AGRA
Growing Africa's Agriculture

Feeding Africa's soils

Fertilizers to support Africa's agricultural transformation

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Content

Part 3: The enabling environment

Part 4: Synthesis

Abbreviations

Organizations

AFAP	African Fertilizer and Agribusiness Partnership
AfDB	African Development Bank
AFFM	Africa Fertilizer Financing Mechanism
AGRA	Alliance for a Green Revolution in Africa
CAADP	Comprehensive Africa Agriculture Development Programme
CILSS	Permanent Interstate Committee for Drought Control in the Sahel
COMESA	Common Market for Eastern and Southern Africa
DFID	Department for International Development
EAC	East African Community
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization of the United Nations
Fertasa	Fertilizer Association of Southern Africa
IFA	International Fertilizer Association
IFAD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
IPNI	International Plant Nutrition Institute
NEPAD	African Union's New Partnership for Africa's Development
NGO	Non Goverment Organization
NIRSAL	Nigerian Incentive-Based Risk Sharing System for Agricultural Lending
SADC	Southern African Development Community
TPDC	Tanzania Petroleum Development Corporation
UEMOA	West African Economic and Monetary Union
UNECA	United Nations Economic Commission for Africa
USAID	United States Agency for International Development
WAFA	West African Fertilizer Association

Fertilizer types and ingredients, other

B	boron
CO_2	carbon dioxide
DAP	diammonium phosphate
MAP	monoammonium phosphate
N	nitrogen
NPK	nitrogen, phosphorus, potassium
P	phosphorus
S	sulfur
SOP	sulfate of potash
SSP	single superphosphate
TSP	triple superphosphate
Zn	zinc

Foreword

"If the high-yielding dwarf wheat and rice varieties are the catalyst that have ignited the Green Revolution, then chemical fertilizer is the fuel that has powered its forward thrust"

– excerpt from the 1970 Noble Peace Prize acceptance speech by the late Dr. Norman Borlaug

More than 50 years ago, the Asian Green Revolution enabled India and China to dramatically increase food production and made possible today's rapid economic development in these two countries. Africa with its rapidly increasing population and declining per capita food production needed to urgently reverse this food production trend.

Recognizing this need and responding to the call for a *uniquely African Green Revolution* by the late H.E. Kofi Annan, African Heads of State, under the auspicious leadership of the African Union, called for an African Fertilizer Summit (AFS), which was held in Abuja, Nigeria, in 2006 with the slogan "we must feed our soils to feed our people". Soon thereafter, the Alliance for a Green Revolution (AGRA) was established to fulfill the aspirations of Africans for their own Green Revolution.

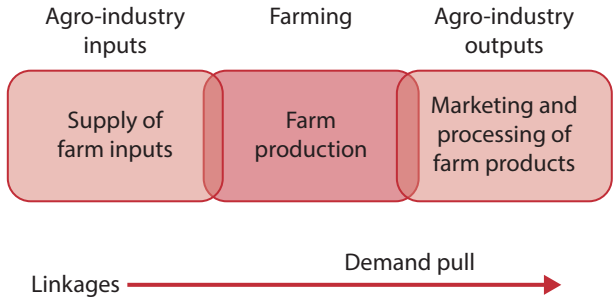
One of the important resolutions of the Africa Fertilizer Summit was to increase fertilizer consumption in Africa from 8 kg of nitrogen, phosphorus and potassium (NPK) per hectare (ha) in 2006 to 50 kg NPK/ha by 2015. In contrast, the average worldwide use rate in 2006 was 95 kg NPK/ha and in sub-Saharan Africa (SSA) it was 8 kg NPK/ha. This situation is confusing since Africa has more than 60% of world's phosphate resources and vast reserves of oil and gas to produce fertilizers. A large part fertilizer produced in Africa are exported to other regions. Africa accounts for only 5% of the global fertilizer consumption. Why is this?

There are various reasons, starting with high cost of fertilizers delivered to farmers—the majority being in land locked countries with poor road infrastructures. The cost of common fertilizers in land-locked countries is more than 80% of global market price. Further, the cost of borrowing by importers, retailers and agrodealers are high compared with other businesses because banks consider agriculture as a risky business.

Additionally, the lack of markets to sell excess produce is a disincentive for farmers to increase productivity. The overarching issue is a lack of conducive policies at both macro and micro levels. Input sector policy where the roles of private and public sectors are not well defined and in some cases input markets are dominated by a very few players and not competitive. And finally, input sector regulations to protect the farmers from unscrupulous dealers are ineffective.

Fertilizer is a derived demand. Fertilizers allow farmers to produce more and sell the surplus to make profit. Hence fertilizers cannot be seen in isolation but should be a part of agribusiness system where output market both in quantity and price increases demand for seed and fertilizers.

Agribusiness system linkages



African agricultural markets are in a nascent state of development, although some high-value export crop markets are well organized and extremely efficient. As a result, many African governments instead of leaving it to the market are using subsidies to reduce input costs and create demand for seeds and fertilizers. Subsidy models in Africa are termed as 'smart subsidy' because they are targeted to

either crops or certain group of farmers compared with the universal subsidy that are prevalent in Asian countries where every farmer is entitled to subsidized inputs. The 'smart subsidy' models have had limited impact, fraught by inefficiencies and corruption and in most cases the private sector have been crowded out. AGRA is helping many countries to overcome these deficiencies and the newer models are allowing the government and the private sector to play their rightful roles.

Fertilizers are critical for intensive agricultural systems, allowing more produce from existing land under cultivation without converting new land. In Africa this is particularly important because the current practice of 'slash and burn' system is encroaching on the wildlife habitats and fragile ecosystems. However, fertilizers particularly nitrogen fertilizers, if not managed properly, can contribute to air and water pollution. In fact, the plant uptake of applied nitrogen, often referred to as nitrogen use efficiency (NUE), ranges from 25% to 72%. The former is for China and India, two largest consumer of nitrogen fertilizers, and the latter is for sub-Saharan Africa where the fertilizer application rate averages around 17 kg NPK/ha. With this low application rate, the plants take up whatever is applied and extracts additional nutrients from soil reducing its fertility.

The current African agricultural system is characterized by low-yield and high-NUE. The longer-term strategy for Africa is to shift crop production directly from a low-yield, high-NUE status to a high-yield, high-NUE status. This shift will require leapfrogging over the historical evolution of agricultural management practices by employing technologies and management practices that promote high NUE before emissions reach alarming levels. Developing and/or acquiring and promoting such technologies, such as improved seed, balanced nutrient fertilizers along with soil amendments, and water management are needed and will require investments in research, technology transfer and capacity building. An example of such a technology is the sub-surface application of large granules of urea that doubles NUE particularly for flooded rice; farmers get 18%-20% more rice with nearly 30% less urea.

AGRA has emerged as the premier institution in Africa that is addressing most facets of agricultural intensification on the continent. With a holistic approach, AGRA's current focus areas include policy, agriculture enterprise, inputs, markets, process & storage and finance.

For those looking to expand their knowledge and understand the complexities of fertilizer sector development as a part of agricultural intensification in Africa, this book *'Feeding Africa's soils: Fertilizers to support Africa's agricultural transformation'* is a comprehensive and timely publication. This book is a part of a series of publications of AGRA, and further consolidates its position as a 'go to institution' for those engaged in transforming agriculture in Africa.

Dr Amit Roy
Former President and CEO
International Fertilizer Development Center

Preface

In sub-Saharan Africa, agriculture accounts for around 80% of the livelihoods, and 70% of the income of the poorest. But African soils present inherent difficulties for agriculture, and land-use practices during the past several decades have exacerbated those difficulties through nutrient mining by crops, leaching, and inadequate erosion control. Even though the quantities of inorganic fertilizer applied are increasing in the region, usage by farmers in most countries is still very low – and far below the commitment made at the 2006 Abuja Fertilizer Summit of 50 kg per ha. This leads to low crop yields – and Africa spends over $35 billion a year to import food. The changing climate and booming populations will add further demands on Africa's overworked soils.

Recent statistics shows that fertilizer use rate is now at 17 kg NPK/ha, nearly double the baseline of 8–9 kg/ha in 2006. The collective efforts across the continent are clearly creating positive results. We need to document these various experiences and innovations, and the lessons that can inform how to further improve fertilizer use as we promote Africa's agricultural transformation.

This book focuses on fertilizer systems in Africa. It takes advantage of AGRA's experience but also brings in expertise from likeminded partners such as UNECA, the African Development Bank, IFDC, IFA, IPNI, AFAP and the public and private sectors. It highlights the importance of fertilizer, taking stock of the collective efforts and the emerging opportunities to inform the scientific community, policymakers, donors and other technical partners. The objective is to increase awareness on the appropriate use of fertilizers and their potential to increase farm productivity and transform agriculture.

The book consists of 12 chapters grouped into four main parts.

Part 1 sets the scene: it describes the food-security situation in sub-Saharan Africa and shows how fertilizers can help bridge the yield gap. The chapters describe the types and uses of organic and inorganic fertilizers, review progress towards the goals set by the Abuja Summit, and depict the institutional landscape surrounding the fertilizer value chain.

Part 2 focuses on the fertilizer value chain, describing the organizations involved in production, importation, distribution, retail and consumption, as well as the organizations supporting the chain: finance, policy, regulation, research and advice. Individual chapters analyze the opportunities to improve the supply, distribution and demand for fertilizers.

Part 3 examines the enabling environment – institutional, financial and physical. Two chapters focus on policy – one on general policies affecting fertilizers, and the other on subsidies, the main instrument that governments in sub-Saharan Africa have used to manage and promote fertilizer use. The chapters also address the complex issue of finance at various stages in the value chain, and the judicious use of fertilizers to avoid environmental pollution.

Part 4, the synthesis, sums up the strides Africa has made in the fertilizer space, the key lessons learnt and emerging opportunities. Overall, for fertilizer use to make sense, the cereal yields of smallholder farmers need to reach 3 tonnes/ha and 7 tonnes/ha on existing farmland to be self-sufficient. African governments need to work with various partners, including donors, development agents and the private sector to exploit opportunities to make fertilizer use profitable for farmers.

With the African Continental Free Trade Area and the recent proliferation of fertilizer production and blending plants, African countries should take advantage of economies of scale, complementarity and vertical integration to achieve fertilizer security and self-sufficiency within the continent. This in turn should increase the productivity and income of small-scale farmers and help achieve food security for Africa.

We hope this book will be an important source of information and inspiration for our intended audience: public- and private-sector actors, donors, development partners, policymakers and stakeholders in agriculture.

Dr Agnes Kalibata
President, Alliance for a Green Revolution in Africa (AGRA)

Acknowledgements

The AGRA soil fertility and fertilizer systems team got the appetite to write this book after two other books were developed: *Investing in soils*, which documented case studies from the AGRA Soil Heath Program, and *Going beyond demos to transform African agriculture*, which describes the journey the program had undertaken. This time around, we decided to document the collective efforts in sub-Saharan Africa with regard to fertilizer, using the 2006 Abuja Fertilizer Declaration as the benchmark.

In early 2018, the idea started shaping up with commitment of authors from various organizations (UNECA, AFAP, the African Development Bank, IFDC, IFA, IPNI and the University of Embu). We sincerely thank the authors from these organizations who spent their valuable time to draft manuscripts, attend the two writeshops where they worked further on their drafts, and finalize their chapters based on the reviewers' comments. We are also grateful to the reviewers for their great work and their participation in the second writeshop, which contributed to improve the quality of the book.

This book is a great experience of integration – the approach at the center of AGRA's new strategy. Our colleagues from different units (Policy, State Capability, Program Development and Innovation, Knowledge Management) have been highly involved and coordinated some of the chapters. We feel greatly thankful to them. To our colleagues who efficiently supported us with logistics during the writeshops, we thank you very much. The book would not have been completed with such quality without our dedicated editor, Paul Mundy, with whom we worked tirelessly day and night, or the designer Conrad Mudibo, Ecomedia Limited. The writing of this book would have not been a reality without the great inspiration of our President, Dr Agnes Kalibata, who always emphasizes the need for AGRA to play a leading role in developing knowledge products that help change the lives of millions of smallholder farmers in Africa. Finally, we deeply thank those who have financially supported AGRA and specifically the fertilizer unit: the Bill and Melinda Gates Foundation, the Rockefeller Foundation, and the Partnership for Inclusive Agricultural Transformation in Africa.

Dr Rebbie Harawa
Head, Soil Fertility and Fertilizer Systems Unit
Alliance for a Green Revolution in Africa (AGRA)

In this book

This book focuses on increasing the use of inorganic fertilizers as the most realistic way to overcome soil nutrient deficits and increase food production in sub-Saharan Africa. But merely increasing fertilizer use is by no means enough. Fertilizer must be combined with organic amendments to maintain soil carbon, promote soil biology and diversity, and improve soil health. Good agricultural practices are needed, including alleviating soil constraints and using improved germplasm. Together, these are the fundamentals of integrated soil fertility management.

Many other components are also required: improved production techniques such as irrigation, soil and water conservation and mechanization, better pest and disease management, improved access to markets, better farmer organization, access to finance for inputs, and supportive policies, to name a few. The following chapters point out the relationships between increasing fertilizer use and these issues.

Part 1, The fertilizer scene in sub-Saharan Africa

Chapter 1, Overcoming food insecurity in sub-Saharan Africa, presents the fertilizer use status in Africa and describes the contributing factors.

Chapter 2, Types of fertilizers, focuses on organic and inorganic fertilizers as sources of nutrients. A wide range of fertilizers exists, and the range is growing with the advent of new types and blends.

Chapter 3, The Abuja Declaration on Fertilizers, reviews progress on the 12 resolutions that make up the 2006 Abuja Declaration.

Part 2, The fertilizer value chain

Chapter 4, The institutional landscape, examines the institutions that manage various aspects of fertilizers in sub-Saharan Africa: research and development, production, imports and distribution, financing, policy, and technical advisory services.

Chapter 5, Fertilizer supply, examines the supply side of the equation. How can local production of fertilizer be increased? How can imports be increased and made cheaper?

Chapter 6, Fertilizer distribution, focuses on getting fertilizers to farmers. How to bridge the gap between supply and demand? How to overcome inefficiencies in the distribution system?

Chapter 7, Stimulating demand, discusses problems relating to demand for fertilizers, and how to stimulate it.

Part 3, The enabling environment

Chapter 8, Fertilizer policy, turns to the government actions and policies that affect the supply and demand for fertilizers.

Chapter 9, Fertilizer subsidies, examines the role of subsidies in making fertilizers cheaper and more available to smallholders.

Chapter 10, Finance for fertilizers, looks at the sources of finance for fertilizer.

Chapter 11, Fertilizers and the environment, examines the impact of fertilizers on the soil, water and climate.

Part 4, Synthesis

Chapter 12, Lessons and prospects, summarizes the arguments in the book and makes some recommendations for the future directions of fertilizer in sub-Saharan Africa.

1 The fertilizer scene in sub-Saharan Africa

1. Overcoming food insecurity in sub-Saharan Africa

James Mutegi, Abdi Zeila, Abednego Kiwia and Shamie Zingore

Occupying the vast triangle between Pointe des Almadies in Senegal in the west, Ras Hafun in Somalia in the east, and Cape Agulhas in South Africa in the south, sub-Saharan Africa encompasses a huge range of landscapes: parched deserts, broad savannas, steaming rainforests, cool highlands, and high mountains. Despite its variety of climate and landforms, the region shares many characteristics. Most of its farms are smallholdings. Over 60% of the population is fully dependent on agriculture for food and employment. Most smallholders do not grow enough to feed themselves and their families, though they sometimes have a little surplus to sell. Governments and development organizations are trying to boost agricultural output in various ways: by promoting improved technologies such as seeds, fertilizer, irrigation and mechanization, by developing markets for inputs and outputs, by improving the availability of information and finance for input suppliers, farmers, traders and processors, and by revising policies governing all aspects of the input and crop value chains.

Food insecurity

The population in sub-Saharan Africa is expected to double from the current 1.2 to about 2.4 billion by 2050. But even at current population levels, the region still experiences food shortages. Crop yields are low as a result of low use of agricultural inputs and a dependency on rainfed agriculture. Crop failures are common, especially when the rains are late and in drought years. Hunger and malnutrition continue to haunt the region. Some 328 million people, or 27% of the continent's population, was classified as "severely food insecure" in 2016, a proportion four times higher than in any other part of the world (Wanzala-Mlobela and Groot 2013, Africa Hunger and Poverty Facts, 2018). One in three children under the age of five is stunted. Food insecurity south of the Sahara is on the rise: from 2014 to 2016, it rose by about 3% (FAO, 2017).

Goal two of the Sustainable Development Goals, developed in 2016, strives for "zero hunger" by 2030. Globally, there has been some progress towards this. Rapid economic growth and increased agricultural productivity over the past two decades have seen the number of undernourished people drop by almost half (UNDP, 2019). Many countries in Central and East Asia, Latin America and the Caribbean that used to experience acute food insecurity have all made huge progress in eradicating extreme hunger, thanks to the mass usage of fertilizers, improved seeds and irrigation practices.

In Africa too, the last decade has seen rapid growth in agriculture. But sub-Saharan agriculture performs poorly compared to other regions. Cereal harvests still average around 1 t/ha, far below the more than 3 t/ha achievable with fertilizer applications (Sileshi et al. 2019, Jama et al. 2017).

Yield gaps

Can sub-Saharan Africa feed itself? The potential exists: current yields of cereals and legumes are only 15–30% of the potential that could be achieved with improved inputs and management. In the Netherlands or USA, by contrast, actual yields are 80% of the potential. By 2050, the region will be self-sufficient on existing farmland only if appropriate soil fertility management technologies are adopted, and if the yield per hectare rises to about 7 t/ha, 80% of the potential. That translates to an annual yield increase of 130 kg/ha (Van Ittersum et al., 2016).

Why are yields low?

Many factors contribute to the low crop yields achieved in African smallholder farming:

Natural: Inherently low soil fertility, erratic and poorly distributed rainfall, pests and diseases keep crop yields low. Much of the continent is either too wet or too dry for farming. In much of the rest, seasonal rains are unreliable. Climate change is exacerbating these problems.

While some areas (mainly in the East African highlands) are very fertile, soils over much of the continent are fragile, lacking essential nutrients and organic matter. More than half of the cultivable land has old, highly weathered, acidic soils with high levels of iron and aluminum that require careful management if used for agriculture. A combination of heavy rains, a lack of soil cover and steep slopes results in severe loss of soil and nutrients through erosion. Erosion both removes nutrients that are crucial for crop growth and exposes the subsoil, which is harder for crop roots to penetrate.

Physical: Irrigation, which could compensate for unreliable rains, is scarce. Roads, alternative means of transport and other forms of infrastructure, are expensive, non-existent or in a poor state. Fertilizers, which could correct for low nutrient levels, are in short supply and or are expensive; farmers consequently use little of them. Relatively few improved varieties that resist pests and diseases and can produce high yields with the right management are available. In many parts of the continent, there is not enough green matter or livestock manure to compensate for nutrients taken up by crops.

Human: Farmers use traditional practices that, from experience, will produce enough to feed their families. They lack information access to improve their crop management. Extension services are weak, and other sources of information are scanty or unreliable. Farmers often understandably avoid taking risks. Without equipment such as tractors and threshers, many farming activities are labor-intensive, limiting the amount of land that can be cultivated and the production methods that can be used.

Financial: Farmers lack adequate capital to invest in inputs, equipment and improvements such as irrigation or liming. Banks see farming (especially by smallholders) as a credit risk due to a myriad of challenges associated with rainfed agriculture, so are unwilling to lend farmers money. Many farmers have no secure land tenure, so cannot use their land as collateral to secure credit. They thus lack the financial resources to invest in agricultural production.

Maize plants with severe zinc deficiency in the foreground, with healthier plants (planted at the same time) in the background.

Social: Few farmers are organized into groups that could help their members to improve production and marketing capabilities. Many of Africa's farmers are women, but for various reasons they are often not permitted to make key decisions about what types of crops to grow and what inputs to apply. They find it even harder than men to get reliable farming advice and credit. Policies often prevent farmers from taking advantage of opportunities to boost their yields.

Markets: Farmers lack access to structured markets for their crops, and therefore are not able to get good prices for their farm produce. The inaccessibility of remunerative markets discourages farmers from investing in inputs such as fertilizers and quality seeds that would boost their yields.

Among all these problems, a combination of inherent low soil fertility, poor management and low applications of both organic and inorganic fertilizers is perhaps the major reason for the huge gap between current and potential yields. Improving soil fertility is vital for changes such as improved crop varieties, better pest management and improved marketing to be effective (Sanchez, 2010, Tittonell and Giller 2013). It is crucial for reversing soil degradation and is the most direct path towards addressing continent-wide food insecurity

How do soils lose or gain nutrients?

Soils can lose nutrients in various ways: some natural and others human-induced (Table 1). Rainwater or irrigation water washes nutrients into streams or leach them downwards through the soil profile, often beyond the reach of the roots of annual crops. Nitrogen may be immobilized in some clays or by soil organisms, or converted into gaseous forms through volatilization and denitrification and lost to the atmosphere. Phosphorus and potassium may become fixed chemically in insoluble compounds or in forms not readily available for plant uptake.

Human-induced forms of nutrient loss include the export of nutrients through crop harvest, or the removal of residues for off-farm uses such as firewood and fodder. Such nutrient export can be significant. For example, the intensively cultivated highlands in East Africa lose an estimated 36 kg N, 5 kg P, and 25 kg K per hectare every year. That leads to further soil degradation as the amount of organic matter in the soil declines, exacerbating leaching and erosion (Henao and Baanante, 1999). Burning of vegetation induces gaseous losses of nutrients such as nitrogen and sulfur.

How can lost soil nutrients be replenished?

Nutrients may be replaced naturally or artificially. Among the natural processes, flooding can add dissolved nutrients and silt in the form of sediments to the soil. Vegetation and manure deposited by animals return nutrients to the soil as they decompose. Soil fauna contribute to litter decomposition, and microbial biomass represents a pool of readily available nutrients with a rapid turnover. Most of these natural processes work slowly.

Human-controlled ways of adding nutrients to the soil include farming systems that retain or recycle nutrients, the use of organic or inorganic fertilizers, irrigation (the water may contain dissolved nutrients) and liming (which changes the soil chemistry and makes nutrients more available to crops). These are discussed in detail in Chapter 2. Below we focus on the use of inorganic fertilizers in sub-Saharan Africa.

Fertilizer consumption

Application rates of inorganic fertilizer in sub-Saharan Africa have been rising over the last few decades, but are still low compared to other parts of the world (Figure 1). While the global average of application per hectare of cultivated land is 135 kg (where about 50% of the crop yield growth is attributed to fertilizer), in sub-Saharan Africa it stands at just 17 kg per hectare (AGRA, 2018). This is because smallholder farmers, who make up the majority of farmers in the region and who farm most of the land, apply little or no inorganic fertilizer. As a result, the soil undergoes continual nutrient mining (Smaling and Braun, 1996).

Applying a relatively small amount of mineral fertilizer can have a major impact on crop yields. Studies in Kenya, Uganda, Rwanda, Malawi and Ethiopia have shown that yields of maize, rice, cowpea and millet could be doubled through the judicious use of fertilizers (Sileshi et al. 2019, Jama et al. 2017). Furthermore, tests on maize at 940 demonstration sites in 47 districts across Malawi, Mozambique, Zambia and the southern highlands of Tanzania resulted in average maize yields without fertilizer of 1.6 t/ha; 2.8 t/ha where up to 50% of the recommended nitrogen rate was applied, and 4 t/ha where 100% or more of the recommended N rate was applied (Jama et al. 2017).

Table 1. How a soil may lose or gain nutrients

	Natural	Human-induced
Nutrient loss	Leaching Runoff Immobilization Denitrification Volatilization Fixation Erosion	Crop harvest Residue removal Burning of vegetation
Nutrient replacement	Silt and dust deposits, rainfall Litter decomposition, mineralization Microbial biomass turnover Manure Natural fallows Weathering of parent material	Fertilization Green manure Improved fallows Agroforestry

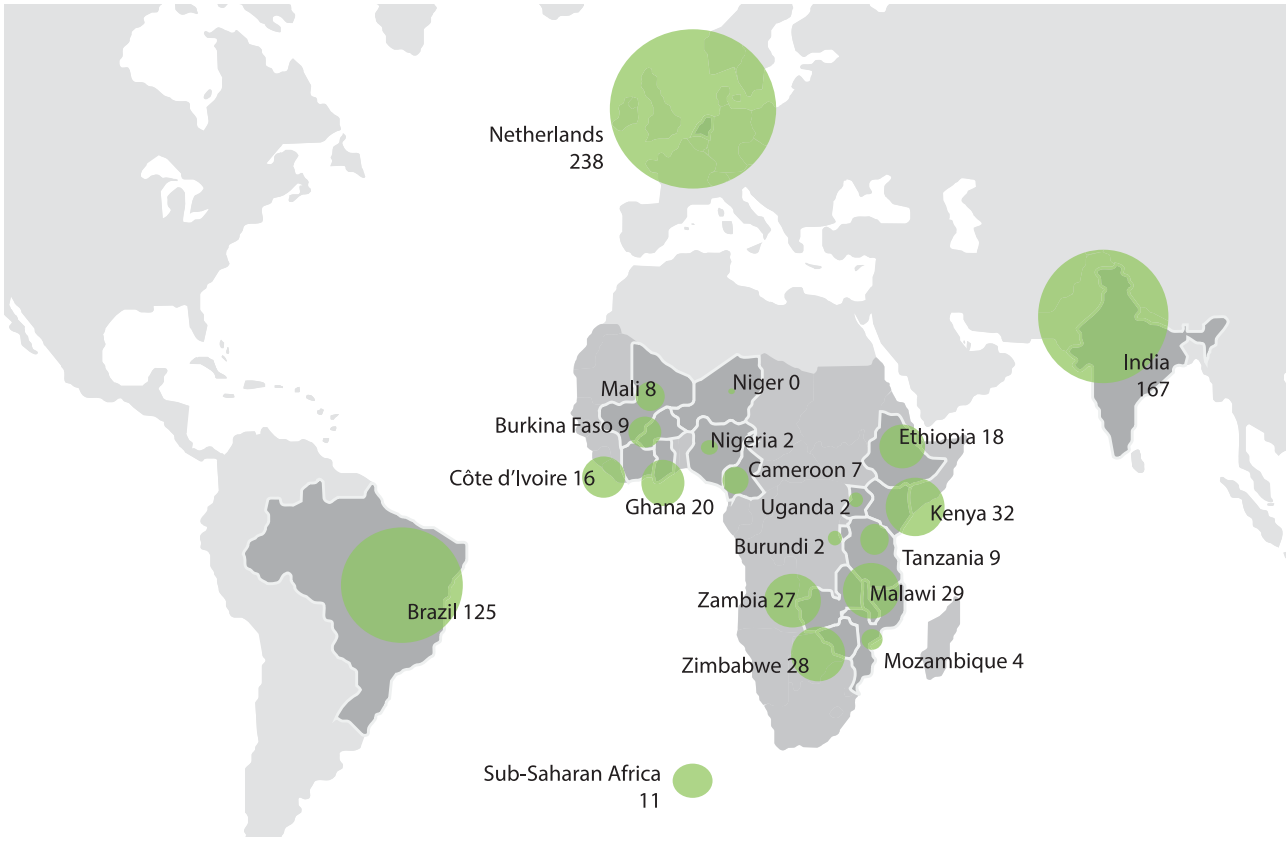


Figure 1. Fertilizer consumption (kg/ha arable land) in sub-Saharan Africa and selected other countries.
Data: FAOSTAT 2015

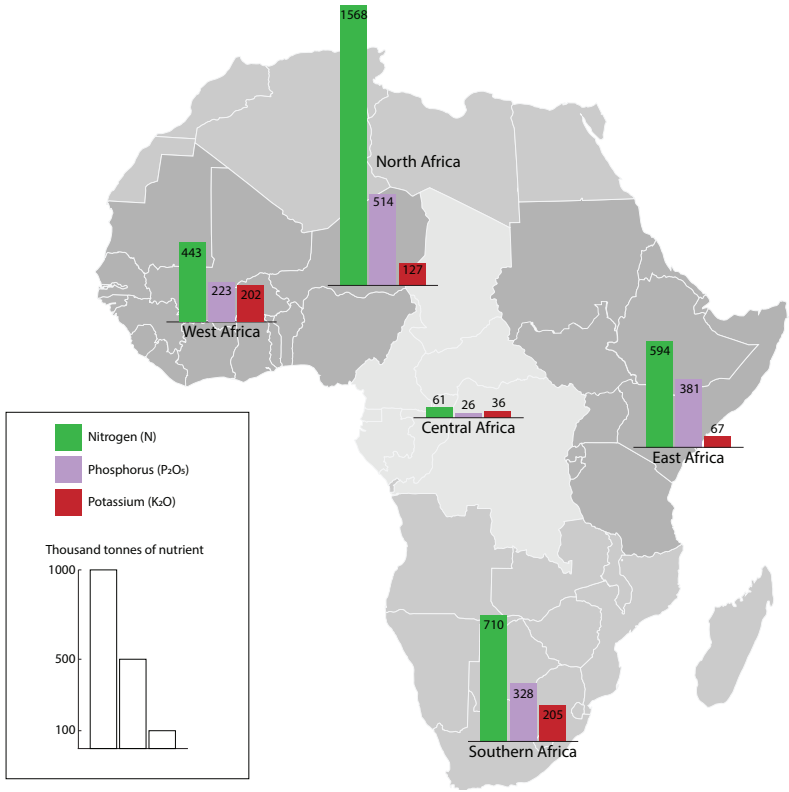


Figure 2. Fertilizer nutrient consumption in Africa, by region, 2015.

Data: FAOSTAT 2015

Reasons for low fertilizer applications

If fertilizer applications can boost yields so dramatically, why don't farmers apply them? As might be expected, the reasons are many and varied. We can divide them into demand and supply issues:

Demand

- **Some farmers may not know about fertilizers.** Some farmers, especially in remote areas, may not be aware of fertilizers and their benefits.
- **Some farmers have a negative perception about the role of inorganic fertilizers.** Some farmers have reservations about using inorganic fertilizers, which they consider not beneficial to the soil or to the crops they are applied on.
- **Some farmers cannot afford to buy fertilizers.** Sub-Saharan Africa has the highest farm-gate fertilizer prices in the world, while smallholder farmers have limited resources and cannot invest in fertilizers, especially before the planting season.
- **Some farmers might not want to invest in fertilizers.** They may not trust fertilizers or the people that promote or sell them. Erratic rainfall and unreliable output prices and markets may make investing in fertilizers a gamble. Farmers used to subsidized fertilizers may not be willing to pay the full price.
- **Fertilizers are ineffective.** On some acidic soils that contain toxic levels of aluminum, crops do not respond to fertilizer, unless lime is applied to address the soil acidity. Crops may not respond to unbalanced fertilizer applications, or they may require secondary or micronutrients. Such problems must be corrected first, before fertilizer applications can be effective. In some countries, fake or adulterated fertilizers are common, and improper handling and storage may result in nutrient losses and poor performance of the fertilizers when applied to crops.
- **Some farmers use fertilizers the wrong way.** Farmers may use inappropriate types and amounts of fertilizer, or apply them in the wrong way or at the wrong time. There are many reasons for this: the recommendations are wrong; the subsidized fertilizer arrives late; the right type of fertilizer is not available; the farmer lacks information and skills, or diverts the fertilizer to other, less suitable crops.

See **Chapter 7** for more on demand.

Supply

Many smallholders are unable to use more fertilizer because of poor supply and distribution systems.

- **Low local production.** Sub-Saharan Africa (unlike North Africa) produces relatively little fertilizer itself. Suitable deposits of phosphorus and potassium remain unexploited. Making nitrogen fertilizer requires vast amounts of energy and a suitable feedstock (usually natural gas). Some countries are short of both.

- **Limited imports.** As a result, the region must import most of the fertilizer it uses. Ports are few, crowded and inefficient. A lack of foreign exchange limits the amount that can be imported. Tariff and non-tariff barriers and a lack of harmonized standards impede trade among countries in the region.
- **Fragmented markets.** Markets in Africa are small, pushing up the cost of importing and distributing fertilizers.
- **Poor distribution systems.** Roads and railway infrastructure are underdeveloped and or in poor condition. Distances from ports to inland consumers are vast. Warehouses, wholesalers and retailers are scarce and poorly organized.

See **Chapter 5** for details on the supply of fertilizers.

International policy declarations

Government policy affects many of the issues above. The right policies could create a framework in which fertilizer use could rise, reducing soil degradation and increasing food output. Inappropriate policies, on the other hand, may hinder this or exacerbate the situation further.

Africa's leaders have long recognized both the importance of agriculture and its potential for stimulating development. Despite the low yields, agriculture is vital to most economies in this region. It accounts for an average of 15% of countries' gross national product, ranging from under 3% in Botswana and South Africa to over 50% in Chad. It generates over one-third of the region's export earnings and is the main source of livelihood for over 50% of the region's labor force (IMF 2012). It accounts for some 70% of the incomes of the poorest.

In Maputo in 2003, African heads of state endorsed the **Comprehensive African Agricultural Development Plan (CAADP)** as the blueprint for revitalizing the agricultural sector. This set a target of 6% growth per year in agricultural productivity by 2015 and called on governments to allocate at least 10% of their budgets to the agricultural sector. However, the Maputo Declaration did not address the food insecurity problem largely due to lack of adequate financial resources (Levin and Vimefall 2015, NEPAD 2016a).

In 2006, at a summit in Abuja, Nigeria, African leaders adopted a 12-point resolution, the **Abuja Declaration on Fertilizer** as part of efforts to achieve an African Green Revolution. They committed their countries to increasing fertilizer use from the current average of 8 kg of fertilizer per hectare in 2005 to 50 kg per hectare of cultivated land by 2015 (NEPAD 2009, 2016b).

The period since 2006 has seen progress. In 2014, the average continent-wide nitrogen fertilizer use was between 12 and 15 kg N per hectare (Sheahan and Barret 2014). Between 2005 and 2015, the highest proportional increase was in Ethiopia, where applications rose from 11 to 24 kg/ha (United Nations 2016). In the same period, Ghana's fertilizer use increased from 20 to 35 kg/ha, and that in Kenya went up from 33 to 44 kg/ha (United Nations 2016). In Kenya, there was a 56% increase in smallholder fertilizer use, and maize yields rose by 18% between 1997 and 2007, according to data from a nationwide household survey (United Nations 2016). **Chapter 3** reviews the progress made since the Abuja summit.

Nonetheless, much remains to be done. Fertilizer consumption in most countries in the region remains far short of the goal of 50 kg/ha (NEPAD 2016b). As a result, yields and production are still very low. **Chapter 8** has more on policy changes needed to increase fertilizer consumption and achieve the Maputo and Abuja goals.

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2. Types of fertilizers

James Mutegi, Abednego Kiwia and Shamie Zingore

Plants require 16 elements to grow and reproduce. Of these, 13 are taken up by plants only in mineral form from the soil or leaves. They must be supplied either from soil nutrient reserves or externally from fertilizers.

Elements derived from air and water. Most plant tissues consist of carbon (C), hydrogen (H) and oxygen (O), which the plants draw from the air (through photosynthesis in the leaves) and through their roots (in the form of air and water).

Primary nutrients or macronutrients. Plants need large amounts of nitrogen (N), phosphorus (P), and potassium (K). These nutrients are the ones most frequently supplied to plants through fertilizers.

Secondary nutrients. Calcium (Ca), magnesium (Mg), and sulfur (S) are required in smaller amounts than the primary nutrients.

Trace elements or micronutrients. The micronutrients consist of seven essential elements: boron (Bo), copper (Cu), chlorine (Cl), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn). These elements occur in very small amounts both in soils and plants, but their role is equally as important as the primary or secondary nutrients. In their absence, yield reductions of up to 20% are common. Micronutrients stimulate growth and yield, enhance the quality of the produce, boost resistance or tolerance to pests and diseases, and mitigate the impact of drought (Dimkpa and Bindraban, 2016).

There has been limited attention to micronutrients because of the long-term belief that African soils could supply enough of them, and because plants do not necessarily respond to micronutrient application.

Fertilizers are compounds applied to plants with the intention of promoting growth; they are usually applied either via the soil, for uptake by plant roots, or by foliar spraying, for uptake through the leaves. Fertilizers may be organic (composed of organic matter, i.e. carbon-based), or inorganic (containing simple, inorganic chemicals).

In a soil, one or more nutrients may be in short supply (or unavailable to plants because of the soil chemistry). These nutrients limit the growth and yield of crops. Applying fertilizer to add this nutrient (or changing the soil chemistry, for example by adding lime) can correct the limiting factor; the yields will then increase until the next limiting factor is encountered. A balance of all plant nutrients is required for a maximum yield and to avoid nutrient shortages.

Organic fertilizers

Organic fertilizers have their origin from living organisms. They cover a wide range of types from various sources, both agricultural and urban or industrial (Table 2). They supply a wide range of nutrients, including macro-, secondary and micronutrients.

Table 2. Types of organic fertilizers

Agriculture		Industrial, urban
Vegetative	**Transformed**	
Crop residues	Animal manure	Wastewater
Green manure	Liquid manure	Sewage sludge
Mulch	Vermicompost	Biosolids
Cover crops	Compost	Urban wastes
Nitrogen-fixing legumes	Biochar	Digestates
Fallows		Struvite
		Ammonium sulfate
		Milling waste (e.g., rice husks, maize hulls)
		Residues from agroindustry, food and other industries

Adapted from FAO (2018)

Farming systems that retain nutrients on the land, or that return nutrients to it, include multiple cropping, growing nitrogen-fixing legumes, sowing cover crops, conservation agriculture, crop rotations, fallowing, agroforestry and crop–livestock raising. Farmers can grow nitrogen-fixing legumes or plant (or retain) deep-rooted that trees tap nutrients that have leached beyond the reach of annual crops. The trees recycle nutrients to the topsoil through litter fall and decomposition and by releasing exudates from their roots. Allowing animals to graze on a field after harvest controls weeds and speeds the decomposition of plant material by converting it into manure.

Farmers can also make and apply various forms of organic fertilizer to the land.

- **Mulch** is plant material that is used to cover the soil; it protects the soil surface from the sun and the impact of raindrops, slows down the flow of water and allows it to percolate into the soil, retains moisture and slows evaporation, and decomposes gradually to add organic matter and nutrients to the soil. The mulch may come from the same field (for example, when crop residues are left on the field, or when weeds are cut and left in between the crop rows) or may be brought in from outside.
- **Compost** is organic matter that has decomposed in a pile or pit, and that is then applied to the soil. The material may come from various sources, including fields and gardens, field boundaries and roadsides, household waste, ash and livestock manure. Vermicompost is compost made with the help of earthworms.
- **Livestock manure** of various types (cattle, poultry, pigs…) may be collected from stables and pens. It may be in solid form, usually mixed with straw or other bedding (this is called farmyard manure), or be a semiliquid or liquid slurry.
- **Biochar** is charcoal used as a soil amendment. While charcoal is relatively stable in the soil (it can last thousands of years), it retains water and water-soluble nutrients, and promotes soil life.

Industrial and urban sources of organic fertilizers include various types of wastes, as well as byproducts from industrial processes such as brewing. Before using such wastes as fertilizer, it may be necessary to process them, for example to remove toxins, pathogens and unwanted materials such as plastics.

A few organic fertilizers are sold by agrodealers in bags. But most (such as manure, mulch and compost) are either produced on the farm where they are used, or close by, on neighboring farms. Products such as liquid manure may be transported in bulk and applied to the land using special equipment.

Roles

Organic fertilizers play vital roles in plant growth and soil environment. These include:

- **Nutrients.** Organic fertilizers deliver valuable amounts of N and K, as well as secondary and micronutrients that most common types of inorganic fertilizers like DAP, urea and CAN do not supply.
- **Soil life.** Application of organic fertilizers increases soil organic matter, which supports a vibrant, balanced below ground biodiversity that is crucial for soil biological processes like mineralization and soil physical characteristics like soil pore connectivity.
- **Water-holding capacity.** Organic matter boosts the soil's water-holding capacity. This is especially important in drier areas.
- **Soil protection.** Organic matter on the surface protects the soil from the impact of raindrops and prevents particles from being washed or blown away.
- **Modulating Fertilizer response.** Soils in which crops do not respond to fertilizer are widespread in sub-Saharan Africa. Organic fertilizers improve long-term soil properties and enhance soil ability to respond more quickly to addition of inorganic fertilizers.

Where sufficient organic fertilizers are available, it may be possible to boost yields significantly and on a large scale without the need for inorganic fertilizers.

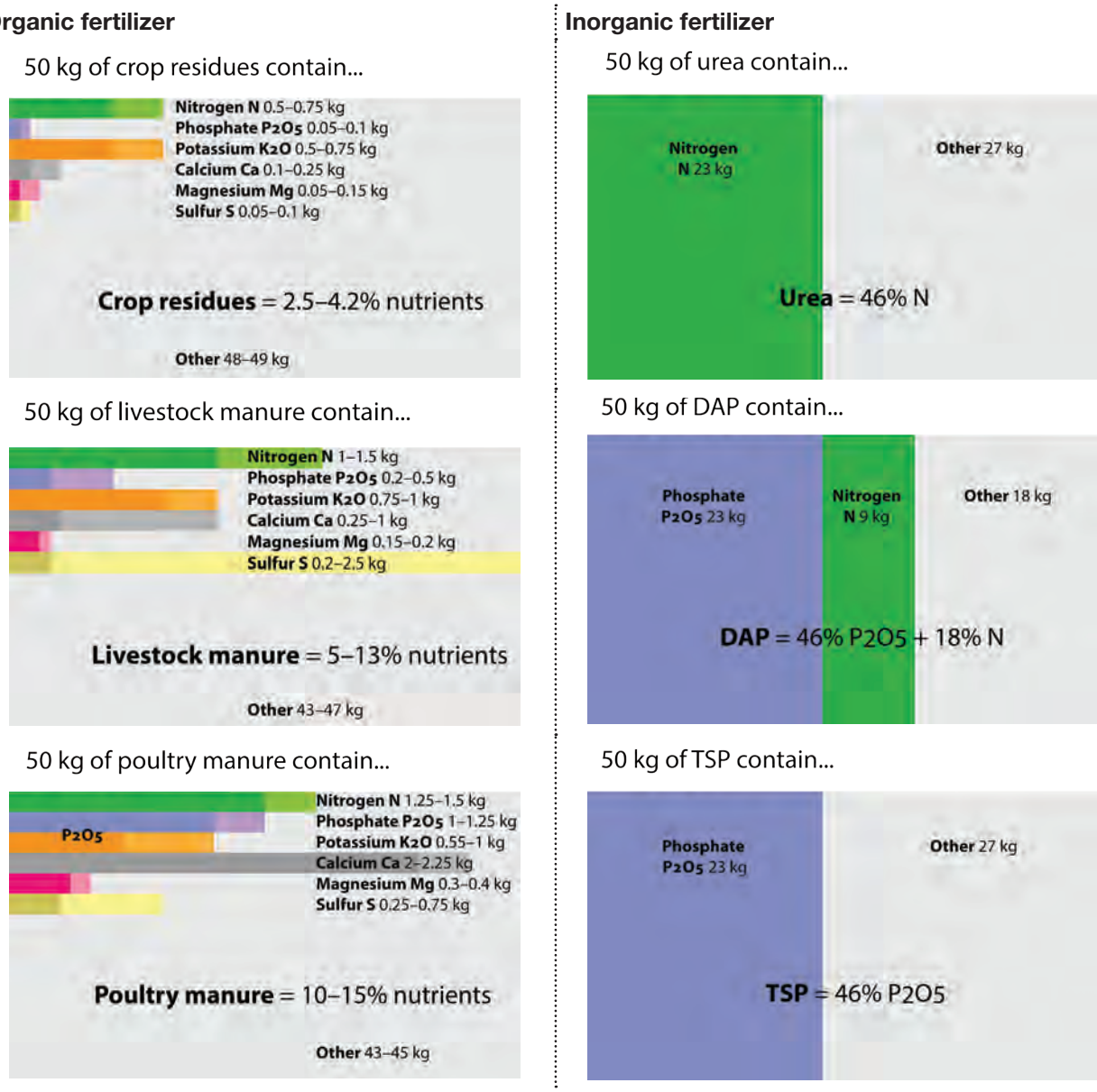
Quality

Soil organic matter is a significant source of nitrogen, phosphorus and sulfur for crops. The supply of these nutrients depends on a number of factors including:

- The quantity and frequency with which organic inputs are added to the soil.
- The quality of the organic resources.

The latter varies widely. Crop residues typically contain 10–15 g of nitrogen and a similar amount of potassium per kilogram, and also between 1 and 5 g of phosphorus, calcium, magnesium and sulfur. Livestock manure is much richer in nutrients (up to 30 g/kg of nitrogen and up to 20 g/kg of potassium, plus larger amounts of the other nutrients. Poultry manure is particularly rich in phosphorus. In Figure 3, these types of manure are shown on the left side. The grey boxes each represent 50 kg of manure; the colored bars show the amounts (and range) of each nutrient in this quantity of manure.

Nevertheless, crop residues and manure still contain relatively low levels of nutrients. Crop residues contain only up to 4.2% of the six primary and secondary nutrients (most of the rest is carbon, hydrogen and oxygen). Poultry manure, the richest type of manure, has only up to 15% nutrients. Compare that to the concentration of nutrients in a bag of urea, triple superphosphate (TSP) or diammonium phosphate (DAP) (right side of Figure 3). These inorganic fertilizers contain between 46 and 64% pure nutrient (Fairhurst, 2012).



Each grey box represents a 50 kg bag of fertilizer. The colored bars show how much nutrient it contains. TSP also contains 15% Ca (Calcium), providing an additional plant nutrient. Data adapted from Barker et al. 2000.

Figure 3. Nutrient contents of 50 kg of common organic and inorganic fertilizers

In practical terms, the farmers would have to apply huge amounts of organic fertilizers to replace all the nutrients lost in the form of harvests or through leaching, runoff, etc. For example, about 2 tonnes of high-quality legume biomass dry matter will provide less than 50 kg of nitrogen, enough to produce only about 1 tonne of maize grain. Transporting and applying large amounts of organic materials means extra labor – beyond the means of smallholders who rely on their own muscle power and animal traction. In many areas, such large quantities of biomass are anyway unavailable, especially since much is used as livestock feed, fuel or construction material.

Many smallholder farmers in sub-Saharan Africa rely on livestock manure to maintain the fertility of their soils. But this has some chemical limitations, and the quantity available may not be sufficient for it to significantly replenish soil nutrients. One cow produces only about 15 kg of nitrogen as manure each year, while a maize crop yielding about 3 t/ha requires about 100 kg of N/ha (Palm, 1995). Livestock production is mostly free range, making it impossible to gather manure. So for most farmers, switching to livestock manure is not a feasible option.

Organic + inorganic

Although it is well understood that organic fertilizers play an important role in improving soil fertility, they have limited potential to supply the required nutrients. This means that Africa cannot produce the food it needs by relying solely on organic fertilizer. Besides, organic and inorganic fertilizers provide complimentary benefits crucial for soil chemical, biological and physical properties. On many soils, the most effective approach is integrated soil fertility management (see below), which combines both organic and inorganic fertilizers.

Inorganic fertilizers

Mineral, or inorganic, fertilizer is a nutrient-rich product produced industrially by chemical processes or mineral extraction. Most commercially available fertilizers fall into this category. Table 3 summarizes some of the common fertilizer products used in Africa and across the world. Unlike organic fertilizers, inorganic fertilizers should have a clearly known nutrient concentration.

