Saharan Africa ports, limited port capacities (leading to the use of small vessels, generally with 15,000 tonne capacity), limited backhaul opportunities, generally low port discharge capacities and inefficient bagging equipment. Delays in berthing of 7 to 10 days are common and all these constraints lead to fertilizer prices being $200 per tonne higher than Free On-Board (FOB) prices in the world market.

4.4.3 Although import is generally conducted by private traders, there are still a number of governments in Sub-Saharan Africa that contract private suppliers to deliver subsidised fertilizers to domestic farmers. This is done to stabilise commodity prices using Marketing Boards. Too much public intervention is however a main concern and the subject of regional and global debate[19], with calls for more privatizations to make the market more efficient. Globally, governments tend to subsidise farmers rather than traders, which seems to be a better model besides being an integral element of the industry's revenues.

4.5 **Distribution**.

4.5.1 Distribution often involves many activities and partially overlaps with the importation component. Most goods are either shipped by the exporting or importing party (hiring external vessels as per agreements), and on some occasions these 2 parties are one and the same. Fertilizers are then bagged (if applicable) and stored at a port warehouse, or at a site in close proximity to the port of discharge. If the fertilizer is liquid it is transported and shipped in tankers, and occasionally fertilizers are already bagged. From the storage location, stock is released in lesser quantities for further distribution, conducted upon procurement of stock to the off-taker (at this point often a wholesaler). This party then transports the fertilizers to inland warehouse facilities in landlocked regions. In these regions it is commonly sold to agro-dealers (ie. retailers) that distribute to local farmers.

4.5.2 In Sub-Saharan Africa this transport of stock has a high degree of dependency on trucks. Even though rail transport would cut an estimated 30% of costs, railway transport is constrained by poorly maintained lines which are often antiquated. The domestic movement of stock in small loads, seasonal nature of demand and limited backhaul opportunities often incur high tariffs. For this reason, it is pivotal to have an effective logistics system. Information provision and a high degree of flexibility in this system increases the ability to react to market fluctuations, much of this flexibility is dependent on storage capacity and storage efficiency.

[19] Burger, 2012.

4.6 **Storage**.

4.6.1 Optimal storage of fertilizers allows traders to position their produce to react to final demand promptly. It enhances the product-to-market flows by spreading supplies over longer periods of time. It therefore decreases pressure on local transport facilities, and increases opportunities for backhauling and other logistic efficiencies. In Sub-Saharan Africa, storage capacity, as well as efficiency, often lacks professional interference and so prevents traders from optimal storage of stock.

4.6.2 Standards and criteria for storing fertilizers are extensive; according to their enhanced professional abilities, experienced collateral managers would implement and maintain additions while following the practices summarised below:

- Fertilizers should always be stored away from other chemicals (eg. pesticides) and under dry conditions (eg. providing pallets can prevent moisture infiltrating drums or bags).

- In the case of bulk container usage, the warehouse should have a containment area of at least 125% of the largest tank.

- Proficient secondary containment of day-to-day spills (often a result of re-bagging, mixing or loading operations) should be in place, as well as the secondary containment of large, accidental spills or leaks.

- Other standard collateral management procedures (eg. lock and seal the warehouse during out-of-operation hours, preventing possible unauthorised access to stock labels that inform on warehouse contents, etc.)

4.6.3 Upon release from storage, fertilizers are handled by wholesalers (off-takers) who secure fertilizers for agro-dealers, after having distributed to inland locations. Agro-dealers dispense fertilizers to farmers on retail levels and should provide information on application procedures. Knowledge of the application processes is however not widely available or currently provided in Sub-Saharan Africa.

4.6.4 For this part of the supply chain, the main concerns for local agro-dealers are the low margins and low volumes of stock that do not encourage financial investment or effort into developing fertilizer expertise. Relating to this are the high price premiums incurred throughout the African fertilizer supply chain, for example, the transport costs of distributors being quite high compared to other global regions. Transportation costs in Sub-Saharan Africa therefore make up a large part of the fertilizer retail price at agro-dealer level in many countries; 22% in Tanzania and over 30% in Mali, Rwanda, Uganda and Zambia, compared to only 11% in Thailand[20].

4.6.5 All too often, fertilizer recommendations are not based on soil nutrient requirements, meaning limited availability of fertilizers. In most Sub-Saharan Africa countries only DAP, urea and NPK are available and micronutrient deficiencies are not taken into account. This means that, once the stock is at the farmer level of the supply chain, few African farmers, who are generally farming on a subsistence basis anyway, use fertilizers. When fertilizers are used, they are often only used on the land given over to cash crops leaving the remaining land with yields far below their potential. Further attention to this is given in the report's conclusion and in the African market section (5.4).

4.6.6 Considering the translation of fertilizers into the food products they produce, Figure 9 depicts the global fertilizer-to-crop ratio (eg. 15% of global fertilizers translate into the cereal wheat). These data are extracted from multiple sources and could differ from regional values of fertilizer-to-crop input.

[20] Wanzala and Groot 2013; Ott 2012.