Fertilizer grade

The grade of a fertilizer refers to the guaranteed minimum percentage of the nutrients. It is expressed in the form N-P-K, where N is the nitrogen content, P refers to the quantity of phosphorus pentoxide (P_2O_5), and K in terms of potassium oxide (K_2O).

Diammonium phosphate (DAP) contains 18% N, 46% P_2O_5 and no potassium, so its grade is 18-46-0. Some other common examples are NPK 17-17-17, NPK 20-20-0, NPK 23-23-0 and NPK 15-15-15.

When discussing quantities of fertilizers, it is important to state whether one is referring to the quantity of the fertilizer product, or the quantity of nutrient. For comparative purposes, the quantity of nutrient should be used.

Straight and compound fertilizers

Each fertilizer product has its own advantages and disadvantages, which may depend on the local soil characteristics, crop or variety requirements, and economic conditions.

Straight fertilizers are those which supply mainly one primary nutrient: N, P or K.

Compound fertilizers are those with two or more primary macronutrients. These may be either complex fertilizers or blends (Figure 4).

Complex fertilizers. These are where each granule of the product contains the same nutrient content. They are made either through chemical reactions or by combining slurries of different types of fertilizers together and forming the resulting mix into granules.

Fertilizer blends. Dry blends are prepared by physically mixing granules of different types of fertilizer to achieve a specific nutrient composition. Two granules may therefore contain different nutrients. Blends can be tailor-made for particular crops and soil types (these are called **custom blends**). Farmers or dealers may mix their own blends; **bulk blends** are produced in blending plants. Blends are less costly to produce than compound fertilizers.

Multi-nutrient fertilizers are usually costlier than straight fertilizers in terms of dollars per kilogram of nutrient because of the manufacturing costs involved. But bulk blends are usually only slightly costlier than straight fertilizers because the blending process is not very expensive. Due to the cost implications, bulk blending is gaining popularity across sub-Saharan Africa, besides, blends are increasing production (Figure 5).

Blending allows many products to be produced for different crops and regions without having to make big changes in the production equipment. A common trend is to integrate micronutrients into the blend. The blends tend to segregate according to size and weight during shipping, handling and storage, so they may need to be remixed before application.

Table 3. Average nutrient content of some common fertilizer materials

Major fertilizers	Chemical formula	N	P (P_2O_5)	K (K_2O)	S	Physical state
Nitrogen (N)						
Ammonia	NH_3	82				Gas
Urea	$CO(NH_2)_2$	45–46				Solid
Ammonium sulfate	$(NH_4)_2SO_4$	21			24	Solid
Ammonium nitrate	NH_4NO_3	33–34.5				Solid
Calcium cyanimide, nitrolime	$CaCN_2$	20				Solid
Calcium ammonium nitrate, CAN	$5Ca(NO_3)_2$-$NH_4NO_3 \bullet 10H_2O$	20.4–27				Solid
Ammonium chloride	NH_4Cl	25				Solid
Urea ammonium nitrate, UAN	$CO(NH_2)_2$, NH_4NO_3	28–32				Liquid
Phosphate (P_2O_5)						
Nitrophosphate	H_2NO_6P	20	20			Solid
Ground rock phosphate	varies		20–40			Solid
Diammonium phosphate, DAP	$(NH_4)_2HPO_4$	18	46			Solid
Monoammonium phosphate, MAP	NH_6PO_4	11	52			Solid
Monopotassium phosphate, MKP	KH_2PO_4		52	34		Solid
Single superphosphate, SSP	$Ca(H_2PO_4)_2$, $(CaSO_4 \bullet 2H_2O)$		16–20		12	Solid
Triple superphosphate, TSP	$Ca(H_2PO_4)_2$		46			Solid
Potassium (K_2O equivalent)						
Potassium chloride, muriate of potash, MOP	KCl			55–61		Solid
Potassium sulfate, sulfate of potash, SOP	K_2SO_4			50	17–18	Solid
Potassium nitrate, nitrate of potash, saltpeter	KNO_3	13–14		44–46		Solid

Nutrient as % of the product. Adapted from IFA (2018).

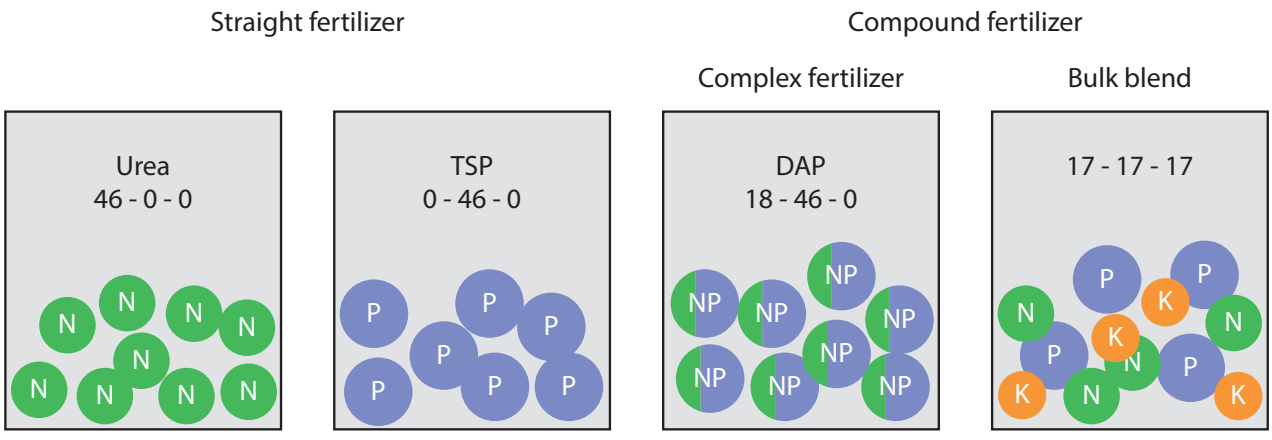


Figure 4. Straight and compound fertilizers

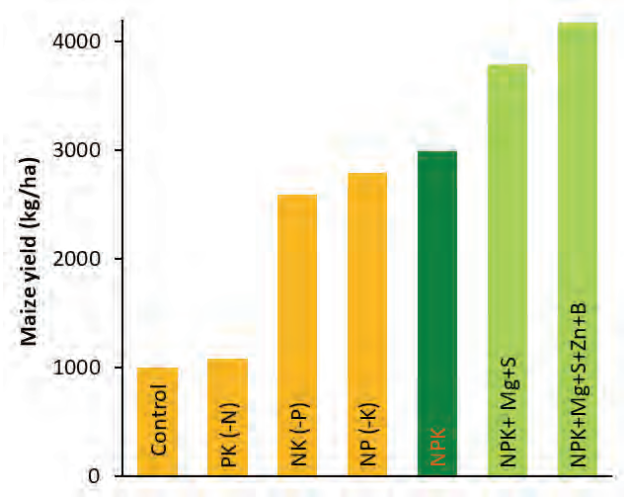


Figure 5. Maize Yield Response to Blended Fertilizers in Mozambique

Source: AGRA database

Soil conditioners

Soil conditioners are amendments that improve the physical, chemical or biological characteristics of the soil without necessarily supplying any nutrients. They may improve the soil structure by increasing aeration, boost its water-holding capacity, improve the drainage, loosen up compacted, hard pan and clay soils, and release locked up nutrients.

On certain soils (called "responsive" soils), crops respond well to nitrogen and phosphorus applications. On others, especially those that are degraded or so-called "non-responsive" soils, fertilizer application has little or no effect (Vanlauwe et al. 2011). The lack of response may result from the soil texture (too sandy or clayey), structure (hardpans), soil pH (too acid or alkaline), water (too wet or dry), salinity, lack of organic matter, toxic levels of iron or aluminum, etc. Such problems must be overcome for the soil to be productive.

Soil conditioners may be organic or inorganic (synthetic). Organic soil conditioners include green manure, compost, peat and crop residues. Inorganic conditioners include gypsum, lime and synthetic binding agents.

Lime

The acidic conditions of many African soils induce nutrient deficiency (of major nutrients) and or toxicity (of aluminum, manganese or iron). In Ethiopia, it is estimated that 45% of arable land is acidic; in Rwanda the figure is 40%.

The most effective way to reduce acidity is to apply agricultural lime, which increases the pH, decreases aluminum toxicity, and promotes the availability of nutrients for crops. At a soil pH close to 7 (neutral, neither acid nor basic), most soil nutrients are available for uptake by plants. Countries such as Brazil have reaped huge benefits by using lime to convert areas that were previously uncultivable because of acidity into highly productive agricultural land.

Agricultural lime is made by crushing limestone or chalk into a powder. Suitable rock outcrops are common throughout Africa, but many still remain unexplored. Lime is bulky and expensive to transport, and a lot is needed to raise the soil pH to an acceptable level. The cost of the product and the labor required to apply lime on fields make it prohibitive for many farmers to use.

Lime is best used in combination with fertilizers. Depending on the buffer capacity of the soil, a substantial amount of lime may be needed to correct soil acidity problems. Recommended amounts range from 0.5 to 2 tonnes/ha, which may require transporting vast amounts of bulky material from the limestone quarries to farmers' fields. Micro-applications of lime in the rooting zone of plants might be a more feasible option (One Acre Fund 2016).

Biostimulants and biofertilizers

Biostimulants

Biostimulants are natural substances that aim to promote crop growth and vigor, nutrient uptake, tolerance to stress, and yield (Vernieri et al. 2006, Roberts 2017). While they may improve efficiency, they definitely do not replace a balanced fertilizer program. The two most common biostimulants are seaweed and humic acid. Others include complex organic materials, beneficial chemical elements, inorganic salts, chitin and chitosan derivatives, anti-transpirants, and free amino acids and other N-containing substances.

Biofertilizers

Biofertilizers are similar to biostimulants, except that they consist of live microorganisms (Roberts 2017). Examples are arbuscular mycorrhizal fungi (AMF), and bacteria that fix nitrogen (such as *Azosporillum*), release plant growth promoting hormones (such as *Bacillus*) or make phosphorus soluble (such as *Pseudomonas*).

The most important biofertilizer is *Rhizobium*, a bacterium that form a symbiotic relationship with legumes. It is the activity of *Rhizobium* in root nodules that allows legumes to fix nitrogen from the air. This

means that legumes need lower applications of nitrogen fertilizer than other crops, or none at all.

Selecting fertilizer

Many factors affect crop yields. In sub-Saharan Africa, their cumulative effect produces a yield gap (the gap between the actual and the potential yield) of up to 80% for most common crops (Grassini et al 2017). We can identify at least five layers of complexity when selecting fertilizers.

First is the **physical characteristics** of the soil and the environment. The ideal fertilizer application will depend on the soil type (soil chemistry, structure and texture), the topography, the climate and weather.

A second layer concerns **farming systems**. The type and amount of fertilizer will depend on the type and variety of the crop, the previous and subsequent crops, the presence of intercrops, applications of organic matter, crop management techniques such as plowing, irrigation and drainage, the management of pests, diseases, weeds and crop residues, and the presence of livestock.

A third layer is **knowledge**. In sub-Saharan Africa, little is known about the soils, crops and farming conditions. Soil mapping is patchy at best; soil-testing services are scarce; research on crop responses to fertilizer on different soils is scanty; the institutions and staff to develop this information and provide it to farmers are inadequate.

Add to this a fourth layer: the **types and cost of fertilizers** that are available. Fertilizers come in a wide range of grades and forms; they are available at different locations, at different times (often too late to be of use in that season), and at different prices (often beyond the reach of smallholder farmers).

A fifth layer relates to the **farmers**. A few farmers in sub-Saharan Africa are well-educated, cultivate sizeable expanses of land close to input supplies and markets, have good marketing channels to sell their produce, and are well-off enough to be able to buy fertilizers and apply them with tractor-drawn equipment. But most are not so fortunate. They face much more challenging situations. They worry more about growing enough to feed their families than about how much profit they will make in the year.

Each of these factors varies over time and space. Soil types vary over short distances: one field may be short of nitrogen, while the adjacent one need potassium. Nutrient needs vary during the cropping season, and from one season to another. The weather is variable; so too are the climate and the farmer's ability to pay for inputs.

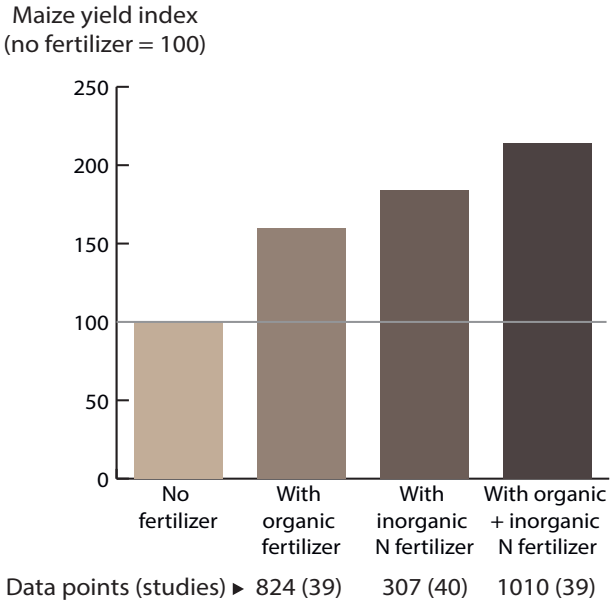
All this complexity and variability makes it impossible to provide specific fertilizer recommendations to the vast majority of Africa's farmers. Instead, advisory organizations must rely on the broad principles of soil chemistry, coupled with a limited array of soil maps and scattered tests, in the hope of providing farmers with enough information for them to make a reasonably informed decision about what fertilizers to apply.

Organic or inorganic?

A question that often arises is whether to promote just organic fertilizers, inorganic fertilizers, or a combination of the two. These sources of nutrients should be considered as complementary rather than as alternatives or mutually exclusive. Providing nutrients from several different sources has several advantages (FAO, 2018).

- **Inorganic fertilizers** generally make nutrients available to crops very quickly. They provide a known amount of nutrients and can be targeted to particular stages of the crop's growth cycle.
- **Organic fertilizers** typically release nutrients over a longer period. They improve the soil structure and texture, promote rooting conditions and microbial activity, help retain water and provide micronutrients.

Crops generally respond better to inorganic than to organic fertilizers alone, but yield most with a combination of the two types (Figure 5).



The studies used in the meta-analysis covered 104 experimental field sites in 12 countries (Benin, Burkina Faso, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Malawi, Nigeria, Tanzania, Togo, Zambia, and Zimbabwe) and represent the humid rainforest, the moist savanna, the dry savanna, the Sudano-Sahelian, and the Guinea savanna agroecological zones. No fertilizer is the baseline. Adapted from Chivenge et al. (2011).

Figure 6. Maize yield responses of organic, inorganic N and a combination of these.

How much fertilizer?

A crop needs a certain total amount of nutrients to grow, flourish, survive pests and disease attacks, and produce a high yield. It can get these nutrients from the soil or from fertilizers that farmers apply. Crop nutrient status can range from acute (strong) deficiency to strong toxicity (Figure 7).

Nutrient deficiency

The soil may contain too few nutrients of the right type, or the nutrients may be present but in an unavailable form for plants to take up due to various reasons (for example, if the soil is too acidic). If the farmer does not correct these problems, the crop's growth will be stunted (or it will not grow at all), and it may become susceptible to pests and diseases, leading to low yields. This is common on smallholdings throughout sub-Saharan Africa.

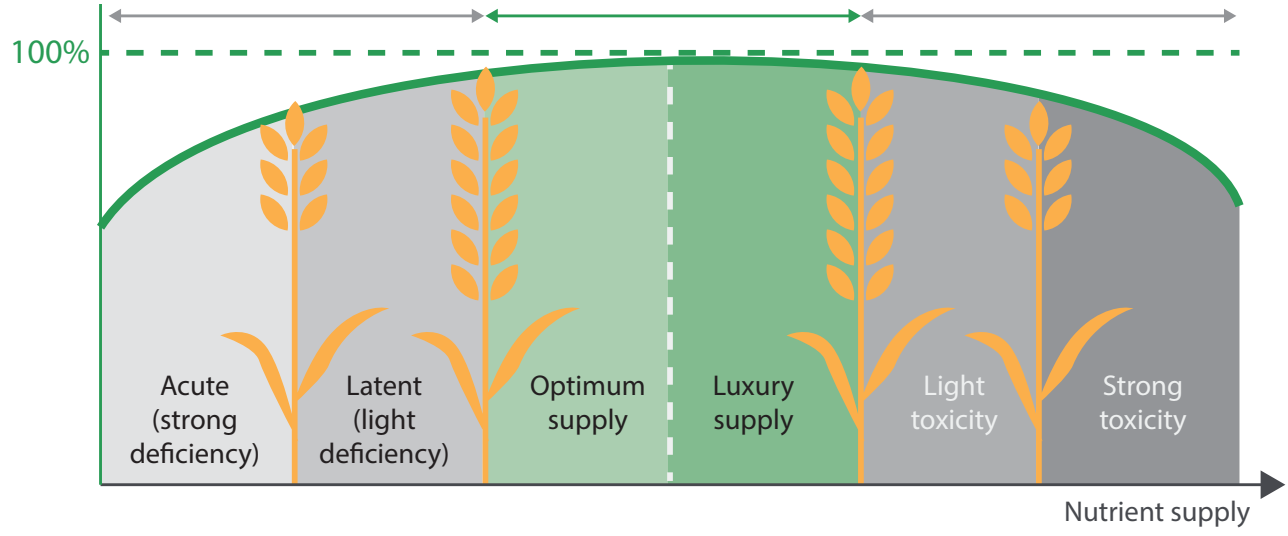
Maximum yield

The soil may already contain all the nutrients the crop needs. If not, the farmer can apply the correct amount of fertilizer to make up the deficiency. It may also be necessary to correct other problems, for example by applying lime to reduce the soil acidity. The more fertilizer applied, the higher the crop yield, up to a point when the yield increase plateaus and then starts to decline.

It is obviously not worthwhile applying more fertilizer than is needed to harvest the maximum yield. The most profitable amount will actually be something less than this because fertilizer is expensive: there is no point in applying an extra kilogram of fertilizer in order to gain only one extra kilogram of grain.

Nutritional toxicity

Too much of a nutrient may actually reduce yields. This is wasteful and expensive, and the excess nutrient may end up polluting streams and the groundwater. Nonetheless, nutrient toxicity is rare on smallholder farms in sub-Saharan Africa.



Adapted from Reetz (2016)

Figure 7. Effects of nutrients on wheat yield.

Balancing crop nutrient removal

Each crop absorbs a certain quantity of nutrients from the soil. Much of this is removed from the field when the farmer hauls away the harvest. Removing straw to feed animals, or stover to burn as fuel, further depletes the nutrients. Allowing livestock to graze on the stubble will take even more away if the animals are penned outside the field and deposit their dung there at night. Burning vegetation leads to loss of nutrients (see Chapter 1).

From a soil nutrient point of view, it is best to keep as much of the crop residue in the field as possible, and allow it to decompose there. Farmers should also return as much material to the soil as possible in the form of farmyard manure, crop wastes and compost.

Nevertheless, a certain amount of nutrients will always be lost in the form of the grain (or other forms of produce) removed from the field. The higher the yield, the more nutrients are removed. Some will also be lost through leaching, runoff, volatilization, etc. Balancing these lost nutrients by applying organic and inorganic fertilizers is vital to maintain fertility and yields. On degraded soils, it may be necessary to apply additional fertilizer to rebuild the soil fertility.

Soil testing

Farmers and agronomists can often tell what nutrients are lacking by inspecting the crop. Pale yellow leaves on maize often mean a lack of nitrogen; purple streaks reflect phosphorus deficiency, and drying along the tips and edges of older leaves portrays a lack of potassium. But by the time such symptoms appear, it may be too late to apply fertilizer. And merely observing symptoms does not tell the farmer how much of a particular nutrient, or of a combination of nutrients, to apply.

The answer is to take soil samples periodically from various parts of the field, and to have them analyzed in a laboratory. However, this is expensive, and few soil-testing services exist in sub-Saharan Africa. Various scanners and mobile labs have been developed for rapid testing and development of fertilizer recommendations for farmers (Box 1).

When to apply fertilizer?

Crops do not need all their nutrients in one big gulp. Rather, they need them more gradually, throughout the growing cycle, starting with a little when the plant is still a seedling, followed by a larger supply to

Box 1. Bringing soil testing to farmers

Various initiatives make it easy for farmers to analyze their soils and get recommendations of fertilizer applications. They include the following.

OCP School Lab

This is a mobile school that trains farmers on best agricultural practices, as well as a mobile laboratory that tests soils. An initiative of the Moroccan fertilizer producer OCP.

www.ocpgroup.ma/en/who-we-are/our-commitments/joint-construction-work-farmers

AgroCares

This firm produces a lab-in-a-box that uses spectrometers to analyze well as a nutrient scanner: a handheld device that measures nutrient levels and delivers results to a mobile phone.

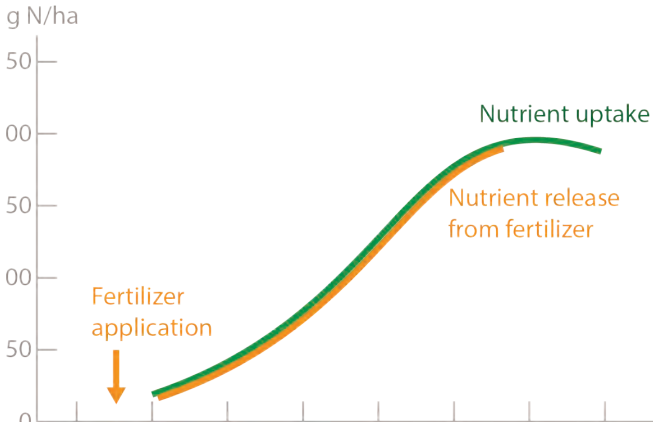
www.agrocares.com/en

SoilDoc

A portable soil-testing kit that produces fertilizer and organic input recommendations following the integrated soil fertility management approach. Developed by the Earth Institute at Columbia University, USA, in collaboration with AGRA.

agriculture.columbia.edu/projects/agriculture/soildoc/

support the rapid growth during vegetative phase, flowering and the formation of seeds, and then tailing off as the plant matures (Trenkel, 2010). Applying all the nutrients at one go at planting time would risk the nutrients being lost through leaching, in runoff, or through denitrification or volatilization. That would be an expensive venture and might pollute the groundwater and streams. The goal should be to make the nutrients available to the plant only when the plant actually needs them (Figure 8). Ideally, the nutrient release should exactly match the crop's uptake needs, and any excess nutrients should remain in the soil for the next crop.



Adapted from Lammel 2005

Figure 8. Making nutrients available when the crop needs them.

Farmers can achieve this in various ways: through split applications, through irrigation water or foliar sprays, and in the form of controlled-release, slow-release and stabilized fertilizers (Guodong et al., 2017).

Split applications

The most usual way is to divide the fertilizer into portions and apply a little at or near sowing time, followed by one or two bigger doses later, when the crops are growing vigorously. This is known as split application. For example, a farmer may apply 20 kg of nitrogen per hectare at planting and 80 kg as a top-dressing, making 100 kg N/ha in all.

However split applications have drawbacks:

- The farmer may miss the time window for applying the fertilizer, for example if it is raining or no labor is available at the time.
- Fertilizer left on the surface may volatilize easily, releasing the valuable nutrients into the air.
- Fertilizer droplets or granules may touch the leaves, stems or roots, scorching the plants.
- Splitting demands more labor for applying at different times over the crop growth cycle

Many smallholders, of course, cannot afford to buy enough fertilizer to make split application worthwhile. They generally apply the small amounts of fertilizer they do buy at or around sowing time. That gives the young plants a boost at the start of their growth cycle; later, when the root systems are more developed, the plants must rely on nutrients available naturally in the soil.

Water-soluble fertilizers

Water-soluble fertilizers may be applied in liquid form, either in irrigation water (fertigation) or as a foliar spray. Care should be taken when applying such products to avoid scorching the crop's leaves, stems or fruit.

Controlled-release fertilizers

Controlled-release fertilizers avoid the need for split applications. These types of fertilizers are becoming common in sub-Saharan Africa, especially for high-value crops. The fertilizer granules are coated with a membrane made from polymer, resin or plastic, that limits how quickly the nutrients inside are released. Different types and thicknesses of membranes make the nutrients available at different times to match the crop's needs.

Controlled-release fertilizer is also known as controlled-availability, delayed-release, metered-release, coated, or slow-acting fertilizer. Examples include polymer-coated urea, polymer-sulfur coated urea, and polymer coated NPK.

Slow-release fertilizers

Slow-release fertilizers also release their nutrient payload more gradually, due to the nature of the fertilizer material itself, but not because of a membrane cover (Guodong et al., 2017). Nitrogen compounds in the fertilizer are decomposed by microorganisms. The rate, pattern and duration of release are not controlled (Trenkel, 2010) because the microorganisms' activity depends on the soil temperature and moisture conditions. The nutrients may be released over a period ranging from 20 days to 18 months (Trenkel, 2010).

Synthetic slow-release fertilizers are made in factories; they often contain high levels of a single nutrient. For example, N-Sure, a liquid fertilizer made by Tessenderlo Kerly, is a slow-release fertilizer that

contains 28% nitrogen (28-0-0) (Cropvitality.com, undated.

Commercial organic fertilizers are made from organic materials such as poultry manure. The macronutrient concentrations are much lower than in synthetic fertilizers. For example, Sup'r Green, a composted chicken-manure fertilizer made by Stutzman Environmental Products, contains only 3-2-2 NPK (Stutzman, 2019). Unlike many synthetic fertilizers, organic products do contain micronutrients.

Organic fertilizers sourced locally, such as manure and compost, also release their nutrients slowly as they decompose in the soil. These contain relatively low levels of nutrients, but farmers can make them themselves or get them for free (if the labour and transport costs are ignored).

Stabilized fertilizers

Stabilized fertilizers are nitrogen-based fertilizers that contain or are treated with inhibitors that slow the process by which nitrogen is broken down by soil microorganisms. This stabilizes the main nitrogen forms in soils and reduces ammonia and nitrogen losses (GPCA, 2015). Nitrification inhibitors are compounds that delay the oxidation of ammonium ions and nitrites by slowing down bacterial activities in the soil. Urease inhibitors delay the transformation of the nitrogen in urea to ammonium hydroxide and ammonium. Slowing down these processes retains the nitrogen in the soil, where plants can take it up.

Global market

The combined global market for water-soluble, slow and controlled release or stabilized fertilizers was around 40 million tonnes of product (17 million tonnes of nutrients) in 2016. This was about 9% of global fertilizer nutrient consumption (RAMS & Co., 2017). More than half (57%) of this total was used in South Asia (where India requires urea to be coated with neem) and East Asia (16%) and North America (15%). Africa accounts for less than 1% of the total.

How to apply fertilizer?

Fertilizer can be applied in many ways. Large-scale farmers use sophisticated machinery which deliver measured doses of fertilizer to the crop root zone. Small-scale farmers are more likely to broadcast the fertilizer by walking through the field, throwing handfuls of granules as they go. This makes it difficult to apply the correct dose, and coverage may be uneven, leading to patchy growth of the crop. More effective, but also more work, to place the fertilizer in a band between the crop rows, then cover it with soil. An alternative is to place bottlecapsful of fertilizer in planting holes near the seed, but this is very labor-intensive.

Applying the fertilizer in the right place permits the crop's roots to reach it easily. That means placing it close to the seeds or plants, but not in contact with them (as this may scorch them). Most types of fertilizers should be buried in the root zone to prevent the nutrients from being lost to the atmosphere.

4R nutrient stewardship

The four previous sections (what type of fertilizer, how much, when and how to apply) reflect the "4Rs" of nutrient stewardship. The four Rs are the right source of fertilizer, to be applied at the right rate, at the right time, in the right place (IPNI 2012).

- **Right source.** This means applying the appropriate type of fertilizer for the soil type and crop grown.

Table 4. Examples of key principles and associated practices that form the basis of 4R nutrient stewardship

	Right source	Right rate	Right time	Right place
Principles	Ensure balanced supply of nutrients Suit soil properties	Assess nutrient supply from all sources Assess plant demand	Assess dynamics of crop uptake and soil supply	Recognize crop rooting patterns Manage spatial variability
Practical choices	Mineral fertilizer Livestock manure Compost Crop residue	Test soils for nutrients Calculate economics Balance crop removal	Pre-plant At planting Vegetative phase At flowering At fruiting	Broadcast Band Spot

Source: Zingore et al. (2014).

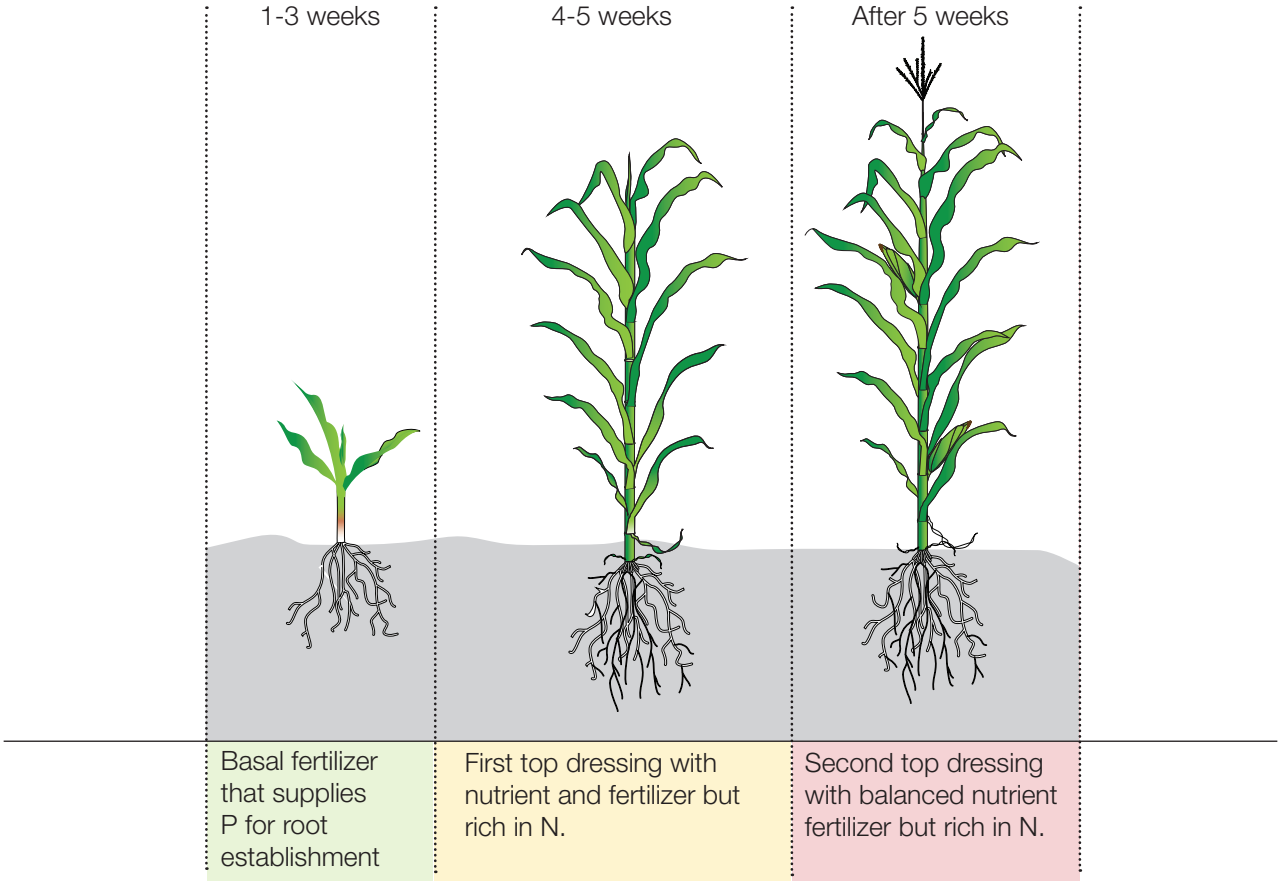


Figure 9. An example of fertilizer application in maize. Illustration: Ecomedia

- **Right rate.** This means applying the correct amount of fertilizer to fulfil the crop's needs, maintain soil fertility, and avoid wastage and pollution.
- **Right time.** The fertilizer must be available when the crop needs it.
- **Right place.** The fertilizer must be applied where crops can use it. Usually this means in the root zone.

The 4Rs are all necessary to manage plant nutrition properly in order to sustainably increase the productivity of crops. It is not enough just to apply a certain amount of fertilizer (the right rate); the choice of fertilizer and the timing and placement are equally important. This will improve fertilizer efficiency, avoid wastage, and improve yields.

Table 4 gives some examples of the principles embodied in each of the 4Rs, and the practical choices they imply.

Integrated soil fertility management

While inorganic fertilizer use has the potential to restore the soil nutrients, reversing soil degradation requires an integrated soil fertility management approach. This is the application of locally adapted soil fertility management practices to optimize the agronomic efficiency of fertilizer and organic inputs in crop production (Vanlauwe et al., 2010). Integrated soil fertility management necessarily includes locally appropriate fertilizers and organic resources in combination with improved seeds. The inorganic fertilizer provides most of the nutrients; the organic fertilizer increases soil organic matter status and improves the soil structure and buffering capacity of the soil. Using both inorganic and organic fertilizers improves the efficiency of both nutrient and water use. For example, in an experiment in Zimbabwe, supplementing 5 t/ha of manure with 40 kg N/ha in the form of inorganic fertilizer produced higher yields than using manure alone (Murwira et al. 2002). This approach is especially of interest to smallholders who cannot afford to buy enough fertilizers to apply at the recommended rates.

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3. The Abuja Declaration on Fertilizers

Maria Wanzala-Mlobela, Marie Claire Kalihangabo, Mahamadou Nassirou Ba, Diallo Asseta and Killian Banda

Severe soil degradation and nutrient depletion have led to low yields for A frican smallholders. Africa's governments recognize the seriousness of the problem. In 2006, an Africa Fertilizer Summit was held in Abuja, Nigeria, to address the crisis. Attended by 1,100 key actors from the agricultural sector, the summit was convened by the African Union's New Partnership for Africa's Development (NEPAD), and implemented by International Fertilizer Development Center (IFDC). Other partners included the government of Nigeria, the Rockefeller Foundation, other donors, foundations, banks, and the private sector.

The resulting **Abuja Declaration on Fertilizer for an African Green Revolution** includes 12 resolutions aimed at policy and market development interventions to raise fertilizer consumption through concerted efforts by key stakeholders.

- The **first resolution** calls for African governments to increase their countries' fertilizer consumption from 8 kilograms per hectare (the average in 2006) to 50 kilograms by 2015.
- The next **10 resolutions** identify interventions to be made at the country and regional levels to help achieve this target.
- The **12th resolution** calls for the African Union and NEPAD to monitor and report on progress each year.

Since 2006, more than 30 African countries and four regional economic communities have developed strategies that lay out their vision, goals and objectives for their fertilizer sectors. Initiatives by the regional economic communities have focused on the harmonization of legal and regulatory frameworks on fertilizer trade and production policies within and among the regional communities. The African Union has made other bold commitments for agricultural growth across the continent, including measures to improve farmers' access to fertilizers and other yield-enhancing inputs. The year 2014 was declared "Year of Agriculture and Food Security," and in June of that year the **Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods** pledged to double agricultural productivity, end hunger and halve poverty by 2025.

This chapter tracks progress in the implementation of above resolutions. For each resolution, the rationale and its current status are discussed. The chapter concludes with an overwiew of the situation and a look to a possible future "Abuja II" summit.

Resolution 1: Increase fertilizer use

> […] increase the level of use of fertilizer from the current average of 8 kilograms per hectare to an average of at least 50 kilograms per hectare by 2015

Rationale. Increasing fertilizer use is necessary to achieve an African Green Revolution to end hunger.

Status. Fertilizer markets in Africa are still small. Between 1980 and 1995, fertilizer consumption in Africa fluctuated around 1 million tonnes of nutrients per year. However, after 1995 consumption began to climb substantially, reaching almost 1.6 million tonnes of nutrients in 2010 (Wanzala-Mlobela and Groot 2013). Despite this, sub-Saharan Africa accounted for just 1.6% of the world's nitrogen consumption in 2016, 2% of the phosphate, and 1.5% of the potassium. The equivalent figures for North Africa were respectively 1.7%, 1.5% and 0.5% (UNECA and AFFM, 2018; FAO, 2017).

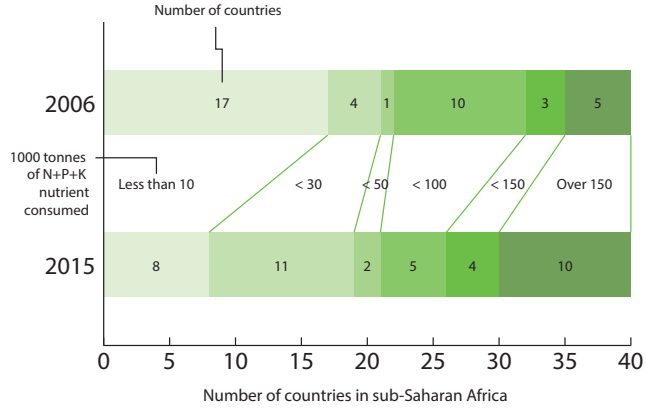
Of the 40 countries in sub-Saharan Africa for which fertilizer consumption statistics are available, only ten consumed more than 150,000 tonnes of nutrients in 2015 (up from five in 2005), while 19 countries used less than 30,000 tonnes (Figure 9). Four countries together account for half of consumption: South Africa (18%), Ethiopia (13%), Nigeria (11%) and Kenya (7%).

According to the International Fertilizer Association, fertilizer supply on the African continent has increased by more than 8% per year over the last decade, and stood at 3.7 million tonnes of nutrients in 2016. Fertilizer markets in some countries are growing rapidly: six countries in East Africa increased their total consumption by 31% between 2015 (1.9 million tonnes) and 2017 (2.5 million) (Figure 9). Six countries in West Africa doubled their consumption between 2015 (1.78 million tonnes) and 2017 (3.47 million) (Figure 10). FAO forecasts that Africa's demand for nitrogen will grow by 3.78% a year between 2015 and 2020 – equivalent to a 20% increase over this period. Demand for phosphate is forecasted to grow by 2.8% a year (15% by 2020), and potassium by 6.76% a year (39% by 2020) (UNECA and AFFM 2018).

The number of countries who consume less than 10,000 tonnes of NPK nutrients decreased from 17 in 2006 to 8 in 2015, while the number of those in the range 30,000-50,000 tonnes increased from 5 to 13. Likewise, the number of those who consume 150,000 tonnes or more increased from 8 to 14. However, the number for the range 100,000-149,000 tonnes decreased from 10 to 5 (Figure 10).

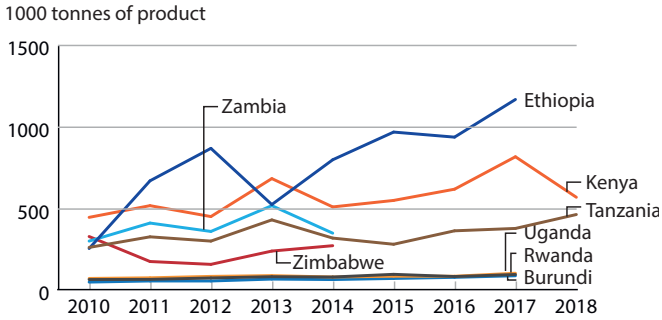
Average fertilizer consumption rates have followed a steady upward trend, increasing from around 8 kg per hectare in 2006 to 15 kg/ha in 2017. They vary widely, with some countries at levels that rival those in developed countries (Figure 11). In Ethiopia, for example, application rates increased from 11 to 18 kg/ha, in Angola from 4 to 8 kg/ha, in Cameroon from 9 to 14 kg/ha, and Zambia from 26 to 56 kg/ha (World Bank 2015).

Nevertheless, current levels are still insufficient to replace the soil nutrients that are mined each year through crop production. A study by IFDC (2014b) found that the total fertilizer consumption in sub-Saharan Africa will need to increase substantially to meet the growth targets set in national agricultural development plans (Table 5).



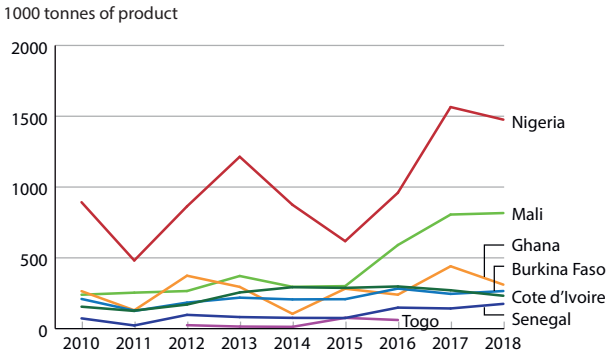
Source: Prepared by authors using FAO data.

Figure 10. Number of countries and quantity of fertilizer consumed per hectare in sub-Saharan Africa, 2006 and 2015



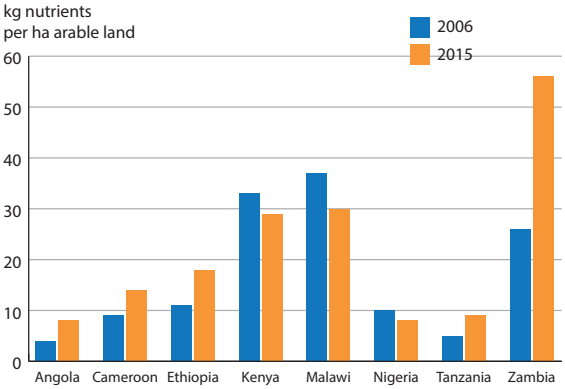
Apparent consumption = Production + imports – exports. Source: www.AfricaFertilizer.org (2019).

Figure 11. Fertilizer consumption in eight Eastern and Southern African countries, 2010–18



Apparent consumption = Production + imports – exports.
Source: www.AfricaFertilizer.org (2019).

Figure 12. Fertilizer consumption in seven West African countries, 2010–18



Source: Prepared by authors from World Bank data

Figure 13. Fertilizer consumption (nutrients NPK) per hectare of arable land for selected countries, 2006 and 2015.

Resolution 2: Harmonize policies for quality control and cut taxes

[…] take appropriate measures to reduce the cost of fertilizer procurement at national and regional levels especially through the harmonization of policies and regulations to ensure duty- and tax-free movement across regions, and the development of capacity for quality control. As an immediate measure, we recommend the elimination of taxes and tariffs on fertilizer and on fertilizer raw materials.

Rationale. Harmonizing policies and regulations across regions and eliminating taxes and tariffs would create regional markets for fertilizer. That would make fertilizer more easily available, reduce prices, and ensure higher quality and more choice for farmers.

National fertilizer policy and regulatory frameworks

Fertilizer policies and regulations. Most countries in sub-Saharan Africa have a wide range of policy and regulatory strategies, but two-thirds of them do not have coherent fertilizer policies. Rather, what passes as policies consists of ad-hoc pronouncements that change frequently, and decrees that depend on who is in charge of the ministry of agriculture or the government as a whole. These countries do not have standalone Fertilizer Acts and the accompanying regulations; the fertilizer industry is instead regulated by decrees.

The remaining one-third of the region's countries have formal fertilizer policies or regulations to guide the

Table 5. Estimated fertilizer required to meet countries' agricultural growth targets

Country	Actual consumption*	Target consumption	Increase factor required to reach target
	Thousand tonnes of product per year		
Liberia	3	28	9.3
Uganda	50	311	6.2
Mozambique	52	225	4.4
Rwanda	35	144	4.1
Senegal	87	239	2.7
Ethiopia	551	1,200	2.2
Mali	250	550	2.2
Ghana	200	400	2.0
Malawi	297	600	2.0
Tanzania	263	528	2.0
Zambia	250	498	2.0
Kenya	489	910	1.9

*Assessments conducted between 2012 and 2015. Source: Feed the Future (2015)

sector. But many of these policies and regulations also cover other agrochemicals (pesticides and veterinary products, as in Uganda and Rwanda), are outdated (as in Zambia and Zimbabwe), do not encompass new products or production technologies, and do not recognize or support the many changes that have occurred in the fertilizer industry (Feed the Future, 2015).

However, some countries including Ghana, Mali and Tanzania, have decided to address the entire process of policy and regulation formulation. Hence, these countries have put regulations in place and implementation is underway. Other countries, including Burkina Faso, Kenya, Mozambique, Rwanda, Uganda and Zambia, have updated or completely rewritten their Fertilizer Acts and regulations. Malawi, Niger and Nigeria have also embarked on this process.

Fertilizer standards. A number of countries have fertilizer standards which are spelled out in their respective fertilizer acts and policies. For example, fertilizer standards in Kenya are prescribed in the Standards Act, while in Ethiopia, Tanzania and Uganda, they are specified in the fertilizer legislation. In many cases, fertilizer standards are different from one country to another, even in the same regional economic community where harmonization is supposed to be implemented.

Market entry. Most countries have allowed the private sector to enter the fertilizer market. Some, such as South Africa, permit private companies to introduce new agricultural technologies with minimum interference. Others have extended input regulations which allow limited private participation in the sector. In Ethiopia and Rwanda for example, the fertilizer industry used to be controlled exclusively by government. However, this has changed. Over the last 15 years, a small but growing number of countries have eased regulations to facilitate the private introduction of new agricultural technology. The landscape has changed.

Registration of new products. Regulations on the registration of new products vary. In general, the requirements to register a new fertilizer are demanding and may hinder the private sector. Most countries have a list of fertilizer products that traders are allowed to sell based on official ideas about crop responses to different nutrients.

New fertilizers must go through a registration process – even if they are globally traded products where the properties and risks are well known. The registration process typically includes 3 years of tests on trial plots at a prescribed number of trial sites. Any alteration in the fertilizer composition, formulation, type, quantity or quality triggers a new registration process. This means that even small changes in the formulation of a registered fertilizer can require a completely new registration.

This may particularly affect blends, which may have to undergo the registration process even if there is only a change in formulation of nutrients already known in the market (NML and AFAP 2016). However, a few countries do allow for the introduction of blends based on the approval of their components.

Import procedures. According to the United Nations Economic Commission for Africa, trade document requirements are particularly burdensome by international standards, with an average of eight documents needed for exports and nine for imports. In Africa, import procedures (including document preparations, customs, terminal handling and inland transport) take 22% longer than export ones, and are 25% costlier relative to export procedures (UNECA and AFFM 2018).

Quality control. In many countries, enforcing quality controls is the task of the ministry of agriculture and supporting institutions. Although it is common to inspect shipments and take samples at the port of arrival, the capacity to inspect consignments after the fertilizer leaves the port is extremely low. Most staff are inadequately trained and equipped.

A major bottleneck arises with the accreditation of testing laboratories. Many countries have established such laboratories, often for a range of services, including fertilizer, soil and animal-feeds testing, but they are not internationally accredited. This reduces the authority of the test findings and limits the power the regulatory authority has over firms that are trading in non-compliant products.

Regional harmonization

This section is based on Ariga et al. (2017).

Common Market for Eastern and Southern Africa (COMESA). In 2014 COMESA and its specialist agency, the Alliance for Commodity Trade in Eastern and Southern Africa (ACTESA), launched a joint program on Fertilizer Policy and Regulatory Harmonization. This is a six-phase program being implemented in partnership with the African Fertilizer and Agribusiness Partnership (AFAP). The program aims to promote the regional harmonization of fertilizer policies, laws and

regulations to facilitate the fertilizer trade. The second phase was completed in 2014; the third phase got underway in 2015. The main activities have been a review of fertilizer policies and regulations in 15 COMESA member states. A framework document delineating the key policy areas and recommendations in national fertilizer policy and harmonization has been developed.

Economic Community of West African States (ECOWAS). In December 2012, ECOWAS adopted regulations for the harmonization of fertilizer policies, laws and regulations, known as ECOWAS Fertilizer Regulation C/REG.13/12/12. This set up the West African Committee for Fertilizer Control to facilitate the implementation of the regulation by member states. It works with national fertilizer-development bodies to fast-track implementation by member states. In addition, in June 2018 a tripartite agreement was signed between ECOWAS, CILSS (the Permanent Interstate Committee for Drought Control in the Sahel) and UEMOA (the West African Economic and Monetary Union), whose memberships overlap with that of ECOWAS. This recognized the leadership of ECOWAS in the region in terms of policies; through it, ECOWAS regulations apply to two CILSS member states, Chad and Mauritania. As of July 2017, a status report developed by IFDC shows that 12 countries in ECOWAS (plus Chad), have published the regional regulation in their newspapers, and 13 have developed at least an implementing regulation. Only Ghana and Mali have put in place a registration system; in Burkina Faso the system development is ongoing.

East African Community (EAC). The EAC adopted the Harmonized Regulatory Framework and Procedures for Fertilizer Market in September 2014.

A meeting of experts from EAC partner states to review existing policies, standards, legislation, and regulations on fertilizers in the EAC was held in December 2015. Its main objective was to facilitate the development of EAC harmonized fertilizer policies, legislation and regulatory frameworks. The main output was a comprehensive guideline with proposals and recommendations on how harmonization of fertilizer policies and regulatory framework should be undertaken in the EAC. The EAC is now developing legislation to govern the fertilizer sector, to be passed by the East African Legislative Assembly.

Southern African Development Community (SADC). In 2004, the SADC took several initiatives to harmonize the agriculture sector. The SADC Food, Agriculture and Natural Resources Directorate started developing a harmonized system for labelling fertilizers. However, little progress has been made on these efforts recently.

Trade policy

About one-third of countries in sub-Saharan Africa still have import duties on fertilizers; half still have taxes on fertilizers. Even where there is no value-added tax on fertilizers themselves, countries still charge other taxes and impose burdensome regulations.

- Services such as transport and materials used to import fertilizers are subject to value-added tax.
- In Uganda, importers are charged withholding tax. This raises the prices that farmers pay because it takes time for the importer to get refunded, resulting in extra costs.
- Zambia requires all trade be conducted in kwachas, the local currency, exposing importers to the risk of currency fluctuations.
- Frequent inspections or roadside checks by police or customs officials delay transport and are an opportunity for corrupt practices.
- Weighbridges intended to enforce axle-load regulations and weights often create logjams and further increase costs.

Such limitations raise costs and slow down deliveries. Table 6 summarizes some tariff and non-tariff barriers in selected countries (Ariga and Wanzala 2014).

Table 6. Summary of tariff and non-tariff barriers to trade

Barriers	Countries
Tariff, levies and taxes	Mozambique (2.5% customs duty officially waived but still imposed) Kenya (refundable VAT) Ghana, Mali (shipper and council levies) Uganda (withholding tax)
Non-tariff restrictions (documentation requirements, border delays, currency restrictions, etc.)	Kenya, Uganda, Zambia, Tanzania, Malawi
Differential quality standards	All countries

Source: Ariga and Wanzala (2014)

In summary, major progress has been made in the last decade. Some countries have developed a complete regulatory framework and enforcement is under implementation. However, other countries are still at the early stage. Within the regional economic communities, some progress has been made in terms of harmonization. ECOWAS is the most advanced. COMESA is at an advanced stage compared to SADC or EAC.

More details on policy and regulation harmonization are provided in Chapter 8.

Resolution 3: Improve agrodealer networks

> […] improve farmers' access to fertilizers, by developing and scaling up input dealers' and community-based networks across rural areas. The Private Sector and Development Partners are hereby requested to support such actions.

Rationale: Smallholders have limited transport and need to be able to buy fertilizers close to where they live. They need fertilizers suited to their soils and crops, in quantities that they can afford, and at the right time. Agrodealers must be knowledgeable so they can advise their customers on the best products and application rates and methods.

Status: Several development agencies and donors have implemented programs to promote agrodealers. These have focused on:

- Training in marketing, business skills and technical knowledge of fertilizer products.
- Establishing business linkages between agrodealers, distributors, and banks.
- Providing credit guarantees for agrodealers, and loans and matching grants to increase storage capacity.
- Improving access to market information.

More than one-third of African countries now have over 500 agrodealers distributed in rural areas. Farmers now have to travel less far to buy fertilizer: an average of around 10 km. Entrepreneurial agrodealers have become change agents: they have developed into professional service providers who have taken over part of the role of the government extension services.

Nevertheless, in most countries there are still too few agrodealers to serve the needs of smallholders, and the farmers still have to travel too far – over 20 km, and sometimes over 100 km – to buy a bag of fertilizer. The price of a 50 kg bag at the farm gate remains relatively high. Concurrently, a lack of competition among traders allows them to charge high margins; bottlenecks in the supply chain push up prices further. The majority of agrodealers lack marketing and business skills and access to credit, limiting their ability to increase their inventory or improve the services they provide to farmers.

Chapter 6 provides details on fertilizer distribution.

Resolution 4: Improve access for women and youth

> […] address the fertilizer needs of farmers, especially women, and to develop and strengthen the capacity of youth, farmers' associations, civil society organizations, and the private sector.

Rationale. The Abuja Declaration recognizes the need to build the capacity of women farmers and young entrepreneurs to access fertilizer: women constitute the majority of smallholder farmers in Africa and account for over half the agricultural labor force. The CAADP target of enhanced agricultural growth and food security cannot be achieved without taking gender issues into account. In addition, farming may become an occupation of the elderly as young people move out of agriculture in search of more lucrative employment opportunities.

Status. Governments and their development partners have tried to reach out to women's groups and farmers in various ways: through workshops, seminars and training. Activities have often tried to target female participants and have worked closely with producer and trade associations. But relatively few efforts have focused specifically on younger

people, and little investment has been made in building the capacity of women. Some initiatives have made a special effort to include women and youth. For example, the African Union's African Youth Decade of 2009–2018 was a framework for multi-sectoral and multi-dimensional engagement of stakeholders to support the African Youth Charter (African Union 2011).

The African Development Bank's Feed Africa Strategy 2016–2025 includes two enablers on youth and women. The $350-million Enable Youth Program aims to empower youth in agribusiness development; it operates in 12 countries and aims to create 10,000 youth "agri-preneur" enterprises by 2025. Affirmative Finance Action for Women in Africa supports women entrepreneurship and ensures that women-owned businesses can access finance. Under this program, the Bank is also setting up a $300 million risk-sharing facility for women-owned and -led small and medium enterprises to unlock access to commercial financing for women (African Development Bank 2016).

Resolution 5. Provide subsidies for smallholders

Improve farmers' access to fertilizer by granting targeted fertilizer subsidies, with special attention to poor farmers.

Rationale. Smallholders cannot afford the high cost of fertilizers. By offering targeted and smart subsidies, governments hope to boost small farmers' production and incomes.

Status. About two-thirds of the countries in sub-Saharan Africa have fertilizer subsidy programs, and around 40% of the fertilizer consumed in the region is subsidized to varying degrees. Over the last 18 years, ten African countries spent a total of roughly $1 billion annually on subsidy programs, amounting to 28.6% of their public expenditures on agriculture (Gilbert et al. 2011, Wanzala-Mlobela and Groot 2013). Subsidies range from non-targeted or universal programs with complete government control of all aspects, to targeted programs with importation and distribution carried out exclusively by the private sector. Input vouchers are the most commonly used mechanism to deliver targeted fertilizer subsidies.

Both targeted and non-targeted subsidy programs have faced many challenges. On average, both types of programs halve the price of fertilizers for farmers. But non-targeted subsidies also disrupt the development of fertilizer markets.

- If the government controls the import and distribution, farmers are not directly linked to the market; they have no opportunity to establish business relationships with agrodealers that might continue after the program ends.
- Farmers who would normally purchase fertilizers at the market price naturally opt for the subsidized product, so reducing the customer base for private dealers.
- Delays in budget approvals and tendering mean that subsidized fertilizer often arrives late. Farmers apply the fertilizer late, reducing the yield benefit, and discouraging them from investing in fertilizers the next season, even at subsidized prices.

In the case of targeted subsidies, farmers enjoy a reduced price. Poor farmers who could not afford fertilizer can get the subsidized product. That might expand the customer base for private dealers. Targeted subsidies also typically provide farmers with complementary services, such as access to microfinance and extension services.

Targeted subsidies may also have disadvantages. They may be linked to political events (such as elections) or particular interests (such as to promote the ruling party). Some governments still hand out paper vouchers, which may be cumbersome to redeem, especially where farmers have to track down extension agents and district officials to get their signatures. This system raises transaction costs and creates opportunities for rent-seeking: farmers may opt to sell a voucher instead of using it, and retailers may refuse to accept the voucher if they fear it will be hard to redeem. Because of this, many countries are switching to e-vouchers. These are easier to administer and reduce the possibility of diversion, but they are more expensive to introduce, and farmers need access to a cellphone to receive and redeem the e-voucher.

Subsidies have often succeeded in introducing fertilizer to first-time users. They also tend to increase the overall availability of fertilizers nationally. But there is not enough evidence to show their impact on yields and production (Wanzala-Mlobela and Groot, 2013). To be effective and relevant, subsidies must be "smart" (electronic vouchers granted to particular farmers, who can redeem them with the agrodealer of their choice), and time-bound (granted only for a particular period, after which the subsidy program ends).

More details about subsidy programs are provided in Chapter 9.

Resolution 6. Improve infrastructure and output marketing

[…] accelerate investment in infrastructure, particularly transport, fiscal incentives, strengthening farmers' organizations, and other measures to improve output market incentives.

Rationale. Better infrastructure (both "hard" infrastructure such as roads and bridges, and "soft" infrastructure such as standards and financial institutions) and greater incentives to link farmers to inputs and output markets would increase the availability of fertilizers and reduce the price farmers have to pay for them. They would make it easier and cheaper for farmers to sell their output. That would increase demand for fertilizers and encourage farmers to improve their production methods so they can grow more to sell.

Status. Progress has been limited as port and transport infrastructure are still inadequate, resulting in high freight rates and port charges. Limited port capacity forces shipping firms to use small vessels (15,000 tonnes). Ports are congested and poorly maintained; cranes, bagging equipment and warehousing capacity are inadequate. Delays in berthing and low discharge rates generate high demurrage costs (charges for the slow unloading of a vessel). A vessel through Mombasa requires an average of 23 days from its arrival to leaving port (Ariga and Wanzala 2014). As a result, the prices of fertilizer just outside the port gate are typically between $100 and $200 per tonne higher than the free-on-board prices on the world market (IFDC, 2018).

Inland haulage is expensive due to the poor condition of road and rail networks. Although rail transport is potentially 30% cheaper than moving fertilizers by road, it is unreliable. Railway lines are not well-maintained, there are not enough covered wagons, and container-loading equipment is inadequate. Consequently, importers and agrodealers prefer to use trucks – even though they are more costly due to long distances between ports and farming areas, poor road conditions, frequent stops for inspection and weighing, a lack of competition among trucking companies, and taxes and levies. It may take more than 30 days for a consignment of fertilizer landed at Mombasa to reach Nairobi or other locations in East Africa (Ariga and Wanzala 2014). Other important ports handling fertilizer include Port Harcourt in Nigeria, Douala in Cameroon, Lomé in Togo, and Durban in South Africa.

A UNECA and AFFM fertilizer study (2018) notes that in many countries, including Ghana, Kenya, Nigeria, Tanzania and Zambia, main highways and inter-city roads are well maintained, but feeder roads linking the main cities to other areas are largely in poor condition. This adds to transportation costs and makes inputs costly. Improvements in rural road networks are essential to promote social and agricultural development and to reduce transaction costs (Reardon et al. 2001). Poor infrastructure also explains the limited development and delays in the completion of fertilizer production projects (Huang Jikun et al. 2017).

The same study states that, in terms of fertilizer output marketing, non-tariff barriers tend to raise costs of doing business. Efforts to facilitate trade in the region must also aim to address these barriers. In West Africa, Hoppe and Aidoo (2012) argue that Ghanaian manufacturers believe the key barriers to increasing trade with Nigeria include substantial informal payments and delays–regardless of whether documentation is complete–transit charges, and requirements for product registration. Compliance with standards remains burdensome, and there have been reports of standards being used as disguised protectionist measures. Products need to be registered before landing in Nigeria, and certification and registration require that a product sample has to be imported into Nigeria. This in turn requires an additional import license prior to the importation of the sample. Products can then only be registered by a locally registered subsidiary company or a local partner, who needs to have a power of attorney from the producing company, which can create legal problems.

Resolution 7. Improve financing for input suppliers

[…] establish national financing facilities for input suppliers to accelerate access to credit at the local and national level, with specific attention to women.

Rationale. Finance is a major constraint to the supply chain. Importers are constrained by high finance charges associated with letters of credit and interest which limit their ability to purchase big consignments of fertilizer. As a result, they procure relatively small quantities (sometimes as little as 1000 tonnes), which limits their bargaining power and increases prices. Distributors face similar financial constraints. They also lack the storage capacity to buy fertilizers when prices are low and stock it close to where it is needed. That raises the risk of late deliveries or unsold stocks.

Status. Some government and donors have launched initiatives to reduce the risk to financial institutions of lending to importers and agrodealers. These initiatives include a credit guarantee scheme launched by AGRA and Standard Bank, and the African Fertilizer and Agribusiness Partnership (AFAP). AFAP provides financial assistance to international, regional and local agribusinesses in return for contributions towards developing the fertilizer market, boosting the responsible use of fertilizer, and improving its availability to smallholders. AFAP assistance may come in the form of credit guarantees or (in limited instances) matching investment grants and technical training.

However, the number and size of such initiatives is inadequate relative to the need. There is a major need for risk-sharing mechanisms to bridge the financing gap in the fertilizer value chain and to link commercial banks with importers and agrodealers so as to spread the risk among banks, fertilizer market actors and donors. Banks would then be more willing to extend credit to importers and agrodealers, and to reduce their interest rates and collateral requirements.

There are inadequate innovative approaches to improve the availability of finance at each stage in the fertilizer supply chain. A lack of credit constrains the availability of fertilizer. Farmers find it difficult to get funds to invest in better technology. The same is true for traders who want to import, distribute or blend fertilizers. Potential solutions range from group lending, credit guarantee funds (which require private–public partnerships), and agribusiness partnership contracts (such as those that AFAP is piloting).

According to the 2018 UNECA and AFFM study, most developing countries, lack sufficient financial instruments and risk-mitigating tools to increase access to credit. Where such financial services exist, agrodealers and farmers are often excluded as a result of the risks that banks associate with agricultural activities (IFDC 2014a). The sources of finance for importers, distributors and agrodealers include governments, development banks, commercial banks and value chain financing.

Chapter 10 provides more information on financing for fertilizers.

Resolution 8. Establish regional procurement and distribution facilities

> […] request the establishment of Regional Fertilizer Procurement and Distribution Facilities with the support of the African Development Bank, the Economic Commission for Africa, the Regional Economic Communities and the Regional Development Banks, through strategic public-private partnerships […].

Rationale. The procurement and distribution of fertilizers is a common problem throughout sub-Saharan Africa, especially for landlocked countries. Regional facilities would make it easier to obtain fertilizer and make it available where it is needed.

Status. No regional procurement and distribution facilities have so far been established. Various regional economic communities have discussed the issue and decided on the way forward.

Eastern and Southern Africa. In 2009, the African Union Commission's Department of Rural Economy and Agriculture, the African Development Bank and AGRA convened a workshop on regional procurement for East and Southern Africa. The meeting was attended by ministers of agriculture and finance from Ethiopia, Kenya, Rwanda, Tanzania, Uganda and Zambia, and a representative from Mozambique. The meeting agreed that regional procurement is a short-term solution to the problem of fertilizer supply; the long-term solution is regional fertilizer production. The meeting agreed that the Bank would launch a pilot project on regional procurement for Rwanda, Tanzania and Uganda in the same year. But it was not possible to source funds and agree on key priorities, so this project has not yet been financed.

ECOWAS is exploring the possibility to promote and/or establish regional fertilizer procurement and distribution facilities. ECOWAS and UEMOA (the West African Economic and Monetary Union) plan to establish a regional procurement center (UEMOA 2013). Niger is implementing bulk procurement, and Burkina Faso has developed a mechanism and is raising funds to do so. Some member states have decided to focus on capacitating farmer and trader organizations to aggregate their demand for fertilizers and negotiate with fertilizer manufacturers and importers.

Resolution 9. Promote fertilizer production and trade

[…] promote national/regional fertilizer production and intra-regional fertilizer trade to capture a bigger market and take advantage of economies of scale through appropriate measures such as tax incentives and infrastructure development […]

Rationale. Sub-Saharan Africa currently has to import most of the fertilizer it uses. Producing fertilizer closer to home and increasing trade within the region could increase the quantity of product available, reduce delivery times and dependency on foreign suppliers, cut import bills and save foreign exchange.

Status:[1] The production of fertilizer in Africa is concentrated among six countries: Algeria, Egypt, Morocco, Nigeria, South Africa and Tunisia. These countries have a developed fertilizer industry and also a high level of fertilizer use. A significant increase in production capacity of nitrogen and phosphorus is expected in the near future (Prud'homme 2016). These additions are expected mainly in Egypt and Nigeria for urea (about 8 million tonnes) and Algeria, Egypt, Morocco and Tunisia for phosphates (about 5 million tonnes).

There are several on-going fertilizer development projects in sub-Saharan Africa (UNECA and AFFM 2018). These include the following (Harrison 2018):

- **Republic of Congo:** Elemental Minerals (2 million tonnes a year of MOP).
- **Eritrea:** Danakil Potash (0.8 million tonnes of potassium).
- **Ethiopia:** Yara (0.6 million tonnes of SOP) and OCP/CIC (2.3 million tonnes of NPS and 1.5 million tonnes of urea).
- **Gabon:** Gabon Govt/Olam (1.4 million tonnes of urea).
- **Mozambique:** Yara (1.3 million tonnes of urea).
- **Nigeria:** Dangote (2.8 million tonnes of urea).
- **Senegal:** Indorama (0.8 and 1.5 million tonnes of phosphates).
- **Tanzania:** TPDC/Ferrostal/Topsoe/Fauji (3.9 million tonnes of urea).
- **Uganda:** Sukulu mines (0.3 million tonnes of SSP/TSP).

1 This section benefited from comments and data provided by Grace Chilande, project coordinator and fertilizer market specialist, IFDC

Cross-border intra-regional fertilizer trade is limited by poor infrastructure, weak economic integration, and ocassional conflicts (UNECA and AFFM 2018). Delays in crossing borders can be attributed to inefficient custom procedures, bothersome roadblocks and checks, and burdensome documentary requirements. These raise transaction costs and hence the costs of doing business. Some cross-border trade of fertilizers takes place informally, for example from Malawi to Zambia and Mozambique. Rwanda exports about 2,000 tonnes of fertilizer a year to Burundi. Burkina Faso imports 95 percent of its fertilizer requirement from international traders and from bordering countries such as Mali and Cote d'Ivoire (Wanzala-Mlobela et al. 2013).

Resolution 10. Improve access to other inputs and services

[…] improve farmer access to quality seeds, irrigation facilities, extension services, market information, and soil nutrient testing and mapping to facilitate effective and efficient use of inorganic and organic fertilizers, while paying attention to the environment.

Rationale. To be effective, fertilizers must be accompanied by other inputs and services. Farmers must be able to sow crop varieties that can respond better to fertilizer applications. Some crops require (or can benefit greatly from) irrigation. Farmers also need to know what type of fertilizer to use on which crops (hence the need for soil testing and mapping), and advice on crop management, farm enterprise management, and marketing.

Status. Ministries of agriculture have increased their efforts to promote quality seeds, rehabilitate or expand irrigation facilities, and increase extension services. Most conduct field demonstrations and fertilizer trials on farmers' fields. They also disseminate information about input use via radio and TV, newsletters and brochures. Many collect data on fertilizer use and disseminate information on prices and availability, often in collaboration with development partners such as AfricaFertilizer.org, and AMITSA (Ariga and Wanzala 2014).

Nevertheless, the overall use of fertilizer, hybrids and crop protection products remains low. Only 4% of arable land in sub-Saharan Africa is irrigated. Most smallholders still sow seeds saved from the previous year's crop – meaning that access to improved seed varieties is limited. While many ministries of agriculture collect data on fertilizer use, supply and prices, geographical coverage is patchy and too infrequent.

Extension services. Extension services in many countries are defunct or under-resourced. A weak

extension system cannot spread information on improved agronomic practices. Many ministries of agriculture carry out only two to three trials and one or two demonstrations of fertilizers a year. Most countries still have blanket fertilizer recommendations across different agricultural zones. That means that farmers are discouraged from using fertilizers the right way, or persist in using the wrong products or dosages. That in turn reduces the size of the market and the range of products available.

Soil nutrient testing. Many of Africa's soils are deficient in nitrogen and phosphorus. But soils are not uniform, and ways to improve their fertility will differ from one area to another. Crops also vary in the types and amounts of nutrients they require.

Soil mapping and nutrient testing are key to finding the best ways to improve soil fertility. But both have not received enough the dedicated attention. Most countries of the continent lack soil mapping and testing facilities. That means that farmers have no way of finding out which types of fertilizer or other soil amendments they should use.

Resolution 11. Establish a fertilizer financing mechanism

> […] establish […] an Africa Fertilizer Development Financing Mechanism that will meet the financing requirements of the various actions agreed upon by the Summit. […]

Rationale. The fertilizer system lacks adequate financing all the way along the supply chain – from production and imports, through warehouses and trader networks, down to farmers. Farmers cannot get loans to buy the fertilizer they need; without capital, agrodealers cannot afford to buy and stock fertilizer; producers and importers lack credit to procure, manufacture and distribute their products. Financial institutions are currently unwilling to fund the fertilizer chain because of the high costs and perceived risks, and (at the farmer end) the cost of serving large numbers of scattered clients with no collateral.

Status. The Africa Fertilizer Financing Mechanism (AFFM) was formally established within the African Development Bank in 2007, but has been slow to become operational. It nevertheless received sufficient funds to start its operations in 2015, mainly from the Bank itself and the government of Nigeria (Table 7). However, it was only in 2018 that the AFFM secretariat became operational.

Most African governments have not yet contributed financially to the AFFM. Other ways to mobilize resources are therefore being explored, without these funds necessarily passing through the AFFM accounts. For example, AFFM is trying to leverage funds from other departments in the African Development Bank for its credit guarantee scheme, and to use Bank instruments for actors in the fertilizer value chain.

AFFM is supporting the provision credit guarantees for fertilizer importers, distributors and agrodealers (starting in Nigeria and Tanzania), as well as other financial solutions along the value chain. Moreover, it is engaging in policy advocacy and targeted technical assistance to governments to address obstacles in the fertilizer value chain.

See Chapter 10 for details about AFFM.

Resolution 12. Monitor progress

> […] set up a mechanism to monitor and evaluate the implementation of this resolution […]

Rationale. Passing resolutions is relatively easy; fulfilling them is harder. This resolution called on the African Union Commission and the New Partnership for Africa's Development (NEPAD) to set up a mechanism to monitor and evaluate the implementation of the Abuja Declaration, in collaboration with the Economic Commission for Africa and the African Development Bank.

Table 7. Commitments and actual contributions to the African Fertilizer Funding Mechanism

Year	Country/ organization	Commitment (million euros)	Actual contribution (million euros)	% of commitment
2009	African Development Bank	5.8	5.8	100%
2010, 2015	Nigeria	8.8	5.3	60%
2015	Tanzania	1.8	0.2	11%
2015	AGRA	0.9	0.9	100%
2015	Chad	0.9	0	0%
Total		**18.1**	**12.1**	**67%**

Status Dec 2018. Source: African Development Bank (2019)

Status. The Commission and the NEPAD Planning and Coordinating Agency monitored progress on the 12 Abuja Declaration resolutions at the country and regional levels, and reported it to the heads of state for six years (2006–11).

Since then, various other institutions have reported on the current situation and progress made regarding fertilizers.

African Union. Since 2018, the African Union Commission, has begun issuing biennial reviews on the implementation of the 2014 Malabo Declaration on accelerated agricultural growth. This includes a scorecard for each country's progress on the seven areas of commitment in the Declaration, which highlights (where appropriate) progress or action needed in boosting fertilizer use (African Union 2018).

World Bank. The Enabling the Business of Agriculture index has monitored the regulatory framework and institutions that affect agribusiness in a large number of countries since 2012–13, including 23 in Africa (as of 2017). It aims to inform and encourage policy decisions that support inclusive participation in agricultural value chains. The index covers 12 topics, one of which is fertilizer (the others are seed, machinery, finance, markets, transport, information and communication technology, water, livestock, land, gender and environmental sustainability). Fertilizer indicators cover the registration, import and quality control of fertilizer products.

FAO. FAO and the Global Soil Partnership's booklet "Boosting Africa's soils" (FAO 2016) documents progress in the implementation of the Abuja Declaration. It calls for high-level policy commitment to take the issue of soil fertility beyond fertilizers and instead adopt a more holistic approach of soil health and sustainable soil management.

IFDC. Since 2010, IFDC has extensively documented and disseminated information on agricultural inputs, in particular fertilizers, in Africa. It works closely on this with the African Union Commission, regional economic communities, USAID and AFAP. For instance, in 2010–12 it assessed the fertilizer sector in 12 countries, highlighting the status of reforms, regulations and market development. It has also implemented the USAID West Africa Fertilizer Program, including policy harmonization and documenting subsidies across ECOWAS.

AFAP. The African Fertilizer and Agribusiness Partnership has focused on increasing participation by the private sector in policy development to boost fertilizer supply and distribution in eastern and southern Africa. In 2015 AFAP and IFPRI held a series of roundtable meetings to track progress and commitments by each country. In 2014–15, AFAP reviewed the status of national fertilizer policies and regulations in 15 COMESA member states. In 2015–17 it helped set up a fertilizer policy and regulatory framework to guide countries on policy reform.

Despite these efforts, there is currently no initiative that systematically monitors and reports on the status of the Abuja Declaration. Sub-Saharan Africa is switching rapidly from government-dominated to private-sector-led fertilizer markets, and blended fertilizers are becoming more available. The public and private sectors, as well as development partners and donors, increasingly need reliable, accurate and consistently available information on fertilizer policies and markets.

One such initiative that is still in the conceptual stage is the "fertilizer dashboard" conceived by the Bill and Melinda Gates Foundation. This will most likely track indicators of prices, consumption, availability, policy and quality. Current plans are for the dashboard to be developed in 2019 and to cover just six countries. Another option may be to develop an instrument that coordinates all these initiatives, so covers an agreed set of indicators in all countries in Africa.

Abuja: Where are we now?

In the 13 years since the Abuja Declaration, fertilizer use in Africa (both total consumption and quantity per hectare) has increased substantially, and the outlook is improving. First, oil and metal prices are rebounding, and sub-Saharan Africa's economy is on the upswing. That should increase demand for food, and hence spur demand for fertilizer. Second, infrastructure improvements such as the Djibouti–Addis and Mombasa–Nairobi railways should cut transport costs: such costs now make up 30–60% of the farm-gate price of fertilizers. Third, higher prices for some cash crops should also boost demand (Sheahan and Barrett 2017).

Overall, progress on the Abuja Declaration has been substantial – though not uniform. Some resolutions have seen marked change, while others have lagged – or are outdated and should be discarded. The scorecard in Table 8 provides a snapshot.

Table 8. Abuja Declaration scorecard

Resolution	Indicator	Status
1	Increase fertilizer use	Partially satisfactory
2	Harmonize policies and regulations	Unsatisfactory
	Develop quality control	Unsatisfactory
	Eliminate taxes and tariffs	Satisfactory
3	Improve agrodealer networks	Satisfactory
	Reduce distance travelled to purchase fertilizer	Good
4	Improve access for women and youth	Satisfactory
5	Provide subsidies for smallholders	Good
6	Improve infrastructure and output marketing	Unsatisfactory
7	Improve financing for input suppliers	Satisfactory
8	Establish regional procurement and distribution facilities	Unsatisfactory
9	Promote fertilizer production and trade	Good
10	Improve access to other inputs and services	Satisfactory
11	Establish a fertilizer financing mechanism	Satisfactory
12	Monitor progress	Partially satisfactory

Source: Developed by authors

Drivers of change

What has led to the successes in Table 8: the rows with a status of "good" or "satisfactory"? We can identify various drivers of change.

Greater private-sector participation. The number of market actors has increased at all levels in the supply chain. This is especially true for agrodealers, resulting in a big drop in the distance farmers need to travel to buy fertilizers, as well as much lower market margins.

Greater industry interest. Given its low level of fertilizer use (Africa accounts for around 4% of world consumption), Africa has the highest potential for fertilizer industry expansion. Fertilizer producers have made considerable investments in manufacturing and blending in various countries. In 2016, OCP, a Moroccan-based phosphate producer, launched a subsidiary to penetrate the sub-Saharan market. It has projects for manufacturing or blending plants in Ethiopia, Nigeria, Rwanda and Tanzania. Indorama, a global chemicals conglomerate, has invested in a production plant in Nigeria and Senegal.

Renewed donor interest. This increase in industry interest has been complemented by renewed donor interest. Donors have commissioned studies on fertilizer policy and market development, and have funded various projects. Major actors include:

- **USAID:** Feed the Future studies.
- **AGRA:** studies in 11 countries; grants to various partners to implement fertilizer policy and market development projects in 13 countries.
- **Gates Foundation:** grants to AFAP for hub-agrodealer development in five countries; development of the fertilizer dashboard.
- **African Development Bank:** the African Fertilizer Financing Mechanism.

Government subsidies (Resolution 5). The number of countries with official and non-official fertilizer subsidies has increased. About two-thirds of African countries now have some type of subsidy program in place. Many provide not only fertilizer but also seeds and extension services.

Financing (Resolution 7). Although national financing facilities for importers and agrodealers are not yet established, this gap is being partly filled by supplier credit guarantees, most notably by AFAP (the African Fertilizer and Agribusiness Partnership, funded by AGRA and the Gates Foundation). Since its inception in 2013, AFAP has facilitated $264 million of credit to fertilizer suppliers and distributors in Ghana, Mozambique and Tanzania. The African Development Bank is increasingly providing investment loans to manufacturing and blending companies, as well as trade finance for fertilizer and other agricultural inputs. NIRSAL, a Nigerian credit fund, is a good example for a public–private partnership for agriculture financing.

Remaining gaps

Despite this progress, the implementation of some aspects of the Abuja Declaration has lagged.

Fertilizer policy (Resolution 2). At least one-third of the countries in the region still either do not have a fertilizer policy and regulatory framework, or if they do, it is outdated or ill-adapted to the rapid shift towards markets that are driven more by the private sector, the increasing emphasis on fertilizer blends, and the addition of micronutrients. Only one regional economic community (ECOWAS) has established a harmonized regulatory framework (and, still, this has not yet been adopted by all member countries). Both COMESA and EAC have initiatives to create a harmonized framework. Differing quality standards still pose considerable trade barriers.

Subsidies (Resolution 5). Over 20 countries have introduced fertilizer subsidies. Many have switched (or are switching) from universal or non-targeted subsidies that ignored the private sector, to "smart" subsidies that use vouchers or other ways to target the benefits, and that involve the private sector in importing and distribution. However, these programs typically lack an exit strategy, so will continue to be a serious drain on development funds for the foreseeable future.

Governments need to seriously reconsider the continued used of subsidies to achieve their food-security and poverty-alleviation objectives. On one hand, there is a strong argument that the resolution on subsidies in the Abuja Declaration is obsolete and that resources should instead be used for other interventions that are more likely to achieve the objectives, such as research, extension and infrastructure development.

On the other hand, substantial subsidy rates and subsidy programs have been implemented or are still underway in the top six fertilizer-using sub-Saharan African countries. The resolution can be considered obsolete only in those countries where development policy depends heavily on donors, and that do not review their internal resource mobilization and resource allocation strategy.

Regional procurement (Resolution 8). Progress here has been limited. The intentions were sincere, but when the implications became clearer (for example, relinquishing sovereignty and setting up regional funds), interest and enthusiasm died down.

Intra-regional trade (Resolution 9). The lack of trade finance opportunities is exacerbated by weak business relationships with their suppliers and the financial institutions. This limits the amount of fertilizer that can flow through the system, driving up costs and reducing availability. But as OCP and other producers invest in the region, and as more production facilities come online, prospects for improvements in intra-regional trade are good.

Human capacity (Resolutions 3 and 10). The lack of human capacity is an important area requiring attention. Both the public sector (particularly regulatory officials and extension workers) and the private sector (particularly agrodealers) lack the requisite skills and knowledge to serve farmers and operate effectively and efficiently in fertilizer markets. Regulatory agencies are poorly financed, staffed and equipped. Extension workers are too few, are not equipped to carry out

their duties, and need additional and regular training. This is particularly the case as fertilizer blends and micronutrients become more common. Agrodealers, the "last mile" interface with farmers, lack knowledge about the products they sell, so cannot advise farmers what to buy. They lack business and management skills, resulting in poor recordkeeping and documentation. That harms the industry as a whole.

Monitoring (Resolution 12). While various initiatives have reported progress since 2011, none monitors the fertilizer system in the region in a systematic way. That leaves huge gaps and uncertainties in the data, making it hard for firms and governments to plan.

Towards an Abuja II summit?

Substantial progress has been made since the Abuja summit in 2006. For the last decade, Africa has been the only continent with sustained growth in fertilizer consumption of over 8%, yet sub-Saharan Africa still accounts for just 1.9% of global fertilizer use. This is not enough to replace the soil nutrients lost every year to crop production; it falls far short of what is required to meet national agricultural production targets. While the call for 50 kg of nutrients per hectare was a good target, it was rather too abstract. It did not account for fertilizer use efficiency (applying the right type of fertilizers to the right crop according the soil and the crop's requirements).

This has led to the call by sector stakeholders for an "Abuja II". This would involve countries and regional communities taking a second pass at implementing initiatives to increase fertilizer use levels. It is likely that the African Union Commission will convene a second Africa Fertilizer Summit in the next 2 years. The focus is likely to go beyond fertilizers, to cover soil health, integrated soil fertility management, and the importance of farming profitability. To maximize the chances of success, such a summit should take into account the new realities of the fertilizer markets. Effort will be made to convey recommendations to more realistic action-taking. There would be a real move towards genuine suggestions for a relevant development agenda, which would include demand-driven training and optimal investment support to the fertilizer sector's stakeholders, especially smallholder farmers facing new global markets' challenges.

Private sector involvement. The 2006 Abuja Declaration prioritized rapid increases in mineral fertilizer use, and because investment in the fertilizer sector in Africa has been historically confined to governments and donors, it had a strong government-led focus. The private sector has since recognized the growth potential in sub-Saharan Africa and is at the forefront of the region's evolving fertilizer markets. Its involvement in all aspects of fertilizer supply and distribution has increased dramatically. Companies such as OCP, Yara, Notore, Indorama, and Dangote are expanding capacity and production in Africa, with over $10 billion worth of new investments in production facilities on the continent. A number of blending plants are in the pipeline. These companies are also working closely with governments to increase the supply and use of fertilizers. All this is changing the types of fertilizers available (more blends and micronutrients) and placing new demands on the enabling environment.

Changing policies. The increasing interest of the private sector is encouraging governments to be open to new policies and models that improve product availability, reduce prices, and increase volumes. Governments are increasingly revising or developing new policies and regulations that are more relevant to the evolving sector.

Need for information. As incumbents and new investors compete for market share, many governments are being forced to clarify their policy directions. To do this, they will need accurate information about the status and needs of the market. Development partners and the private sector also require reliable, accurate data on a consistent basis to improve their planning and decisions. The Gates Foundation is already investing in a "fertilizer dashboard". But other players also need to invest in documenting the status of markets, emerging opportunities and evolving needs.

Any follow-up to Abuja I should involve the following elements.

- First, a good balance between **industry and the public sector**. Abuja II should involve key players from both the private and public sectors who are well versed in fertilizer markets, and who have the knowledge, skills and muscle to make and commit to critical decisions. Political will from governments and the willingness and capacity of the private sector are both vital for fruitful partnerships.
- Second, adequate **time for preparation** so that the deliberations are informed by current realities.
- Third, clear **objectives, outcomes and targets.** There should be a stocktaking exercise of progress and drivers in the most important markets, preferably the countries that account for 90% of fertilizer use, and the market potential from countries that do not consume enough fertilizers yet but are on a strong drive to do so, considering their agricultural growth rate and potential and

policy moves towards meeting the Sustainable Development Goals. A realistic path should be mapped out for what the industry needs from the public sector (including the donor community). A monitoring and reporting mechanism on progress in implementation is also critical. Unlike Abuja I, there should be more than one target for fertilizer markets. Multiple but realistic targets should build on each other, and milestones should be set along the way to show how things are progressing.

Abuja II should also take into account the lead time for effective responses to resolutions. Moving from a resolution to a policy change is cumbersome in each country, and harmonizing policies in a regional economic community takes even more time. Similarly, moving from a resolution to activities on the ground, which often requires the involvement of the private sector, is a complex process. To avoid developing unrealistic resolutions, targets and timelines, the private sector needs to be involved in the planning and execution of the summit. Just as governments know it takes time to move from policy formulation to implementation to achievement, the private sector also needs time to plan. Companies need several years to understand the market and develop a strategy. It takes even longer to decide on investments, build plants and bring them into operation.

In summary, the approach should be more inclusive, comprehensive and integrated. The preparatory process should not be fast-tracked. Organizers should mobilize scientific inputs for proper preparation and informed policy discussion. The private sector should be actively involved to ensure that the decisions create an enabling environment for business and industry to play its role.

It is essential that the decision to hold a second summit is informed by the conviction of most or all stakeholders for the need for the Abuja II, and by their interest and firm determination to take part in the process and be involved in implementing resolutions.

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2 The fertilizer value chain

4. The institutional landscape

Abdi Zeila, Abednego Kiwia, Rebbie Harawa and Bashir Jama

To increase the use and efficiency of fertilizers in sub-Saharan Africa, and to make them more widely accessible, the value chain and supporting institutions must also function efficiently. This chapter describes the evolving institutional landscape that facilitates and influences fertilizer use in the continent and makes some recommendations on how to improve it.

A wide range of organizations and institutions play a role in the fertilizer sector in sub-Saharan Africa (Figure 14, Table 9, Table 10) (the terms "organizations" and "institutions" are used interchangeably in this chapter). We can divide them into four major categories:

- **Public sector:** government and intergovernmental bodies
- **Private sector:** farmer organizations, fertilizer producers, industry associations, importers, distributors, dealers and users
- **Non-profit actors:** international organizations and NGOs
- **Banks and donors:** investment, commercial and development banks.

These organizations and institutions perform a range of functions:

- Oversight, policy formulation, regulation, enforcement
- Production and blending, importation, distribution, warehousing, retail
- Research and development, technical advisory services, advocacy, policy support
- Commercial financing
- Strategic support, financing.

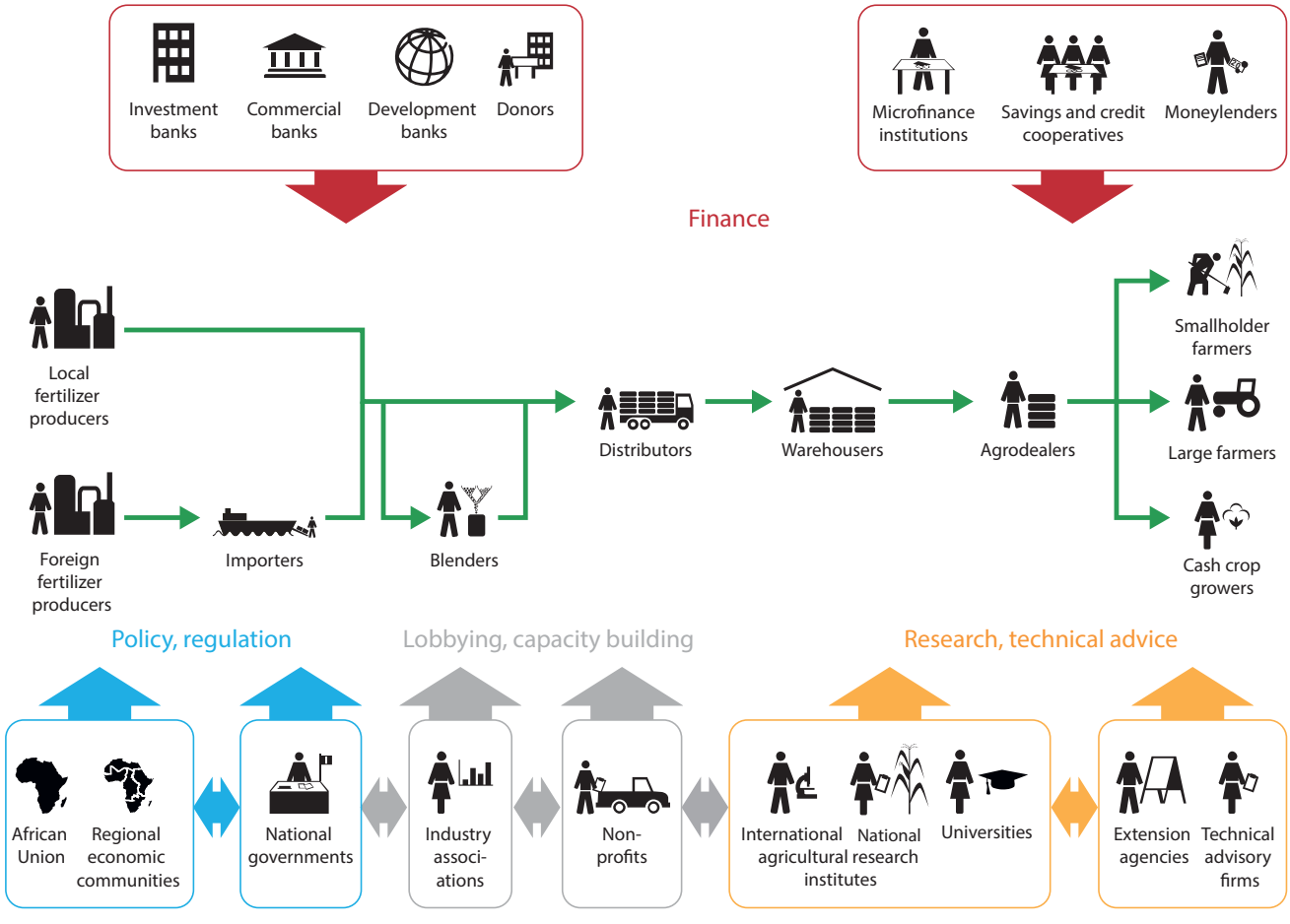

Figure 14. The fertilizer value chain and supporting institutions

Table 9. Selected private-sector fertilizer manufacturers, blenders , importers and distributors in sub-Saharan Africa. Source: From the Authors

	Company, website	Headquarters, operations	Major products
	Archer Daniels Midland adm.com	USA	NPK
	Belaruskali kali.by/en/	Belarus	K
	Brass Fertilizer brassfertilizer.com	Nigeria*	N
	Bunge bunge.com	USA	NPK
	Circum circumminerals.com	Ethiopia*	K
	Colluli Mining Share Co. Danakali/ ENAMCO danakali.com.au	Eritrea*	K
	Dangote dangote.com	Nigeria*	N
	ETG etgworld.com	Kenya	NPK
	Foskor foskor.co.za	S Africa	P
	Haldor Topsøe topsoe.com	Denmark, Angola*	N
	Indorama indoramafertilizers.com	India, Nigeria, Senegal*	N, P
	International Raw Materials www.irmteam.com	USA, Mauritius	N
	Kore korepotash.com	Rep. Congo*	K
	MEA mea.co.ke	Kenya	NPK
	Notore notore.com	Nigeria	N
	Nutrien nutrien.com	Canada	NPK
	OCP www.ocpgroup.ma	Morocco, Ethiopia*	P
	Olam olamgroup.com	Singapore, Gabon*	N
	Omnia omnia.co.za	S Africa	NPK
	PhosAgro www.phosagro.com	Russia	NPK
	Spic spic.in	India	N, P
	Tanzania Mbolea & Petrochemical Co. TPDC/Ferrostaal/Topsoe/Fauji	Tanzania*	N
	Toyota Tsusho toyota-tsusho.com	Kenya	NPK
	URALCHEM www.uralchem.com	Russia	NPK
	Yara yara.com	Norway, Ethiopia*, Mozambique*	NPK

**planned*

Table 10. Selected actors in the fertilizer sector in sub-Saharan Africa

Actors		Importation, distribution	Finance	Policy, regulation	Research, technical advisory
Policy and regulation					
National government ministries		X	X	X	X
	African Union, AU au.int			X	
	Regional economic communities			X	
Research and development					
Universities					X
National and international research institutes					X
	Industry associations				
	West African Fertilizer Association, WAFA wafafertilizer.org			X	
	Fertilizer Association of Southern Africa, Fertasa fertasa.co.za			X	
	International Fertilizer Association, IFA fertilizer.org			X	
Non-profit					
	African Fertilizer and Agribusiness Partnership, AFAP afap-partnership.org			X	
	Alliance for a Green Revolution in Africa, AGRA agra.org		X	X	X
	Food and Agriculture Organization, FAO fao.org				X
	United Nations Economic Commission for Africa, UNECA www.uneca.org			X	X
	United States Agency International Development, USAID usaid.org			x	x
	International Fertilizer Development Center, IFDC ifdc.org				X
	AfricaFertilizer.org africafertilizer.org				X
Finance					
Commercial banks			X		
	World Bank worldbank.org		X		
	African Development Bank, ADB afdb.org		X		

Actors		Importation, distribution	Finance	Policy, regulation	Research, technical advisory
	African Fertilizer Marketing Mechanism, AFMM		X		
	Islamic Development Bank, IsDB isdb.org		X		
	International Fund for Agricultural Development, IFAD www.ifad.org		X		X
	Bill & Melinda Gates Foundation gatesfoundation.org		X	X	
	Rockefeller Foundation rockefellerfoundation.org			X	

Production, blending, importation and distribution

Large-scale investments in fertilizer production are growing in sub-Saharan Africa (Chapter 5). Nigeria has relatively large plants producing urea; IFDC South Africa produces phosphate. A number of new production facilities have been announced or are under construction in different parts of the continent, though several have been put on hold for various reasons. However, these plants are relatively small compared to facilities in North Africa and elsewhere in the world.

Blending plants are more common than production facilities; they generally rely on materials imported from elsewhere. While there are no firm data on the proportion of blends in total fertilizer sales, it seems that the blending industry is growing rapidly. For instance, Nigeria, which had only six plants in 2016, now has 48 (FAO, 2019).

Fertilizer production and blending is dominated by the private sector. Setting up and running a fertilizer plant requires large amounts of capital, so the firms involved are large and capital-intensive. Many have operations throughout the world. Operators include:

- **Foreign private companies**: Indorama (based in Singapore), Yara (Norway), International Raw Materials (United States) and Haldor Topsøe (Denmark).
- **Government-owned foreign firms**: OCP, which is wholly owned by the government of Morocco.
- **Firms based in sub-Saharan Africa:** Dangote and Notore (Nigeria); Olam (founded in Nigeria but now based in Singapore); MEA and ETG (Kenya); and Omnia, Foskor and Sasol (South Africa).
- **Joint ventures**, such as the planned nitrogen plant in Gabon, which involves Olam, Tata (an Indian company) and the Gabon government.

Some companies focus on manufacturing fertilizers; others—such as MEA and ETG—import fertilizers, blend them to suit local needs, and distribute them. Some companies are conglomerates, manufacturing and trading in other chemicals or in seeds and grain.