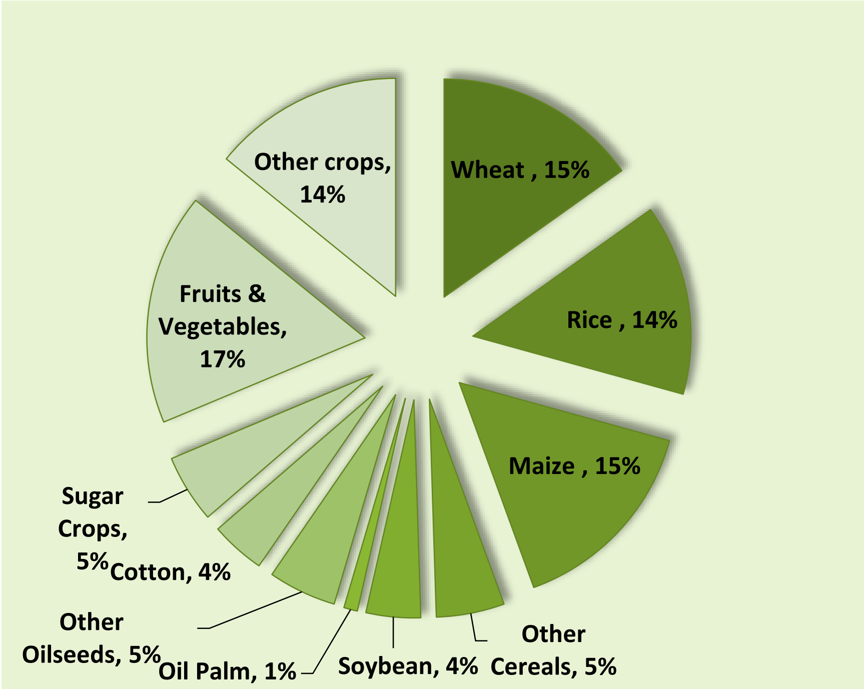

Figure 9: Fertilizer -to-crop ratio (Global)

4.7 **Current DCL Operations**.

4.7.1 DCL currently controls fertilizer stock in four African countries: Kenya, Malawi, Mozambique, Nigeria, Senegal, South Africa, Tanzania and Zambia. As discussed in 4.6, the handling of fertilizer in storage needs to be conducted with the utmost care, it is therefore important that ground-staff are competent in maintaining a safe environment. The fertilizers that DCL works with, listed in Appendix 3, are part of a portfolio of fertilizer stock that has been managed by DCL since 2009.

4.7.2 The collateral management that DCL conducts regarding fertilizers takes into account scientifically underpinned storage standards and criteria, professional experience, and is always done by competent, knowledgeable and professional individuals. DCL helps mitigate the storage risks of fertilizers and assists in managing the financial risk of storing commodities on the African continent.

5. FERTILIZER MARKET PLACE

5.1.1 Weak economic activity commonly impacts commodity prices; the fertilizer market is always dependent on the state of the economy, both on a domestic and a global level. Globally, overall demand is heavily dependent on the commitment of national governments to subsidise the use of fertilizers. An estimated 55% of world demand is accounted for by countries subsidising the domestic use of fertilizer[21]. The outlook in the coming decade is that fertilizers will play an increasing role in food security policies of governments. The EU's Common Agricultural Policy (CAP) has already been updated; in 2013 it was confirmed that subsidies and the application of fertilizers has been adopted accordingly. In the following 2 sections, both the global and African market will be scrutinised, taking into account both supply and demand.

5.1.2 Macro-segmentation of the fertilizer market is accomplished by segregating the Nitrogen (N), Phosphate (P) and Potash (K), demand and supply (ie. market segments). This segregation is done in most fertilizer market research[22]. It enables new market entrants or current traders to conduct a more comprehensive analysis of the market data at the appropriate level of detail. While the application rates of these 3 main nutrients may vary according to local soils, they are all necessary for optimal crop production[23]. A fertilizer is considered to be within the N division if it is a straight N fertilizer or if its N level in the fertilizer grade is highest (eg. Urea with 45 – 0 – 0). This is evidently alike for the P and K market segments.

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[21] Heffer and Prud'homme 2013
[22] eg. Hernandez and Torero 2011; FAO 2012; Ott 2012; IFA 2013, Heffer and Prud'Homme 2013
[23] Ott, 2012

5.2 **Global Fertilizer Market**.

5.2.1 The vast global fertilizer market has shown remarkable growth since the first development of inorganic fertilizers in the 19th century. Import and export data (occasionally including organic fertilizer) records were initiated in 1961 by FAOSTAT. In the last 50 years, the market and industry have grown into a fully functional international presence.

5.2.2 The global consumption of fertilizers has risen steadily over the past decade. A minor decline in 2008 coincided with a major spike in fertilizer prices[23] that in turn coincided with a spike in food prices at the beginning of the Great Recession. The global upward trend is expected to continue as the need for an increase in agricultural output continues to rise. Figure 10 compares fertilizer consumption in the UK, the world and Sub-Saharan Africa.