In many countries, national governments also play a major role in importing and distributing fertilizers. Governments do this to support the production of export crops such as cotton, as well as to supply smallholders with subsidized fertilizers. These programs are typically managed by the ministries of agriculture; a large part of the national agriculture budget is often spent on fertilizer subsidies (see Chapter 9).

The importation of fertilizers is handled by specialized companies that deal with bulk goods. An example is Vallis Group, which provides assurance services in 38 countries in Africa. The local distribution of fertilizers is handled by a host of independent warehousers, transport firms and local agrodealers and (in some countries) through the hierarchy of farmers' associations and cooperatives.

The private sector is becoming more heavily involved in the fertilizer business. This is partly through the expansion in the sector as firms invest in fertilizer production and blending plants, and increase in the number of private dealers. It is also because governments are tending towards the withdrawal from importation and distribution, and are taking on a role of enabling and regulating the marketplace.

Finance

Fertilizers are products that are produced or imported in bulk, but must be distributed to and consumed by huge numbers of farmers. For farmers, fertilizer is an investment good: to be profitable, they need to buy it before the planting season begins, and can only hope to get a return after the harvest. The fertilizer value chain is thus shaped like a pyramid, with a few large companies at the top, and a host of small consumers at the bottom. This pyramid structure and the delay (and risk) inherent in any agricultural production pose major challenges and costs.

Four major groups of actors are involved in financing the fertilizer value chain.

- **Commercial and investment banks**
- **Development banks and donors**
- **Governments**
- **Credit cooperatives**

These institutions operate at different stages in the chain:

- Commercial banks, investment banks, development banks and governments support the construction of fertilizer **production** facilities and infrastructure such as ports, railways, roads and warehouses.
- A similar group of institutions finances fertilizer **imports**, for example by providing import credit for shipments.
- Some governments **subsidize** the price of fertilizers and target deliveries of fertilizers to particular groups, including smallholders and the growers of high-value export crops (see Chapter 9).
- Governments, development banks and donors support the development of the fertilizer **distribution** system, for example by supporting the construction of warehouses and the training of agrodealers.
- At the far end of the chain, governments, donors and credit cooperatives support groups of **farmers** to purchase fertilizers. The idea is to offer them credit so they can buy fertilizer from dealers. Applying the fertilizer increases their yields, enabling them to repay the loan when markets work well.

Substantial amounts of money are involved, especially at the production and importing ends.

- The **World Bank** lends an average of $1.2 billion a year for fertilizer enterprise development in Africa (IFC, 2018).
- The **African Development Bank** has set up the African Fertilizer Financing Mechanism to support the sector (African Development Bank, 2016).
- The **Islamic Development Bank** supports contract and out-grower schemes for smallholders and finances infrastructure such as rural access roads and storage facilities. It also supports financing (including microfinancing) following Islamic rules for the private sector, small enterprises and farmers.
- The **International Fund for Agricultural Development** (IFAD) supports smallholder farming projects in individual countries.

Financing initiatives may be focused on the fertilizer sector, or they may be more general. An example of the latter is the Nigeria Incentive-Based Risk Sharing

system for Agricultural Lending, or NIRSAL. This is a public–private initiative, set up by the Central Bank of Nigeria, whose aim is to reduce the risk in agribusiness. It offers both financial products and technical assistance to commercial banks to improve their lending to agriculture. NIRSAL has earmarked 56% of its total portfolio (of $213 million) for financing inputs for farmers; some of this amount has been allocated for fertilizers (Business Day, 2018).

Policy and regulation

Policies regarding fertilizer are made at two levels:

- **National and local governments** – mainly ministries of agriculture, trade and finance, as well as the office of the president. National governments are also responsible for issuing and enforcing regulations that affect the fertilizer sector.
- **The African Union and regional economic communities**, which set targets and advocate with national governments for agreements on policy practices.

Various organizations advise on and try to influence fertilizer policy. These include:

- **Industry associations**, which represent the interests of the private sector: fertilizer producers, importers, distributors and agrodealers.
- **Fertilizer consumers**: associations of large-scale farmers, producers of export commodities, and smallholder farmers' associations.
- **Development agencies**: development banks and non-profit organizations.
- **Nongovernment organizations**, some of whom promote inorganic fertilizers, and others who campaign against them.

Each of these groups has different interests and different degrees of power and influence.

National governments and development partners

Governments must weigh the advantages of increasing fertilizer applications against the cost of importing them, the interests of different fertilizer consumers, the vote-getting potential of fertilizer subsidies, and the danger of annihilating votes if the subsidies are withdrawn. Also worth considering are the risk of reinforcing regional imbalances within the country, and the interests of different factions within the government (and not least, the private interests of wealthy politicians).

Development organizations and donors work closely with government in developing fertilizer systems. Donor funding tends to be project-based and short-term. It helps set up elaborate systems to deliver measurable outputs within a limited timeframe, but they are then dismantled as the project phases out: the systems, funding, staff, and expertise all evaporate, with little effect on established institutions, and little sustainable impact. All too often, successful pilots are often not scaled up, innovative approaches are not institutionalized, the capacity of organizations on the ground is not built, and the procedures and priorities of governments are not adequately changed. In addition, graft and rent-seeking on the part of local elites contributes significantly to insufficiently developed fertilizer markets.

Nevertheless, this is beginning to change. Development partners are abandoning quick-fix solutions and now fund longer-term involvement with local partners and in particular regions. The shift in emphasis towards creating self-sustaining systems involving the private sector makes it more likely that initiatives will continue after the end of outside funding.

African Union and regional economic communities

The African Union and the regional economic communities strive to promote growth and increase trade by developing common standards, fostering free-trade agreements, and promoting joint investment and infrastructure projects. Some regional communities have become engaged in policy-advocacy campaigns for fertilizers.

Industry associations

Major actors in the fertilizer value chain have formed industry associations to represent their interests.

The **International Fertilizer Association** (IFA, www.fertilizer.org) is a global association of 480 companies in 68 countries, representing 75–80% of global fertilizer production. The IFA has 45 members from Africa. The IFA Africa Forum provides a platform to exchange views and expertise, facilitates communication between the fertilizer industry and key African stakeholders, raises awarene ss on the role fertilizers can play in Africa's development, and contributes to increased fertilizer use by African farmers.

- The **West African Fertilizer Association** (WAFA, www.wafafertilizer.org) includes 28 companies from nine countries, including fertilizer manufacturers, importers, blenders and traders. It claims to represent over 85% of the fertilizer trade in West Africa.
- The **Fertilizer Association of Southern Africa** (Fertasa, www.fertasa.co.za) represents the fertilizer industry in Southern Africa, with its members producing, trading, blending and distributing fertilizer products across this region.
- **National fertilizer trade associations** include the Uganda National Agro-input Dealers' Association; the Association for the Promotion of Fertilizers in Mozambique (AMOFERT); the Fertilizer Association of Malawi (FAM); the Fertilizer Association of Kenya (FAK); Agrodia in Burkina Faso, Fertilizer Association of Malawi; and the Fertilizer Producers and Suppliers Association of Nigeria (FEPSAN).

Fertilizer consumers

Some fertilizer consumers are well-organized and influential. **Large-scale farmers**, plantation owners and companies that contract smallholders as out-growers are powerful and well-resourced enough to ensure that they obtain the right types and quantities of fertilizers when they need them. Such actors focus mainly on cash crops such as tea, coffee, sugar, cotton and horticultural export crops.

Smallholder farmers who grow staple food crops, on the other hand, tend to be less well organized and influential. Some are members of cooperatives or marketing associations, which may in turn be grouped into umbrella organizations that arrange fertilizer purchases and can lobby for their members' interests. An example is National Association of Smallholder Farmers of Malawi (NASFAM).

International development agencies

Major development agencies and non-profit organizations include the development banks and foundations (see above under *Finance*), and a small group of specialist organizations that focus on the fertilizer sector or more broadly on agricultural development. Two major foundations that support the fertilizer sector are the Bill & Melinda Gates Foundation and the Rockefeller Foundation, another is USAID. All three support international non-profit initiatives such as AGRA and IFDC.

Other major players include the following:

- **Alliance for a Green Revolution in Africa** (agra.org). Using market-level middlemen (including a network of about 23,000 agrodealers spread all over Africa), AGRA has unlocked physical and financial access to more than 450,000 tons of inorganic fertilizers, worth $151 million, benefiting nearly 6 million smallholder farmers tilling 1.5 million ha of farmland. AGRA's Soil Health Fertilizer Supply sub-program supports the production and distribution of fertilizers, maily through its agrodealer network. AGRA's Soil Health Program also supported ISFM reach 5 million farmers. AGRA has invested in the production of site- and crop-specific multi-nutrient fertilizer blends. Its policy advocacy aims to encourage private-sector investment in the supply chain, smart use of subsidies, regulations on quality, and credit guarantees to commercial banks.
- **Food and Agriculture Organization of the United Nations** (fao.org). This specialized United Nations agency gathers statistics on agriculture, advises governments on policies, and conducts agricultural development projects. In particular, it focusses on conservation agriculture and climate-smart agriculture.
- **International Fertilizer Development Center** (ifdc.org). IFDC helps bridge the gap between research on soils and fertilizers, and farmers. It conducts research, offers training courses for farmers and agribusiness owners, links farmers to markets, and engages with policymakers to foster private-sector-driven agricultural systems. It promotes the production and use of balanced fertilizers and the use of integrated soil fertility management. Using demonstration plots, farmer field schools and in-field training, IFDC's projects and programs have helped millions of farmers in Africa understand the importance of the use of mineral fertilizers.

Non Governmental Organizations

A wide range of international and national non-government organizations support agricultural development in sub-Saharan Africa. Their focus is generally on promoting the interests of smallholders, for example by helping them improve their yields, productivity and product marketing. Improving access to fertilizers is an important part of their work.

Some nongovernment organizations oppose the promotion of fertilizers in Africa, pointing to factors such as the ecological damage caused by fertilizers in other parts of the world, and the risk of pushing smallholders into debt and dependency on far more powerful market actors. They propose alternative visions for boosting agricultural production through better crop and soil management and relying primarily (or exclusively) on organic fertilizers to improve soil fertility.

There is a large degree of common ground in the positions advocated by the pro- and contra-fertilizer advocates. Both sides wish to improve the livelihoods of smallholder farmers; both wish to boost, maintain and improve soil fertility as well as smallholders' yields, crop productivity and incomes; both want to avoid undue debt and overdependence on external actors; both wish to maximize the use of organic materials; both aim for economic and environmental sustainability. The arguments are more often about the means rather than the ends.

Research and development

The consumption of fertilizers in sub-Saharan Africa is very low compared to the rest of the world. Research and development efforts on fertilizers mirror this: relatively little research has been done on fertilizers in the continent, and most of the product-development work is done elsewhere.

Fertilizer related research and development work cover a wide range of topics:

- **Fertilizer formulation and production**, including the development of blends suited to local soils and crops.
- **Crop fertilizer response and field verification/validation trials:** agronomic studies on the types, timing and application methods of fertilizers for various crops and soil types. Investments in this work is slowly paying off, with evidence trickling in (for example in Kenya) where fertilizer formulations are beginning to change as a result of such trials. Recommendations and blends can be designed to suit the soils, agro-ecological conditions and crops in areas served by specific agrodealers.
- **Socioeconomic studies** on fertilizer profitability and marketing.
- **Soil mapping.** Soil databases and maps have been developed for a few countries and regions (e.g., the Africa Soil Information Service, africasoils.net). Digital maps of soil properties are now available, but validation studies and algorithms are needed to correlate the various methods.

Much of the research conducted to date has focused on cash crops and high-potential regions. Some crops (non-staple foods) and regions (marginal and remote areas) have been neglected.

The major research and development organizations include:

- National agricultural research institutes
- International agricultural research institutes
- Universities
- The private sector

National agricultural research systems

Some of these have greater capacity and resources than others. Nonetheless, they have many tasks, and soil fertility and fertilizer are not necessarily a priority. Some key research institutes have had relatively little involvement in such research.

International agricultural research institutes

Those with their headquarters in Africa are:

- **Africa Rice Center** (Boake, Cote D'Ivoire, africarice.org): focus on rice.
- **International Institute of Tropical Agriculture** (IITA, Ibadan, Nigeria, iita.org): focus on banana and plantain, cassava, cowpea, maize, soybean and yam.
- **International Livestock Research Institute** (ILRI, Nairobi, Kenya, ilri.org): focus on livestock and fodder crops
- **World Agroforestry Center** (ICRAF, Nairobi, worldagroforestry.org): focus on agroforestry.

In addition, various other international research institutes based outside Africa have strong Africa programs. These include the:

- International Center for Tropical Agriculture (CIAT, ciat.cgiar.org)
- International Maize and Wheat Improvement Center (CIMMYT, cimmyt.org)
- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT, icrisat.org)
- International Center for Agricultural Research in the Dry Areas (ICARDA, icarda.org)
- International Food Policy Research Institute (IFPRI, ifpri.org).

Universities

These also have differing capacities and focuses. Those with a particularly strong focus on soil fertility include:

- **Ahmadu Bello University**, Nigeria, abu.edu.ng
- **Jomo Kenyatta University** of Agriculture and Technology, Kenya, www.jkuat.ac.ke
- **Kwame Nkrumah University** of Science and Technology, Ghana, www.knust.edu.gh
- **Makerere University**, Uganda, mak.ac.ug
- **Sokoine University** of Agriculture, Tanzania, sua.ac.tz
- **University of Nairobi**, Kenya, uonbi.ac.ke

Some universities working on fertilizers in the region are located outside Africa. Examples are Wageningen University in the Netherlands, and the Earth Institute of Columbia University in the United States. The latter has developed SoilDoc, a portable soil-analysis kit, with support from AGRA.

Private sector

Most of the research on fertilizers in sub-Saharan Africa is conducted by the private sector. These perform research on fertilizer formulations and blends, and conduct tests of fertilizer applications for various crops, soils and locations. Research is often combined with demonstrations of fertilizers for farmers and agrodealers. However, commercial imperatives dictate the types of research conducted: companies want to sell more of their products over the next few seasons, and are less interested in issues such as long-term sustainability or whether organic matter can substitute for purchased fertilizers.

Technical advisory services

Technical advisory services include:

- Government-run extension agencies
- Private sector-run farm advisory services
- NGO extension services
- Online information and advisory services
- Business development services.

Government extension agencies

Traditionally, advisory services were confined to government-run extension agencies that advised farmers on production issues: choice of crops and varieties, cultivation practices, pest and disease control, and fertilizer applications, etc. Supported by funding from the World Bank and other donors, extension services used to be reasonably (but still inadequately) well-resourced and staffed. But reductions in this funding, in part due to externally imposed structural adjustment programs in much of the continent in the 80s and 90s, led to a decline in extension services, at the same time as the tasks of extension widened to include non-production-related topics such as crop marketing and community organizing.

Government extension services have since been revived in several countries such as Ethiopia, which has invested heavily in this area. The gap has been partially filled by other forms of extension advice: those run by NGOs or private firms, and online services.

NGO extension services

As government extension services declined, in several countries international NGOs stepped in to provide similar types of services. Organizations such as Catholic Relief Services (CRS), a US-based charity, employ tens of thousands of field staff throughout Africa, either directly or through local partner organizations. NGO agents tend to be well-motivated and are often better paid than their government counterparts. But they are often employed on a project basis, rather than permanently.

NGO extension services often have a broader remit than their government counterparts, focusing on community development rather than only on agricultural production. They help organize farmers into marketing groups, set up savings and lending schemes, teach financial skills, promote environmental conservation, alongside dealing with technical farming issues. NGOs are often involved in promoting organic farming and fair-trade marketing of products. An increasing recognition of the importance of the private sector has seen NGOs collaborating with and training agricultural input suppliers, traders and processing firms.

Private sector advisory services

Private advisory services have also stepped in to fill the gap left by government extension, offering services such as soil testing and pest scouting. Commercial soil-testing services are becoming more common as farmers learn about the technique and gain confidence in it. Because farmers have to pay, these services tend to be restricted to larger growers and those who cultivate high-value crops.

Contract farming arrangements often include the provision of farming advice and inputs such as fertilizer to smallholder out-growers. Various models exist, including centralized models managed by a commodity buyer or processor, nucleus estates (where the manager runs a large farm but also buys from neighboring smallholders), and multipartite arrangements involving farmer organizations and NGOs (Eaton and Shepherd 2001). Such arrangements focus on cash crops rather than subsistence crops.

Online information and advisory services

The explosion in the use of mobile phones across Africa has opened up new possibilities for farmers to get information on a whole range of topics. Various providers now offer information and advice via mobile phone apps and the internet. Content includes agronomic, pest-control and marketing advice, links to agrodealers and product buyers, and information on prices and the weather. AGRA, IFDC and other development agencies have been promoting such services on a commercial basis: mobile-phone users are billed a small fee automatically when they access the information. Web services offer some categories of information for free; they charge a fee for access to premium information.

The costs of developing, promoting and maintaining such services are considerable, and have generally relied on donor support, along with agreements with development organizations to promote (and pay for) the service among their smallholder clients. Switching to relying on individual subscribers for funding has proved difficult, as a big increase in subscriber numbers would be needed to cover the costs. As a result, most such services are not yet commercially viable.

AfricaFertilizer.org is an information service that provides production and consumption statistics, prices, business links and news on fertilizers. It is supported by partners including IFDC, IFA, AFAP, FAO and the African Union. It draws on international databases run by FAO (FAOSTAT) and IFA (IFASTAT), fertilizer intelligence agencies and several regional and national agro-input market information systems. It serves 10,000 agrodealers across West and East Africa.

Business development services

As agriculture becomes more commercialized, the ecosystem of supporting industries is also becoming larger and more sophisticated. Business development services are evolving to advise entrepreneurs, small and large, on how to take advantage of the emerging opportunities. They provide financial, technical and logistical assistance to businesses through training, coaching and mentoring, and by providing linkages to input suppliers, financial services and buyers. Some of these business development services are supported by the government or development organizations.

African Fertilizer and Agribusiness Partnership. Founded in 2012 by a partnership of African development organizations, AFAP (afap-partnership.org) is an independent non-profit organization that advises both public and private sectors on sustainable development projects and policies related to fertilizers. It builds the capacity of agrodealers and smallholder farmers and links them to input suppliers and output markets. Among its technical and advisory services are advice on market entry (such as on developing investment and trade relationships), market analysis (such as feasibility studies on fertilizer blending and audits of blending plants), linkages to the public sector, and advice on input-subsidy programs.

Conclusions

The efficiency of the fertilizer institutional value chain in Africa must be improved. In 2015, Africa spent $35 billion importing food (African Development Bank 2018) in part because of inefficiencies in the fertilizer value chain that depressed fertilizer use by smallholder farmers. This import bill is projected to rise to $110 billion by 2025. Significant cost savings can be achieved if the institutional set-up supporting fertilizer production and consumption is restructured and made to work for smallholder farmers. Restructuring is also necessary to meet Africa's increased annual increase in fertilizer use, projected to be as high as 6.8% by 2020 (African Development Bank 2018). There is, for instance, a sound case for local-level blending to improve productivity, and for greater investment in mass awareness to stimulate demand for fertilizers.

Recommendations

- More private sector investment in area- and crop-specific fertilizers is needed.
- For smallholders to achieve cereal yields of at least 3 tons/ha of staple food crops (e.g., rice, maize), they will need to use fertilizers. African governments need to work with farmers and put in place the infrastructure necessary to supply them sufficient fertilizer to make such yield increases possible.
- Key constraints to private-sector systems should be addressed to unleash their potential to supply appropriate fertilizers to farmers. This includes access to financing. Lessons from credit guarantee schemes (including from AGRA/AFAP schemes in Ghana, Mozambique and Tanzania) should be taken into consideration going forward.

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5. Fertilizer supply

Asseta Diallo, Ayodele Balogun, Mahamadou Nassirou Ba and Michel Prud'homme

Despite its vast arable land, water and manpower resources, the African continent is largely food-insecure and is a net food importer. It is also one of the regions of the world with the lowest agricultural productivity. Better technologies, including the adoption of fertilizers, are essential to improve this situation, especially among smallholder farmers. History shows that no region of the world has been able to increase its yields and ensure food security without using fertilizers to replace nutrients removed from the soil through successive harvests and associated losses. This chapter looks at the following aspects:

- Imports
- Production of the major nutrients (nitrogen, phosphorus and potassium), plus lime
- Blending facilities
- Supply constraints and opportunities.

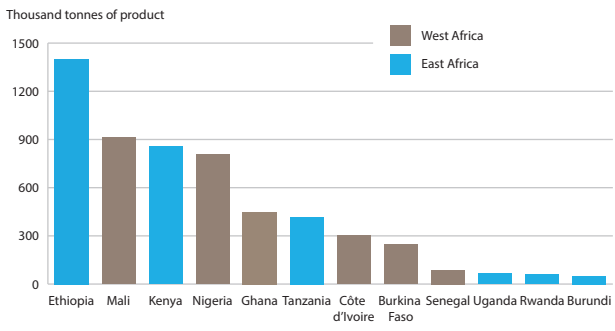
Imports of fertilizer and raw materials

Africa as a whole is a net exporter of fertilizer as a result of major production facilities in North of the Sahara. But most countries South of the Sahara are heavily dependent on imported fertilizers, with the region as a whole importing 95% of the fertilizer it uses. The main importers are Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Mali, Nigeria and South Africa (Figure 15). The major suppliers include the North African countries (from Morocco to Egypt), Belarus, Chile, China, Germany, Jordan, Norway, Qatar, Russia, Saudi Arabia, South Africa and the United Arab Emirates (Harrison, 2018).

Nevertheless, fertilizer use in sub-Saharan Africa is very low compared to the rest of the world; the region consumed an estimated 4.7 million tonnes of nutrient in 2017 (Argus Media Group, 2019).

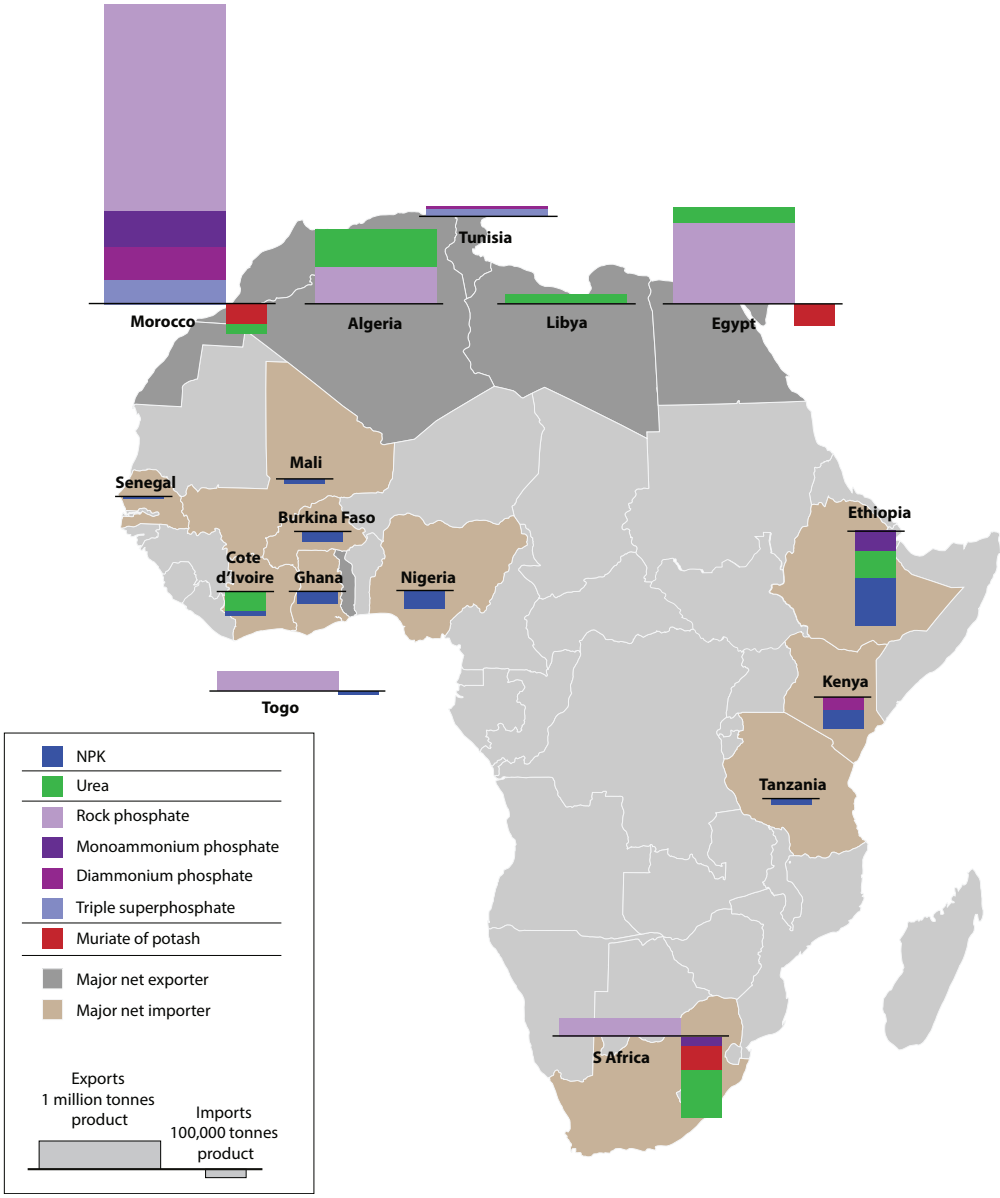
Some countries in Africa do produce fertilizer (or the raw materials that go into them), but ironically, much is exported from the continent because of the limited market and the weak intra-regional trade. These exports are mainly from North Africa, South Africa and Nigeria; they consist mainly of phosphate rock, NPS, TSP, MAP, DAP and urea. These products are sent all over the world (UNECA and AFFM 2018).

The main ports of entry of fertilizer in sub-Saharan Africa are Djibouti, Mombasa, Dar es Salaam, Beira and Durban on the east coast, and Dakar, Abidjan, Tema, Lomé, Cotonou and Lagos on the west (Figure 14). Historically most of these ports suffered from infrastructure, congestion and slow discharge of cargos. This is changing. An analysis of fertilizer port cost buildups in East Coast of Africa carried out by AFAP and IFDC (2018) showed that costs for bringing products across the ports of Djibouti, Mambos, Dar es Salaam, Beira and Durban are becoming competitive as a result of improvements in port infrastructure and vessel lay times.



Source: AFO (2018)

Figure 15. Fertilizer imports in selected countries in Africa, 2017

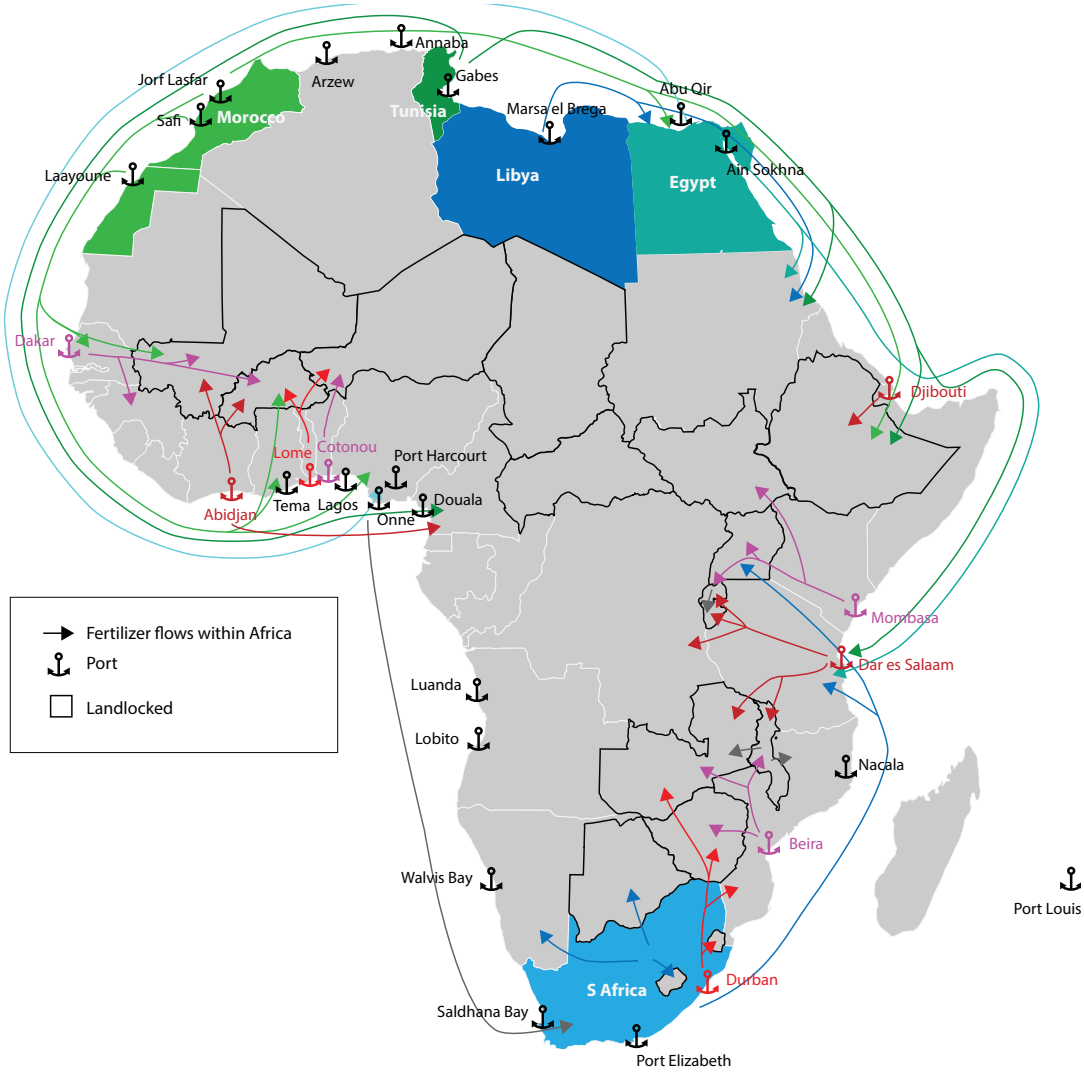


Adapted from Harrison (2018)

Figure 16. Fertilizer exports and imports in Africa, 2015

Nonetheless, there is some inter- and intra-regional trade within Africa. Much of this involves landlocked countries importing from and through coastal countries, as well as from other regions of the continent (Wanzala-Mlobela and Groot 2013, UNECA and AFFM, 2018).

- **East Africa.** Tanzania imports from manufacturers in Egypt, South Africa and Tunisia, while Uganda imports from Kenya and South Africa. Burundi, Rwanda and Uganda obtain their fertilizers from overseas via the ports of Mombasa in Kenya and Dar es Salaam in Tanzania.
- **Central Africa.** Cameroon imports from Côte d'Ivoire and Tunisia.
- **Southern Africa.** Botswana, Lesotho, Namibia and Swaziland import from South Africa. Seychelles obtains fertilizer from Mauritius and South Africa.
- **North Africa.** Sudan imports from Libya, Egypt and Tunisia. Egypt imports from Libya and Morocco. OCP, a major Moroccan producer, has an aggressive strategy to promote and sell fertilizers within the African continent, and has dedicated more than 1 million tonnes a year to this market.



Adapted from Harrison (2018)

Figure 17. Major flows of fertilizer within Africa.

Landlocked countries depend on corridors from the major ports in neighboring coastal states. Key ports serving such corridors include Djibouti, Mombasa, Dar es Salaam, Beira, Durban, Cotonou, Lomé, Abidjan, and Dakar (Figure 17).

Cross-border trade is limited by poor infrastructure, weak economic integration, and conflict. Delays in crossing borders are attributed to inefficient custom procedures, time-consuming roadblocks or checks, and burdensome documentary requirements. This raises transaction costs and hence the cost of doing business (UNECA and AFFM 2018).

Production overview

Fertilizer production in Africa increased from 4.9 million tonnes of nutrients in 1990 to 7.4 million tonnes in 2013; this was just 4% of world production (Wanzala-Mlobela and Groot, 2013).

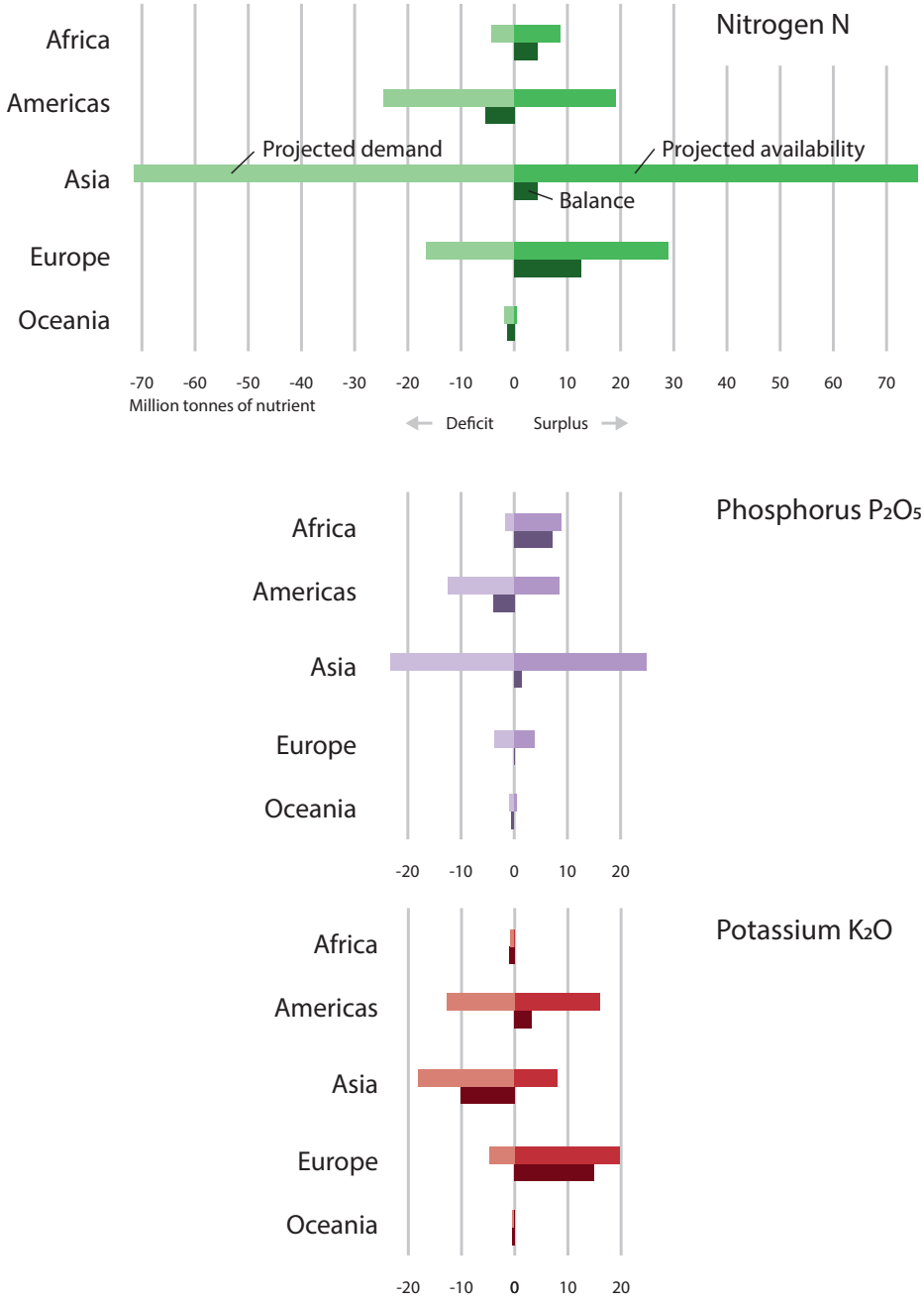
The majority of the continent's fertilizer production comes from North Africa and is marketed globally. Production is concentrated among six countries: Algeria, Libya, Egypt, Morocco, Nigeria, South Africa and Tunisia. These countries have a developed fertilizer industry and use a lot of fertilizer (UNECA and AFFM 2018). Fertilizer is produced in sub-Saharan Africa a handful of corporations; no more than four firms operate in any of the producing countries in the region.

Africa as a whole (including North Africa) is projected to have a surplus of both nitrogen and phosphorus by 2020 (Figure 18), but a deficit of potassium. This means that the continent will continue to be dependent on exporters of this nutrient such as North America, Eastern Europe and Central Asia (UNECA and AFFM, 2018).

Between 2018 and 2022, the fertilizer industry is expected to invest close to $100 billion worldwide, constructing 60 new production units and adding 78 million tonnes of product capacity. Investments are shifting from production assets to plant nutrient solutions, distribution infrastructure, customer/farmer services and added-value products (IFA 2018).

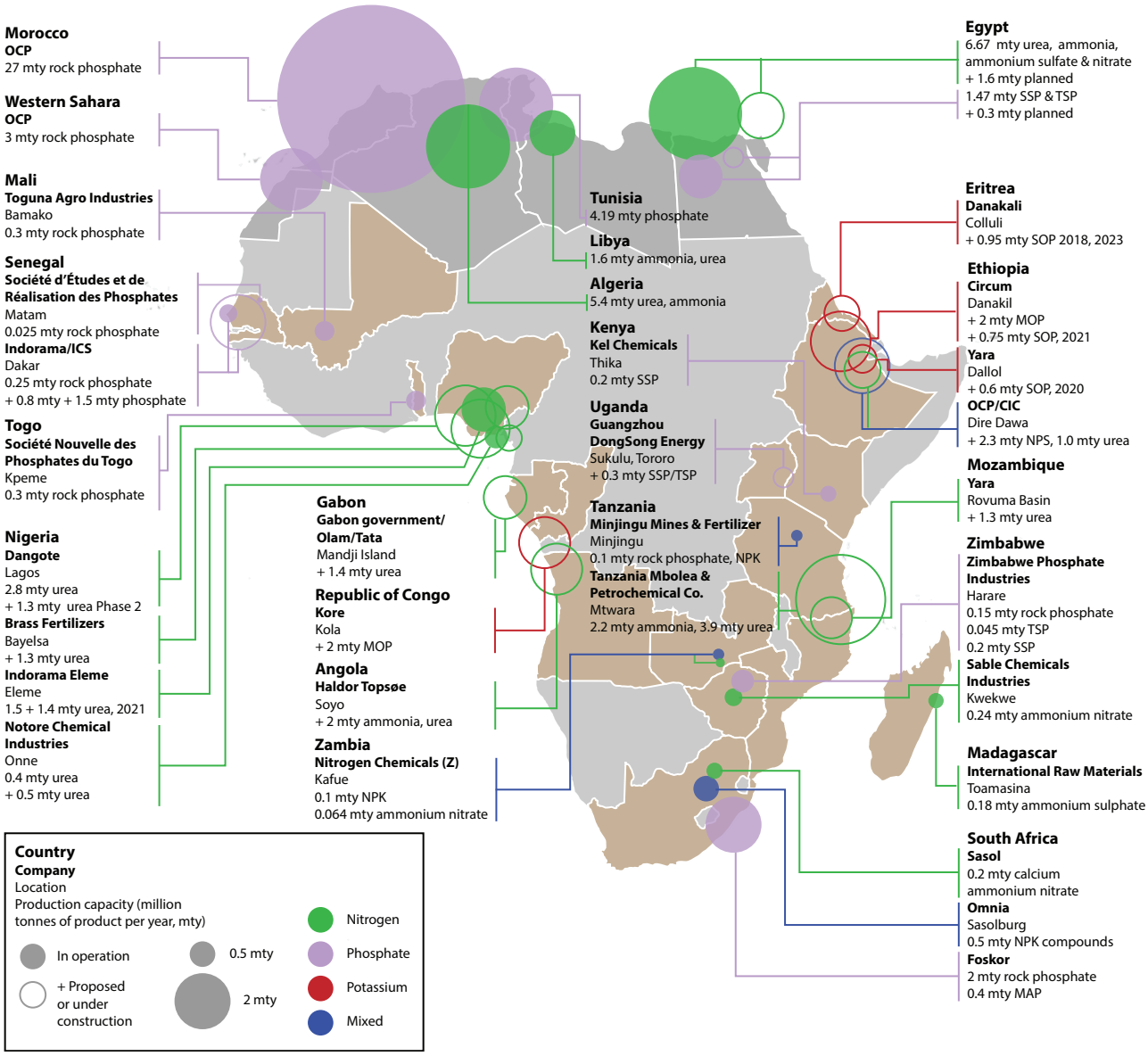
Over the past decade, major mining and fertilizer entities and smaller firms have engaged in exploration and capacity development work in Africa. The continent is well endowed with mineral and hydrocarbon reserves that could be used to produce fertilizer or to power the facilities and infrastructure needed to get it to market.

Figure 19 shows current capacity and new projects that are proposed or under construction. Even with these new projects, fertilizer production in sub-Saharan Africa will still be dwarfed by that of North Africa.



Source: FAO (2017)

Figure 18. Forecast fertilizer surpluses and deficits by continent, 2020



Sources: Chilande, G. IFDC (2018), Harrison (2017, 2018), CRU (2017), AFO (2018), Heffer and Prud'homme (2018), news reports and company websites

Figure 19. Fertilizer production capacity in sub-Saharan and North Africa: actual and planned

Nitrogen

Current production

Producing nitrogen fertilizers takes a great amount of energy: it accounted for 2% of global energy demand in 2014. Urea is produced locally from natural gas reserves in Algeria, Egypt, Libya and Nigeria. Ammonia sources in South Africa and Zimbabwe are used to manufacture ammonium nitrate and NPK/NP. Madagascar, Zambia and Zimbabwe import ammonia or ammonium nitrate to produce ammonium-based NPK fertilizer or ammonium sulfate.

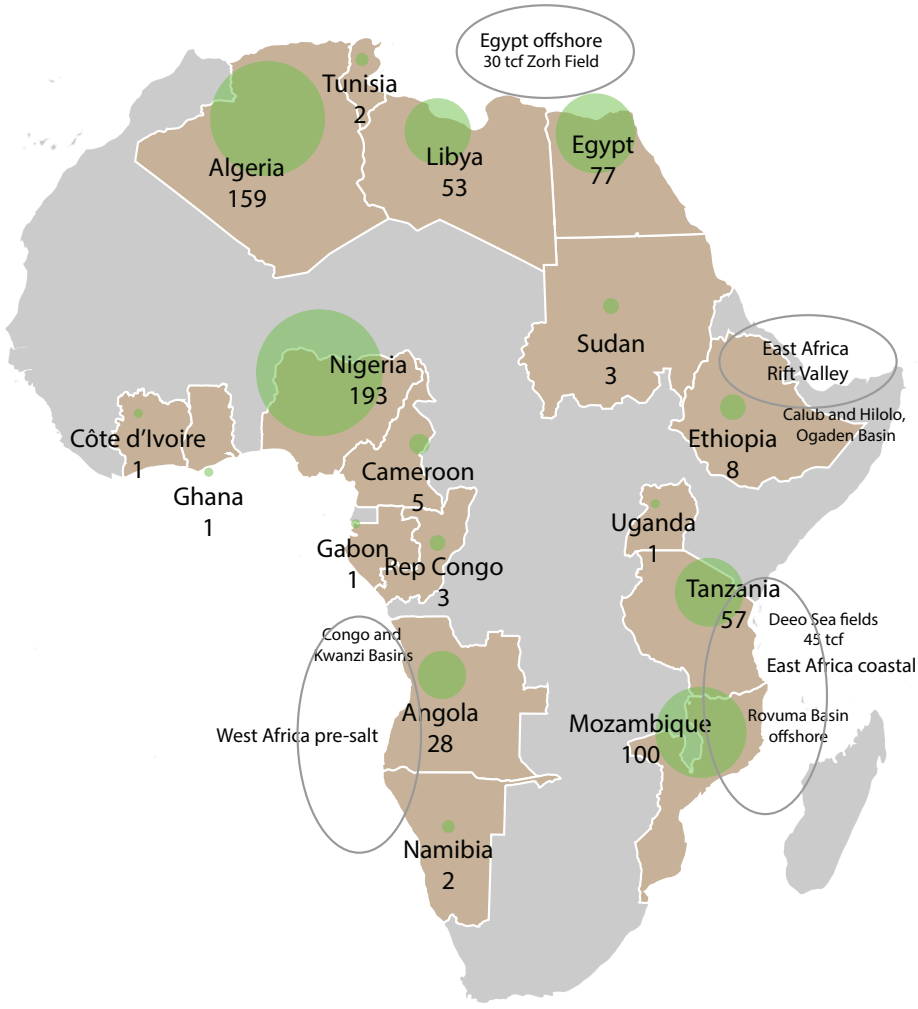
Nigeria is currently the only urea producer south of the Sahara. The country currently has two plants, run by Indorama, with a capacity of 1.5 million tonnes per year, and Notore (0.5 million tonnes per year). Nigeria exports around 0.7 million tonnes of urea a year to Brazil and Europe.

Natural gas reserves

Urea, ammonia and NPK production is based largely on using natural gas as a feedstock and energy source. Sub-Saharan Africa's gas infrastructure is underdeveloped, with only two cross-border pipelines and liquefaction plants in just three countries: Nigeria, Equatorial Guinea and Angola. But during the past decade, some of the world's biggest gas discoveries have been made in the region. In 2018, proven gas reserves were estimated at 9 trillion cubic meters (5% of the global total), of which around 70% is in deep water and 18% on land. While large gas discoveries in Mozambique and Tanzania dominate, discoveries have also been made in Angola and Ethiopia.

Natural gas reserves that could be used to make nitrogen fertilizer are found in at least 13 countries (Figure 20). Nigeria, South Africa and Angola are currently large producers of natural gas, and a few are emerging, including Mozambique and Tanzania, thanks to huge offshore discoveries.

The region has more than enough energy resources to meet its needs, but they are unevenly distributed and under-exploited. Such resource-rich countries can fuel their domestic economic development and boost export revenues. This requires more effective systems of governance; businesses often cite governance shortcomings as a constraint to investment in the continent (World Bank, 2019).



Adapted from various sources, including IEA and US EIA. Units = tcf (trillion cubic feet)

Figure 20. Natural gas reserves in 2018

By 2040, sub-Saharan Africa is expected to make the fourth-largest contribution to the additional global gas supply (IEA, 2017). Its production is projected to increase fourfold, from 58 billion cubic meters in 2012 to 230 billion in 2040. Mozambique will join Nigeria as a major gas producer. By 2040, these two countries will together account for two-thirds of the region's natural gas production. Angola is expected to be the third-largest producer (15% share), followed by Tanzania (14%). This increase in gas production will permit an increase the production of nitrogen fertilizer.

New nitrogen production plants

Over the past 8 years, several companies have shown interest in establishing new complexes to produce ammonia or urea. More than a dozen projects in Nigeria, Ethiopia and elsewhere have been under study since 2010, and several have broken ground. Large greenfield projects are under consideration in several countries, either as autonomous projects or in partnership with foreign entities; locations include Algeria, Angola, the Republic of Congo, Egypt, Ethiopia, Gabon, Ghana, Mozambique, Nigeria, Tanzania and Zimbabwe. Most of these projects aim first to feed their domestic markets, but the bulk of output would be earmarked for export, essentially aiming for markets outside Africa. Apart from those in Nigeria, none is expected to be completed before 2023.