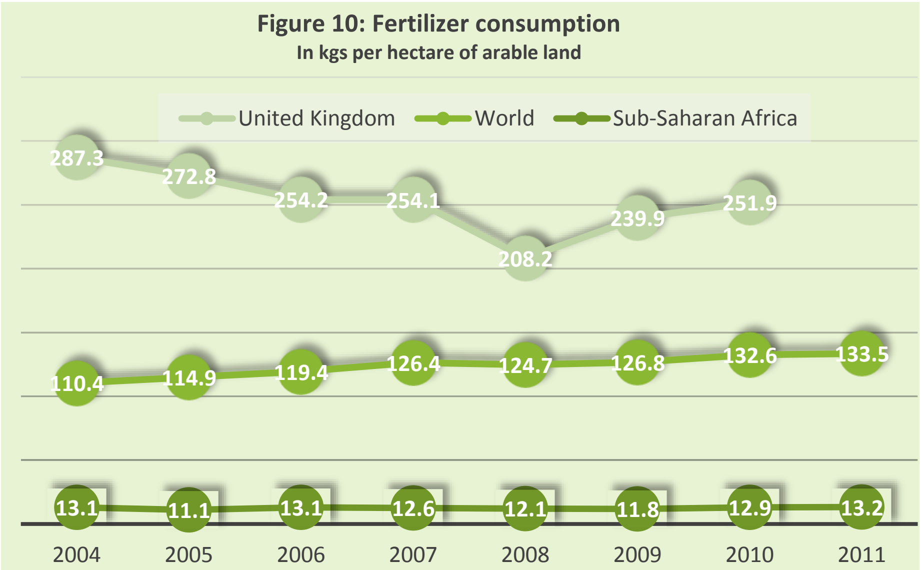


Figure 10: Fertiliser Consumption

5.2.3 The rise in global demand for fertilizers, or nutrients, slowed in 2013 due to impoverished market conditions, a rise in new uncertainties, delayed crop harvests and a decline in agri-sector commodity prices, as well as a 7.4% reduction in the regional demand from South Asia. Even though market growth has contradicted the predictions of 2 years ago and despite having stagnated in 2013, demand is expected to soar during the coming years. The total demand is set to increase by 2.7% from base year 2013 to 184.3 tonnes in 2014/15. This increase is nonetheless subject to changes. Forecasts provided for this year are highly speculative as the fertilizer market is fairly volatile, a result of the volatility in global agricultural commodity markets.

5.2.4 In terms of demand per market segment, the N segment has by far the largest market share, followed respectively by the P and K segments. The segment with the highest expected growth rate for the year 2013/14 is K with 2.4%, followed by the equal growth rates of 1.8% for P and N. These growth rates translate into a global demand for N, P and K of 109.6 tonnes, 41.1 tonnes and 28.7 tonnes respectively[24].

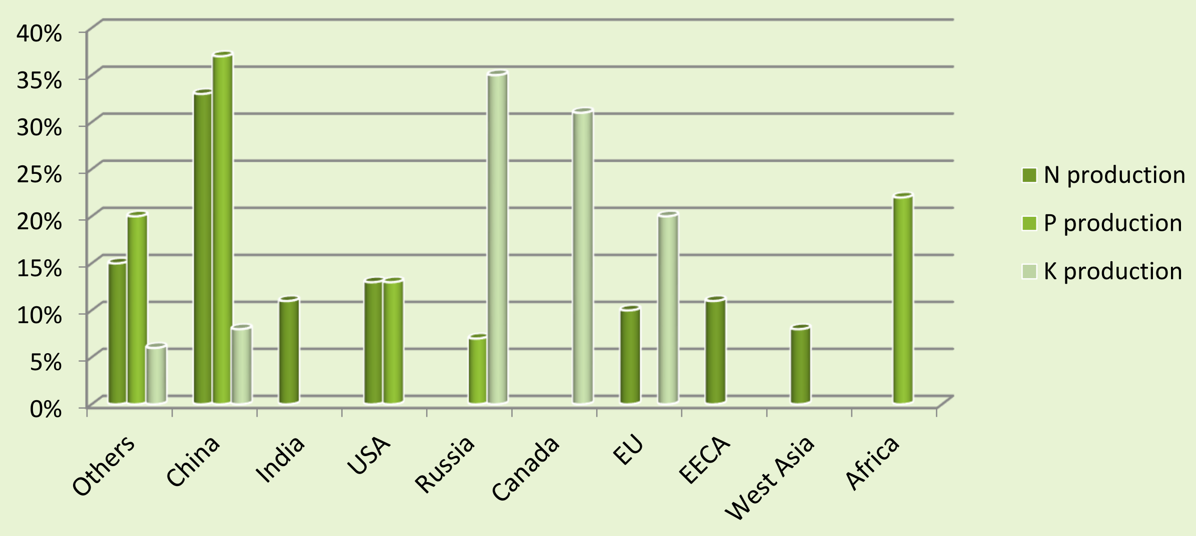
5.2.5 The supply side of the global market is mostly dominated by 5 global players on a per segment basis, usually being good for over 50% of production and export rates in that segment. The global sales of nutrients were set at 232 tonnes, with 179 tonnes (real fertilizer demand in 2013) comprising fertilizer use. The global demand was met by the fertilizer industry running at 87% of its full installed capability. The growth forecast for global sales is set at 2.3% in 2014 and this is mainly due to the previously mentioned recovery in global demand and imports. The fertilizers DAP (Diammonium Phosphate) and potash show noticeable growth projections, along with urea and some raw materials (ie. feedstock, ammonia, phosphate rock, phosphoric acid and sulphur) having a part in this projected growth.

[24] Heffer and Prud'homme, 2013

5.3 **Key Players**.

5.3.1 The key players in the global fertilizer market can be assessed on both a national and international level, in terms of industry research, by representation of industry stakeholders, or as main exporters and importers of the following countries: China, United States, Russia, India and Canada. These countries have the highest recorded export rates of fertilizers. These lists might differ on a per-product, year-to-year basis, however throughout the industry can generally be considered the main producers and exporters of fertilizers. This translates into the production percentage shares projected in Figure 11 below.

Figure 11: Nutrient production shares per entity



5.3.2 Global stakeholders are found to be the IFA, Europe Fertilizers, FAO, the World Bank and many other domestic fertilizer industry stakeholder organisations (ie. ANDA, TFI, IFS, etc.) which take an interest in the global market for the sake of improving knowledge sharing throughout the industry.

5.4 **African Fertilizer Market**.

5.4.1 The African market for fertilizers is relatively marginal on both the demand and supply sides. According to FAOSTAT data, total consumed imported fertilizers in 2011 were worth $3,330,139[25] against an export value of $2,537,679 in that same year. The North African nations currently have the main share of fertilizer production capacity and exports; the only Sub-Saharan Africa country that currently exports a significant amount of fertilizer is Togo. In 2010 Africa accounted for just 4% of the world fertilizer output, sub-Saharan Africa only produced between 100,000 and 200,000 tonnes of nutrients[26]. It becomes apparent that Sub-Saharan Africa countries are far below the world standard in fertilizer consumption and production, a trend consistent throughout many other statistics and reports, although one reason for this may be that the deposits of raw material found in many of these countries are often too small to be commercially viable[27].

5.4.2 Even though the overall agricultural sector makes up an average 17% of GDP in African countries, the main revenues are incurred from simplistic agronomic activities rather than from a sophisticated agri-business sector. While the world market is projected to be worth more than US$185 billion in 2019, the African market accounted for approximately 1% of this global market in 2006, only growing to 2.9% in 2011[28].

5.4.3 The importance of increased sustainable use of fertilizers in Africa has been advocated by both government organisations and NGOs (CAADP, Gates Foundation, etc), especially before the Great Recession. When the crisis hit developed economies in 2008, governments struggled with their own economies and implementation of austerity measures. The focus on agronomy and development of agriculture

[25] Manufactured (3,292,401) + Organic (37,738) Fertilizers, data available at: FAOSTAT Fertilizer Data Section
[26] Wanzala. M., Groot. R. 2013. *Fertiliser Market Development in Sub-Saharan Africa*
[27] *ibid*
[28] World Bank 2006; FAO 2012; Ceresana 2013

in Africa was therefore not the world's main concern. Though development initiatives continued, most were stalled, downsized or even completely cancelled.

5.4.4 Sub-Saharan Africa's consumption of fertilizers, as shown in Figure 10, is low compared to the rest of the world. Appendix 7 lists year-on-year consumption figures in the countries of DCL operations. The table's comparative colour scheme reveals that the largest end-users of fertilizers are the MENA countries, UAE and Bahrain.

5.5 **Africa's Key Players**.

5.5.1 The African market's supply side is dominated by North-African countries and, although the region would benefit from more regional dispersion of these fertilizers, they are generally marketed on a global level. As suggested in Figure 11, Africa produces 22% of the world's global phosphate rock supply[29]. This production is mainly concentrated in Morocco and a regional trade flow map, provided in Appendix 8 (extracted from the ICIS fertilizer trade flow map), shows how the second largest exporter is Egypt and the third is Algeria, with a relatively small share of ammonia exports. As previously mentioned, the only Sub-Saharan Africa country that exports a small amount of fertilizer in the form of phosphate rock is Togo.

5.5.2 The African market for fertilizers appears to have numerous external and internal stakeholders, mostly organisations of regional or global nature. These include, among others, AFAP (African Fertilizer and Agribusiness Partnership), USAID West Africa Fertilizer Program, ECOWAS, AfDB, The AU Africa Fertilizer Summit etc. These organisations often have large agendas and their ultimate goals in developing this sector in Africa often differ. The main thought that drives these programmes, however, seems to be the same: increasing the quantity and quality of food production in Africa.

5.5.3 In financial terms the IMF, IBRD and IDA all run, facilitate or finance development projects with an interest in the development of the African fertilizer market in some way or form. Of these financial initiatives, worth mentioning is the AFFM, which is a collaborative financing mechanism set up to aid sectorial development, providing credit guarantees for fertilizer importers and distributors. It is an important feature that is fully utilisable for traders and distributors alike who are interested in developing existing trade or penetrating this market.

6. CONCLUSION AND RECOMMENDATIONS

6.1.1 Fertilizers are crucial elements in providing food security and for combatting the expected food shortages associated with a decline in the arable land per capita. Soils, and the appropriate balance of nutrients in these, are considered to be of great importance to numerous stakeholders. The world population, as a significant stakeholder, would benefit from optimising African soils properly for crop production, facilitated by the sustainable use of fertilizers. As Sub-Saharan Africa currently has a significant number of arable land areas which are being degraded due to unsustainable subsistence farming practices, the study of and increased knowledge of local soils is considered an important topic. This report highlights a number of facts and data sets that show how Sub-Saharan Africa has unsustainably low levels of fertilizer input, a concern that is amplified by agricultural practices that degrade the fragile soils found there.