Ammonia

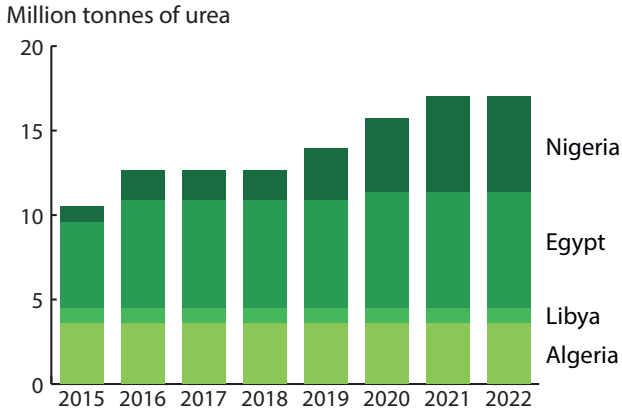
Global ammonia capacity is estimated to reach 232 million tonnes NH_3 in 2022, growing by an overall 8% compared with 2015 (214 million tonnes) (IFA, 2018). The main capacity increases are expected to take place in South Asia, North America, Eastern Europe, Central Asia, and Africa.

In 2015, Africa contributed 5% of the world ammonia capacity. This share is expected to grow to 6% by 2022, reaching 14 million tonnes NH_3 as a result of new capacity in Nigeria (IFA, 2018).

Urea

Global urea capacity is projected to increase by 8% from 2015 to 226 million tonnes in 2022. While urea capacity is declining in China, increases are planned in South Asia, Africa, North America, Eastern Europe and Central Asia (IFA, 2018).

Africa is forecast to contribute 30% of the additional global capacity between 2015 and 2022, thanks to major developments in Nigeria and Egypt (Figure 21), and in the long run in Ethiopia and probably Mozambique and Tanzania. Africa's urea capacity is projected to reach 17 million tonnes in 2022, growing by 70% compared to 2015, and equivalent to 8% of global capacity. In Egypt, Egyptian Chemical Industries Company (KIMA) plans to start commercial production at its new KIMA II unit in 2020.



Source: Prud'homme 2018

Figure 21. Projected urea production capacity in Africa, 2015 to 2022

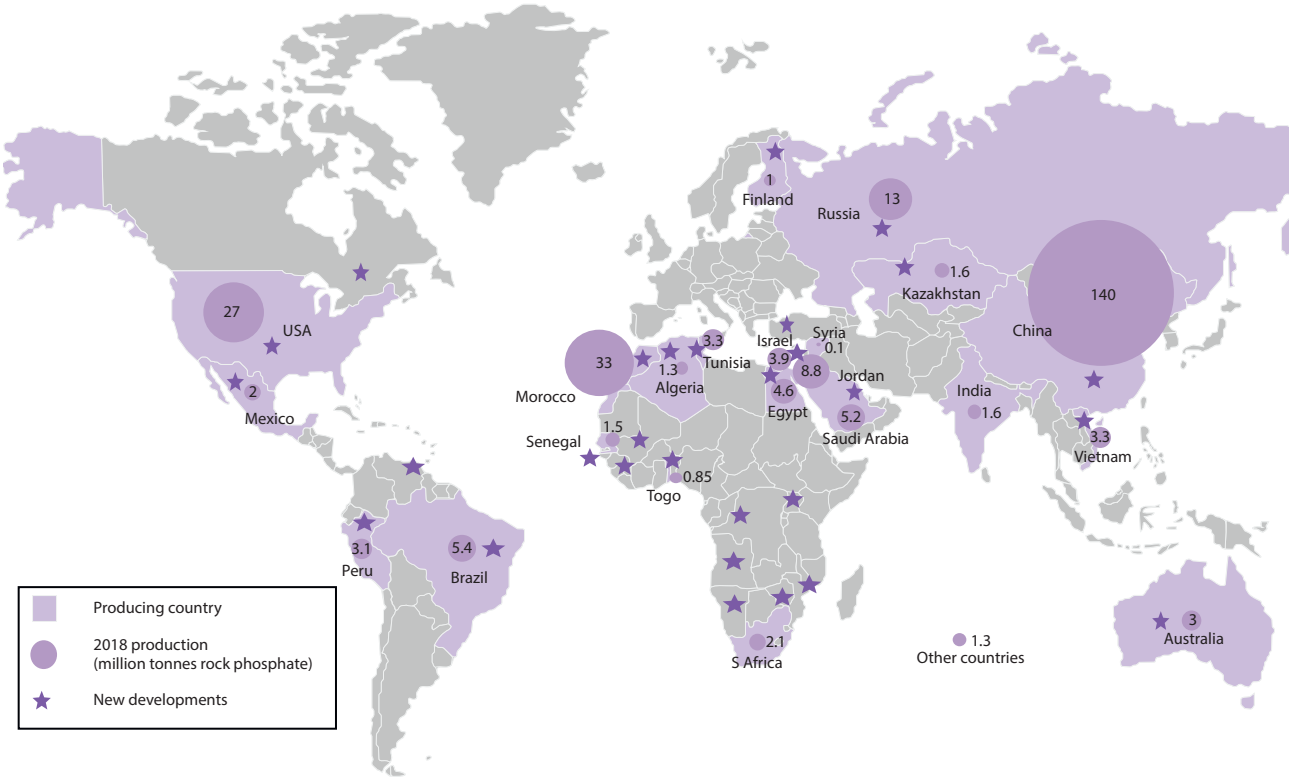
Nigeria's nitrogen industry is centered on urea. Its urea capacity is projected to increase tenfold from 2015 to perhaps 5.7 million tonnes in 2022, thanks to four new complexes that will add 5.2 million tonnes of extra capacity. This is more than sufficient to meet Nigeria's future needs. Despite the sizeable growth expected in domestic demand, the bulk of production is likely be exported. With its potential and projects under development, Nigeria is likely to become a manufacturing and export hub within the next five years (UNECA and AFFM, 2018).

Phosphorus

Current production

Commercial phosphatic fertilizers are derived from phosphorus-containing rocks that are mined, crushed and treated with sulfuric acid to make superphosphates and ammonium phosphates, or with nitric acid to make nitrophosphates.

In 2017, phosphate rock was mined in more than 40 countries worldwide. The biggest producer by far is China, followed by Morocco, the United States, Russia and Jordan. Phosphate rock extracted from sedimentary deposits accounted for 87% of global P production; the rest comes mainly from igneous rocks. In late 2016, at least 50 development projects on phosphate rock were being carried out in about 30 countries globally (Figure 22) (Prud'homme, 2016).

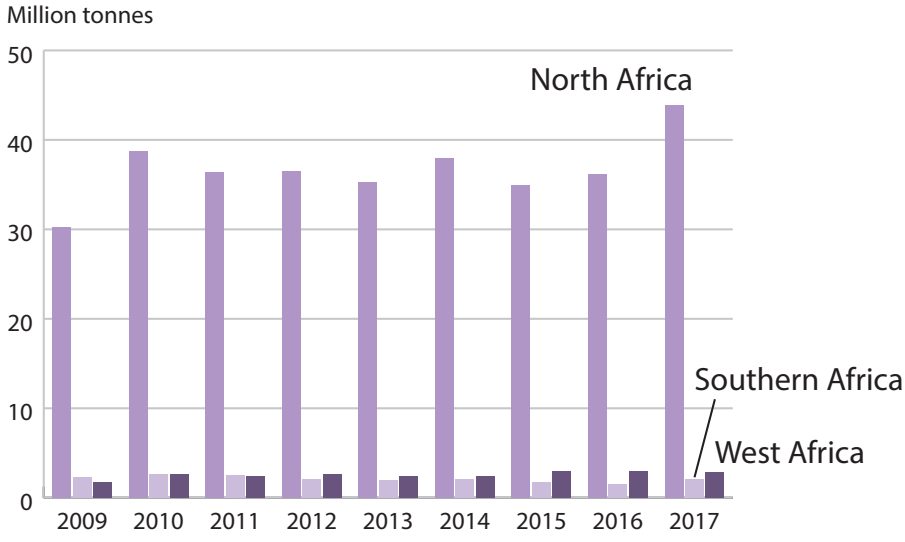


Source: Statista.com; M. Prud'homme (2016)

Figure 22. Phosphate producing countries and potential capacity developments

In 2018, Africa accounted for 23% of global phosphate rock production, with North Africa dominating. OCP, a Moroccan firm, accounts for 29% of global phosphate rock exports; it has a production capacity of over 32 million tonnes and plans to increase this to 55 million tonnes (IFA, 2018).

Other major producing countries in Africa are Egypt (phosphate rock, SSP), Algeria (phosphate rock), Tunisia (processed phosphates and phosphoric acid) and South Africa (phosphate rock). Mali, Senegal and Togo also produce phosphate rock. Plants in Kenya, South Africa and Zimbabwe manufacture SSP, TSP or monoammonium phosphate.



Source: IFASTAT (2018)

Figure 23. Phosphate rock production by African sub-regions, 2009–17

Phosphate reserves and resources

Estimates of global reserves and resources vary widely: between 16 and 100 billion tonnes of reserves, and between 50 and 350 billion tonnes of resources (Van Kauwenbergh, 2010; USGS, 2008–18; Prud'homme, 2016). Africa has by far the largest share: up to 85% of reserves and around two-thirds of resources (Box 2, Figure 24).

Box 2. Mineral reserves and resources

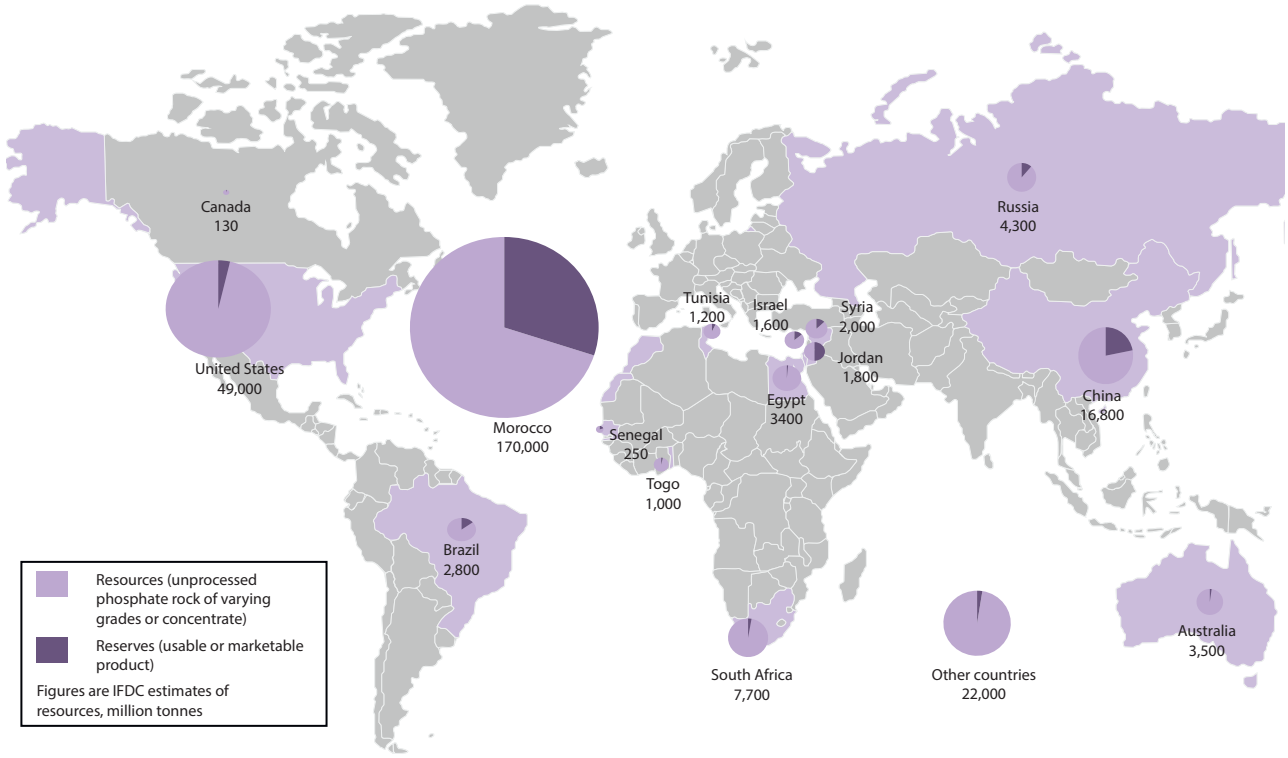
In mining parlance, a **reserve** is a mineral deposit that is valuable **and** legally, economically, and technically feasible to extract.

A **resource** is a broader measure: it is potentially valuable, and for which reasonable prospects exist for eventual economic extraction. Resources are thus considerably larger than reserves.

Morocco dominates the world's phosphate reserves and resources. But more than 30 countries in Africa have some phosphate deposits of commercial significance. Outside Morocco, substantial deposits also occur in Algeria, Egypt, South Africa, Senegal, Tanzania, Togo and Tunisia. There are only a few phosphate deposits of economic significance in East Africa (Uganda, possibly Ethiopia) and Central Africa (Republic of Congo, DR Congo, Gabon). More detailed descriptions of the geological occurrence in sub-Saharan Africa are available in Van Kauwenbergh (2006 and 2010), Notholt et al. (1989) and van Straaten (2002).

New phosphate production plants

Various on-going projects are expected to add to global production capacity. If all are completed, global capacity may by 2030 reach 400 million tonnes per year of phosphate rock concentrates. That compares to an actual production of 209 million tonnes in 2017, out of a capacity of 250 million tonnes. Africa and West Asia together will account for 76% of the capacity increase. Latin America and Eastern Europe/Central Asia will both account for 11% (Prud'homme 2016, 2018).



Adapted from Van Kauwenbergh (2010)

Figure 24. World distribution of phosphate resources and reserves

Africa will see the largest increase of more than 20%—adding 11 million tonnes a year over a five-year period (2017–2022) of new potential supply, to reach 67 million tonnes by 2022. The largest on-going capacity projects are mainly in North Africa, notably in Morocco, Egypt, Algeria, and Tunisia, as well as Senegal and South Africa. It is projected that by 2020, potential phosphate rock supply will reach 61 million tonnes, with most coming from Morocco, followed by Algeria, Egypt, Senegal, Togo and Tunisia (UNECA and AFFM, 2018).

Pre-production work has been done in several countries with large phosphate reserves, including Guinea Bissau, Mali, Togo and Uganda. None of these are expected to start before 2022 (Prud'homme 2016, 2018).

Potassium

Current production

There is currently no commercial production of potassium anywhere in Africa, except a few secondary sulfate of potash plants in Egypt that use imported potassium chloride (UNECA and AFFM, 2018).

Potash reserves and resources

Potash rock is mined worldwide, typically in shaft mines, to produce potassium. In 2018, the US Geological Survey estimated global potassium resources at about 250 billion tonnes and reserves recoverable with existing technology from known deposits at approximately 4 billion tonnes K_2O. Canada accounts for 26% of the reserves; Russia for another 13% (Orris et al. 2014, USGS, 2017).

Exploitable potassium ores occur in Western Africa (Niger), Eastern Africa (Ethiopia, Eritrea), North Africa (Morocco, Tunisia, Libya and Egypt) and Central Africa (Republic of Congo). None was identified in Southern Africa (Van Kauwenbergh 2006). Deposits in the Danakil areas on the Ethiopia/Eritrea border are shallow enough for open-cast mining methods to be used.

New potassium production plants

Since 2008, exploration and pre-production development have centered on the Republic of Congo, Eritrea and Ethiopia. In 2018–19, interest in potassium deposits emerged in Morocco and Tunisia, leading to intensified exploration in these countries. IFA predicts that no potash mining operation in Africa would come into production before 2023 (Prud'homme, 2018).

Lime and organic fertilizers

Soil acidity, with its associated elemental toxicities and nutrient deficiencies, harms crop growth and limits agricultural productivity (AGRA, 2016). In addition to traditional artisanal production, there is industrial lime production in some sub-Saharan countries (Rwanda, Kenya and Tanzania) where soil acidity is severe.

About a dozen plants in sub-Saharan Africa produce organic fertilizers. These include Safisana in Ghana, Orgafert of PROFEBA in Mali, and Éléphant Vert in Mali, Senegal and Côte d'Ivoire (AFO, 2019).

Blending

Current production

A network of fertilizer blending plants process imported or locally produced fertilizer into balanced NPK blends throughout Africa. In 2019, AfricaFertilizer.org (AFO 2019) lists 80 such plants throughout sub-Saharan Africa outside South Africa (other plants exist but are not listed) (Figure 25). These use pre-manufactured ingredients to formulate products for end use.

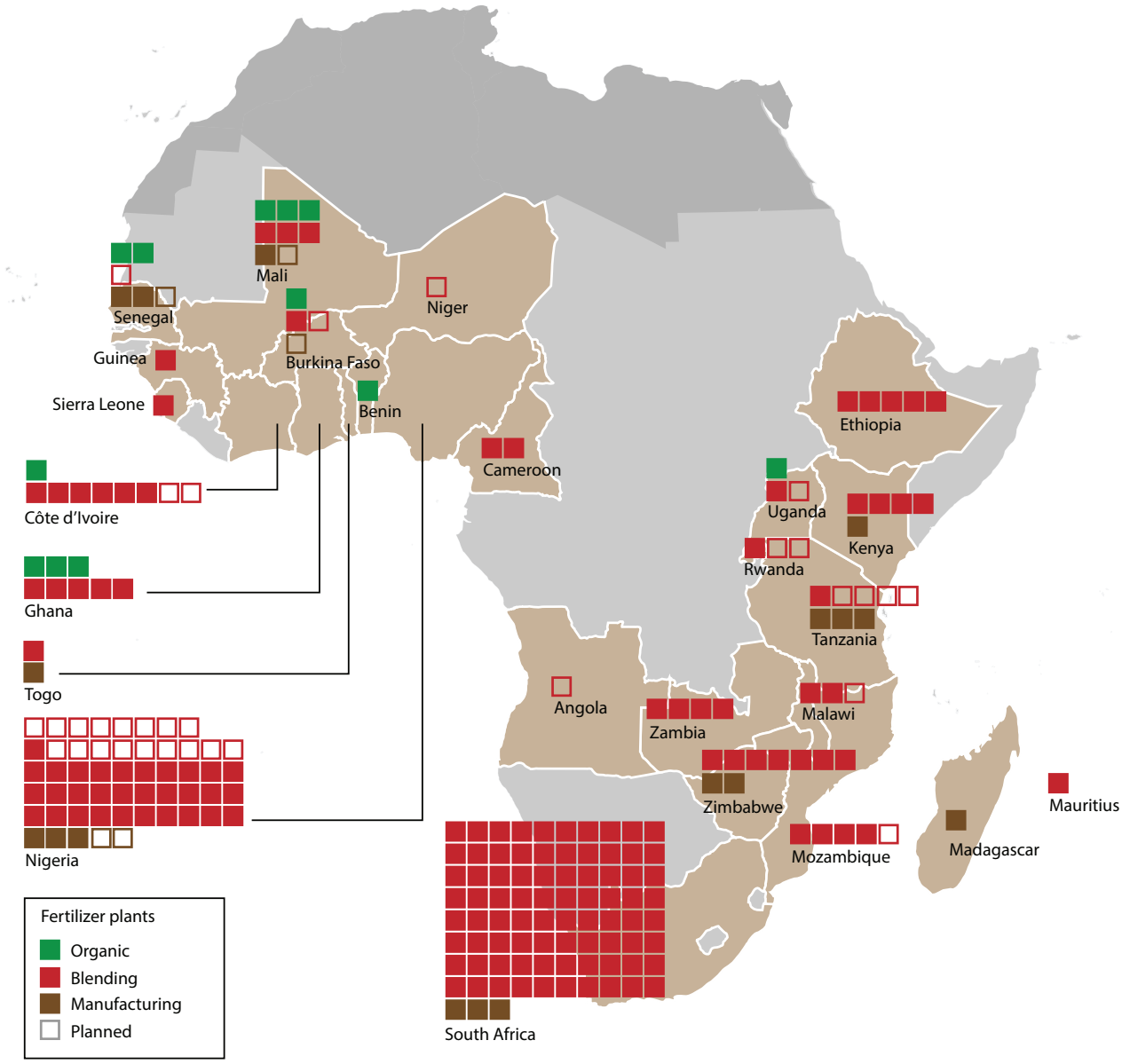
Southern Africa. There are over 80 blenders in South Africa. The majority operate on a micro-scale and serve individual farmer cooperatives across the country.

There are four blending plants in Zambia. Nitrogen Chemicals of Zambia (NCZ), a state-owned company, has two plants. The company imports most of its raw materials to produce Compound D (NPKS). It currently produces around 100,000 tonnes of Compound D and 40,000 tonnes of ammonium nitrate per year, well below its installed capacity of 252,000 tonnes annually for Compound D and 62,000 tons for ammonium nitrate. Discussions are ongoing on the need to revamp the firm to increase its capacity.

Yara has two blending plants with a total installed capacity of 500 tonnes per day, together producing 67,500 tonnes per year (also well below capacity). Zambian Fertilizer Limited has a blending facility in Lusaka with a capacity of 8 tonnes per hour that produces crop-specific blends for the Zambian market. It currently produces 8,000 tonnes of fertilizer a year.

Southern Africa, Mauritius, Malawi, Mozambique, Zambia and Zimbabwe also have blending plants.

West Africa. Nigeria is where the industry has received the most investments the last three years, with more than 30 operations throughout the country.



Data source: AFO (2019)

Figure 25. Fertilizer manufacturing blending plants in sub-Saharan Africa, 2019

However, blending competencies are still lacking since the blends produced are not many. Mali, Ghana and Cote d'Ivoire also have several blenders, Burkina Faso has two, and Togo and Guinea one each (CRU, 2017).

East Africa. Four blending facilities in **Kenya** have a total capacity of 230,000 tonnes per year. But actual production is much lower than this: each plant produces only between 3,000 and 10,000 tonnes a year. In 2017, one of the firms started building a granulation plant in Nakuru. Toyota Tsusho started producing multi-nutrient blends in Eldoret targeted to maize, barley and potatoes in Rift Valley and Western Kenya in 2016.

Grain Pulse installed a blending plant in 2017 in **Uganda**. A phosphate production project in Tororo is in the pipeline, but the phosphate rock has high iron levels and will only make SSP. This initiative has been slowed by land-settlement issues, and the completion date is unclear.

Five blending plants have been set up in **Ethiopia** to serve its main cereal-producing regions. Blends produced for the Tigray region, for example, include NPS, NPKSB, NPKSZn and NPKSBZn.

Central Africa. Along with other components of the fertilizer industry, blending facilities are rare in Central Africa. **Cameroon** has two facilities.

Planned blending facilities

More than 30 new plants are planned in sub-Saharan Africa, more than half of them in Nigeria (AFO, 2019). The success of blending industry depends on various factors. Key among them are:

The availability of soils information. Fertilizer blends must be tailored to specific soils' nutrient requirements characteristics and crops. However, there is lack of soil maps and soil testing facilities for key chemical properties and nutrient content/requirement. A study of 11 countries carried out by IFDC and AFAP (2018) found that such information was "excellent" or "good" in only five: Ethiopia, Tanzania, Rwanda, Ghana and Nigeria (Table 11). In the remaining six countries, the information base was seen as "fair", "marginal", or "poor".

Overall, Southern Africa is in the best position with a status of "good" compare to East or West Africa where it is "fair". Within the region, there are differences between countries. In East Africa, Kenya and Rwanda have the best conditions; in West Africa, Ghana and Mali.

Supply constraints and opportunities

Location of mineral endowments

Obviously, the production of fertilizers is limited by geology: the presence of oil and natural gas fields for nitrogen, phosphate rock for phosphates, and potash ores for potassium. Exploitable deposits are restricted to certain locations in Africa. The most attractive deposits are either near the coast (where the product can be loaded onto ships for export) or in areas with adequate infrastructure (as in South Africa). Few fertilizer plants are located inland – a distinct disadvantage for landlocked countries.

However, some landlocked countries do have substantial mineral reserves that offer a good potential for exploitation. Such countries may not need to engage in fertilizer production themselves; they could instead develop joint ventures with their coastal neighbors that generally have better infrastructure, so taking advantage of production specialization and mutually beneficial development. The African Union could facilitate instruments that would make such cooperation possible.

Infrastructure

The lack of infrastructure is a severe constraint to production in many countries. Fertilizer plants are large-scale investments that typically have to install their own power supplies and own road or rail links, wherever they are in the world. But many places in Africa lack the supporting infrastructure that is available elsewhere: ports; an adequate, well-maintained road and rail network; communications facilities, transport companies with more than one lorry; warehouses with the necessary equipment.

Table 11. Status of factors affecting the blending industry in 11 selected countries across Africa

	Availability of soils information	Viable blending industry	Ingredient availability	Products ready for validation	Policy and regulations	Overall
East Africa						
Kenya	3	1	1	3	3	2.2
Rwanda	1	2	2	2	4	2.2
Ethiopia	1	3	3	3	5	3
Uganda	3	3	3	4	3	3.2
Tanzania	1	5	5	4	5	4
Southern Africa						
Mozambique	4	1	1	4	1	2.2
Malawi	3	1	1	4	4	2.6
West Africa						
Ghana	1	3	1	4	4	2.6
Mali	4	1	1	4	4	2.8
Nigeria	2	3	3	4	3	3
Burkina Faso	5	2	2	4	4	3.4

1 = Excellent	2 = Good	3 = Fair	4 = Marginal	5 = Poor

Adapted from IFDC and AFAP (2018)

Companies must also take care of housing and education facilities for staff and their families, water supplies, sewerage services, etc. All this pushes up costs.

Current or planned road and railway projects include the Addis Ababa–Djibouti railway, trans-Sahelian road projects, and roads to link the North Africa with the rest of the continent.

Ports

Africa has relatively few deep-water ports with adequate facilities to handle fertilizer imports. Other problems include congestion, hight port charges, the time and cost of securing licenses and clearing imports, and getting access to finance. Transport links to the port hinterlands are often inadequate. It may take at least 30 days between a ship's docking in the port and the arrival of the fertilizer at its destination inland.

New developments aim to increase capacity and improve accessibility. In Djibouti, new ports at Tadjoura and Doraleh were opened in 2017; the Addis–Djibouti railway was completed in the same year. These will facilitate the export of potash from Ethiopia and the transport of fertilizers inland. Improvements are being made in the Beira corridor in Mozambique and the ports of Dar es Salaam in Tanzania, Tema in Ghana and Lomé in Togo (AFAP-IFDC, 2018). These improvements have strengthened, or promise to strengthen, trade between coastal and landlocked countries in East, West and Southern Africa. However, the challenge of road infrastructure remains.

Finance

It takes a huge up-front investment to develop production capacity for fertilizer. A world-class ammonia/urea complex with a capacity of 2 million tonnes a year costs more than $2 billion. The scale of such investments, the expertise required, and the perceived risk of operating in Africa, limit the number of firms that are able to invest in the fertilizer production business *(see Chapter 5. Fertilizer supply)*.

The high cost of capital also restricts the number of local traders that are able to import fertilizers. High interest rates, stringent collateral requirements and limited access to domestic financing make it difficult for local traders to become major importers (UNECA and AFFM, 2018). Interest rates may be 15–28% in Africa, compared to just 5–7% in Thailand. Strict collateral requirements of up to 150% minimize the risk to lenders (Wanzala and Bumb, 2011).

As a result, a limited number of players are able and willing to invest in fertilizers. This gives them economies of scale but tends to create natural monopolies in small markets: larger companies with access to international and internal financing tend to dominate the market.

Key financing institutions (the African Development Bank, World Bank, etc.) and technical partner institutions such as the African Fertilizer and Agribusiness Partnership and Africa Fertilizer Financing Mechanism are already active in the fertilizer sector. They need to revive dormant projects and reconsider their approaches in order to make investment funds accessible to fertilizer manufacturers.

Fragmented market

Most fertilizer markets in Africa are small. The projected nutrient consumption for all of Africa in 2018 was 7 million tonnes: just 4% of the world fertilizer consumption (IFA 2019). Nigeria, Ethiopia, Kenya, Mali and to some extent Ghana were the main fertilizer consumers in 2017 (AFO 2018). But this level of demand is too low to trigger the types of investment needed to achieve agricultural transformation in these countries. That is why local producers of fertilizer find it more profitable to serve distant bulk markets instead of supplying fragmented domestic markets or neighboring countries. Because importers have to order in small batches, they are forced to pay higher prices on the world market.

Several regional economic communities (ECOWAS, COMESA and SADC) are working to develop regional trade which will improve the size of markets.

Government intervention

Many African governments fear that the private sector cannot supply agricultural inputs in a cost-effective way. Accordingly, they intervene heavily in the fertilizer market: importing fertilizers or delivering them to farmers at subsidized prices (World Bank and ARD, 2006). This crowds out private-sector investment. Cartels, monopoly and government control over fertilizer imports and distribution also feature in much of sub-Saharan Africa.

Inappropriate policies

Policies in a number of countries are outdated, or are not specific to fertilizers but cover a wide range of inputs and foodstuffs under the same law. This causes delays in the validation and registration of imported fertilizer, limits inter-country trade, and

restricts the range of products available for the market. This in turn restricts the market size and leads to higher fertilizer prices (IFDC, 2013) *[see chapter 8: Fertilizer policy]*.

Even where suitable regulations and laws exist, enforcement is frequently poor. This is often due to inadequate human capacity or facilities such as laboratory equipment (IFDC, 2013).

Governments that provide subsidies often procure fertilizer in bulk, even though they have limited technical capacity.

Tariff and non-tariff barriers

Trade policies are generally liberal in Africa, and most countries have removed trade tariffs on fertilizers. The regional economic communities EAC, ECOWAS and COMESA have removed tariffs on fertilizers within their regions. However, non-tariff barriers have been a major bottleneck to trade and consumption of fertilizer as well as other goods and services (UNECA and AFFM, 2018).

The African Union has launched the Continental Free Trade Area to create a single continental market for goods and services, with free movement of businesspeople and investments. When this becomes operational, it will improve intra-African trade by removing tariffs and liberalizing trade.

Conclusions

While the continent of Africa produces more fertilizer than it consumes, the vast majority of production is in North Africa. The rest of the continent must import what it uses. Markets in the region are fragmented and intra-regional trade is weak. But new phosphate and potash mines, and manufacturing facilities based on natural gas discoveries, promise to increase production capacity significantly in North, East and West Africa. Much of this new production will be exported from the continent, but some will supply domestic needs or demand in neighboring countries.

Blending is also growing fast, powered by the increasing availability of soil information (which makes it possible to design blends suited to local needs), and improvements in the supply of ingredients and in product-validation processes.

Further progress will depend on improved port and transport facilities, as well as access to finance, and policies that encourage production and trade – all of which promise to lower costs for the farmer. Increasing demand will also be key: many fertilizer plants in sub-Saharan Africa currently operate at below capacity.

Africa's nations need to line up together to put their comparative advantages to work, start producing from their natural resources, and supply their own

national, regional and sub-regional markets. The Continental Free Trade Area offers a solution when it becomes a reality; it will help remove the non-tariff barriers which constitute a major bottleneck for trade in the region.

Recommendations

- Intra- and inter-regional trade policies should be revised to correct the current situation, where most production is exported outside the continent. Traditional trade links built on colonial ties should be bypassed, and inter-regional trade should be promoted so that neighboring countries and other regions in Africa can procure the fertilizer they need.
- The private sector in each country should develop a new trade perspective out of existing inefficient business links. Agrodealers and other rural entrepreneurs need to trigger farmers' demand for new fertilizer products, especially blends.
- Governments should put in place the right policies and regulations for infrastructure development, financing, etc. Policies should favor agriculture but avoid direct interventions in the fertilizer sector. Rather, public–private partnerships are needed to improve the private sector's capacity to develop cost-effective fertilizer procurement and distribution systems.
- The African Union and its regional economic communities should reinvigorate current and planned road and railway projects, including trans-Saharan links.
- Proactive and effective high-level financial arrangements and mechanisms will be key. Financing institutions and technical partners should revive their dormant projects and reconsider their approaches in order to make investments funds accessible to fertilizer manufacturers. Governments should enable these mechanisms to be implemented more effectively.

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6. Fertilizer distribution

Ayodele Balogun, Asseta Diallo and Rebbie Harawa

Distribution systems move fertilizer product from the source of production (the port, domestic production plant or blending unit) through a chain of distributors, warehouses, retailers and to the farmers who apply it on their fields.

We can group distribution systems into three main categories:

- Private systems that seek to serve individual farmers,
- Government bulk-procurement systems that deliver fertilizers to known farmers or farmer groups,
- Private bulk-procurement through "anchor" crop buyers and plantations (IFDC and AFAP 2018).

This chapter first describes each of these approaches. It then poses the frequently asked question: "why can't fertilizer be sold like Coca-Cola, which is available nearly everywhere in Africa?". It then goes on to comparing private and government-run distribution systems.

Private sector distribution

In this system, the private sector handles the flow of fertilizer from the source to the farmer (consumer) (Figure 26). Each organization in the chain aims to make a profit. Fertilizer flows from the source, through distributors, warehouses and retailers to farmers. Orders and money flow the other way.

At the far end of the chain (at the right side of Figure 26), individual smallholders may buy directly from agrodealers, who obtain supplies from a wholesaler. Larger farmers are more likely to buy in bulk from the wholesaler. Members of farmer groups may get their fertilizer from a cooperative, which obtains it from the wholesaler (or perhaps directly from the fertilizer importer, producer or blending plant). The wholesalers typically act as hubs serving a particular region of the country.

There may be several actors in the chain, especially in remote areas, where the fertilizer passes through more hands before it reaches the farmer. This adds to the cost of the product, as each actor needs to earn

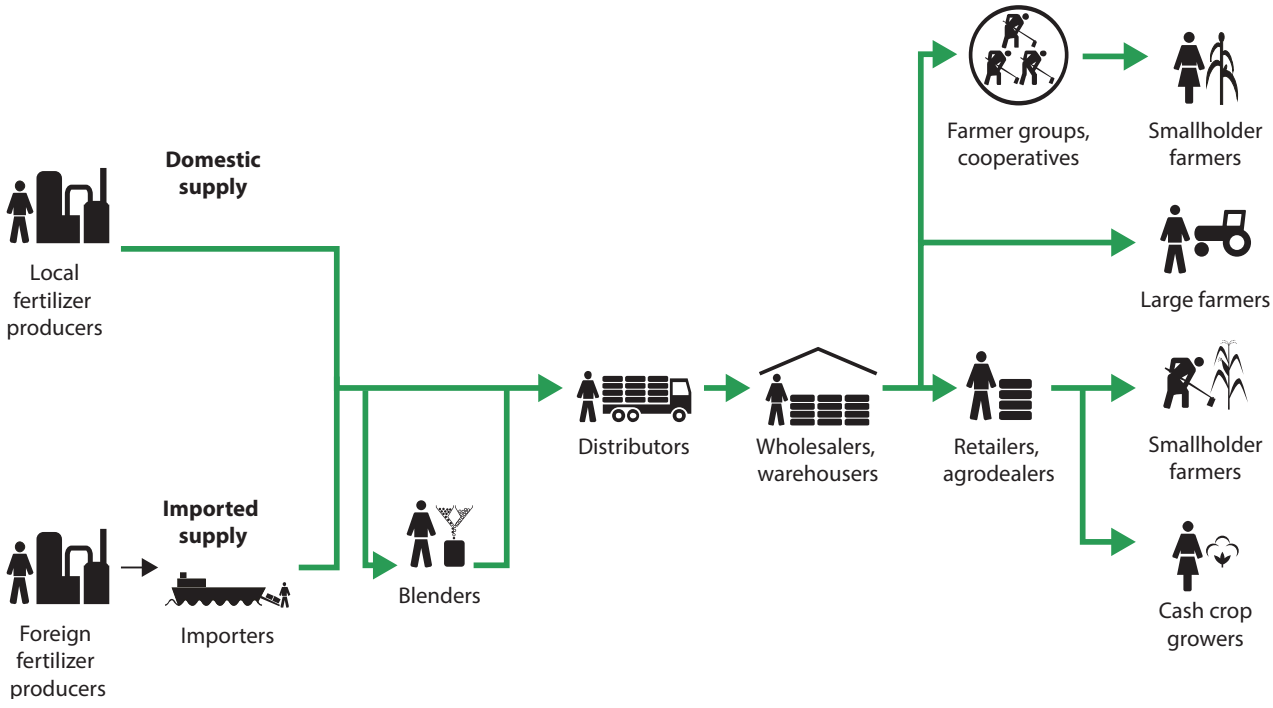

Figure 26. Private-sector distribution system

a profit. Remote locations also tend to suffer from poor roads, costly, inefficient and unreliable transport, and a lack of infrastructure such as electricity, mobile-phone connectivity, warehouses and banks. All these also push up the price and make it less likely that fertilizer will be available when it is needed (IFPRI 2012).

Some private trade relationships have existed for years and are strong, others–again especially in remote areas–are weaker. Where relationships are strong, the wholesaler is more likely to give retailers trade credit: allowing the retailer to pay for a consignment of fertilizer after the retailer has sold it and received the cash. Where relationships are weaker and volumes lower, wholesalers are less likely to offer such credit.

Government distribution

In many countries, the government is a major actor in the fertilizer value chain (Figure 27). It procures fertilizer from foreign manufacturers, importers or domestic producers and distributes it to farmers, often at a subsidized price. Such subsidies often consume a large chunk of the government's budget for the agricultural sector. Ten African governments spend roughly $1 billion annually on input-subsidy programs, amounting to 28.6% of their public expenditures on agriculture (Jayne and Rashid 2013). A special case was Nigeria, where "between 1990 and 1996, the fertilizer subsidy cost as a percentage of the national budget ranged from 16.8% in 1991 to a high of 42.7% in 1992" (Nagy and Edun 2002).

Government systems have traditionally supplied generic products to farmers. These products flow either through the government's own network of warehouses and distributors, or through private warehouses and dealers that store and distribute the fertilizer for a fee. In both cases, the distribution partners do not carry out any marketing activity; they are paid as service providers.

The government may target fertilizers for a particular region, crop or category of farmers – such as members of cooperatives or farmer groups. The intended beneficiaries may or may not be identified individually. Since the first decade of this century, governments have been trying to target farmers better – for example, by giving farmers vouchers they can use to purchase subsidized fertilizers from dealers.

Such systems are subject to corruption (officials sell subsidized fertilizers at market prices) and leakage (farmers divert the fertilizers to crops other than those intended, or sell them to someone else). Smuggling of cheap fertilizers across the border to where they can fetch a higher price is a problem in some locations. Anecdotal evidence suggests that the illegal flow of subsidized fertilizers from Ghana to Burkina Faso could be higher than 20% of the total subsidized volumes.

Most fertilizer-distribution systems in Africa were set up to deliver government-owned products and were managed directly by the government. While such systems purport to serve farmers, the farmers themselves have no influence on how they operate.

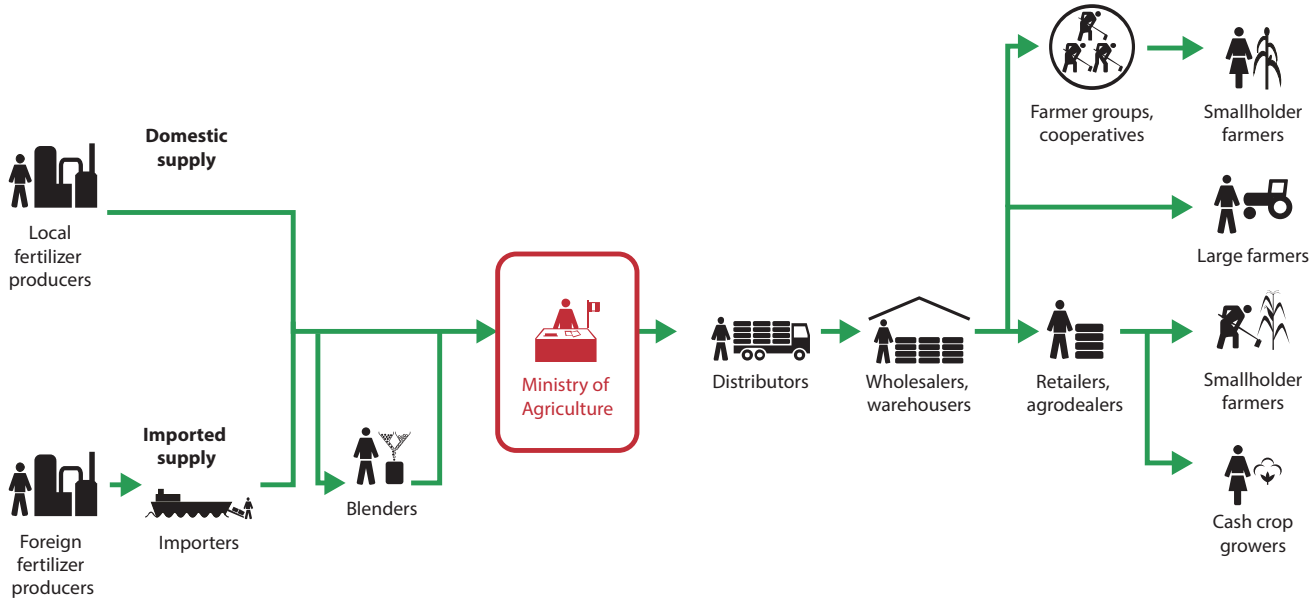

Figure 27. Government distribution system

The delivery system regards the farmer simply as the endpoint in the supply chain, not as a customer to keep satisfied. There is no penalty for inefficiency, and there is no incentive for the delivery system to improve.

Bulk procurement by plantations or anchor buyers

The third type of distribution system also involves bulk procurement, through large plantations or "anchor buyers" (Figure 28).

The **plantation** bulk-procurement system serves either large, commercial farmers or a farmer association. The plantation selects fertilizers based on its own needs, and procures the product through a competitive tender process from an importer, domestic manufacturer, blender or distributor. The fertilizer is usually delivered to a warehouse owned by the plantation. Depending on the volumes, the delivery system may be short and efficient, bypassing some intermediaries within the distribution system. The plantation uses the fertilizer on its own land; it may also distribute to outgrowers.

Anchor buyers are companies that process or export the output of individual farmers or farmer groups. The company contracts with the farmers to grow particular crops. It supplies them with inputs such as seed, fertilizer and credit, and agrees a purchase price with them.

These procurement systems give organized farmer groups and commercial farmers the opportunity to buy cheaper fertilizers by shortening the supply chain and negotiating bulk discounts. This in turn enables the farmers to grow crops more cheaply, produce higher-quality products, and negotiate higher output prices. The system thereby becomes self-funding. The suppliers and farmers are able to get bank finance or trade credit because of the system.

On their own, such systems complement private-sector distribution. The volumes are not large enough to create a distortion but are big enough to create competition between private suppliers, distributors and wholesalers. Some farmer credit is usually included in the plantation system, either directly from the plantation or through banks (with the plantation company guaranteeing the credit). The reputation of the plantation usually allows the supplier access to a trade finance facility from a bank.

In some countries, the government considers plantation crops as strategic and gets involved in the procurement process, usually by introducing subsidies and by increasing the number of farmers involved. When this happens, the dynamic changes. The number of target farmers rises significantly, and the procurement process comes under government influence and loses efficiency. Apart from government officials intervening, the subsidies create an arbitrage market that is attractive for suppliers. Governments may also choose to intervene in anchor-buyer systems when the product is considered strategic. An example is cotton in Burkina Faso and Mali, where the governments subsidize inputs for the cotton companies.

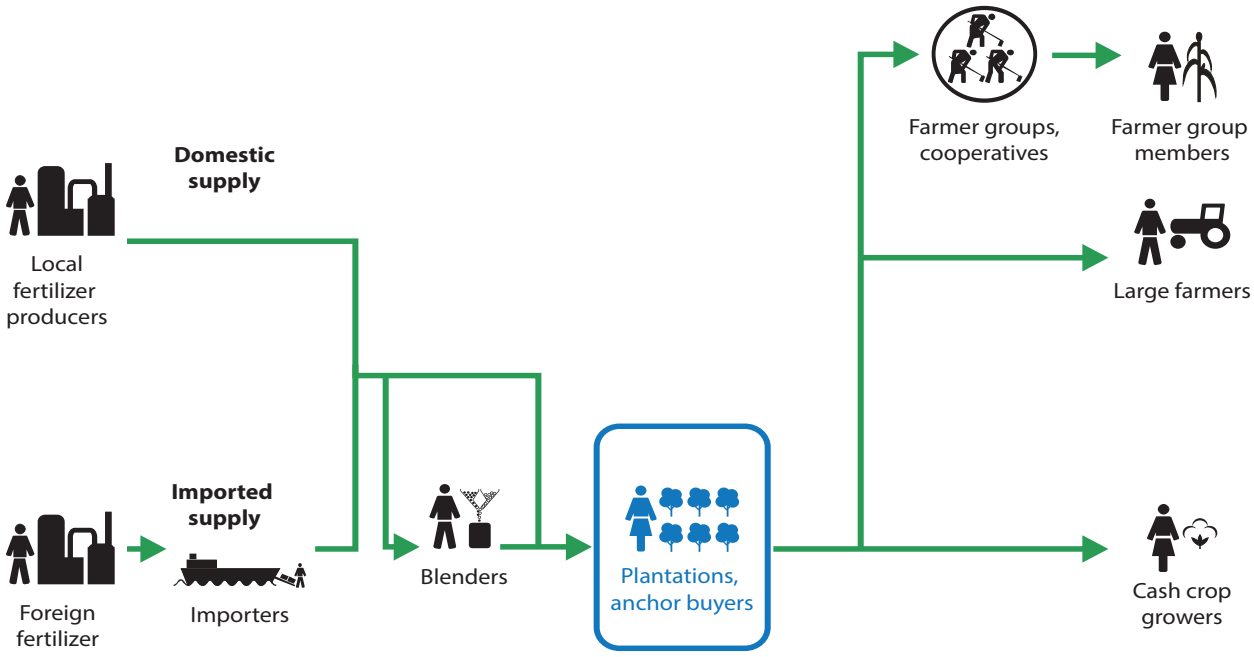

Figure 28. Private bulk procurement system

Fertilizers vs Coca-Cola

Getting fertilizers to farmers has been an enduring problem in developing Africa. Policymakers are made more intolerant of the failures of fertilizer availability by the success of consumer goods such as Coca-Cola, which can be found even in remote villages.

Though fertilizers and fast-moving consumer goods are strategically different, they share consumers and have similar distribution chains. Nevertheless, fertilizers are scarce whilst Coca-Cola is ubiquitous. Can fertilizers be distributed like Coca-Cola? Can fertilizer benefit from the success of the distribution of Coca-Cola?

The general rule is that the marketing of a product is to stimulate adoption and repeated use of the product. Marketing professionals often use the "four Ps" of the "marketing mix" (McCarthy 1960) to analyze and plan marketing strategies:

- **Product:** the characteristics of the product and their appropriateness to meet consumers' needs
- **Pricing:** the price of the product to consumers
- **Place:** the location where the consumer can obtain the product
- **Promotion:** marketing communication such as advertising, training and sales promotion.

The factors that affect demand and supply for fertilizer and Coca-Cola are different, but the marketing principles are similar. Table 12 compares the two.

Table 12. Fertilizer and Coca-Cola marketing decisions

	Fertilizers	Coca-Cola
Consumers		
Target consumers	Farmers	All rural and urban people above a particular age (not infants)
Product		
Type of product	Type of product to use depends on soil conditions and crop type, which may be unknown	Single, uniform product. (Other products also available to match consumer preferences)
Competing products	Few or none	Many: other fizzy drinks, fruit juice, tea, water…
Production constraints	Raw materials: natural gas, suitable mineral ores	Water, imported concentrate
Decision to consume	Risky. Based on an objective analysis of the value created by fertilizer as a production input	Hedonistic: reward centers in the brain triggered by consumption
Technical knowledge required	Complex: must match crops, soils, cultivation methods and complementary products	Simple: must know how to open a bottle or can
Benefit	Long-term, deferred by several months: improves yields at harvest-time Uncertain: effect on yield subject to weather, pests and other factors	Momentary, immediate: quenches thirst now Certain (unless you drop the bottle)
Price		
Price level	A costly input into a survival business. An investment decision	A relatively cheap recreational (and impulse) purchase
Price variability	Price varies by location	Price varies by location
Place		
Distribution network	Government influenced. Disparate actors. Relatively few retail outlets	Private. Large organization managing distribution partners. Strong relationships from manufacturer to retailer. Many retail outlets
Seasonality	Highly seasonal demand; requires storage and transport at right times of year	Non-seasonal; storage and transport even all year round
Promotion		
Communication	Little marketing effort. Costly per consumer, fragmented and inadequate overall	Cheap per consumer but considerable and organized brand spend overall
Government involvement	Strategic product, therefore heavy government involvement in control, communication, subsidy and distribution	Consumer item, limited government involvement

On the surface, the utility of such consumer goods should be less than that of fertilizers. Coca-Cola gives the consumer an immediate, momentary feeling of satisfaction, while fertilizer is an investment that can significantly increase the farmer's income (and enable him or her to buy lots more fizzy drinks). But while a Coca-Cola quenches your thirst now, you have to wait for several months to get the benefits of applying fertilizer. Even then, the benefits are uncertain: the crop may not respond to the fertilizer, or it may fall victim to the weather or pests before you can harvest it.

The Coca-Cola Company spends significant resources on creating consumer value through promotion and distribution: mass communication, consumer and trade promotions, maintaining a large organization to manage distribution, training distributors, investing in distribution and managing pricing. It must market its product strongly to compete with many other alternative products, all of which quench the thirst. Coca-Cola's distribution is private and is targeted at individual customers.

Fertilizer firms, on the other hand, do little active marketing; most of the available resources from government subsidies go on reducing the farmgate price. The distribution of fertilizer is heavily influenced by the government and mostly serves bulk buyers. There are few or no alternative or competing products: the typical African market is supplied by only a few fertilizer manufacturers.

It appears the gap between the two industries is primarily one of focus on consumer value and the resources devoted to marketing. The marketing of Coca-Cola is consumer-focused and devotes a lot of resources to marketing; that of fertilizers is much less consumer-oriented and has less attention devoted to persuading farmers to buy the product.

Private vs government systems

Over time, private distribution has grown across the continent, leveraging the initial structures that governments had set up. Unlike the government system, the private sector does regard farmers as customers, and is more responsive to their needs. It therefore attempts to bridge the gap between the government supply system and the effective demand from farmers.

When government-owned fertilizer is delivered through a private system, the private system is corrupted. The client is no longer the farmer but the upstream partner. Wholesalers have to compete to get the government's attention, and retailers have to compete to get the wholesaler's attention. Because government volumes are usually significant, loyalty to the upstream partner becomes necessary to be party to the contract.

The growth of private-sector systems alongside the continued participation of the government in the supply chain has also led to competition between the government and the private sector. Farmers who have come to expect subsidized products refuse to buy higher-priced fertilizer from private dealers. That reduces demand for fertilizer, and so stunts the development of the private sector.

Nevertheless, private distribution systems are expanding. Large, private-sector investments in the sector and interventions by development organizations are helping improve the efficiency of distribution systems. A well-functioning private system recognizes the farmer as the consumer, and distribution practices are improved to create value for the farmer.

This transition is not without tension. The growth of private distribution systems is reducing the influence of governments on the sector. Governments are incumbents, and they will defend their positions. Though distribution systems are tending to become more private, dual systems will exist for some time.

Quality control

Because governments have historically controlled the fertilizer industry, they have not put together strong systems to regulate the sector. Quality is a particular problem in some countries: unscrupulous private distributors have tried to boost their profits by skimping on nutrients or reducing the quantity of fertilizer in the bag. Distributors also do not have an incentive to improve their services and often ignore important quality aspects of the trade, such as fertilizer handling.

Farmers who are cheated by adulterated products not only waste their money; they harvest lower yields and are unlikely to return for more next season.

The emergence of large private-sector investors, who are brand-conscious, creates a favorable environment for quality control. In many countries, the regulatory system is now being improved. Standards are being agreed on, laboratories are being set up with adequate testing equipment, and inspectors are being trained. All stakeholders recognize that widespread acceptance of fertilizers depends on guaranteeing quality, which requires developing or tightening quality-control systems.

Improved service

If they cannot compete with the government system on price, private dealers have to find other ways to make their products attractive. They do this through superior service – for example by making

their product available early (government deliveries are routinely late), offering credit (farmers pay at the end of the season when they sell their crop), and by offering a broader range of fertilizers. Part of the appeal of blends is the desire to differentiate products from the government's generic straight (single-nutrient) offerings.

Building brands

Fertilizer manufacturers and importers have traditionally left the distribution system in the hands of downstream partners, leaving the retailer with the sole responsibility of serving the farmers. With increasing competition between manufacturers and importers, this is beginning to change. Some are beginning to develop partially controlled distribution channels so they can provide farmers with a branded service and product. In Nigeria, Notore actively manages around 80 distributors. Developing distribution partnerships means taking at least partial control over inventory, merchandizing, promotions, data and credit. The downstream partners are compensated for the loss of control through additional volumes, margins, training and information to improve performance.

Strong distribution partnerships facilitate market access for new products. The industry intends to develop new products – such as blends and different-sized packaging – to suit a wider range of farmers, crops and soil types. This means agrodealers will have to sell a wider variety of items, and will need to market, rather than just stock, the products. They will need training on what products are suitable in what conditions, and on how to advise farmers so as to increase the likelihood of repeat purchases.

But private systems are still weak. Strengthening them will require investments by large, brand-conscious manufacturers and importers. This is already happening in some countries: Indorama and Notore are building their brands in Nigeria, as is Yara in East Africa. But in most countries, government procurement systems are still dominant, and immature private distribution systems risk being dominated completely by one or a small number of large manufacturers that lack competitors to keep them in check.

Improving government-run systems

Given that fertilizers are considered essential for food security, and that governments have a huge stake in intervening in fertilizer supply, government procurement systems are likely to be around for some time. Development organizations – the World Bank, AGRA, AFAP, FAO, USAID, IFDC, DFID and a host of others – recognize this. They are working towards improving the traditional government-run systems, for example by helping introduce smart subsidies (see Chapter 9).

Development organizations often advise governments to introduce more competition into their distribution systems. For example, governments could negotiate discounts on bulk imports, but leave the distribution to the private sector. This would turn the government into a procurement agent for the distribution system, but not a client. The Nigerian Presidential Fertilizer Initiative (Box 3) is a variant of this model. However, this Initiative decides on the product and manages all the distribution logistics up to the wholesaler: the distribution is only partly free.

Box 3. Nigeria's Presidential Fertilizer Initiative

The Presidential Fertilizer Initiative aims to improve the fertilizer supply in Nigeria. Inaugurated in November 2016, a presidential committee on gas and fertilizer is mandated to find ways to ensure that fertilizers are affordable and available throughout the country. This committee is chaired by a state governor and draws membership from various branches of government and the Fertilizer Producers and Suppliers Association of Nigeria (FEPSAN).

The Nigeria Sovereign Investment Authority set up a special company, NAIC-NPK, to manage the Fertilizer Fund on behalf of FEPSAN (Government of Nigeria 2017). NAIC-NPK negotiated generous discounts on the four inputs: locally produced urea and limestone, diammonium phosphate from Morocco, and muriate of potash from Europe. These ingredients are blended in Nigeria to suit the needs of particular crops. This required reviving blending plants that were operating below capacity or not at all. The government of the state where each blending plant is located has the right to purchase about 60% of the fertilizer produced for its state's need; agrodealers take the remaining 40%. The fertilizer is then sold to farmers either directly or via wholesalers and retailers.

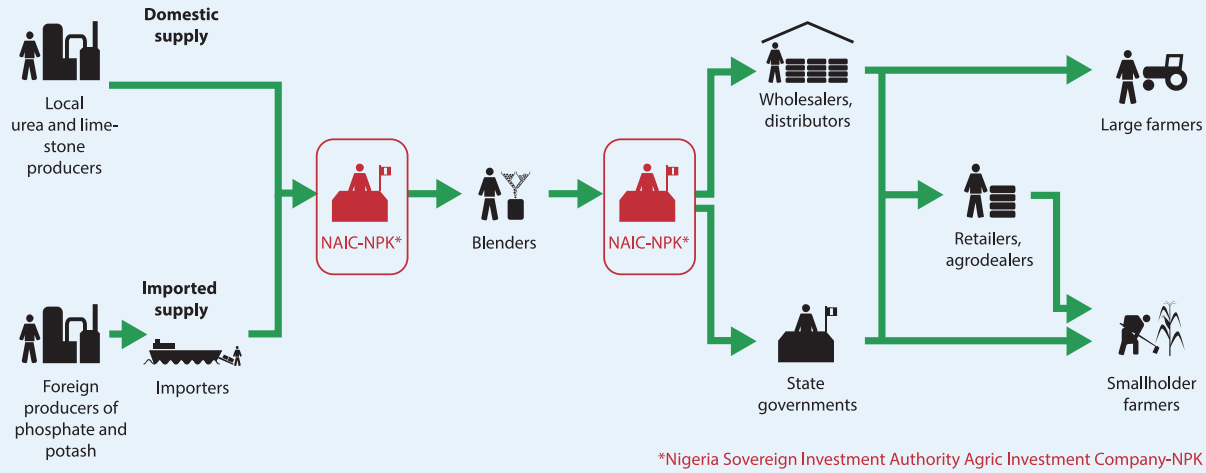

Figure 29. The Presidential Fertilizer Initiative in Nigeria

The Initiative aimed to produce 1,000,000 tonnes of blended NPK fertilizer during the 2017 wet cropping season, and to deliver these to farmers at 5,500 naira per 50-kilogram bag (the prevailing market price was 8,000–9,000 naira). By mid-August 2017, it had in fact distributed only 400,000 tonnes. Some 38 blending plants had been operating at low capacity or not at all; 11 of these that had been operating at less than 10% aggregate capacity boosted their performance to 80%. The price of NPK blends has fallen significantly, and over 250,000 jobs have been created directly or indirectly.

The Initiative has faced numerous challenges: delays in offloading raw materials from ships; flooding in Lagos State; logistical problems due to bad road and rail infrastructure; the uneven distribution of participating blending plants across the country; seasonal market demand; adulteration and price racketeering (which are being tackled by the government and private sector).

To resolve these challenges, FEPSAN has implemented several steps:

Reviving and adding more blending plants. Further blending plants were added to those already participating in the Initiative. This reduced the cost of moving the finished products to agrodealers and enabled broader reach across the country.

Combating adulteration and price racketeering. A task force comprising the Office of the National Security Adviser, the police and civil defense was set up. Barcodes on the bags have a unique code that identifies the blending plant, making it possible to track movements around the country.

The second phase of the Initiative was signed in May 2017. It strengthens logistics and increase capacity by optimizing road and rail transport, establishing strategically located storage facilities, modernizing and expanding existing plants, establishing new plants, and ensuring geographical spread. Complementary measures include adding capacity to current blending plants. Investment is being expanded in shared logistical hubs, roads, railways, ports and warehouses. Such investments will improve the distribution of fertilizers and other inputs, such as farm equipment, pesticides and insecticides. FEPSAN has partnered with Unity Bank of Nigeria to offer credit facilities to agrodealers through the Nigerian Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL).

From government to private

In some countries, development organizations are leading the shift in distribution from the government to the private sector. They focus mainly on building the capacity of distributors and strengthening the relationships between partners in the distribution network. They do this in four main ways:

- Providing credit guarantees
- Promoting new products
- Building distribution associations, and
- Training and certification.

Providing credit guarantees to importers and manufacturers to supply wholesalers or "hub agrodealers". AFAP uses credit guarantees to reduce or eliminate the risk for the importer or manufacturer to supply wholesalers with consignments of fertilizers. This improves the supply of fertilizer to the wholesaler, and thus to actors further down the chain. The wholesaler's business becomes more transparent because of the information system set up to manage the credit. The subsequent improvement in communication improves the relationship between the manufacturer or importer and downstream partners. This approach has significantly improved the supply and use of fertilizer and also reduced the distance between agrodealers and smallholder farmers (AGRA 2016).

Promoting new products with a consortium of private and public organizations. In AGRA's consortium approach, blenders, distributors, research organizations, farmer groups and financial institutions work together to develop and promote improved fertilizer blends. AGRA builds capacity development activities into the process. This process generates information about the market, improving the various parties' perspectives and decisions. The process covers three phases: product development, trials and commercialization. Interactions at each phase build relationships between the participants and creates awareness among farmers.

Building distribution associations. Development organizations facilitate the formation of associations of distributors. When mature, these associations can help set the policy agenda for the fertilizer sector, regulate members' professionalism, provide information to members on fertilizers and related topics, and reduce the structural constraints within the sector. AFAP has supported the development of distribution networks in Ghana, Tanzania and Mozambique through hub-dealers. It has supported close to 80 hub-dealers and has developed linkages with a network of rural retailers in the three countries. AGRA, IFDC and CNFA (Cultivating New Frontiers in Agriculture, an international NGO) and other partners have supported such associations in Burkina Faso, Ghana, Mali, Mozambique, Niger, Nigeria, Rwanda, Tanzania and elsewhere. Such associations develop interactions among the actors and give them a new vision of the farmer as the final paying client. Members are trained on management practices and can use their membership of the association to access credit.

Training and certification. Development organizations have also invested in the training and certification of warehouses and agrodealers. AGRA alone has supported 23,000 agrodealers all over Africa, including in Burkina Faso, Ghana and Mozambique. IFDC has trained agrodealers in Nigeria. AFAP is using a "hub-agrodealer" model (Figure 30) to build the capacity of distributors across many countries.

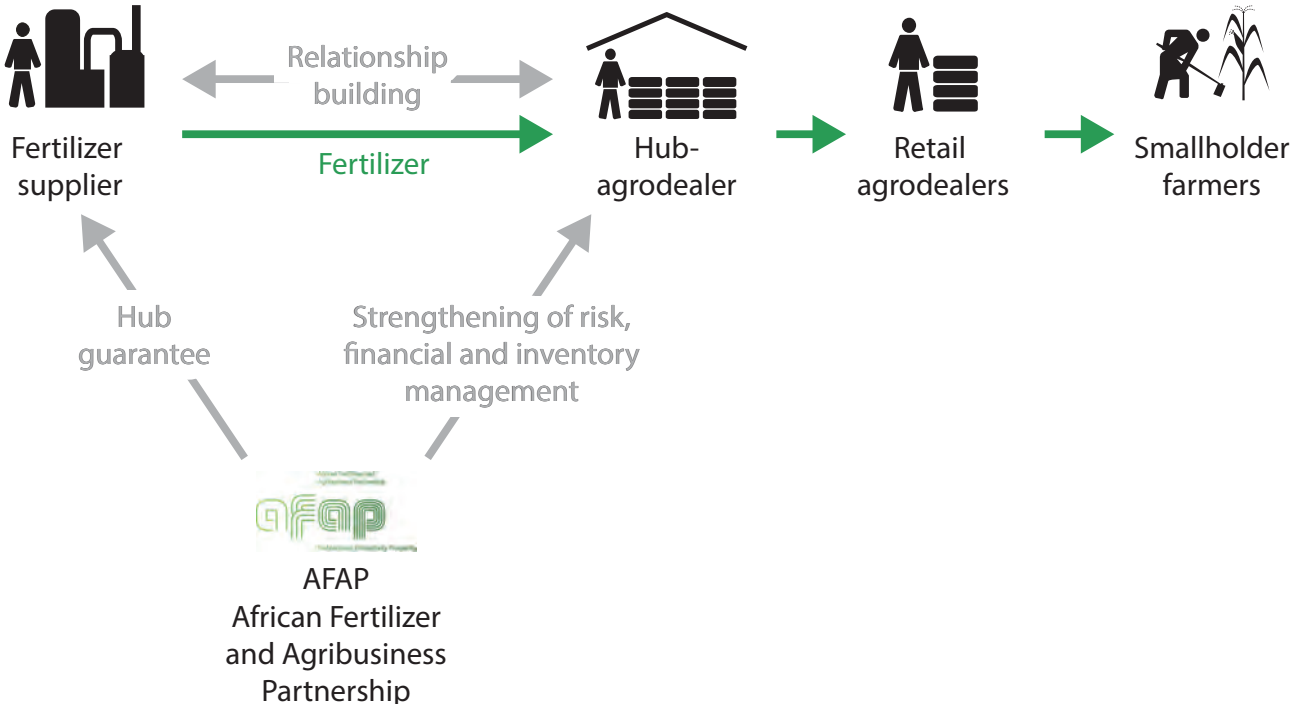

Figure 30. AFAP's hub-incubation credit-guarantee program

Conclusions

Fertilizer distribution systems in sub-Saharan Africa grew out of government programs aimed at promoting fertilizers or exporting cash crops. These developed a culture of servicing their clients – government, processors and plantations – while farmers were merely drop-off points to complete the contract. Since the government has been the principal client in most countries, the volume of throughput has been dependent on the government budget, which is unpredictable. It was therefore too risky for distributors to invest for growth. Current government systems still struggle to make products available and on time to farmers.

Whilst government fertilizer systems continue to struggle to target farmers, private bulk systems are able to train, supply inputs to, finance, and purchase output from their farmers. These systems usually operate without competition, however, and are limited by budget and growth capacity. They serve large farmers and plantations well, but often fail to reach local retailers and their farmer customers. The further downstream the chain, the weaker the actors in the chain are.

The fertilizer business is evolving from one dominated by governments to one where the private sector is playing an increasingly important role, buoyed recently by large fertilizer and processing investments in the region. These investments are accompanied by brand-building activities focused on the farmer, the eventual consumer of the product. Investors are gradually increasing their product offerings to improve farmers' yields, and they see distribution as increasingly important to ensure the availability and visibility of their products. They also recognize distribution structures as an effective and non-costly vehicle to promote products and advise farmers.

The involvement of large investors will bring more structure and professionalism to distribution, as managing (or partially controlling) distribution becomes a competitive advantage and competition increases. As they improve, distribution systems will increasingly attract investment for growth.

Greater adoption of fertilizers requires efficient, farmer-driven distribution systems. These can only be achieved by the private sector. Governments should, however, act as the regulator, ensuring fair competition and controlling quality. They can also support the growth of private systems by removing structural constraints and by helping to create access to the unserved, for example, by finding ways to enhance the availability of credit to distributors and farmers.

Recommendations

- Government participation in distribution competes with private systems and has not led to efficiencies. Governments should stop their direct participation in the fertilizer supply chain.
- Governments should instead develop a dynamic regulatory organization. This will require a new vision, a change in structure and new competences.
- Governments should support the development of competitive private distribution systems through a regulatory system that covers the whole fertilizer supply chain, including communication. The regulatory system should emphasize the professionalism of distributors, for example through standards and certifications.
- The government's anti-competition organization should pay particular attention to the relationships between manufacturers and distributors on one hand, and anchor buyers and farmers on the other. An imbalance in these relationships could create systems that are inefficient.

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7. Stimulating demand

Rebbie Harawa, Nega Wubeneh, Ayo Balogun, Paul Seward , Fred Muhhuku and Peter Musyoka

There is general acceptance that a Green Revolution is possible in Africa. Crop yields are currently low – but that means the potential to raise them is high if farmers use the right technologies and can market their output better. Fertilizers – the "fuel for a Green Revolution", according to Norman Borlaug – must play a key role raising yields, and the latent demand for them among farmers is high.

Latent demand is demand that remains unfulfilled because of some barrier. Converting latent demand into effective demand means overcoming such barriers. This chapter analyses three issues that limit effective fertilizer demand among smallholder farmer s in sub-Saharan Africa.

- Farmers do not know about fertilizers or how to use them.
- Farmers cannot afford to buy fertilizers.
- Farmers have weak incentives to use fertilizers.

Lack of knowledge among fertilizer users

A vast majority of smallholders in sub-Saharan Africa have little or no experience with fertilizers and may therefore not know about their potential to boost crop yields (Chianu et al., 2011). Many do not know about soil nutrients and how to maintain and replenish them. This is in turn the result of low education and literacy levels and weak agricultural extension capacity. Education and extension services are important determinants of the demand for fertilizers in Kenya, alongside land size, population density and soil texture (Staal et al. 2003).

In the 1960s and 1970s, the World Bank supported governments in the region to put a major emphasis on agricultural research and extension, especially on planting practices and awareness of fertilizers. But the structural adjustments programs of the 1980s and 1990s forced them to reduce their spending. The main causalities of this policy included the public research and extension systems. Consequently, the extension system in many parts of the continent has weakened (Heidhues et al. 2004): the number of extension workers has fallen significantly; most have not been properly trained; many lack the transport and incentives required support farmers.

Many farmers have misconceptions about the value of fertilizers. In Uganda, for example, there is a myth that the country's soils are fertile (the national anthem says so) and do not require fertilizers. Some farmers think that fertilizers "spoil" soils (MAAIF, 2014). Perhaps as a result, the country has among the lowest fertilizer consumption in Africa: 1 kg nutrient per /ha (MAAIF 2014)

Even if farmers do know that fertilizers exist and can help increase crop yields, many gaps remain. Many have no idea which types of fertilizers they should

use on which soils and crops, or what the correct rate, placement and time of application are. These issues still depend on knowledge that may be lacking: about the soil nutrient status, balanced fertilization, site-specific nutrient management, the combination of inorganic and organic fertilizer, and issues such as crop rotation and nitrogen-fixing crops. Many farmers place fertilizers on top of the soil (where it is far from the roots and may volatilize into the atmosphere). Others apply fertilizer only at sowing but not as top-dressing, or vice versa. Yet others buy a little fertilizer and spread it over a large field. Farmers sometimes use cheap or free fertilizer distributed through input-subsidy schemes on totally different crops for which it is not suited.

Improving extension services

Extension advisory services – both government and private – play a key role in disseminating knowledge and good practices. Returns to agricultural extension are often even higher than those to agricultural research: a review of social rates of return in 95 developing countries showed that returns to extension were 80%, compared to 50% for research (Alston et al. 2000).

A few countries such as Ethiopia have chosen to buck the trend and invest heavily in the agricultural sector, particularly in the extension system. Ethiopia embarked on a crash program that trained 72,000 frontline extension workers to diploma level in under 10 years. The number of diploma holders shot up 30 times, and the number of farmers per extension worker fell 100 times (Mandefro, et al 2009). In 2010, Ethiopia had 475 extension workers per 10,000 farmers, while Tanzania had just four (Fantu et al. 2018). Better access to extension advice in Ethiopia has significantly increased adoption of modern inputs such as chemical fertilizers and improved seeds (Berhane et al. 2018).

With some stakeholders working towards the introduction of balanced and blended products, creating awareness of fertilizer products is even more important. As with any new product, it is necessary to introduce it to the consumer, show them what it looks like, where to get it and how to use it.

Farmer training by the private sector and NGOs

Plantation companies, anchor buyers, NGOs and development projects may set up their own training activities for farmers. Like government and private extension services, these generally do not focus just on fertilizers, but cover a range of good agricultural practices. The organizations may have in-house trainers, or they may recruit third-party institutions to do the training.

Box 4. AGRA's awareness-creation on fertilizers (AGRA 2016).

Over the years, AGRA has created farmer awareness of fertilizers through a number of avenues. These include:

- Training extension staff and lead farmers
- Farmer field days, on-farm demonstrations, and radio messages
- Village-based farming advisors linked to nearby agrodealers
- Distribution of small, sample packs of inputs from interested local suppliers
- IT applications that inform and orient farmers on inputs and improved farming practices
- Supporting input suppliers and distributors to design and implement effective farmer education campaigns
- Working with interested off-takers in the private sector to increase farmer awareness of quality requirements and input use.

The promotion of fertilizers is closely linked to that of improved seeds and good agronomic practices. AGRA works closely with agrodealers to build demand for seeds, fertilizers and other inputs, and helps facilitate the supply of these inputs to rural areas.

AGRA Soil Health Program (2009–15) awareness activities across 13 countries

Extension staff trained	5,392
Lead farmers trained	142,108
Farmer-based organizations trained	16,660
Demonstrations set up	140,554
Farmers aware of soil technologies (including fertilizers)	4.9 million

Each organization has its own objectives for training. Plantations and anchor buyers train farmers on how to produce crops according to their specifications: the training covers subjects such as the required crop varieties, planting rates and dates, fertilizer and pesticide use, cultivation and harvesting methods, and delivery requirements.

Training by NGOs generally covers a much wider set of crops and farming approaches, and may also cover subjects such as environmental conservation, health, nutrition, group organizations, finance and enterprise development. NGOs often conduct training with or through farmer groups.

NGOs and development agencies such as the Food and Agriculture Organization of the United Nations (FAO) often use "farmer field schools" as a training approach. A group of 25–30 farmers with a common interest meet regularly throughout the cropping season. A facilitator, often an extension agent who has received a special training, does not teach content but helps the farmers discover solutions to their own problems. It assumes that farmers experiment as experts, learn systematically, and value their own knowledge (Van den Berg et al. 2001). This approach was developed in Indonesia in the late 1980s as a way of teaching farmers about integrated pest management (Van de Fliert 1993). It has since been adapted to cover integrated soil fertility management (Chapter 2).

Retail extension

Retail agrodealers have a special interest in teaching farmers about the product they sell. By advising farmers well, they can create happy customers who come back to buy not just fertilizers but other products as well.

The potential of the farmer–dealer interface is being used in two ways. Development organization such as AGRA, IFDC and AFAP train agrodealers on the features of various fertilizer products, how to apply them appropriately, and how to pass on this knowledge to farmers. The dealer thus acts as an extension worker who is specialized in fertilizers.

Fertilizer manufacturers and distributors see agrodealers as potential brand ambassadors. They teach the dealers about their particular product range (and not the products of their competitors), and give them the information and skills they need to advise farmers on which product to use under what circumstances.

Village-based agents

Most agrodealers are based in urban centers rather than in villages. The farmers have to travel into town to buy fertilizers – and face the problem of transporting them back home. Village-based agents help bridge this last-mile distribution gap. They are individuals who provide extension advice as well as fertilizer and other inputs. Such agents are linked to a private-sector system that supplies inputs; the firm offers incentives for them to provide extension advice and a commission on sales to motivate product promotion.

The agents may be entirely private – such as those coordinated by the One Acre Fund in East Africa and Babban Gona in Nigeria – or they can be managed by partnerships of private and development organizations. If the village-based agents are embedded within a private structure, they receive a salary and operate within the resources of the structure. If they are independent, they may face problems of inventory, credit and supervision.

AGRA, through its extension implementing partners, has adopted the use of self-employed village-based advisors (VBAs) to rapidly create demand for fertilizers. These VBAs, who are identified and trained by Government extension agents, use the "mother-baby" demonstration method to practically train farmers in their villages on how to use the most appropriate fertilizers the correct way. Many VBAs graduate to become village-based agro-dealers, or agents of agro-dealers. This enables small-holder farmers to access fertilizer and other complementary inputs and services at the village or community level.

Mass media and information technologies

Talking to farmers face-to-face is expensive: it requires training and payments to thousands of extension workers, as well as providing the extension workers with means of transport to get out into villages. Traditional broadcast media – radio, television and video – have been used to spread information about fertilizers and related farming techniques. Organizations such as Digital Green are using video in new ways to provide farmers and extension workers with skills (Box 5).

Box 5. Digital Green

Digital Green is an international development organization that uses information technology to help farmers learn better farming techniques. It teaches local people how to make simple videos about their problems and solutions. These videos are then shown to other people in the community. Digital Green also produces training videos for extension personnel and makes these available via mobile phone. An app monitors the trainees' learning.

www.digitalgreen.org

More recently, the spread of the internet and mobile phones in Africa has opened up new possibilities. Computer- and tablet-based services can reach dealers to provide them with technical information and tools for business management.

Many farmers in Africa now have a mobile phones, and signal coverage now reaches even some remote areas. That makes it possible to deliver individualized information to farmers cheaply – and for farmers to interact with the advisory service. For example, they can ask questions, choose the information that is relevant to them, and negotiate purchases and sales. Services can be tailored automatically to individual farmers through a combination of the information that the farmers themselves supply when they register for the service, the data stream they generate by using it, and geolocation information transmitted by the phone. None of these are possible through radio or TV. Service providers can create apps that respond automatically to certain requests; call centers can fill in the gaps where human expertise is required. The information may include weather forecasts, prices and availability of inputs, the market prices of outputs, agronomic advice, and links to potential buyers and sellers.

Two tools developed specifically for fertilizers include the Africa Soil Health Consortium's Fertilizer Optimization Tools and IPNI's Nutrient Expert (Box 6).

The tools described in Box 6 rely on location-specific data on soil types, fertilizer responses, etc. There is a case for developing a common set of information for

Box 6. Apps for fertilizer applications

Fertilizer Optimization Tool

The Africa Soil Health Consortium is a partnership of development organizations working on issues relating to soil health. It has developed a tool based on Microsoft Excel (a commonly used spreadsheet program) that can tell extension workers how much fertilizer of what type a farmer should apply for each type of crop. The extension worker enters the area planted of each crop, the expected value of the harvest, the price of a 50-kg bag of various types of fertilizer, and the maximum amount of money the farmer can afford to spend on fertilizer. The tool then calculates the amount of fertilizer the farmer should apply on each crop.

The calculation is based on the expected responses of each crop type to various nutrients. These vary according to the soil type. The responses are based on data generated by Optimizing Fertilizer Recommendations for Africa, a project funded by AGRA. The Consortium has developed separate tools for the major agroecological zones in each country: three for Mali, for example, six for Nigeria, and 13 for Ethiopia. Other countries covered include Burkina Faso, Ghana, Kenya, Malawi, Mozambique, Niger, Rwanda, Tanzania, Uganda and Zambia. So far, 74 separate fertilizer tools have been developed for 67 agroecological zones in 13 countries.

http://africasoilhealth.cabi.org/tools/fertilizer-tools/fertilizer-optimisation-tools/

Nutrient Expert

Nutrient Expert, developed by the International Plant Nutrition Institute, is a computer-based decision support tool that enables farm advisors to formulate nutrient management guidelines for maize and other crops. It suggests a meaningful yield goal for a specific location and proposes the best nutrient management strategy to attain it.

The app does not rely on detailed soil-testing data, as this is rarely available. Instead, it asks the farmer or advisor for information that is readily available: the location and season, the current crop yield, the amount and types of fertilizer applied, the row spacing, etc. The app then calculates the recommended fertilizer rates and makes a profit analysis, comparing the costs and benefits of the farmers' current practice and the recommended alternative. The results can also be used together with other field tools, such as soil test kits, leaf color charts and a "Crop Doctor" that allow farmers to diagnose nutrient requirements for crops.

http://software.ipni.net/article/nutrient-expert

farmers with best practices for crop planting, fertilizer utilization (broadcasting, burying, spraying etc.), seed planting, use of pesticides and water management. Such a platform would be a common good (like a weather forecast): it would be available for anyone to use. It would assume that fertilizer quality standards are defined and controlled. Fertilizer manufacturers and distributors would then be able to concentrate on product information – features, benefits and dosage.

The role of government

Few countries have come up with bold human-development initiatives like Ethiopia. Governments must make investments in the research and extension system to develop appropriate fertilizer technologies and recommendations and to disseminate such knowledge through the extension system.

Governments have also used fertilizer subsidies to encourage farmers to use fertilizer. While the design, implementation and the overall effectiveness of subsidies has been controversial, there may be some benefits of using them to encourage farmers to use fertilizer where the knowledge and the adoption rate remain low. The support should be for a limited time and have a clear exit plan (Chapters 8 and 9). This would encourage farmers to test technologies that they have not used before, and then to buy the product on their own without a subsidy. A complement to this approach is the supply of small packages that farmers can test on small plots without jeopardizing their families' food security.

High cost and lack of credit

Smallholders usually have disposable cash for a few months after harvest time but are low on cash during the lean season when they need to buy fertilizer and other inputs. Loans are expensive: interest rates are typically 20–30% a year.

Governments subsidize fertilizers in order to encourage farmers to use them. But subsidies distort the market and undercut private-sector distributors and agrodealers, as well as the few credit providers that exist.

Farming, like any other business, needs working capital. But due to the real or perceived risk to smallholder farming, farmers cannot get access to credit to buy fertilizer and other inputs from the traditional financial sector. When credit is not available and farmers do not have their own capital, they either do not buy any fertilizer, or they buy less than the recommended quantity.

Reducing fertilizer costs

The long-term solution to high fertilizer costs is to invest in infrastructure and make the fertilizer supply chain more efficient (see Chapters 5 and 6). Subsidies are a stopgap at best (Chapters 8 and 9).

Strong, viable agrodealer networks comprising of well-linked retail agrodealers, hub agrodealers and input-supply companies considerably reduce transaction costs for fertilizers and, ultimately, farm-gate prices.

Given the variability of fertilizer prices in the international market, it may be possible to time purchases to reduce the cost of fertilizer. Bulk purchasing of fertilizer in collaboration with neighboring countries may be beneficial, especially for small, landlocked countries.

It may be possible to increase supplies and cut costs by producing fertilizer in-country. This is possible in countries that have suitable mineral deposits or natural gas reserves.

Improving the policy and regulatory environment to ease entry barriers and foster competition in the fertilizer market is another way to reduce margins and reduce the cost of fertilizer to smallholders.

Increasing famers' ability to buy fertilizer

Another approach is to help farmers purchase fertilizer. Approaches include:

- **Buying in bulk.** Cooperatives or farmer groups can combine orders from their members and place a bulk order. Plantations and anchor buyers do the same thing for their outgrowers and contract farmers. Larger cooperatives can use their connections with suppliers to get discounts on deliveries.
- **Farmers' associations and cooperatives** can put political pressure on the government and on industry to find ways of ensuring cheaper products.
- **Farmers can grow higher-value crops,** such as export commodities or horticultural crops. Such crops are more demanding, but the profits are higher, and fertilizer is likely to be a smaller proportion of the total turnover. Farmers will thus be able to afford more fertilizer than for lower-value crops.

Weak incentives for fertilizer use

The effectiveness of fertilizer applications depends on many factors. Some of these relate to the fertilizer itself:

Appropriate fertilizer. The right type of fertilizer for the soil and crop must be applied in the right way at the right time. Even if farmers know all the details, they may not be able to buy the right type of product; it may not be available in the local agrodealer's store, or may arrive too late to be of use.

Complementary technologies. To be effective, fertilizer must also be combined with various other technologies and practices: improved seed varieties, irrigation, lime, appropriate land-preparation, sowing, weeding and pest and disease control. Without any one of these, spending money on fertilizer may not be worthwhile – or may result in lower yield than expected.

Profitability. The farmer has been able to get enough of the right type of fertilizer, has used it in the correct way, in combination with all the complementary technologies. The yield is good. All OK? Not necessarily. Much depends on the sale of the crop: can a buyer be found? What price can be agreed on? No buyer or the wrong price means a failed season.

Because of such risks and uncertainties, many farmers decide to use fertilizers only on crops for which they are confident they can make a reasonable profit.

Most smallholders are risk-averse for a very good reason: a harvest failure means the family will go hungry. Plus, the pain of losing is psychologically larger than the pleasure of gaining. Research shows that each additional unit expenditure on fertilizer must bring in an expected gain of at least twice that amount if farmers are to consider adopting it (FAO 2000).

Balanced and blended fertilizers

Part of the solution is to apply fertilizer products that are better suited to the soil and crop type. Generic straight NPK products are unlikely to be the best possible option, and it is unrealistic to expect farmers to buy and mix the appropriate combination of straight fertilizers. Balanced and blended fertilizers are a better option; they can also include secondary and micronutrients that are in deficit in many soils.

Soil mapping and testing

Soil mapping and testing is important not only for developing new fertilizer types, but also for advising farmers which products to use and at what dosages. Fertilizer application recommendations in Africa are typically blanket recommendations, covering a large area regardless of the specific soil type in each location. This is beginning to change with the establishment of soil-testing services – though these are often still expensive or unavailable in many areas.

Creating balanced fertilizers that respond to soil-specific needs must be based on soil testing and mapping, and the new formulations must be validated through field trials. These test the response of various crops to the new fertilizer; they typically compare the fertilizer at different rates with the standard fertilizer dosage, local farmers' fertilization practices, and a control (no fertilizer at all). Complex blends are subject to "nutrient omission trials", in which adequate amounts of all nutrients are applied except one. The yields are then compared with plots where no nutrient has been omitted.

Various technologies and approaches to soil testing and mapping are currently available, including digital soil testing by the Africa Soil Information Services funded by the Bill and Melinda Gates Foundation, and a wide range of credible wet-chemistry labs. Recently a number of countries, including Ethiopia (Box 7), Ghana (Box 8), Nigeria and Tanzania, have undertaken extensive soil surveys and mapping to determine the soil structure and the macro-and micronutrient status. This has led to the development of new fertilizer blends and more location- and crop-specific recommendations.

Improving fertilizer use

Training farmers to apply fertilizers in the correct way can increase their effectiveness. Methods include applying the right product at the right rate, at the right time and in the right place (the 4R nutrient stewardship approach), and integrated soil fertility management (see Chapter 2).

Complementary technologies

Helping farmers access and use complementary technologies can help improve the effectiveness of fertilizers. This may be by encouraging farmers to apply lime to acidic soils, finding ways to conserve soil moisture or to irrigate suitable areas, developing and marketing improved crop varieties, encouraging the mechanization of tasks such as land-preparation, weeding and harvesting, and improving pest and disease management.

Produce marketing

If smallholders can get a decent price for their crops, they are more likely to want to explore ways to boost their output – and so start demanding more fertilizer. Efforts to improve the marketing of crops include:

Box 7. Soil mapping in Ethiopia

A nationwide mapping effort was launched by the Ethiopian Soil Information System (EthioSIS) in 2012. This has led to a comprehensive digital map that charts soil fertility in Ethiopia and to the development of area-specific fertilizers. New fertilizer combinations boost wheat yields from around 1 ton to 3 tonnes per hectare on more than 40% of its agricultural land (ATA. 2016).

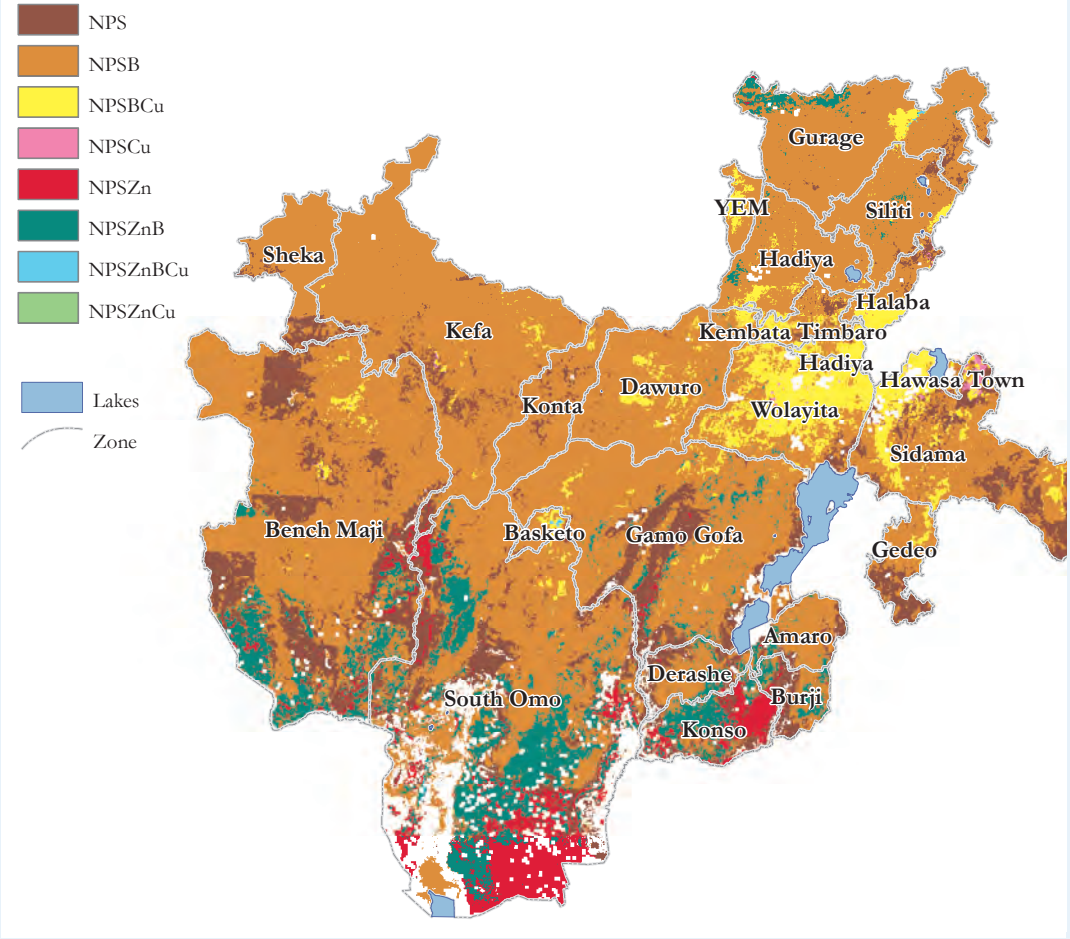

Figure 31. Fertilizer types recommended by the Ethiopian Agricultural Transformation Agency in the Southern Nations, Nationalities, and Peoples' Region. Boron (B) is the micronutrient that is most widely needed.

- **Organizing farmers into groups** to market their produce in bulk. This reduces transaction costs and allows them to serve more distant, higher-value markets.
- **Improving the quality of output** by ensuring it complies with quality grades and standards set by the government or by potential purchasers.
- **Creating linkages to markets.** This includes putting farmers in touch with potential buyers and helping them negotiate purchasing terms.

Analysis

With every farmer, there is a latent demand for good-quality inputs. Bridging the latent demand–consumption gap is conventionally called demand creation, which has traditionally been driven by and through governments. The focus of demand creation has been on training farmers on fertilizer utilization and reducing the farmgate price of fertilizer.

In the demand-creation process, there has been very little effort on supply-chain efficiencies and even less acknowledgment of the financing needs of the farmer and the supply chain.

Box 8. Soil-SMaRT: Soil Mapping Recommendations and Transfer

IFDC's Soil-SMaRT is a systematic approach process to diagnose nutrient deficiencies and other soil constraints and to develop and validate fertilizer recommendations (Wendt and Mbuthia 2017). SMaRT stands for Soil Mapping Recommendations and Transfer.

The soil testing is done by qualified laboratories. Hundreds of samples are collected from a wide area to represent the various agroecologies and soil types there. The results are plotted on maps showing soil nutrients and acidity levels. Field trials, including nutrient omission trials, are conducted to develop and evaluate fertilizer recommendations and, if necessary, to formulate new blends. The technology is then disseminated to farmers through government and private channels.

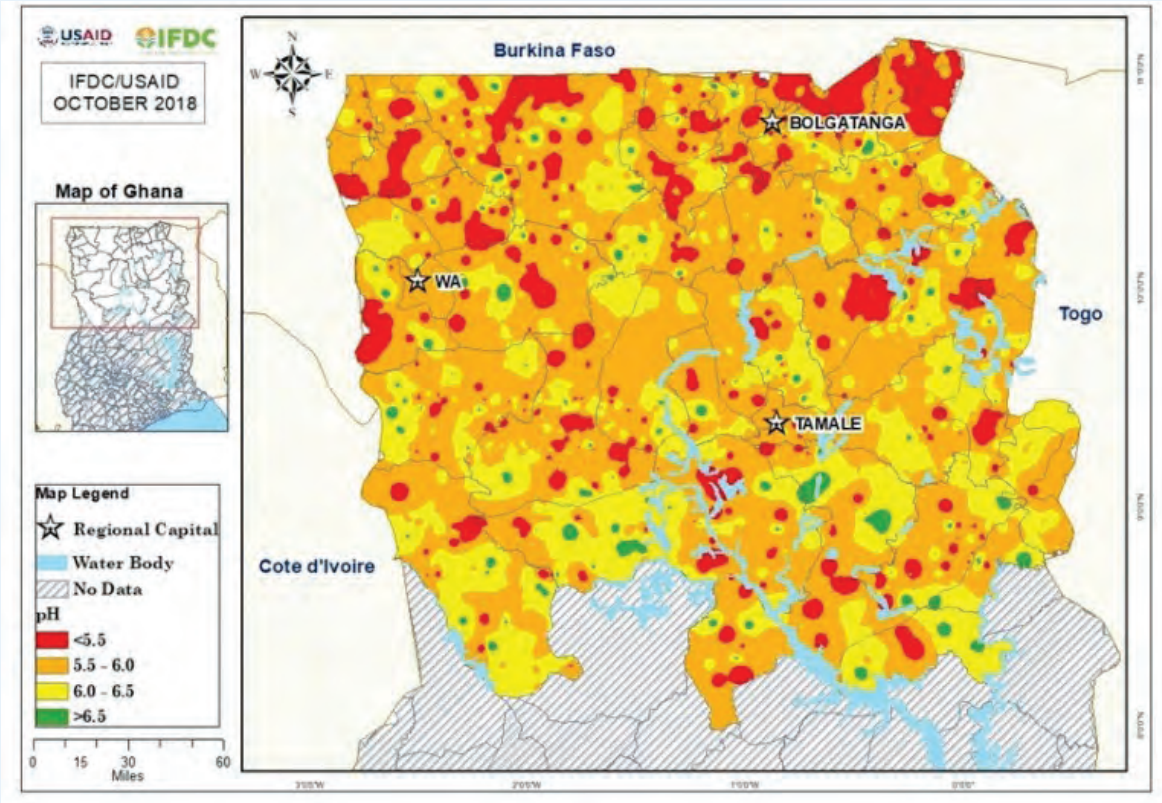

Figure 32. Soil acidity map of northern Ghana.
Source: https://ifdc.org/2018/12/05/soil-smart/

In policy decisions, farmer revenue has also been consistently subordinated to the farmgate price of fertilizer. This is despite the recognition that fertilizer adoption is an investment decision that depends on the returns to the farmer, which are influenced significantly by crop yields and price.

Policy appears to have been more sympathetic towards boosting total output than intensifying farming, resulting in increases in the area cultivated while yields remain flat. Increases in agricultural output have lagged population growth, resulting in food insecurity.

In some countries, the pressure to feed a growing population while curbing inflation often leads to policies that suppress the price increases of staple crops (rice in Nigeria is an example). In some other countries, the need to be competitive in strategic cash crops leads to policies that result in price fixing for such crops (cotton in West Africa is an example).

It has, however, been shown that a 10% increase in competition among fertilizer suppliers could increase fertilizer use by 13–19% and rural incomes by 1–2% in sub-Saharan Africa (Hernandez and Torero 2013). Moreover, an IFDC and AFAP study demonstrated that crop price inflation is more important than a drop in fertilizer prices: a 1% increase in crop prices boosts fertilizer consumption, while a 1% fall in the fertilizer price has no influence (IFDC and AFAP 2018).

It seems that sub-Saharan Africa has been in a vicious cycle of limiting the fertilizer supply chain efficiency to keep farmgate costs low, curbing the availability of higher-yielding fertilizers by focusing on generic products, and restraining crop prices because of concerns about inflation (for staple crops) and competitiveness (for strategic cash crops). Has policy been penny wise and pound foolish?

Breaking the cycle might require reframing the adoption problem not as a farmgate fertilizer-cost problem but as an individual farmer-income problem. This might lead to increased and sustained adoption arising from higher yielding products, competitive distribution chains, and vibrant output markets.

Conclusions

Smallholder farmers in Africa are faced with numerous challenges that limit their effective fertilizer demand. The majority of these smallholders have little or no experience with fertilizers and may not know its potential to enhance crop yields.