6.1.2 The FBMPs are a good standard for carrying fertilizer use forward on a global level, but also on a regional level in Sub-Saharan Africa. In understanding how to reach and encourage favourable outcomes, the supply chain is a useful tool for the implementation of food security policies, including those related to fertilizers (eg. FBMPs). Research suggests an efficient global fertilizer supply chain that appears to be functioning in an inefficient manner in Africa, partially due to transport and storage related issues. Consequently, financial risks of increasing storage capacity are higher and price premiums (or add-ons) in the supply chain are at high levels compared to the rest of the world. This leads to higher retail prices and lower usage of fertilizers. The result is a cyclical problem as storage capacity is essential for facilitating the trade that could develop local markets and practices. Local prices do not encourage farmers to purchase more fertilizers, which means higher risks when increasing storage capacities.

6.1.3 Nonetheless, market analysis shows that, in global terms, fertilizer trade and consumption is growing. The industry incorporates enough capacity that could be used to promote an increase in trade volumes. Fertilizer demand in Sub-Saharan Africa has shown relatively steady growth which could be inviting to both

[29] IFA, 2013

current and new traders in the industry. It is then comforting to know that development initiatives in this region continue and there is significant potential to increase trade.

6.1.4 Increasing trade volumes of fertilizers, especially in Sub-Saharan Africa, is necessary to assist global food security policies as well as developing operations on retail levels. Increased trade could positively influence the level of investment put into advancing expertise in the industry. These increased volumes would require greater storage capacity, which in turn could improve the market's efficiency and lead towards developing more sustainable industry practices in the MENA and Sub-Saharan Africa regions.

6.1.5 Indirectly, these increased trade volumes and storage capacities would help regional and global stakeholders to develop the region's agricultural practices. Increasing storage capacity does however mean more risks, emphasising the importance of collateral management to uphold specific storage standards and criteria.

7. BIBLIOGRAPHY

AfDB, 2014. *African Fertilizer Financing Mechanism*, [Webpage] Available at: <http://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/african-fertilizer-financing-mechanism/> Accessed on: 02 January 2014.

Brenton, P., Isik, G., 2012. *De-Fragmenting Africa: Deepening Regional Trade Integration in Goods and Services*, World Bank: Washington DC.

Bruinsma, J., 2009. The Resource Outlook to 2050: By how much do land, water and crop yields need to increase by 2050? *Export Meeting on How to Feed the World in 2050, FAO Economic and Social Development Department.* Food and Agriculture Organization of the United Nations: Rome

Burger, L., 2012. *Governments and Agricultural Markets in Africa.* Development Economics: Article presentation [Online] Available at: <http://issuu.com/leo.b/docs/governments_and_agricultural_market> Accessed on: 6 January 2014.

Ceresana, 2013. *Market Study: Fertilizers – World.* [Online] Available at: <http://www.ceresana.com/en/market-studies/agriculture/fertilizers-world/ceresana-market-study-fertilizers-world.html> [Accessed on: 24 December 2013 at 09:53 GMT]

Deckers, J. A., Nachtergaele, F. O., Spaargaren, O. C., 1998. *World Reference Base for Soil Resources: Introduction.* Acco: Leuven.

Erisman, J.W. *et al*, 2008. How a century of Ammonia synthesis changed the world, *Nature Geoscience 1, pp.636 – 639,* DOI: 10.1038/ngeo325

FAO, 1998. *World Reference Base for Soil Resources*. Food and Agriculture Organization of the United Nations: Rome, Italy.

FAO, 2012. *Current World Fertilizer Trends and outlook to 2016,* Food and Agriculture Organization of the United Nations: Rome, Italy.

Heffer, P., Prud'homme, M., 2013. Short Term Fertilizer Outlook 2013-2014, *39th IFA Enlarged Council Meeting Paris (France), 4-5 December 2013.* International Fertilizer Industry Association: Paris, France.

Hernandez, M. A., Torero, M., 2011. Fertilizer Market Situation: Market Structure, consumption and trade patterns, and Pricing Behaviour. *IFPRI Discussion Paper 01058,* International Food Policy Research Institute: Washington DC

IFA, 2013. *Fertilizer Indicators*, 3rd Edition, International Fertilizer Industry Association: Paris, France.

IUSS Working Group WRB, 2007. World Reference Base for Soil Resources 2006, First Update 2007, *World Soil Resources Reports No. 103*, Food and Agriculture Organization of the United Nations: Rome, Italy.

Lammel, J., 2007. Fertilizer best management practices in the context of product stewardship. In: IFA, 2007. *Fertilizer Best Management Practices, First Edition,* International Fertilizer Industry Association: Paris, France, pp. 71 – 76.

Nash, J., Halewood, N., Melhem, S., Saghir, J., Van Nieuwkoop, M., Kodderitzsch, S., Sallah, T., Damania, R., Oliver, C., Hussain, S., Russ, J., Monchuk, D., Giovannelli, C., Barra, A. F., 2013. Unlocking Africa's Agricultural Potential: An Action Agenda for Transformation, *World Bank: Sustainable Development Series.* World Bank: Washington DC

Ott, H., 2012. *Fertilizer markets and their interplay with commodity and food prices,* Publications Office of the European Union: Luxembourg

Ryan, J., 2007. Fertilizer best management practices: what level of adaptation to local conditions is realistic in a developing country context? In: IFA, 2007. *Fertilizer Best Management Practices, First Edition,* International Fertilizer Industry Association: Paris, France, pp. 87 – 96.

Horner, M., Williams, H., Halliday, S., Blyth, S., Adams, R., Wheaton, S., etc. etc. 2013. The chemical industry: The fertilizer industry. In: Horner *et al.* 2013. *Grade 12 Physical Sciences,* Version 0.9. Siyavulu: Cape Town, South Africa, pp. 180 – 187.

Wanzala, M., Groot, R., 2013. *Fertiliser Market Development in Sub-Saharan Africa,* International Fertiliser Society: York, United Kingdom
Watson, C., 2013. *Slow and Controlled Release and Stabilized Fertilizers: A Growing Market.* [Online] Available at: <http://www.newaginternational.com/current/productstrends201309a.pdf> [Accessed on 25 November 2013]

World Bank, 2013, *Agricultural land (% of land area).* [Online] Available at: <http://data.worldbank.org/indicator/AG.LND.AGRI.ZS/countries/1W?display=graph> [Accessed on: 29 November 2013 at 11:49 GMT]

World Bank, 2013b. Why Are Fertilizer Prices Higher in Africa? , *Fertilizer Toolkit: Promoting Efficient and Sustainable Fertilizer Use in Africa,* [Online] Available at: <http://www.worldbank.org/html/extdr/fertilizeruse/documentspdf/HighPrices.pdf> [Accessed on 27 December 2013]

Yaalon, D.H., 1998. Pedodiversity and global soil patterns at coarser scales, *Geoderma 83, pp.193-196, In discussion of J,J.Ibáñez, S.De-Alba, A.Lobo, V.Zucarello.* Elsevier: Amsterdam, the Netherlands

8. APPENDIX 1 - GLOSSARY

AfDB	African Development Bank
AFFM	African Fertilizer Financing Mechanism
AfSIS	Africa Soil Information Systems
ANDA	National Association for Fertilizer Distribution (Brazil)
AU	African Union
CAAPD	Comprehensive Africa Agriculture Development Programme
CFI	Canadian Fertilizer Institute
DCL	Drum Commodities Limited
ECOWAS	Economic Community of West African States
EECA (countries)	Eastern Europe and Central Asia
FAO	Food and Agricultural Organization of the United Nations
FAOSTAT	(United Nation's) Food and Agricultural Organization Statistics Department
FBMPs	Fertilizer Best Management Practices
FOB	Free On Board (ICC: shift of 'risk of loss' from seller to buyer on board a vessel)
IFA	International Fertilizer Industry Association
IFS	International Fertilizer Society
ISRIC	International Soil Reference and Information Centre
IUSS	International Union of Soil Sciences
MENA	Middle East and North Africa
NGOs	Non-Governmental Organisations
SSA	Sub-Saharan Africa
TFI	The Fertilizer Institute (US)
USAID	United States Agency for International Development
WRB	World Reference Base for Soil Resources

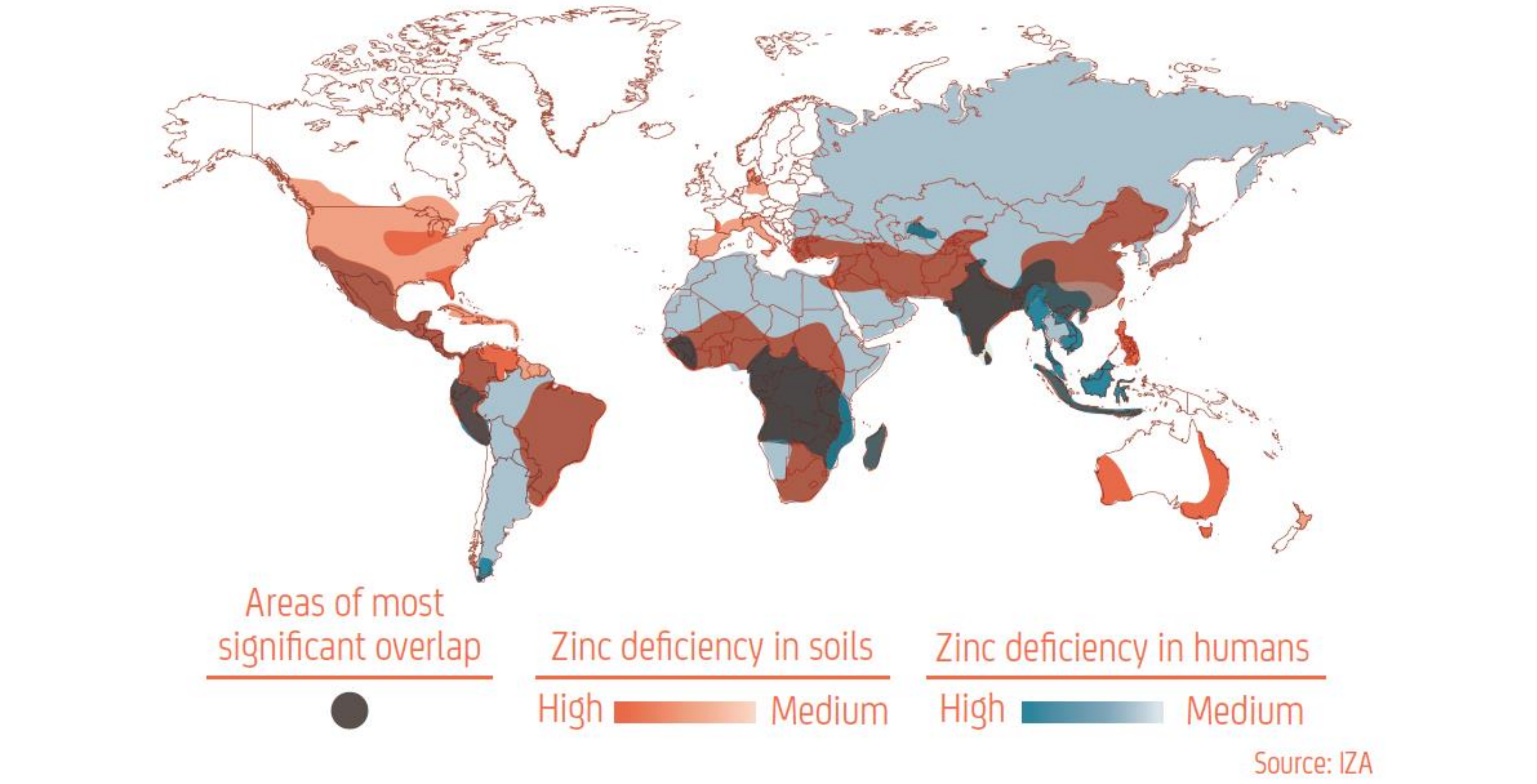
9. APPENDIX 2 - LIST OF COMMON FERTILIZERS