Of the farmers who are aware of the potential of fertilizer use, the majority do not know the right types and rate of fertilizers they should use for their soils and crops. Further, these farmers have limited access to finance which further affects their demand for fertilizer and other inputs. Moreover, farmers, like other people, are risk averse. The many risks and uncertainties associated with farming retard their enthusiasm to invest in fertilizers. A key element that could reduce the risks is to raise returns from applying fertilizers. Returns improve significantly when the farmer understands fertilizers (and other complementary inputs), has credit to purchase the required inputs, can buy good-quality, affordable products, and can sell the output to a market that offers attractive prices.

Institutional stakeholders are implementing a number of interventions to promote demand for fertilizer in sub-Saharan Africa. They have focused mostly on:

- Farmer education through a number of channels – public and private – and leveraging technology to reduce the cost of education while increasing coverage.
- Reducing the cost of fertilizers through subsidies, local fertilizer production and more efficient supply chains.
- Improving the incentives for farmers to adopt by developing more appropriate blends, introducing complementary technologies, and linking farmers to markets.

Recommendations

The following approaches are needed to increase the effective demand for fertilizers among smallholders.

- Extension advisory services should be strengthened in terms of both content and reach. The government and private sector both play a key role in disseminating knowledge and good agronomic practices. They should disseminate information to explain the benefits of fertilizer, the products available on the market, and how to use them. Innovative extension approaches such as village-based agents, agrodealers, and online services should be used to augment traditional extension approaches.
- The promotion of fertilizers should be closely linked to that of improved seeds, the use of organic nutrient sources and good agronomic practices such as the 4R Nutrient Stewardship: right source, right rate, right time and right place (Chapter 2).
- Farmers' ability to purchase fertilizer should be increased by improving their access to affordable credit, creating avenues for bulk purchasing, and providing them with financial tools to better manage risk. Ways to reduce risk include introducing smart fertilizer subsidies, and insurance instruments tailored to the needs of farmers, such as weather-indexed crop insurance.
- The profitability of fertilizer should be increased. The benefits from applying fertilizer should be high enough to give farmers an incentive to buy it. That means increasing efficiency by developing area- and crop-specific fertilizers, promoting integrated soil fertility management, improving access to markets, and protecting farmers against low and volatile output prices. Prices can be stabilized to some extent by reducing the variability in production, for example through irrigation, research on drought-tolerant crops, and improved post-harvest processing and storage.

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3 The enabling environment

8. Fertilizer policy

Joseph Rusike and Oumou Camara

Fertilizer production and use in Africa is guided by the policies of national governments and regional economic communities. Policies affect many aspects of the fertilizer chain: the availability of finance for producers, distributors and farmers; price and types of fertilizers, institutional landscape, ownership and access to raw materials, research and technology development and dissemination, the number, size and location of fertilizer manufacturing plants, materials management, logistics and physical distribution, the availability of finance for producers, distributors and farmers, the price of fertilizers, the ease of trading both fertilizers and outputs, the availability and quality of hard and soft infrastructure.

This chapter provides an understanding on why policy and regulatory frameworks matter. It describes how policies are made regarding fertilizers. It then reviews the experience of policy formulation and implementation in selected countries to draw lessons about how to resolve the constraints and improve the performance of fertilizer industries.

Using the analogy of a football game, Chapter 4—on the institutional landscape—described some of the players as the organizations playing the game, this chapter looks at the rules of the game.

The major fertilizer-specific policy used by governments in sub-Saharan Africa has been subsidies. We discuss these separately in Chapter 9.

The importance of policies

African farmers pay the highest price for fertilizer around the world, and not surprisingly, fertilizer consumption levels in Africa are the lowest in the world. Fertilizer markets suffer from high costs for import procurement, marketing and distribution mainly resulting from market failures. This situation justifies public-sector interventions.

The policy and regulatory landscape is littered with instruments that governments have used in their attempts to reduce the farm-gate price of fertilizer and boost application rates. Policies have remained focused on the sustained, judicious and increased use of fertilizer by farmers to boost yields and reverse decades of the severe nutrient mining and declining soil fertility.

Billions of dollars are invested every year in implementing fertilizer policies, but without the continent being any closer to achieving the "uniquely African Green Revolution" called for by UN Secretary-General Kofi Annan in 2004. The effectiveness of fertilizer policy and regulatory frameworks is disputed in every corner of the continent. Nonetheless, as governments strive to increase agricultural productivity, fertilizer policy and regulatory frameworks remain the key lever to pull.

Inadequate or inappropriate policies

Many agricultural policies, laws, regulations and practices deter rather than encourage private-sector investment in the fertilizer value chain. This is despite Africa's governments' commitment in the Malabo Declaration of 2014 to "create and enhance necessary appropriate policy and institutional conditions and support systems for facilitation of private sector investment in agriculture, agri-business and agro-industries, by giving priority to local investors". The Abuja Declaration on Fertilizer for the African Green Revolution of 2006 is also yet to be realized. A long list of problems includes the following:

- Bureaucracy in registering new fertilizer products, and in registering businesses to import, manufacture and distribute fertilizers
- Requirements of export and import licenses for trade with neighboring countries
- Access to finance (and particularly foreign exchange)
- Subsidies that displace commercial sales of fertilizer
- High costs of fertilizer clearance at ports, charges and demurrages
- Undeveloped fertilizer distribution systems
- Poor regulation that enables the sale of fake and adulterated fertilizers
- Inappropriate fertilizers in terms of nutrient content
- Lack of harmonization and domestication of fertilizer quality standards within regional economic communities.

In many countries, the public sector has dominated production, import, marketing and distribution

systems. This contributes to the high cost and late arrival of fertilizer. Fertilizer is sometimes is used as a political tool to gain votes. In countries that have invested in road and rail infrastructure, transport costs have gone down significantly, resulting in lower farm-gate prices.

Governments, the private sector, farmer associations and other stakeholders must work together to address these impediments. That includes developing and enforcing policies, laws and regulations to ensure smallholder farmers can obtain good fertilizers in a timely manner and at a reasonable cost. This can only happen if the industry is open to the private sector and the development of competitive markets.

Why fertilizer policy?

Governments around the world heavily intervene in agricultural input and output markets, including those for fertilizers. This is because of market, institutional and regulatory failures.

Market failures

A **market failure** may result from:

- Externalities such as the failure by fertilizer sellers to provide farmers with adequate information about the quality of their products.
- Adulterated, sub-standard, counterfeit and unsafe products.
- Imperfect competition due to only one or a small number of suppliers.
- Government involvement in the market, distorting prices or interfering in the functioning of the market.
- Economies of scale in production, resulting in natural monopolies.
- High transaction costs of doing business.
- Missing or incomplete markets because of a lack of purchasing power among potential fertilizer consumers.

Institutional and regulatory failures

Government intervention to correct market failures may themselves impose costs and administrative burdens, increase costs of doing business, worsen welfare outcomes and result in institutional and regulatory failures.

- **Institutional failure** results when policies, laws and regulations are poorly implemented because of overlapping responsibilities and poor coordination among different ministries, departments, and agencies.
- **Regulatory failure** results from the ineffectiveness of rules to address problems, inadequate resources for enforcement, and inconsistency and inequity in regulation.

Outdated policies

As demand for fertilizers grows and technologies change, policies, laws and regulations that were developed previously have increasingly been overtaken by events. This results in policies and regulations that are:

- Too old and irrelevant to the current situation
- Duplicated and overlapping among government ministries, departments and agencies
- Missing or ambiguous
- Economically flawed
- Too restrictive or excessively implemented, or
- Poorly implemented.

Such outdated policies need to be reformed to create an enabling business environment for fertilizer firms and farmers.

Policy reform processes

The policy process starts with defining a **problem** (or problems) that needs to be solved (such as low yields and farm incomes) and diagnosing its root causes (Figure 33). This problem may be identified by the government itself, or defined as a result of public pressure. The government department responsible then identifies a **goal** (such as to increase yields and income) and sets **objectives** that will help achieve that goal (e.g. increase fertilizer use). The objectives need to fit with the overall vision and strategy for the agricultural sector and the country's development agenda. The objectives will vary among countries and within a country over time.

These objectives feed into a **policy** (such as "privatize fertilizer supply"), which must be translated into a **law** (or act, decree, directive, promulgation or ordinance). This is particularly so if the policy involves the appropriation of government budgets, imposes taxes (levies, fees or charges), or creates offenses and imposes criminal penalties and fines. The policy needs to be consistent with other related policies and laws.

To implement a fertilizer act, **regulations** (ministerial orders and subsidiary texts under the law) are enacted to provide the needed institutional

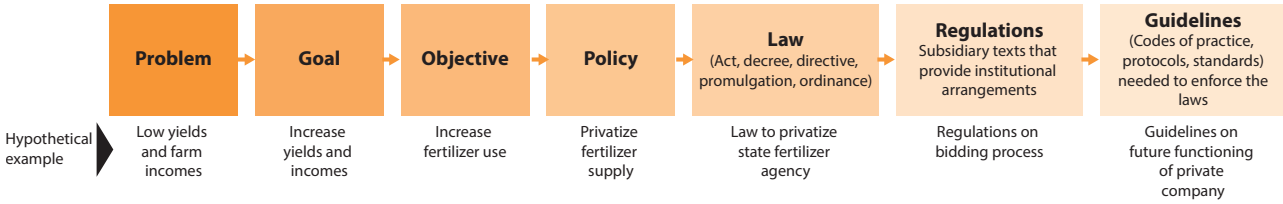

Figure 33. Policies, laws, regulations and guidelines

arrangements and legal underpinnings. The regulations also put in place the implementing **guidelines** (codes of practice, protocols, specifications and standards) that need to be in place to enforce the laws.

The process of policy development is non-linear (Figure 33). The policy must be initiated, developed, validated and approved, before it goes into the legislative process. This entails drafting, validating and approval of a succession of legal texts, followed by legislation by parliament. Once it becomes law, the measures can be implemented and enforced. After a period of implementation, the success (or otherwise) can be evaluated, and the policy or law revised as appropriate.

At various stages in this process, consultation with stakeholders is necessary to ensure the policy is appropriate and realistic, to incorporate the stakeholders' opinions, to inform them of the process and goals, and to get their support. The process may become stuck at any stage because of resistance from the public, stakeholders or actors within the government, or because of external events such as a change of minister or government.

Going through the full procedure in Figure 34 takes time: depending on the complexity of the issue and the administrative, political and legislative processes, the sequence from problem definition to legislation may take 5–10 years. Throughout, the responsible

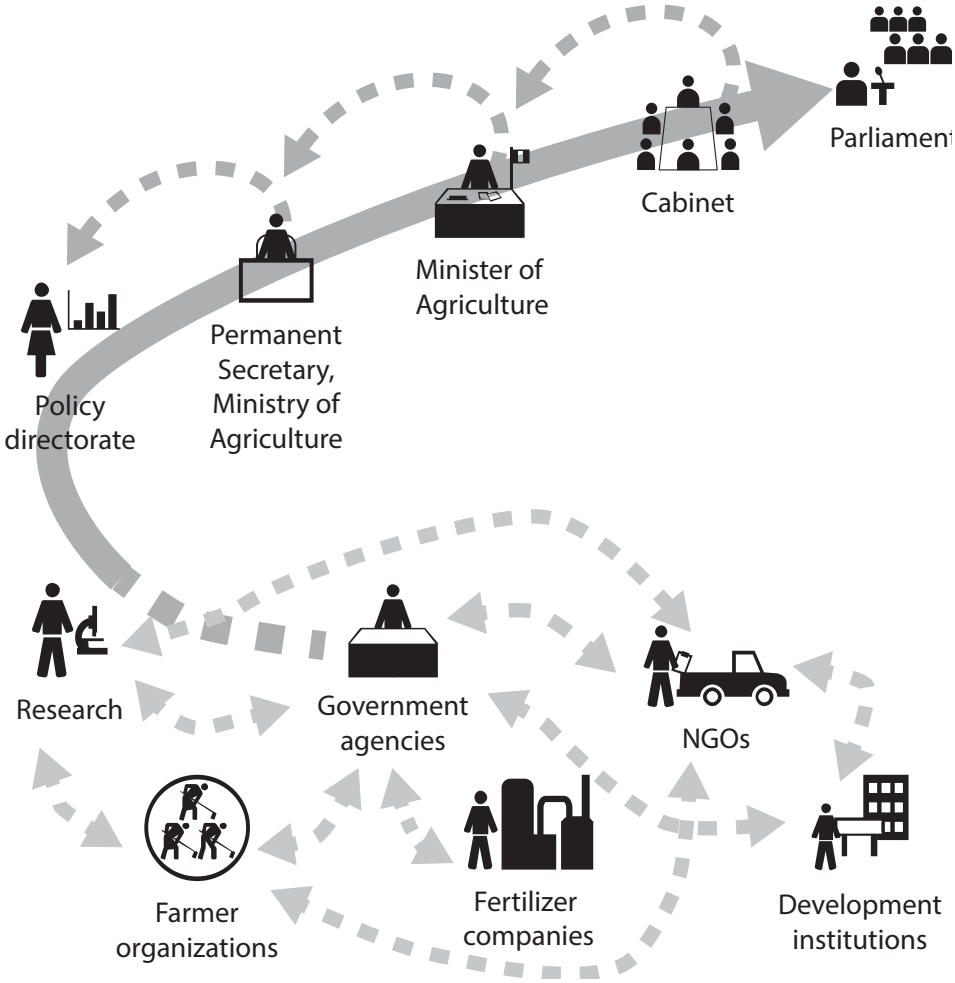

Figure 34. The policy process for fertilizers

ministry (for fertilizers, normally the ministry of agriculture) must coordinate with other ministries and consult with a long list of stakeholders: trade organizations, individual firms, farmers' organizations, civil society organizations, researchers, and other key stakeholders. These may also engage in policy and advocacy work to try to influence the policy process and outcomes.

Experience shows that it is necessary to work closely and consult widely with stakeholders and obtain their support and buy-in from the beginning of the policy development process. This may delay the process and consume resources. But the time and investment will more than pay off as the regulations gain wide acceptance by stakeholders.

The policy process has two dimensions: technical and political.

- The **technical** dimension is to facilitate the development of high-quality laws and regulations which are consistent with international best practices and relevant global, and regional instruments.
- The **political** dimension is to secure the participation of stakeholders in the development of the instruments as well as to ensure the buy-in of the political authorities.

The process is yet more complex if several layers of government are involved (regional community, national, regional, local), if consensus is needed (as in democratic as opposed to authoritarian systems), if the topic is high-profile enough to involve other ministries or the president's office, if the pre-existing legislation is complex, and if evidence is needed beforehand that the policy will have the desired effect. The process may go forward quickly or slowly, or it may be contested, stall or go backwards.

Once a policy is converted into law, implementation and enforcement are by no means assured. Those who are affected by the new rules – and those charged with enforcing them – must be made aware of the rules. Procedures must be put in place, staff hired, reassigned and trained, equipment acquired, facilities built, and so on. During implementation, activities must be coordinated, records kept and the situation monitored to ensure the measures are having the desired effect.

It is also necessary to ensure that the national regulations are harmonized with those of its neighbors in a regional economic community. This is necessary to facilitate cross-border trade in fertilizers and broaden the market for fertilizer firms.

Policies in individual countries

The remainder of this chapter describes the fertilizer policy background in eight countries: Mali, Burkina Faso, Ghana and Nigeria in West Africa, Ethiopia, Kenya and Tanzania in East Africa, and Malawi in Southern Africa. For each country we describe the history of fertilizer policy and show how this has led to the current situation.

Mali

Agricultural development strategies. Since the early 1980s, the government has implemented agricultural policy and regulatory reforms to transform the economy by giving a greater role to the private sector and market processes (Dembele and Staatz, 1999; Dembele, 2004). The process began in 1981 by removing legal constraints to marketing cereals by the private sector. It increased the role of the private sector and linked weekly village markets to urban centers and export markets.

The government has implemented a series of strategies to combat poverty and promote development (MAFAP, 2013). These have included:

- **2002–6:** Strategic Framework for the Fight against Poverty.
- **2007–11:** Strategic Framework for Growth and Poverty Reduction (Cadre Stratégique pour la Croissance et la Réduction de la Pauvreté, CSCRP).
- **2008:** Start of the Program on Social and Economic Development to increase staple food grain production to meet national needs and drive the industrialization plan.
- **2012–17:** Strategic Framework for Growth, Employment and Poverty Reduction (CSCERP)—replaced the Strategic Framework for Growth and Poverty Reduction.

Within these broad frameworks, the government implemented several specific strategy and policy frameworks to guide agricultural and rural development. These included:

- **1992–2010:** Master Plan for Rural Development.
- **2011–20:** Agricultural Development Policy (Politique de Développement Agricole).

Operational programs were shifted from individual projects investment projects before 2010 to the National Agricultural Sector Investment Plan (PNISA) to bring together all national investment plans, programs and projects, and interventions for agriculture in the country for 2011 to 2020.

The **2006 Agricultural Orientation Law** (Loi d'Orientation Agricole) guides the formulation and implementation of long-term policies for agricultural development. The government transferred responsibilities and management of production, transformation, and commercialization of agricultural inputs and products to private-sector firms. This demonstrated the government's commitment to a private-sector approach.

The Ministry of Agriculture's **action plan for 2008–12** (Agreed International 2016a) provided a coherent framework to implement strategies and actions spelt out in the Program of Economic and Social Development, the Letter of the President of the Republic and the Declaration of General Policy General of the Prime Minister.

Fertilizer regulation. After controlling the fertilizer industry from 1960 to 1968, the government liberalized it in 1968. Several companies entered the sector: by 2010 there were 4 importers and blenders, 15–20 wholesalers, 300 distributors and 820 agrodealers engaged in fertilizer supply. In 2008, the government passed a fertilizer law to promote a competitive, open-market-based system (Agreed International 2016a). But it did not implement the law because there were no application decrees to operationalize it, and because it lacked the financial and human resource capacity to enforce it.

Subsidies. Following the global financial crisis in 2008, the government launched a seed and fertilizer subsidy under its Rice Initiative. This aimed to increase cereal productivity through improved access to fertilizer and to contribute to food and nutrition security through increased income and reduced consumer prices. The main component of the subsidy is fertilizer. The program was expanded to include maize, wheat, millet, and sorghum, seeds, pesticides, and agricultural equipment. The government provides subsidies through the Presidential Initiative. The subsidy program is provided using an open-market system based on companies tendering to supply fertilizers. The government subsidizes 40% of the cost and the farmer pays the remaining 60%.

The subsidies now account for a large share of the agricultural budget, with a share expenditure of around 25% of all government spending on rural development.

National Fertilizer Committee. In 2011, Ministerial Order 2011-2220/MASG appointed members of the National Fertilizer Committee (Agreed International 2016a). This committee includes a representative of the Minister of Agriculture and 18 members, including all actors in the fertilizer sector. But it does not function as well as it should due to lack of funding and challenges with its internal organization. An order from the Minister of Agriculture is needed to fix the modalities of this committee's operation.

Fertilizer quality. The ECOWAS Regulation C/REG.13/12/12 aims to harmonize rules governing quality control, certification, and marketing of fertilizers in the ECOWAS region. Mali has published this in its official gazette. A fertilizer testing laboratory was designated in 2013. Inspectors conduct field inspections (Keyser et al. 2015), but there is only one laboratory for the country and its capacity is limited. The national laboratory can only analyze for nitrogen, phosphorus, and potassium, but not other macro- or micronutrients. There is no systematic control of imported and locally produced fertilizers before they are distributed for sale. Substandard fertilizers are not removed from the market. Penalties have been identified but no prosecutions have been made. Therefore the supply of high-quality fertilizer is a major challenge.

Fertilizer recommendations are not based on soil- or crop-specific conditions, the nutrient content of the soil, or the needs of the crops. A new product must be tested in government-run trials for 3 years and give at least 30% higher yields than a standard fertilizer formulation.

Regional trade. The national law on fertilizer is not consistent with the ECOWAS fertilizer decree: it specifies different maximum variations in nutrient content and in heavy metals from those designated by ECOWAS. The Mali legislation includes chrome as a controlled heavy metal; this is not listed by ECOWAS. This implies that foreign fertilizer can be blocked at the border. The Mali legislation allows for much higher concentrations of cobalt than does ECOWAS. This makes it difficult for Mali to export its own products. Malian regulations also dictate different and less specific requirements for labeling of nutrient content than does ECOWAS.

Mali has followed an approach to fertilizer institutional and regulatory reforms based on developing a competitive, open-market system. Competitors import raw materials and finished fertilizers from several countries, including Belarus, Morocco, Nigeria, Russia and Ukraine.

The country has a relatively developed network of hub agrodealers, which helps explain the rate at which the fertilizer industry is growing. Annual fertilizer

consumption exceeds 700,000 tonnes (IFDC and AFAP 2018a). However, as much as 88% of the fertilizers consumed each year are subsidized. Only about 80,000 tonnes are sold through commercial markets.

Constraints. Constraints to improving the performance of the fertilizer industry include the poor enforcement of existing legislation, the quality of warehouses, limited human resources to control fertilizer, the lack of conformity with ECOWAS rules, soil mapping, and the high cost of fertilizers. Regulations on the axle load of trucks operating in the West African Monetary and Economic Union region is a constraint because it increases the cost of transporting fertilizers.

Burkina Faso

Agricultural development strategies. Starting in the 1990s, the government has implemented agricultural policy and regulatory reforms to accelerate the development of sustainable agriculture and growth to improve people's livelihoods. From 1994 to 2009, it implemented structural-adjustment macroeconomic-policy reforms. These improved the environment for private investment in general and agricultural sector investment in particular (Abt Associates 2014).

Fertilizer regulation. Efforts to develop regulations for fertilizers started in the 1990s when the government committed to a private-sector-driven approach and began to emphasize expanding the private sector's role in fertilizer distribution. In 1999, the government adopted the National Strategy of Soil Fertility. Beginning in 2005, the government subsidized fertilizers for cotton: cotton companies are allocated public funds to maintain stable prices of fertilizers.

Following the Abuja Summit for fertilizer in 2006, a national strategy was developed to promote fertilizers. The overall objective was to double the average application rates from to 7.5 in 2006 to 15 kg/ha in 2015. Investments were made to develop a network of agrodealers to distribute agricultural inputs and expand farmers' access to fertilizers. A Fertilizer Act and regulations to control the quality of imported, exported and locally manufactured fertilizers was passed in 2007. This required imported fertilizers to be approved by the Minister of Agriculture and to obtain a National Certificate of Conformity issued by the Minister of Trade. The law is not explicit about compulsory registration of new fertilizers, but it specifies penalties for importing, marketing and manufacturing fertilizer without approval. The Ministry of Agriculture is mandated to enforce the controls; it does so by checking the quality of fertilizers, labeling and packaging at the borders, manufacturing plants, sales and storage points.

Subsidies. Following the global financial crisis in 2008, the government began to subsidize fertilizer for rice, maize, sorghum and cowpeas. From 2008 to 2011 these subsidies were distributed by the staff of the Ministry of Agriculture (Agreed International 2016b).

In 2011, the government adopted the Strategy for Accelerated Growth and Sustainable Development ("Stratégie de croissance accélérée et de développement durable") for implementation from 2011 to 2015. The National Program for the Rural Sector (PNSR) covers the planning, implementation, monitoring and evaluation of all public and private interventions in rural development. These two initiatives provide the vision, strategy and policy framework for agricultural and rural development. The National Program for the Rural Sector permits firms to push reforms forward through innovations that trigger increased production through prioritized value chains. A Presidential Council was set up for the private sector to meet with government officials and discuss policies and regulations, because the reality on the ground can be different from that envisaged in planning documents.

Starting in 2012 the government began to involve the private sector in the distribution of subsidized fertilizer in order to reduce the cost of reaching beneficiaries (Agreed International 2016b). It organized the Competitiveness and Growth Credit program to do this. This allocated 30,000 tonnes of fertilizer a year for distribution by private firms. The quantities of subsidized fertilizer distributed by the private sector during the 2012/13 to 2015/16 cropping seasons ranged from 40 to 56% of the planned 30,000 tonnes. The government has stated that it intends to withdraw progressively from supplying agricultural inputs in favor of the private sector. However, subsidized inputs for cotton are distributed through cotton companies (SOFITEX, SOCOMA, Faso Coton) and their trade association. There is the perception that a substantial proportion of fertilizers marketed are of poor quality.

Regional trade. The ECOWAS Regulation C/REG.13/12/12 governs the harmonization of rules governing quality control, certification, and marketing of fertilizers in the ECOWAS region. Burkina Faso published this regulation in its official gazette and designated a national regulatory service. In response, the Direction Générale des Production Végétales,

Ministry of Agriculture, Hydraulic and Fisheries Resources (DGPV/MAH) pushed through various orders and decrees:

- Inter-ministerial Order 2014-045/MASA/MEF/MICA, fixing the amount of approvals for the manufacture, import and distribution of fertilizers.
- Joint Order 2014-044/MASA/MICA, on fertilizer labeling standards.
- Ministerial Decision No. 2014-075/MASA/MICA/MERSI/MEDD, on methods of sampling, analysis and determination of the maximum concentration of heavy metal fertilizers.
- Order 2014-045/MASA/CAB on seizure and confiscation procedures in fertilizer control.
- Order 2016-131/MAAH/CAB appointing the members of the National Commission for Fertilizer Control.
- Decree 2017-1131/ PRES/PM/MINEFID/MAAH authorizing the collection of revenue relating to the control of fertilizers.
- Joint Order 2018-004/MAAH/MINEFID on pricing and payment arrangements for fixed inspection fees and other fertilizer control revenues.

Fertilizer quality. The National Committee for Fertilizer Control is supported by the laboratories of the National Soil Bureau for testing and the National Institute for Environment and Agricultural Research for fertilizer recommendations. That means Burkina Faso has in place regulations that are in compliance with ECOWAS quality regulations. But implementing the control structure has been a problem. An equipment problem at the National Soil Bureau is being fixed by a $5 million investment, but problems with inspection procedures, human capacity and supervision remain. Moreover, the regulations do not cover fertilizer distribution. Fertilizers used are not tailored to the different situations of farmers depending on crops and soils. The availability of good-quality inputs is thus a problem. The government has been recommended to target fertilizer subsidies to support private fertilizer firms to open up new markets. Such subsides would reduce investment costs to encourage companies to invest in distribution in more rural but high-potential markets.

Constraints. A comparative institutional analysis of ECOWAS regulations and the Fertilizer Act (Garane and Barry 2017) showed that the Act does not take into account several provisions of the ECOWAS regulation. The analysts recommended that the discrepancies were so large that a new law would be necessary.

Of the total fertilizer volume of 280,000 tonnes consumed in 2016, 73% are subsidized (of which 66% are directly for cotton), leaving only about 75,000 tonnes supplied by private firms through commercial markets. It is unlikely that the growth in fertilizer consumption will come from subsidies (IFDC and AFAP, 2018b). Only the development of the private system can further the consumption of fertilizers in the country.

Ghana

Agricultural development strategies. Under the Economic Recovery Program starting in 1983, the government removed price controls and subsidies, privatized state-owned enterprises, liberalized agricultural markets and devalued the currency. It developed several frameworks to guide development and interventions in agriculture (Ministry of Food and Agriculture 2007, 2015; National Development Planning Commission 2014):

- **2000–2004:** Accelerated Agricultural Growth and Development Strategy
- **2010–2013 (phase 1), 2014–17 (phase 2):** Ghana Shared Growth and Development Agenda
- **2002–6 (phase 1), 2007–11 (phase 2):** Food and Agriculture Sector Development Policy
- **2009–15 (phase 1), 2014–17 (phase 2):** Medium Term Agricultural Sector Investment Plan
- **2018–20:** Planting for Food and Jobs

The National Development Planning Commission set these agendas. The Agricultural Sector Working Group was organized beginning in 2002 to conduct policy dialogue for engaging the government and development partners on implementation of the policy frameworks.

Fertilizer regulation. Although the government liberalized the procurement, import and distribution of fertilizer beginning in 1988, it did not put in place a legal and regulatory framework to control quality until the enactment in 2010 of the Plants and Fertilizer Act,

2010 (Act 803). It took 9 years from 2001 to 2010 for this Bill to go through the government processes and get passed into law. After the Act came into force, it took another two years to put regulations in place so it could be implemented. The Fertilizer Policy was approved by Cabinet in July 2013.

The ECOWAS Regulation C/REG.13/12/12 on the harmonization of quality, certification and marketing rules for fertilizers were ratified in 2016.

Fertilizer quality. The National Fertilizer Council was reconstituted in 2014 to oversee the performance of the fertilizer industry. The Pesticide and Fertilizer Regulatory Division of the Plant Protection and Regulatory Services Directorate, Ministry of Food and Agriculture, was established under Act 803 as the national regulator. Twenty-five fertilizer inspectors were appointed. At least two inspectors are working in each of the country's region. The Directorate's National Laboratory was designated as the fertilizer testing laboratory, but it cannot yet run all the major nutrient analyses. Four other public and private laboratories were designated to carry out nutrient analysis.

The Fees and Charges Legislative Instrument is reviewed annually to determine fees and amounts for obtaining or renewing a license. However, the regulatory authority has inadequate human, material and financial resources to enforce the regulations. This is a major constraint to implementing the quality-control system.

Subsidies. After the 2008 global financial crisis, the government reintroduced subsidies to increase farmers' access to seeds and fertilizer, increase fertilizer application rates, drive down the cost of food production, and attain household and national food security. It tried different systems for implementing the subsidy scheme. It started by providing fertilizer subsidies to cocoa farmers through the Ghana Cocoa Board through licensed wholesalers, distributors, local agrodealers and agents. Subsidies to cereal farmers were delivered through fertilizer companies selected through competitive bidding. These companies were given a quota based on the company's capacity, historical distribution, the offered price and other factors. Regional quotas were allocated based on historical consumption and projections.

- **2008–9:** Subsidies to cereal farmers were provided through vouchers redeemable through agrodealers (World Bank 2017, Agreed International 2016c).
- **2010:** The government changed this system to a waybill system in order to reduce the cost of administration and the diversion of fertilizers from the intended beneficiaries.
- **2012:** A passbook system was introduced. Farmers used their passbook to go to district agricultural officers and collect fertilizers from the agrodealer.
- **2013:** Switch from universal to targeting by focusing on smallholders in the north, limiting the quantity per farmer, and reducing the subsidy element for fertilizer to less than 30%.
- **2014:** The subsidy program was not implemented because of a lack of funds.
- **2015:** The program was resumed, with targeting and subsidizing only for NPK and urea.
- **2016:** Change to an electronic system.
- **2017:** The database of farmers, piloted by e-Soko, was upscaled and used to operate the electronic voucher for the fertilizer subsidy. By September that year, the Crops Services Directorate had biometrically registered 250,000 farmers in seven of the country's ten regions.
- **April 2019:** 384,000 farmers had been registered electronically.

Constraints. Ten companies import and sell 440,000 tonnes of fertilizers a year (IFDC and AFAP 2018c). The major constraint to improved performance of the industry is that about 84%, of this amount is sold under some kind of subsidy and not necessarily tendered. This likely results in monopoly overcharges. There are also infrastructural problems. The electronic voucher system is difficult and expensive in the environment.

Nigeria

Agricultural development strategies. Starting in 1986, the government began to implement a package of agricultural policy and regulatory reforms under the Economic Recovery Program. This reduced deficit financing, devalued the local currency, removed subsidies, price controls and market boards, eliminated controls on interest rate, restructured public expenditure, reduced tariffs, privatized state-owned enterprises, and liberalized agricultural trade (Moser et. al. 1997). However, these reforms were inconsistently and incoherently implemented until the introduction of Agricultural Transformation Agenda of 2011–16 and the "Green Alternative" Agriculture Promotion Policy of 2016–20 (Federal Ministry of Agriculture and Rural Development 2014, 2016). These provide a framework to guide interventions in the agricultural sector.

In 2011, under the **Agricultural Transformation Agenda**, the government liberalized the fertilizer sector, ending the direct procurement and distribution of fertilizers and seeds, and transferring the importation, manufacture, distribution and retail to private-sector firms. This ended four decades of endemic corruption in the fertilizer sector (Federal Ministry of Agriculture and Rural Development 2014).

The **Growth Enhancement Support Program** provided targeted support for seeds and fertilizer to 20 million farmers in the four years from 2011/12 and 2014/15. This program used an electronic wallet system to deliver seeds at no cost and a 50% subsidy on fertilizers. It was based on a national database of 15 million farmers. Registered farmers received vouchers through their mobile phones, which they could exchange for fertilizer and seeds from independent private agrodealers.

An assessment of the scheme by the Fertilizer Suppliers Association of Nigeria (2013) found it was successful in delivering subsidized inputs to large numbers of farmers. During the 2012, 2013 and 2014 planting years, it delivered inputs to a cumulative total of 14.3 million farmers. The program was successful largely because it was dominated by the private sector. But it lacked a regulatory framework to control quality. This resulted in product faking, adulteration, false labeling and other malpractices (Fertilizer Suppliers Association of Nigeria 2015). Anecdotal evidence indicates that some companies did not deliver fertilizers to farmers but instead bought them back and resold them in commercial markets. After a change in government leadership, the program was not institutionalized into a law that would have made it sustainable.

A **National Agricultural Growth Enhancement Support Scheme Bill** was drafted in 2014. This bill was approved by the Federal Executive Council stage in 2015, but was not sent to the House of Representatives and Senate because of a lack of time before the general elections in December 2016. Consequently the bill got stuck at this stage.

The **National Agricultural Inputs Bill** suffered a serious setback owing to the suspension of the Growth Enhancement Support Scheme in 2016, which provided the policy framework for it.

Presidential Fertilizer Initiative. In 2016, the administration of President Buhari introduced the Presidential Fertilizer Initiative in place of the Growth Enhancement Support Program. The federal government opted to directly support production plants in the country to produce 1.5 million tons of fertilizers in the 2017 farming season, for sale at fixed market prices (see also Box 3). The main aim of the Initiative is to encourage local blending of NPK, so that farmers could use crop and area-specific blends. This required the revival of blending plants that were operating below capacity or not at all, with a combined annual capacity of about 4 million tonnes. Using these plants reduced the cost of production, making it possible to pass on the savings to farmers. State government are given the right to take up about 60% of the fertilizer produced, while agrodealers take the remaining 40%.

The Initiative has recorded some major successes. In 2018, there were 24 blending plants with an aggregate capacity of 5.3 million tonnes per year, up from 11 plants with a combined capacity of about 4 million tonnes at the start of the program (IFDC and AFAP 2018d). The Indorama fertilizer manufacturing plant also came on-stream. The farm-gate price of a 50-kg bag of NPK blend declined from N13,000 to N5,500. Other NPK formulations sold for about N6,800 per bag.

The government banned the import of finished NPK fertilizers in 2018 in order to protect the infant domestic blending industry. There was a dramatic increase in fertilizer consumed, though only one blend now dominates the market. In 2017, consumption rose by 63% to 1.56 million tonnes, but in 2018 it dropped to 1.43 million tonnes. Still this is the highest consumption ever achieved in the country, and has been achieved without a direct farmer subsidy – a key thrust of this policy.

But there were challenges. Delays in offloading raw materials from ships were further complicated by flooding in Lagos State. Road and rail infrastructure are poor, and the participating blending plants are unevenly distributed across the country. Demand is seasonal, and adulteration and price racketeering occur.

These problems are being addressed. Old blending plants were revived and new ones built to reduce the cost of moving fertilizer; the plants are located strategically in each part of the country. Crack teams from the Office of the National Security Adviser, the police and civil defense were set up to resolve adulteration and price racketeering. Whistleblower numbers were established to receive complaints, and a barcoding system with a unique identification for each blending plant was put on bags to track fertilizer movements. A bilateral agreement was signed with OCP, a Moroccan phosphate supplier, to ensure an adequate and affordable supply of fertilizer. The agreement also included expanding investment in shared logistical hubs and assets along the Lagos–Kano–Jibiya corridor, railways, ports, and primary and secondary warehouses.

Fertilizer regulation. Although the government liberalized the fertilizer industry and privatized manufacturing plants in 1997, a coherent regulatory framework to control the registration and quality of fertilizers is still lacking (Liverpool-Tasie et al. 2010). Organizations involved include:

- The Standards Organization of Nigeria (established in 1971)
- National Fertilizer Technical Committee (1983)
- National Agency for Food and Drug Administration and Control (1993)
- Federal Fertilizer Procurement and Distribution Division (began implementing the fertilizer control decree in 2002).

Amendments to update the legislation governing quality control to bring it in line with changes in technology and organization of the industry were required. These had to follow time-consuming processes before they could be approved. It took 17 years, from 2002 to 2019, for the legislation to go through the government processes and get passed into law. The work started in 2002 when farmers pressurized the federal government to establish an agency for fertilizer regulation and control (Ayoola et al. 2002). The government drafted a Bill to establish the National Agency for Fertilizer Regulation to harmonize the competing functions of the Federal Fertilizer Department and the National Agency for Food and Drug Administration and Control. The Bill was adopted by the National Council on Agriculture in 2004 (Ayoola and Yakubu 2015) and reached then-President Obasanjo's desk. But it then went into a hiatus because there was no government appetite to create new agencies. It was revived and revised in 2012 as an executive bill – the National Fertilizer Quality Control Act – under the Agricultural Transformation Agenda under the administration of President Jonathan. The Bill reached the first and second reading stages of National Assembly in 2014, but was not enacted into law. Under the administration of President Buhari, the Fertilizer Quality Control Bill was again resuscitated and was passed by the House of Representatives in 2016. It then went to the Senate, which revised the Bill and forwarded it to the President. The president signed the Bill into law in October 2019.

Because the fertilizer bill still has to be signed into law, the ECOWAS Regulation C/REG.13/12/12 has not been published in the official gazette. The Bill will empower the Federal Ministry of Agriculture and Rural Development's Department of Farm Inputs Support Services to implement the regulatory system. Preparations have been made: draft regulations have been developed (but are yet to be approved); the analysis and inspection manuals have been published; the fertilizer-testing laboratories have been designated; inspectors and technicians have been trained.

Constraints. Other policy reforms must still be addressed. The most critical is the lack of development of the best-bet fertilizer products.

Expanding private-sector investments will need to be supported by an effective regulatory system. The current structure assumes that a regulatory system can be built and that participants will comply with it. But experience in Nigeria shows that enforcing the rules has been a major problem, and regulatory agencies lack the capacity to monitor compliance by the many fertilizer firms and agrodealers. A regulatory system is needed that includes self-regulation, enforcement by the private sector, and the transformation of the Department of Farm Inputs Support Services. Privatized enforcement can be done through certified specialists who monitor company compliance, and audit and certify manufacturing processes, equipment, material, processes and staff competence. This would work in much the same way as financial auditors certify company accounts.

The jury is still out on the costs and benefits of the Presidential Fertilizer Initiative. Arguments have been made that the government has created opportunities for monopolistic competition and rents rather than competitive markets and zero economic profits (IFDC and AFAP 2018d). This has permitted fertilizer firms to capture the rents by extracting farmer and consumer surpluses and revenue paid by taxpayers. Much of the fertilizer is sold through government markets. This reduces incentives for firms to develop open competitive markets.

Ethiopia

Agricultural development strategies. The government introduced economic reforms beginning in 1991. These included a currency devaluation, trade liberalization, the deregulation of agricultural markets, the lifting of restrictions on the participation of private-sector firms, and the privatization of state-owned enterprises (Shiferaw 2017).

- **1992:** Removal of the parastatal Agricultural Input Supply Corporation's monopoly on fertilizer imports and distribution. Fertilizer subsidies ended, and private-sector firms and regional state-operated agencies permitted to enter the industry.
- **1993:** Launch of the Agriculture Development Led Industrialization strategy to accelerate development, build human capacity, expand infrastructure, liberalize the economy, build institutions and decentralize government institutions.
- **1998:** Fertilizer Manufacturing and Trade Proclamation (No. 137/1998).
- **2000:** Poverty Reduction Strategy Program
- **2002–5:** Sustainable Development and Poverty Reduction Program.
- **2005–10:** Plan for Accelerated and Sustainable Development to End Poverty. This was aligned to the Millennium Development Goals and the Comprehensive Africa Agriculture Development Program framework.
- **2010–15:** First Growth and Transformation Plan and Agricultural Transformation Plan. The Ethiopian Agricultural Transformation Agency was established to help make Ethiopia a middle-income country in 20–23 years.
- **2015–20:** Second Growth and Transformation Plan. This emphasizes the commercialization of smallholder agriculture and mobilizing private investment in agribusiness.

By 1996 several private-sectors firms were engaged in fertilizer importation, 67 in wholesaling and 2,300 in retailing (Spielman et al. 2013). But trading policies were biased towards government-affiliated companies and parastatals. For example, import licenses were allocated through a tender process that required that fertilizers be imported in lots of 25,000 tonnes; private importers had to deposit 100% of the value of fertilizer to be imported (Rashid et al. 2013). Private firms failed to compete with the state-owned enterprises and exited the industry.

By 2007, farmers' cooperatives had replaced the regional state-run agencies. In 2008, the government renamed the Agricultural Input Supply Corporation as the Agricultural Input Supply Enterprise and made it the sole fertilizer importer (a status it had pre-reform in 1992). Fertilizer imports and distribution through unions and primary cooperatives once again became dominated by public-sector organizations.

Fertilizer quality. Historically, diammonium phosphate and urea were the only fertilizers registered, imported and distributed. The Ethiopian Standards Authority approved standards covering eleven types of granular, powder and liquid fertilizers. It enforced these through pre-shipment quality inspections and checks of fertilizer quality at the port of Djibouti. No quality tests were conducted in Ethiopia itself. Quality checks at the port were discontinued in the early 1990s as a result of difficult working relationships with local and foreign stakeholders.

Beginning in 2010, various major developments resulted in pressure to reform the quality-control regulations:

- The development of the Ethiopian Soil Information System based on decentralized, digital soil-fertility mapping, the determination of fertilizers, and awareness-creation on new types of fertilizers.
- The development of new compound and blended fertilizers, plants for local production of blended fertilizers (starting in 2014), and marketing channels to supply this fertilizer to different locations based on soil information and awareness creation.
- Increased participation by private-sector firms, cooperatives and unions in the production, distribution and marketing of blended fertilizers.

Quality standards for the new fertilizers were developed by the Ministry of Agriculture. This responsibility was transferred to the Ethiopian Conformation Assessment Enterprise (IFDC 2012).

The Plant Health Regulatory Directorate of the Ministry of Agriculture initiated revisions in the fertilizer policy, drafting proclamations on fertilizer production and trade and fertilizer industry agency establishment, and merging the fertilizer control system with that of plant health protection. It pushed through the

establishment of an independent authority on fertilizer-quality control and plant-health protection, but the authority is still to be set up. The policy and proclamations were submitted to the prime minister's office but are still to be approved and legislated.

Various guidelines and systems have been put in place:

- Guidelines on the registration of fertilizers
- The issuance of certificate of competence for fertilizer administration and operation
- Manuals on fertilizer-testing methods
- Guidelines on fertilizer inspection
- Manuals on fertilizer analysis for laboratory technicians.
- Standard procedures for producing quality fertilizers for private and public manufacturers
- A certification system for quality of blended fertilizers
- A quality-control system spanning activities from import and production to the farm gate.

Fertilizer standards were updated by the Ministry of Agriculture in collaboration with the Ethiopian Standard Agency and the Ethiopian Conformity Assessment Enterprise. The capability of the latter was improved to enable it to carry out tests for chemical and physical quality, efficacy, content validation and labeling beyond diammonium phosphate and urea. The soil-testing laboratories were retooled and technicians were trained to carry out inspections of compound and blended fertilizers. Inspectors were trained on controlling fertilizer quality and collecting samples for testing.

Subsidies. Although Ethiopia does not have a direct fertilizer subsidy program, a hidden subsidy exists. This results from the administrative costs and inefficiencies in the processes of bringing in fertilizer, restricted profit margins through the trade, and delays in payment for credit for distributing fertilizers to farmers. The government perceives that the private sector does not have the capacity to take over activities currently managed by the government. This explains why the government has focused on making the public system work. Beginning in 2014, an input-delivery credit system based on electronic vouchers was introduced. This is being scaled up to several regions.

Constraints. As of January 2019, the fertilizer proclamation had not been altered to allow private-sector parties to be involved in the procurement and distribution of fertilizers. This has been proposed for at least 18 months, with the intent that OCP (a Moroccan firm) would manage blending plants and provide technical skills and agronomic support. Plants are being built in Dire Dawa to produce 1,000,000 tonnes of urea and 1,000,000 tonnes of NP and NPK compounds a year using phosphoric acid from OCP. These are due online in 2022. These facilities will have the capacity to supply most domestic needs.

It may be decided that Ethiopia make a few compound fertilizers (rather than blends) so it can control product quality and use capital resources efficiently. The fertilizer market size of 866,000 tonnes a year is third largest in Africa (IFDC and AFAP 2018e). But the system has 100% government involvement, though there is growing private-sector interest. While the distribution networks are currently through cooperatives, the direct marketing of fertilizers is being introduced.

Kenya

Agricultural development strategies. The government implemented several agricultural policy and regulatory reforms beginning in the mid-1980s. These included market liberalization to remove price controls on agricultural input and output markets, the dismantling of trade restrictions, the transfer of commercial functions to the private sector, and the reduction of government provision of services, including credit, extension services, marketing, dipping and artificial insemination (Gitau et al. 2008). However, there was a lack of political will and commitment, and policy reversals that hindered progress (World Bank 2015).

- **2003:** The government formulated and began to implement the Economic Recovery Strategy for Wealth and Employment Creation 2003-2007.
- **2008:** Launch of the Kenya Vision 2030. This set the overall vision and strategy framework for interventions in agriculture. The government developed a hierarchical structure of layers of policies that nest those for agriculture. The economy wide Economic Recovery Strategy Vision 2030 nests the Sector Sustainable Development Goals, the Comprehensive Africa Agricultural Development Program.
- **2008–12:** First Sector Medium Term Investment Plan.
- **2013–17:** Second Medium Term Investment Plan.

- **2018–22:** Third Mid Term Investment Plan, driven by the Big Four Presidential Agenda.

Within these overarching frameworks are nested various strategies and laws specific to agriculture and to fertilizer:

- **2004–14:** Strategy for Revitalizing Agriculture.
- **2010–20:** Agricultural Sector Development Strategy.
- **2011:** National Food and Nutrition Security Policy, National Social Protection Policy.
- **2012:** National Agri-Business Policy, Crop Production and Livestock Act, National Agricultural Research System Policy, National Agricultural Sector Extension Policy.
- **2013:** Crops Act, Agriculture and Food Authority Act.
- **2014:** Agricultural Policy, Ending Drought Emergencies.
- **2016:** Agricultural Sector Development Strategy,
- **2019–29:** Agricultural Sector Transformation and Growth Strategy. This is aligned with the third Medium-Term Investment Plan and the aspiration for 100% food and nutrition security in the Big Four Presidential Agenda.

These frameworks place heavy emphasis on expanding private sector participation and investment in the fertilizer sector.

Fertilizer regulation. In 1993, the government liberalized fertilizer importation and removed controls on private-sector imports with respect to type, quality, pricing and allocation of foreign currency (Muriuki 2013). Several players entered the industry, and private-sector companies became the main players in marketing and distribution of fertilizers, promoting fertilizer use and improving infrastructure. Companies began to distribute products mainly through agrodealers in different-size packs: 1 kg, 2 kg, 5 kg, 25 kg and 50 kg. Fertilizer companies also sell through the government subsidy program.

The 1985 Fertilizer and Animal Foodstuffs Act (Cap 345) provides the legal basis for fertilizer registration and quality control. There is no rule requiring fertilizer firms to register their products before they are imported. The market decides what types and nutrients get used: farmers look for fertilizers that offer solutions to their production problems.