Fertilizer	Description	Type	Substance
Ammonia	ie. Azane: compound of N and CO_2	N	Gaseous
AN	Ammonium Nitrate	Complex	Solid (white crystalline)
CAN	Calcium Ammonium Nitrate	N	Solid (crystalline)
DAP	Diamonnium Phosphate	P	Water-soluble salt
KCL	Potassium Chloride	K	White/Colorless vitreous crystal
MAP	Monoammonium Phosphate	P	Solid (granular)
MOP	Muriate of Potash	K	Solid (brown/white powder)
NPK	Nitrogen Phosphate Potassium	Complex	Solid (brown/light granular)
Phosphate Rock	-	P	Solid
Phosphoric Acid	-	P	Liquid
Potash	ie. water soaked plant ashes	K	Solid (water-soluble)
SOA	Ammonium Sulfate	Complex	Solid (inorganic salt)
SSP	Single Super Phosphate	P	Solid (Granular)
Sulfur (Sulphur)	-	S	Solid (powder/granular)
TSP	Triple Super Phosphate	P	Solid (granular and non-granular)
Urea	ie. Carbamide	N	Solid (granular)

10. APPENDIX 3 - LIST OF FERTILIZERS UNDER DCL CONTRACT (PER COUNTRY)

Country	Fertilizer
Malawi	UREA
	NPK
	CAN
	MAP
	SOA
	DAP
	MOP
Nigeria	UREA
	NPK
	SSP
Senegal	UREA
	NPK
South Africa	UREA
	KCL

11. APPENDIX 4 - ZINC DEFICIENCY MAP



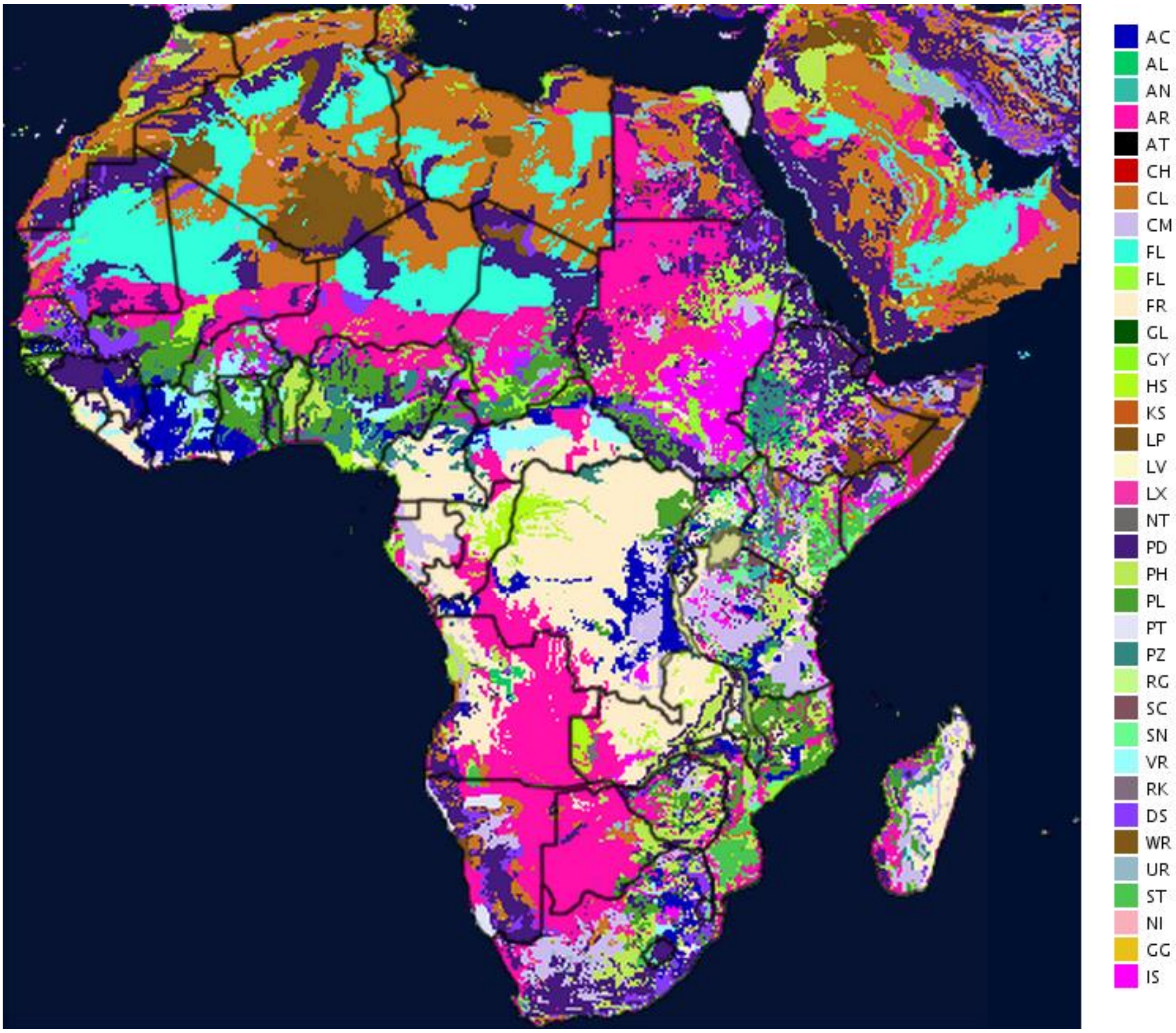
Source IFA, 2013

12. APPENDIX 5 - WRB SOIL GROUPS

Main Groupings	Reference Soil Groups	Soil type
1	**Soils with thick organic layers:**	Histosols (HS)
2	**Soils with strong human influence**	
	Soils with long and intensive agricultural use:	Anthrosols (AT)
	Soils containing many artefacts:	Technosols (TC)
3	**Soils with limited rooting due to shallow permafrost or stoniness**	
	Ice-affected soils:	Cryosols (CR)
	Shallow or extremely gravelly soils:	Leptosols (LP)
4	**Soils influenced by water**	
	Alternating wet-dry conditions, rich in swelling clays:	Vertisols (VR)
	Floodplains, tidal marshes:	Fluvisols (FL)
	Alkaline soils:	Solonetz (SN)
	Salt enrichment upon evaporation:	Solonchaks (SC)
	Groundwater affected soils:	Gleysols (GL)
5	**Soils set by Fe/Al chemistry**	
	Allophanes or Al-humus complexes:	Andosols (AN)
	Cheluviation and chilluviation:	Podzols (PZ)
	Accumulation of Fe under hydromorphic conditions:	Plinthosols (PT)
	Low-activity clay, P fixation, strongly structured:	Nitisols (NT)
	Dominance of kaolinite and sesquioxides:	Ferralsols (FR)
6	**Soils with stagnating water**	
	Abrupt textural discontinuity:	Planosols (PL)
	Structural or moderate textural discontinuity:	Stagnosols (ST)
7	**Accumulation of organic matter, high base status**	
	Typically mollic:	Chernozems (CH)
	Transition to drier climate:	Kastanozems (KS)
	Transition to more humid climate:	Phaeozems (PH)
8	**Accumulation of less soluble salts or non-saline substances**	
	Gypsum:	Gypsisols (GY)
	Silica:	Durisols (DU)
	Calcium carbonate:	Calcisols (CL)
9	**Soils with a clay-enriched subsoil**	
	Albeluvic tonguing:	Albeluvisols (AB)
	Low base status, high-activity clay:	Alisols (AL)
	Low base status, low-activity clay:	Acrisols (AC)
	High base status, high-activity clay:	Luvisols (LV)
	High base status, low-activity clay:	Lixisols (LX)

Main Groupings	Reference Soil Groups	Soil type
10	**Relatively young soils or soils with little or no profile development**	
	With an acidic dark topsoil:	Umbrisols (UM)
	Sandy soils:	Arenosols (AR)
	Moderately developed soils:	Cambisols (CM)
	Soils with no significant profile development:	Regosols (RG)

13. APPENDIX 6 - AFRICAN SOIL MAP



DRUM commodities

14. APPENDIX 7 - FERTILIZER CONSUMPTION PER DCL COUNTRY

Country	2007	2008	2009	2010
United Kingdom	254.1	208.2	239.9	251.9
Bahrain	798.6	1,993.30	947.8	1,953.80
Benin	0.2	0.3	6.5	0.5
Cameroon	8.6	6.6	6.7	5
Egypt	521.8	696.6	502.8	605.1
Ghana	17.8	14.5	19.2	17.9
Ivory Coast	24	18.2	15.3	32.2
Kenya	36.4	33.3	31.9	30.3
Liberia	*N/A*	*N/A*	*N/A*	*N/A*
Malawi	41.7	35.4	29.3	33
Mozambique	2.9	12.8	4.3	8.9
Nigeria	4.1	5.7	5	5.7
Senegal	2	2.3	4.9	7.6
Sierra Leone	*N/A*	*N/A*	*N/A*	*N/A*
South Africa	61	56.3	55.8	53.2
Tanzania	5.1	5.7	7.5	6.6
Togo	6.3	0.2	0.9	0.4
United Arab Emirates	1,104.90	423.6	1,324.80	674.9
Uganda	1.2	2.9	2.1	1.7
Zambia	32.3	38.7	27.3	26.8

15. APPENDIX 8 - REGIONAL TRADE FLOW MAP (ICIS)