It can be costly to register fertilizers. Agrochemicals are required to undergo field trials for 2–3 years before they may be imported. This is a disincentive for private firms to introduce new products. The Kenya Bureau of Standards sets standards for products through a technical committee on fertilizers and soil conditioners. These standards are then approved by the National Standards Council and are gazetted under the Ministry of Trade. The quality of fertilizer imports is ensured by conforming to these standards.

The Kenya Bureau of Standards appoints independent inspecting agencies, including the Société Générale de Surveillance, Bureau Veritas, Intertek, and China Quality Control Inspection Service, to carry out pre-export inspections in the country of origin. If the product conforms to the standards, a certificate of conformity is issued, without which the fertilizer is not permitted to enter the country. The Bureau itself conducts surveillance tests and takes samples during discharge at Mombasa, the port of entry.

After leaving the port, no proper system of quality control exists. There are reports of adulteration, where unscrupulous traders open bags and mix the contents with cheaper materials, then sell the bags as a more expensive fertilizer product (Sanabria et al. 2018). Kenya Bureau of Standards certifies locally produced fertilizers. Inspectors from the Bureau of Standards do monitor retail outlets and the Standards Act, Chapter 496, to enforce quality control. But there are too few inspectors, and they lack the technical capacity to enforce compliance. The Ministry of Agriculture is putting in place a system to collect samples and take them to the Bureau of Standards for analysis.

The Ministry of Agriculture also imports fertilizers using public funds, thus competing with the private sector. The ministry operates in secrecy; the private sector then is left with having to mitigate the harmful effects of the government.

Subsidies. After liberalization of the fertilizer industry, fertilizer prices started going up especially from 2002 to 2009. Prices of DAP in the market rose dramatically, from KES 2,000 to 6,000 per 50-kg bag. Following the 2008 global financial crisis, the government reintroduced subsidies to cushion farmers against high fertilizer prices. Five types of subsidy programs have since emerged (Le Turioner and Karuri 2019):

- **National Accelerated Agricultural Inputs Program:** The government issues vouchers to farmers with less than 1 hectare of land in selected districts. These enable them to purchase 50 kg of planting fertilizer, 50 kg of top-dressing fertilizer, and 10 kg of

maize seed. Farmers obtains the inputs from stockists and agrodealers; the stockists redeem the vouchers from the government.

- **National Subsidy Program:** The Ministry of Agriculture tenders for procurement of fertilizers from the international market and distributes them at uniform, subsidized prices through National Cereals and Produce Board depots.
- **Safaricom electronic fertilizer subsidy:** This service operates through the Safaricom mobile phone network. Farmers self-register using an SMS text message on their mobile phones. This gives them access to fertilizer at subsidized prices using vouchers (Safaricom 2018).
- **Kenya Cereal Enhancement Program–Climate Resilience Agricultural Livelihoods electronic voucher scheme:** Farmers and agrodealers enroll in an electronic voucher system that allows them to access farm inputs through the platform. This uses working capital loans advanced to agrodealers by financial institutions.
- **County government subsidy schemes:** Since 2015, some counties have operated their own input subsidy programs. These include Bungoma, Kakamega, and Trans-Nzoia.

Electronic vouchers: Electronic vouchers replace paper documents and provide real-time settlement. The shift from paper to electronic vouchers results from various concerns: poor targeting and fraud in subsidies, the high cost of reaching farmers, the traceability of input distribution, delayed payments by the government to the private sector, sale of fertilizer across borders, unscrupulous traders buying subsidized fertilizers and reselling commercial prices, fiscal sustainability, and poor impact on yields and profitability. It is estimated that as many as 80,000 tonnes of subsidized fertilizers are redirected to retailers, who divert them to the retail market. About 40,000 tonnes are thought to go to Uganda through informal traders.

The government is restructuring the subsidy programs to harmonize the voucher schemes at national and county levels. The aim is to serve farmers nationwide and allow them to purchase a range of inputs, and not just fertilizers and maize seed.

But reforms are difficult. Fertilizer is highly political, and parties can capture economic rents from the current system, so resist change.

Revising legislation: In 2014 the Ministry of Agriculture initiated reforms to amend the 1985 Fertilizer and Animal Foodstuffs Act (Cap 345). This was to bring it in line with changes in fertilizer demand, technology and the shift to a competitive market-organized industry. The Ministry originally wanted to repeal the Act and replace it with two separate acts dealing with animal feeds and fertilizers. This intention was never realized; a private-member's bill was introduced in Parliament to amend the 1985 Act. This amendment was made law in October 2015, and resulted in the creation of a Fertilizer and Animal Foodstuffs Board. However, it is still necessary to repeal the 1985 Act and enact two comprehensive laws dealing with fertilizers and animal feed separately.

Fertilizer quality: Disputes have arisen over permissible amounts of trace elements in fertilizer imports. In 2010, the technical committee on fertilizers and soil conditioners lifted the permissible levels of cadmium in phosphate fertilizers from 7 to 30 parts per million. This allowed products of the Moroccan firm, OCP, to be bought into the country (Mwiti 2017).

In 2018 the permissible level was dropped to 15 parts per million, forcing OCP to exit the market again (Kamau 2019). OCP products were detained in Mombasa, and investigators claimed that they contained "mercury". Kenya Bureau of Standards officials and some foreigners were charged for unlawfully releasing substandard fertilizer in Kenya; ships carrying fertilizer were delayed, and importers cancelled orders because of the risk of being left with an illegal product.

The charges have now been dropped and the impounded fertilizer consignments released (Ndonga 2019). OCP lawyers claim the dispute was the result of a battle to dominate the Kenyan fertilizer market: after the ban, the only source of phosphates available to farmers was from Saudi Arabia, and prices quickly rose.

A similar story concerns NPK 17:17:17. This is made in only a few locations in the world. NPK 16:16:16, on the other hand, is more common. The Kenya Bureau of Standards was influenced to permit 1.2% variation for nutrients – making it possible to import NPK 16:16:16 and sell it as NPK 17:17:17. But when NPK 16:16:16 is exported to Uganda, it fails product tests because the country has a tolerance of only 1%, and the major product there is NPK 17:17:17. This explains the high product failures in that country.

Constraints: There is a need for a competent, neutral and independent body within the Kenya Bureau of Standards with a strong technical team that

is respected, can guide decision making on product quality, and can challenge firms if they misdirect their efforts to protect their interests. There is a need to build technical capacity in the public sector to ensure that what private sector says is not biased.

Kenya's reforms have been based on permitting private-sector companies to buy fertilizers from international markets, regulating quality, and attracting international manufacturers to enter rural markets. The government has left the market to make pricing decisions. Currently 16 fertilizer firms are engaged in manufacturing, importing and blending, 500 in distribution, and 6,000 in retail (Muriuki 2018). The companies sell fertilizer to farmers at different prices.

At the level of manufacturers, importers and blenders, there are no quality problems, but at the distributor level some exist. Stockists and agrodealers need capacity building and training (Sanabria et al. 2018). Financing is an issue for agrodealers.

The market size is 682,000 tonnes a year (IFDC and AFAP, 2018). About 28% of the fertilizer has government involvement through the subsidy program managed by the National Cereals and Produce Board. But some 40% of fertilizers in this program leak to agrodealers, across borders, and to farmers who are not targeted.

Tanzania

Agricultural development strategies: The government began to implement agricultural policy and regulatory reforms in 1986 (Muganda, 2004). These included a whole raft of measures: the removal of the state monopoly in food crop procurement, the elimination of export taxes, the revival of cooperatives, the privatization of non-performing public-sector estates, the relaxation of price controls, the liberalization of the foreign exchange allocation system, the devaluation of the currency, controls on public expenditure, increases in interest rates, the privatization of state-owned banks, the opening up of agricultural input and output marketing to the private sector, the removal of fertilizer subsidies, and scaling down the activities of the crop marketing parastatals (Potts 2005).

Several overarching policy documents guided interventions in agriculture:

- **2000–25:** Tanzania National Development Vision 2025.
- **2005–10:** National Strategy for Growth and Poverty Reduction phase one (Mkukuta I).
- **2010–15:** National Strategy for Growth and Poverty Reduction phase two (Mkukuta II).
- **2011–25:** Long Term Perspective Plan 2011-2025 (Tanzania Investment Centre 2011), to be implemented in three five-year development plans and annual development plans (United Republic of Tanzania 2011).

Agricultural policy documents include the following:

- **2001–25:** Agricultural Sector Development Strategy phase one (United Republic of Tanzania 2001).
- **2007–12**: Agricultural Sector Development Program.
- **2009:** Kilimo Kwanza ("Transforming Agriculture").
- **2011–21:** Tanzania Agriculture and Food Security Investment Plan.
- **2011–30:** Southern Agricultural Growth Corridor.
- **2013:** National Agriculture Policy, New Alliance for Food Security and Nutrition, President's "Big Results Now" initiative.
- **2016–25:** Agricultural Sector Development Strategy phase two.

All these frameworks place heavy emphasis on expanding private-sector participation and investment in the fertilizer sector.

Fertilizer regulation: In 1992, the government liberalized the fertilizer industry, withdrew from procurement and distribution of fertilizers through the monopoly Tanzania Fertilizer Company, and allowed private companies to enter the industry. Several firms did so, importing from international manufacturers and selling from depots in Dar es Salaam or up-country. Some firms established their own retail networks. Several of these early entrants are still important importers and wholesalers of fertilizer today. By 2015 there were 80 registered importers (Mkumba 2015). Twenty-five of these were actively engaged in fertilizer importation.

- **2003/4:** the government re-introduced fertilizer subsidies in selected grain-basket areas order to rectify the problem that majority of smallholder farmers were using low rates of fertilizer and certified seed as a result of unaffordable prices (Agreed International 2016d). This subsidy lasted five years until 2007/2008. It operated by subsidizing the cost of transport to deliver fertilizers to farmers, signing contracts with fertilizer companies to sell fertilizers at particular locations at

subsidized prices, and reimbursing firms that had sold the fertilizer to farmers.

- **2008:** Following the global financial crisis, the subsidy mechanism was switched to voucher scheme for farm inputs (Agreed International 2016d). This was done for several reasons: delays in fertilizers reaching farmers, the distance between farmers' homes and the distribution points, the sale of subsidized and non-subsidized fertilizers at different prices in the same markets, poorly trained agrodealers, and the agrodealers' lack of financial capacity to finance stock to sell.
- **2008/9–2016/17:** The voucher scheme was implemented for eight years (except in 2014/15). Farmer beneficiaries were selected by a village committee. Recipients had to be a full-time farmer farming less than one hectare of maize or rice, and able to co-finance the inputs. Beneficiaries redeemed the vouchers at local dealers in exchange of inputs. The dealers redeemed the vouchers with the National Microfinance Bank. The program trained 3,850 agrodealers in the procedures and requirements.

  Problems included delays paying input-supply companies, slowing the delivery of fertilizers. A parallel market for vouchers emerged; political interference occurred in the selection of stockists; and village officers, voucher committees and agrodealers created lists of ghost farmers. In 2014, recommendations were made to switch from paper to electronic vouchers, but they were not adopted by the Ministry of Agriculture.
- **2014/15:** The government replaced the voucher scheme with subsidized interest rates on agricultural credit. Farmer groups, associations and savings cooperatives could buy fertilizers on credit from fertilizer companies by depositing 20% of the cost as collateral. The government deposited a matching fund of 20%. The farmers were then issued with the inputs and paid the remaining 60% after harvest. Alternatively, members of farmer groups and primary societies could get loans on inputs from commercial and community banks at subsidized interest rates. The program was organized hastily, resulting in some groups receiving fertilizer late or failing to get any fertilizers at all.
- **2015/16:** The government reintroduced an improved version of the national input-voucher scheme. Local governments no longer appointed agrodealers; instead input suppliers appointed their own agents to distribute and sell inputs.
- **2015/16 and 2016/17 seasons:** The government reduced its expenditure on subsidies.
- **2017:** To do away with fertilizer subsidies, the fertilizer bulk procurement regulation was gazetted. After a bidding process, contracts were awarded to two companies to supply DAP and urea. The same year, the Minister of Agriculture abolished 108 crop-related taxes.

Fertilizer quality: The liberalization of the industry, entry of new players, and the rising demand for fertilizers without an up-to-date regulatory framework led to an increase in volume of substandard fertilizers.

- **2006:** The Tanzania Bureau of Standards implemented fertilizer standards to guide manufacturers, importers, traders, regulatory authorities and farmers in producing and selecting fertilizers of good quality.
- **2009:** The Fertilizers and Animal Foodstuff Act Chapter 378 was repealed and replaced with the Fertilizer Act. This established the Tanzania Fertilizer Regulatory Authority to regulate the manufacture, import, sale and use of fertilizers and fertilizer supplements.
- **2011:** The fertilizer regulations came into force.
- **2012:** The Tanzania Fertilizer Regulatory Authority started operating.
- **2015/16:** The Ministry of Agriculture approved changes in the Fertilizer Act and Regulations to bring them in line with changes in technologies to blended products and the shift from a government to a market-based supply system.
- **2017:** New fertilizer regulations were gazetted in 2017. These included a reduction in registration fees, the abolition of various registration and license fees, and the elimination of the need to retest blended products. The Tanzania Bureau of Standards revised standards set in 2006, for example to raise acceptable cadmium levels from 7 to 30 ppm (Tanzania Bureau of Standards 2017).

  The Tanzania Fertilizer Regulatory Authority and Tanzania Bureau of Standards

agreed to use one testing laboratory for fertilizers instead of each agency testing independently. This eliminated duplication and double payments for testing and allows the results to be shared.

The government abolished various fees and taxes on fertilizer imports. A harmonized procedure has been established, coordinated by the Tanzania Fertilizer Regulatory Authority, for the clearing of fertilizers.

The introduction of bulk-procurement regulations introduced new challenges. Firms think having a one-stop-shop (the Tanzania Fertilizer Regulatory Authority) is beneficial, but it raises a serious structural problem because the Authority is also a purchaser and can change the rules as it deems fit. Some actors argue that the mechanisms for estimating indicative prices for fertilizer products fail to capture all the costs, cutting the fertilizer traders' profits. The arrangements also have shifted fertilizers used at planting from DAP to NPKs, and transshipments through Tanzania to its neighbors have been disrupted by a ban on plastic bags.

A review of the bulk-procurement system (Amani and Lunogelo 2019) found that:

- Fertilizer importing companies actively participated in bidding to supply fertilizers using the bulk purchasing scheme.
- The landed cost at Dar es Salaam port was reduced (as expected).
- Inland transportation costs remained unchanged because of the old system of reliance on trucks instead of railway wagons.
- Previous beneficiaries of the subsidized-inputs system (25% of smallholder farmers) were losers in the new system
- Previous non-beneficiaries of subsidized system (75% of smallholder farmers) who are not linked to commercial off-takers but buy directly from shops were the main beneficiaries, as the lower costs were reflected in retail prices.
- Farmers served by off-takers and linked to the banking system had a marginal saving.
- Cooperative unions and agricultural and marketing cooperatives societies failed to engage in bulk procurement or credit facilities
- Banks appeared to offer cheaper bank guarantee facilities to private companies while offering more expensive guarantees to cooperative unions and cooperatives societies.

The analysts recommended that the bulk-procurement system be continued but improved.

- More importers should be involved to increase competition.
- Indicative selling prices should be abandoned
- Institutional arrangements are needed to link farmers to off-takers (agroprocessors, exporters and domestic traders) through contract farming to permit farmers to pay at the end of the cropping season
- Institutional support is needed for piloting the system under the research and extension committee
- Importers should provide requirements and bank guarantees on time.
- The Tanzania Bureau of Standards should issue certificates of chemical analyses and verification of conformity to standards, enforce safety and quality controls for fertilizers, and allow the independent testing of fertilizers before and after importation.
- Rail transportation should be considered.
- Regulations are required to allow for fertilizer re-export.

Tanzania has followed a different approach to reforms from Kenya. The reforms have focused on tenders for fertilizer companies to buy from international markets, evaluating tenders, and permitting the lowest tenderer to import fertilizers. The government chose to focus on DAP and urea. It reintroduced indicative prices for fertilizer products rather than letting the market set prices. There is a conflict of interest when the regulatory authority conducts tenders, decides on the quantity and quality of fertilizers to be brought into the country, and controls the regulations.

The argument is that the government cannot just sit aside. This is important – but private-sector firms need incentives to operate.

Malawi

Agricultural development strategies: The government initiated agricultural policy and regulatory reforms in 1981. These included repealing the Special Crops Act (making it legal for smallholders to grow export crops such as tobacco), eliminating subsidies and controls to agricultural input and consumer prices, liberalizing agricultural input and output markets, commercializing and privatizing state-owned enterprises, devaluing the currency, increasing interest rates, imposing

fees for public utilities and services, reducing public expenditures, and changing investments from the National Rural Development Program to agricultural research and extension (Chirwa et al. 2008, Lele 1989, Harrigan 2003, FAO 2014).

Before the reforms in the 1980s and 1990s, the state-owned Agricultural Development and Marketing Corporation had a monopoly on importing fertilizers and marketing them to farmers through its network of rural depots (Kherallah and Govindan 1997). The government provided seasonal credit through the Agricultural Development and Marketing Corporation. Fertilizer was sold at subsidized prices. The overvaluation of the kwacha further lowered fertilizer retail prices.

- **1983:** The government started to remove fertilizer subsidies.
- **1988:** The Smallholder Farmers' Fertilizer Revolving Fund of Malawi began to import and distribute fertilizers to farmers through the Agricultural Development and Marketing Corporation.
- **1993:** The importation and distribution of fertilizers were opened to the private sector.
- **1996:** The fertilizer subsidy was eliminated (Kherallah and Govindan 1997). Several domestic, regional and international companies entered the industry and established distribution and retail networks to sell to smallholders (African Centre for Fertilizer Development 2007). However, the Agricultural Development and Marketing Corporation continued to dominate the industry for several years because of the government subsidy.
- **1998:** The government developed and adopted the Malawi 2020 Vision to provide an economy-wide strategic planning and management policy framework for long-term development (National Economic Council 2000). This Vision identifies agriculture and food security as priority areas to foster economic growth and development.
- **2006–11:** First Malawi Growth and Development Strategy as an overarching policy framework to achieve the long-term development goals laid out in Vision 2020.
- **2007:** National Fertilizer Strategy formulated to improve farmers' access to affordable fertilizer and develop private sector-led fertilizer markets to improve agricultural productivity and profitability among smallholder farmers (Ministry of Agriculture and Food Security 2007).
- **2012–16:** Second Malawi Growth and Development Strategy.
- **2012:** Economic Recovery Plan to achieve quick development results and economic recovery (Banda 2013). This identified the private sector as the engine of growth and focused on implementing programs to create a conducive environment for business and development of cooperative and small and medium-scale enterprises.
- **2013–18:** National Export Strategy to serve as a critical component of the second Malawi Growth and Development Strategy and of the Economic Recovery Plan by providing a framework on enabling business environment for building productive capacity for exports.
- **2017–22:** Third Malawi Growth and Development Strategy.

In 2010, the government designed frameworks for the agricultural sector to translate the priority on agriculture development into sector-specific strategic documents. Key documents included:

- **2010–16:** National Agricultural Policy Framework
- **2010:** National Irrigation Policy and Development Strategy.
- **2011–15:** Agriculture-Sector Wide Approach program to implement priority investments for agricultural development.

Other initiatives include:

- **2006:** National Adaptation Program of Action to combat climate change.
- **2010:** Presidential Green Belt Initiative to use water resources for irrigation to increase production, productivity, incomes and food security (Chinsinga 2017).
- **2012:** Presidential Initiative on Hunger and Poverty Reduction to diversify agriculture, with special emphasis on the legume and livestock value chains.

Subsidies: Free fertilizer distribution programs were introduced in 1995:

- **1995/96:** Supplementary Inputs Program.
- **1998/99–1999/2000:** Starter Pack.

- **2000/1–2004/5:** Targeted Input Program and the Expanded Input Program (Harrigan 2007).
- **Since 2005/6:** The government has reintroduced large-scale agricultural input subsidies through the Farm Input Subsidy Program.

The Farm Input Subsidy Program targets fertilizer and seed subsidies to poor smallholder farmers using paper vouchers. Farmers redeem the vouchers through agrodealers, where they can purchase two 50-kg bags of fertilizers at a subsidized price. When it coincides with favorable weather, this has resulted in bumper harvests. It focuses on maize and is limited to two 50-kg bags per household. Also, there are diminishing returns to the subsidy program. and its effectiveness has waned significantly over time.

The land cultivated by medium scale farm holdings (5–50 hectares) increased by 49% between 2000 and 2015 (Anseeuw et al. 2016). This was driven by tenure reforms favoring the conversion of land from customary to titled land under the 2002 Malawi National Land Policy. This implies that if the subsidy program were to target these farmers (rather than the current resource-poor households) and if maize productivity on medium-scale farms were to increase to 4.5 t/ha (as with commercial farmers in South Africa and Zambia), there would be significant impact on national food security. Increasing the productivity of medium-scale farmer requires holistic packages that include good technical advice, output market development and finance. These farms can be specifically targeted by private-sector companies. Some firms already serve this group. Medium-scale farmers can cultivate customary land on a commercial basis on behalf of the traditional owners, so that jobs and income can go to the poor smallholders. This is better than the smallholders feeling forced to "sell" to bureaucrats or breaking up the land parcels, which makes it difficult to farm economically. Such an action would make the subsidy program sustainable.

Fertilizer regulation: The institutional framework governing the production, marketing and use of fertilizer lags behind changes in blending technologies and the shift from a government monopoly to market-based supply. The Fertilizers, Farm Feeds and Remedies Act of 1970 was repealed during the structural adjustment program to permit implementation of the reforms.

- **1996:** The regulations were amended; changes covered specifications, labeling and sampling and analysis, offenses and penalties for fertilizers imported, distributed and sold to farmers.
- **2003:** A Fertilizer Bill to govern the registration of fertilizers and regulation of imports, manufacture, distribution and sale was drafted. It was not debated in parliament because lawmakers required that there first be in place a national fertilizer policy to guide the legislative process.
- **2015:** The national fertilizer policy was initiated and is now awaiting submission to the Office of the President and Cabinet for approval. This will enable the Fertilizer Bill to be debated in parliament.

The Fertilizer Bill will include standards for organic fertilizers, biostimulants and blends. There is a major issue of fertilizer adulteration by traders, suppliers, transporters and manufacturers. This is because regulations are outdated, penalties are small, and there is a lack of institutions able to ensure compliance.

Fertilizer is a sensitive issue, constantly under the eyes of politicians.

Fertilizer quality: New fertilizers must be registered before they can be offered for sale. This is governed by the old Fertilizers, Farm Feeds and Remedies Act, which requires new fertilizers to be evaluated and approved.

The Department of Research evaluates the fertilizers, and the Agriculture Technology Clearing Committee releases and approves them. If it is not registered in any of the SADC member countries, a fertilizer product must be evaluated for three seasons before it may be released for sale to farmers (one year if it is already registered in an SADC country). After release, the product is submitted to the Malawi Bureau of Standards to develop and enforce standards.

Fertilizer standards are not overly restrictive, allowing businesses to enter the industry and develop over the last 20 years. The government has articulated its intention to continue with this progressive practice, but the proposed Fertilizer Bill is punitive and restrictive on blends. The government argues that it must protect smallholders and prescribe products that can be offered for sale to them.

A few companies started selling government-prescribed fertilizers, and blending products for commercial farmers, in 1997. They have been allowed to do so without registration. These companies are now marketing the area- and crop-specific fertilizer blends to smallholders; they are strengthening agrodealers, training farmer, and performing soil analysis to generate recommendations and soil maps to help farmers decide what product to use. Competition among firms is driving these investments.

Constraints: The legal and regulatory framework needs to encourage diversity. But payoffs to investments are limited when a large part of the market is subsidized or is managed by estates, and there are burdensome testing restrictions and controls by the Department of Research.

Recommendations

We can draw four lessons on how countries can strengthen their policies.

- **Consistent policies.** Governments are placing emphasis on expanding private-sector investment in agriculture and the fertilizer industries. The countries have implemented agricultural and policy reforms to increase such investments in agricultural input supply and output marketing. The policy objectives for fertilizers must be consistent with the vision and strategic frameworks at the economy-wide, sectoral, cross-sectoral, sub-sectoral and commodity levels.
- **Different paths:** Countries have followed different pathways for expanding private-sector investments in the fertilizer industries.
- **Subsidies:** All the countries have tried different kinds of fertilizer subsidy, with varying success. Subsidies have raised the level of fertilizer consumption and the production and yields of major crops. But subsidies are difficult to manage, and problems of cost, corruption, targeting and leakage remain.
- **Fertilizer quality:** Although ensuring good-quality fertilizer products is the primary responsibility of governments, they typically lack the capacity to monitor compliance. Self-regulation by private companies through trade associations is needed, along with competition to deter suppliers and dealers from cheating.

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9. Fertilizer subsidies

Mahamadou Nassirou Ba, Marie Claire Kalihangabo, Joseph Rusike and Oumou Camara

Fertilizer promotion programs in Africa began in the 1970s. They were characterized by large, direct government expenditures using various entry points to ensure supply and to stimulate fertilizer demand and use. They included direct fertilizer subsidies, government input credit programs, and the centralized control of fertilizer procurement and distribution and of key output markets. The main aim was to increase productivity, but also to ensure smoother credit management. But these programs were expensive and fiscally unsustainable, governments lacked the capacity to implement them effectively, and the programs did not meet the diverse needs of many farmers. Most were dropped in the 1990s as part of the structural adjustment programs to reduce government indebtedness.

Subsidies came back into fashion following the 2006 Abuja Declaration on Fertilizers (Chapter 3). A dramatic rise in global food and fertilizer prices in 2007 and 2008 threatened food security in many countries, leading several to revive their subsidy programs (UNECA and AFFM 2018). Malawi was the pioneer, starting to distribute free fertilizers in 1998 (after having discontinued a similar program in the early 1990s). Nigeria followed suit in 1999, followed by Tanzania (2004), Kenya (2006), Burkina Faso, Ghana, Mali and Rwanda (2008), and Mozambique (2012). All of these subsidies were "targeted", except in Kenya, which retains "universal" subsidies. Governments were more equipped to bear the costs because of donors' support and an open shift and support from the World Bank in favor of "smart" subsidies (Druilhe and Barreiro-Hurlé 2012, Jayne 2013).

Today most sub-Saharan African countries have some type of subsidy program in place. This usually goes along with import liberalization, allowing the private sector to import fertilizers as the government is not capable of covering the fertilizer need by the subsidy program over the whole country. The subsidies are usually included in the national agricultural investment program, which is part of the national development strategy. In 2016, the share of subsidy in total volume of fertilizer supply ranged from 12% in Zimbabwe, 28% in Malawi, 69% in Burundi, to 92% in Rwanda and 100% in Ethiopia (IFAP and IFDC 2017).

In order to support the subsidies program, countries such as Ghana, Mali and Tanzania have fertilizer policies, acts and regulations in place, while Burkina Faso, Malawi, Mozambique, Nigeria and Rwanda are on track to establishing a conducive policy environment. In some countries, the government retains a dominant role in managing the subsidy program; in others, the private sector plays a larger role. Mozambique and Uganda are yet to implement large-scale subsidy programs.

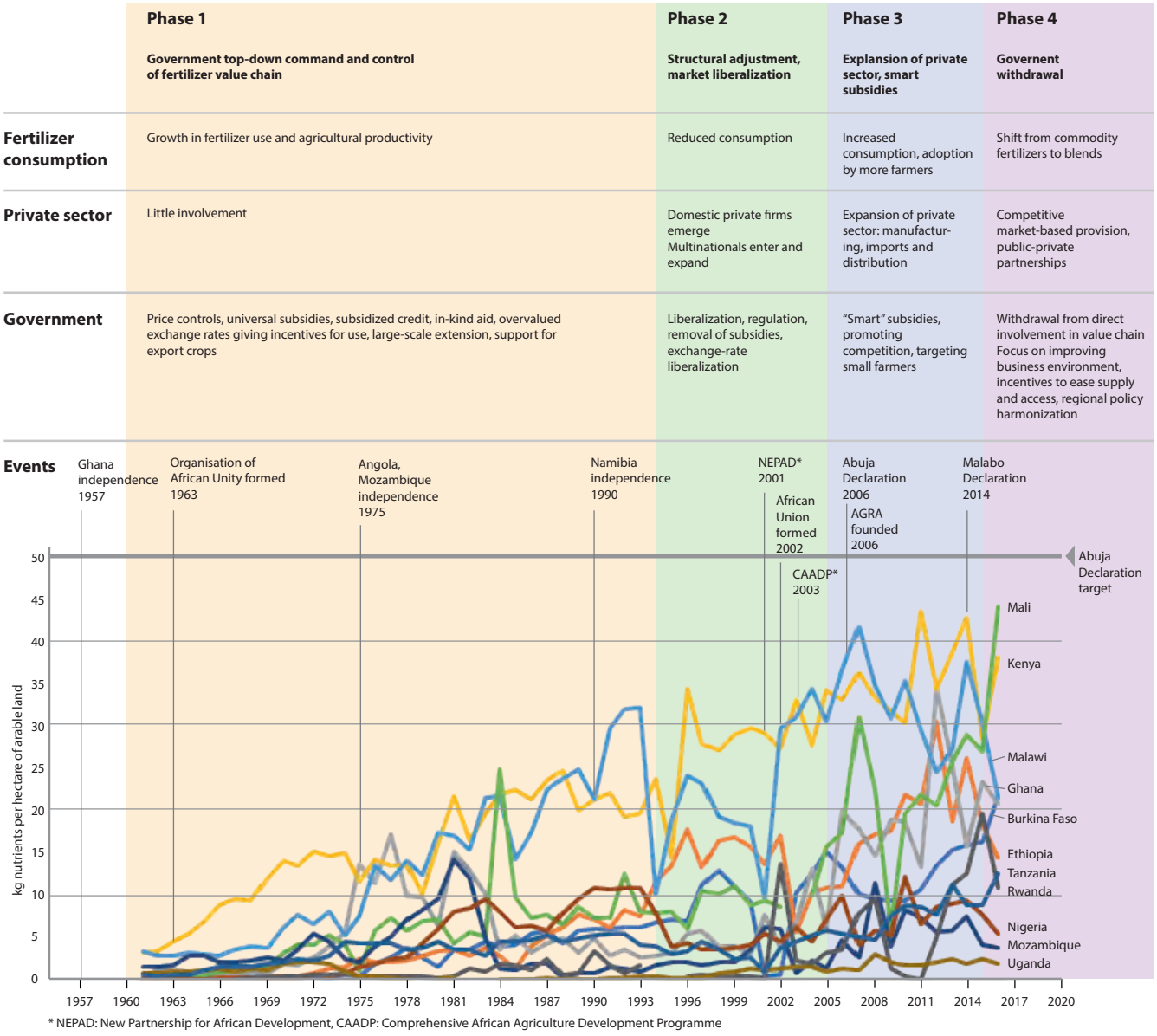


Figure 35. Phases in fertilizer policy since 1960, and fertilizer use per hectare in selected countries

Four phases

There are four relatively distinct phases in the evolution of fertilizer subsidies in Africa (Figure 35).

Phase 1: 1960-early 1990s

The first phase lasted from the early 1960s, when most sub-Saharan African countries gained independence, to the mid-1980s and early 1990s when governments started implementing structural adjustment programs. During this time, governments managed the fertilizer value chain with a top-down approach (Kherallah et al. 2002, Dorward and Chirwa 2014). They used a range of policies to do this (Kelly and Crawford 2007):

- Price controls on fertilizers
- Universal subsidies on the retail price of fertilizer
- Subsidized credit to farmers for fertilizer purchase with repayment through state marketing agencies
- Fertilizer aid-in-kind by donors
- Incentives for fertilizer use through overvalued exchange rates and foreign exchange allocation

- Large-scale demonstration and extension programs
- Company models for export crops such as cotton and tobacco.

These policies resulted in the growth in fertilizer use and agricultural productivity. However, they increased government budget deficits, and were fiscally unmanageable and unsustainable. Governments were forced to discontinue them during the structural adjustment programs of the late 1980s and early 1990s.

Phase 2: 1990s–mid-2000s

During the second phase, governments liberalized and privatized fertilizer industries under structural adjustment programs. Domestic private-sector firms emerged, and multinational fertilizer companies entered and began to expand their role in manufacturing, procurement, importing, trade, distribution, blending and selling of fertilizers. Governments increasingly played a regulatory role in the fertilizer value-chain. The removal of subsidies and the liberalization of the exchange rates raised fertilizer prices for farmers and reduced their consumption (Heisey and Mwangi 1996, Camara and Heinneman 2006).

Phase 3: mid-2000s–2015

In the third phase, the private sector expanded its participation under government regulation and "smart" subsidy programs (Jayne et al. 2015). This followed the Africa Fertilizer Summit in Abuja in 2006, during which African governments committed to liberalize the import and distribution of fertilizer and to introduce smart subsidy programs.

Countries pursued various policy approaches to expand private-sector participation in fertilizer production, importation and marketing. "Smart" subsidies were a major component of these. They include (Byerlee et al. 2007, Agreed International 2016):

- Promoting the development of private manufacturers, distributors and agrodealers
- Strengthening of markets
- Promoting competition and lowering costs by reducing or removing barriers to entry
- Targeting those smallholder farmers who do not currently use fertilizers but would find it profitable

These policies improved the environment for fertilizer agribusinesses and some farmers, resulting in higher fertilizer consumption. The average fertilizer use in West Africa increased from 5–6 kg of nutrients per hectare in 2002 to about 9 kg in 2011 (Keyser et al. 2015). Farmers who had never before used fertilizer on food crops became aware of their benefits. Higher consumption ensured private importers and local blending companies to exploit economies of scale.

Phase 4: Since 2015

Since 2015, governments have begun withdrawing from fertilizer manufacturing, procurement, import, distribution and sale and from public-private partnerships (Jayne et al. 2018).

- **Burkina Faso.** In 2016 the government stated its intention to fully disengage from the fertilizer market and to devolve management to private-sector firms (Agreed International 2016).
- **Nigeria.** The government discontinued "smart" subsidies implemented from 2012 to 2015 under an electronic wallet voucher system under the Growth Enhancement Support Scheme and replaced this with the Presidential Fertilizer Initiative (Box 3).
- **Tanzania.** The government reformed its 7-year implementation of smart subsidies. It enacted regulations for bulk procurement starting in 2017 to drive down the costs of importing and transporting fertilizers and farm-gate prices (Agreed International 2016).
- **Kenya.** The government is still involved in fertilizer procurement. But the Ministry of Agriculture aims to redesign subsidies using flexible voucher and incentive-based models.
- **Malawi.** The private sector is increasingly taking over the procurement and sale of fertilizers to farmers. Firms are expanding their participation in procurement, import and distribution of fertilizer for the subsidy program.
- **Rwanda.** The government is implementing policies to put in place a private-sector-led fertilizer industry.
- **Ghana.** In 2016, the government began to implement an electronic platform to register farmers and improve the efficiency and transparency of subsidy programs.
- **Mozambique and Uganda.** Full-fledged government subsidy programs do not yet exist. The governments are giving firms incentives to expand investments

in procurement, import, manufacturing, blending, distribution, marketing and sale of fertilizer through e-voucher programs. Laws and administrative practices are slowing down the shift to a competitive market-based system and from commodity to balanced fertilizers. Quality problems are likely to increase if the market continues to grow without effective controls.

In the future, governments are likely to focus on providing information, strengthening the enforcement of regulations, improving legal institutions, and improving infrastructure. They will transition from being interventionists to being regulators (IFDC and AFAP 2018).

If governments continue to provide subsidies, they will need to reform them to encourage farmers to use appropriate balanced and blended fertilizers, and to target new areas where use is still low. Moving towards balanced fertilizers will require developing technical competence among actors in manufacturing, blending, and distribution. Policies also need to enable private-sector-driven dealer-certification programs and avail working capital finance for dealers and farmers and actors in the last mile of distribution and support private sector expansion The logic of subsidies

The issue of fertilizer subsidies is a long-term issue in Africa, and there are no one-size-fits-all solutions. Higher crop yields do not necessarily translate to higher farmer incomes, especially where output markets are unstable and farmers are not linked to national or international markets.

The combination of low awareness of fertilizers (and skepticism about their utility) and high prices means that the demand for fertilizers is low in much of Africa (Figure 36 and Chapter 7). This leads to low productivity and low yields, which in turn causes household and national food insecurity. Low yields also inevitably mean low incomes for farmers, and the lack of money in farmers' pockets prevents the development of rural areas. At the same time, low productivity means more food imports and fewer crop exports, reducing the foreign -exchange balance.

In economics, this can be classified as market failure, a situation in which the allocation of goods and services by a free market is not efficient, often leading to a net social welfare loss.

Fertilizer subsidies aim to break this logjam. They reduce the fertilizer price for farmers, making them more attractive to try out, raising demand and producing higher crop yields. That leads to greater food security, higher farmer incomes and more

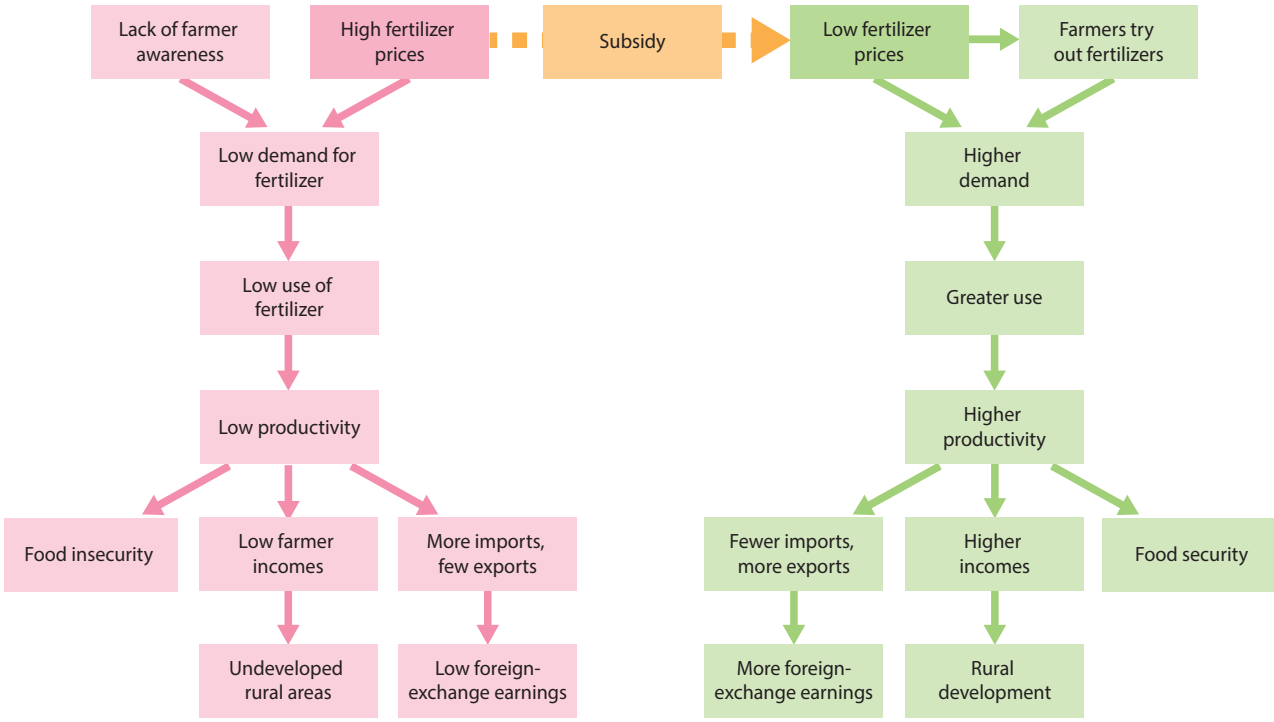


Figure 36. The logic of fertilizer subsidies

vibrant rural areas, and to lower food imports and more commodities that can be exported.

Subsidies are unlikely to achieve all these benefits on their own. Other factors include the availability of improved seed, appropriate agronomic and pest-management practices, improved transport, market and communications infrastructure, the availability of credit, better marketing possibilities, higher output prices, and farmer-training programs (Chapter 7). The subsidy program itself must be well-managed and targeted to the right farmers.

It is important to have clear policy goals for subsidy programs. For example, are they expected to generate lasting benefits, or merely to offset high fertilizer prices? Is the aim to improve food security, or to boost export earnings? Should the subsidies be targeted towards particular regions, crops or groups of farmers, or should they apply to all? How should the program be managed – by the government directly, or through the private sector? How can the subsidy system be structured so it encourages (rather than hinders) the development of the private-sector fertilizer distribution system? When and how should the subsidies be phased out? These things need to be clear from the onset. Such goals determine the structure of the subsidy program.

The main challenge often lies in the circumstances under which the subsidies are availed to farmers which is mostly in synchrony with political calendar. Fertilizer subsidies are popular with farmers, who make up a large proportion of voters in many countries. This makes them attractive policy options for governments – but hard to phase out.

However, some countries are struggling to sustain their subsidies (UNECA and AFFM 2018). In Ghana and a number of other countries, subsidy rates have been revised downwards. In Nigeria, the Growth Enhancement Support Scheme was discontinued in 2016 because it had accumulated a huge debt and had not achieved its objective of better targeting beneficiaries.

Types of subsidies

Subsidy programs are normally funded by the government, but may also be sponsored by donors, development banks or large development agencies. Development agencies such as the International Fertilizer Development Center (IFDC) design and manage subsidy programs on behalf of governments.

Subsidies fall into four main groups: universal, targeted, vouchers, and smart.

Universal or blanket subsidies

Universal subsidies do not make a distinction among farmers, crops or regions of a country. Such subsidies were common up to the 1980s and 1990s. While they are thought to have contributed to higher yields, much of the benefit accrued to influential or better-off farmers, and the cheap fertilizer displaced commercial sales, stunting the development of the private-sector fertilizer-distribution system (Druilhe and Barreiro-Hurlé 2012). This is found in Kenya, for instance.

Targeted subsidies

These subsidies are aimed at specific crops, types of farmers or regions of the country. The crops may be staples (where the aim is to boost food security) or cash crops (to boost exports). Growers of these crops get special access to the subsidized fertilizer, which may be specially formulated to the needs of the specific crop. The program sponsor (the government or a donor) may also target particular groups of farmers (such as poor smallholders) or a region (to increase productivity there or to introduce the fertilizer to farmers in the area.). This type of subsidies is found in Mali, Burkina Faso and Ghana.

Vouchers

One way to target particular farmers is to distribute vouchers to them. The farmer presents the voucher to an agrodealer, who cancels it and exchanges it for fertilizer at a reduced price. The agrodealer then

Table 13. Status of fertilizer subsidies and role of government and private sector in selected countries

Current situation	Major players	
	Government	Private sector
Fertilizer policies, acts and regulations in place	Kenya, Mali, Ghana, Burkina Faso	Ghana, Mali, Tanzania
Establishing conducive policy environment	Malawi, Nigeria	Rwanda
No large-scale fertilizer subsidy program	Mozambique, Uganda	

Source: AGRA (2016b)

redeems the voucher with the sponsor. This system makes it easier to target particular farmers, but it is open to fraud: paper vouchers can fall into the wrong hands, and despite safeguards such as watermarks and serial numbers, it is possible to forge them.

Smart subsidies

E-vouchers (often called "smart subsidies") are an improvement on the paper sort. The farmers receive a voucher code on their mobile phones; they can then use this to purchase fertilizer from a private dealer. The dealer cashes in the voucher and is paid by the government, also electronically. Such arrangements are less exposed to abuse than paper-based systems. Since the global food crisis of 2007–8, various development organizations and the World Bank have helped governments to develop these programmes (Jayne et al. 2018). These types of subsidies can be found in Mozambique and Ethiopia (Box 9) (Wubeneh 2018).

In theory, smart vouchers turn farmers into clients: if they are not happy with one retailer, they can go to another one. The vouchers could also be designed to reveal potential demand: for example, farmers might use their vouchers to buy different types of fertilizer from those that have so far been on offer.

Criticisms of subsidies

Fertilizer subsidies remain controversial and are subject to number of criticisms. Here are the main ones:

Cost-effectiveness. Most evaluations of subsidy programs point out that they have increased fertilizer use, but at a high cost and with no assurance that farmers will continue to buy fertilizers after the subsidies are phased out (UNECA and AFFM 2018, Ariga 2017, AGRA 2014b).

Subsidy programs absorb a large proportion of national budgetary allocations to agriculture (AGRA 2014b). Over the last 18 years, ten African countries spent a total of roughly $1 billion annually on subsidy programs, amounting to 28.6% of their public expenditures on agriculture (Jayne and Rashid 2013). Some countries (e.g., Malawi, Ghana and Zambia) spend 40–70% of their entire agricultural budgets on fertilizer subsidies, leaving little for research, extension or other important activities (UNECA and AFFM 2018).

Targeting. Most programs are of national scope and cover not only fertilizers, but also seeds and other inputs. The main targets are crop producers, particularly smallholders who produce food crops, but the targeting systems are generally inadequate or corrupted and do not ensure the inputs reach the intended beneficiaries.

Types of fertilizers. Governments often do not select the appropriate types of fertilizers to support. The products selected for subsidy are often compounds (e.g., NPK 15-15-15), lack appropriate micronutrients, and are not tailored to particular agroecological zones or crops. Some are not appropriate for the locations or crops they are applied on (USAID 2017), so have a sub-optimal impact on yields. Subsidized fertilizers are often also of questionable quality.

Improper use. Some farmers who obtain subsidized fertilizer do not know how to use it correctly: they apply it at the wrong time, in the wrong way, to the wrong crops. Services such as soil testing and extension advice are lacking in many areas.

Logistics. Most subsidy programs face logistical problems due to cumbersome government approval systems that delay the payment of import and delivery bills. This can lead to the late delivery of fertilizer (Keyser 2015). Late payments discourage private investors and dissuade some of the best providers from becoming involved (USAID 2017).

Diversion and corruption. Subsidy systems are open to abuse at various points: funds may be diverted, licenses may be misallocated, subsidies may go to people other than those intended, and the fertilizer may end up in the wrong hands or sold for more than the specified price. The private-sector providers are selected through a government-managed tender system, but this is often plagued with transparency and competition issues (USAID 2017). A lack of an authenticated farmer database makes programs prone to fraud: non-existent "ghost farmers" are allocated fertilizer, while genuine farmers are left empty-handed.

Roles of public and private sectors. The technical design of subsidies is dominated by the public sector, with little or no role for the private sector. The government is in charge of overall supervision and organizes and manages the targeting and distribution. Procurement and field delivery of subsidized fertilizers are carried out mostly by the private sector. Fertilizer subsidies usually divert customers away from private dealers, so discourage the development of private-sector markets (Wanzala-Mlobela et al. 2013).

Evaluation. Subsidy programs are not regularly evaluated, especially by external and independent entities. Accessible and reliable data are lacking.

Other factors. Cheaper fertilizer cannot, on its own, overcome all the problems in the agricultural production system. A range of other problems, including a lack of other inputs, lack of credit, inadequate extension services and limited output markets also constrain farmers' production. An integrated approach is necessary to resolve these issues.

Box 9. Ethiopia's Input Voucher Scheme

Ethiopia's Input Voucher Scheme relies on six flows (Figure 37):

1. The Commercial Bank of Ethiopia offers financial institutions such as savings and credit cooperatives, microfinance institutions and commercial banks with local branches a loan so they can support purchases of fertilizer and other inputs, as well as capital for the voucher scheme. These loans are covered by a guarantee from the state government.
2. The financial institutions make loans to cooperative unions to buy inputs such as fertilizer, seed and agrochemicals from suppliers.
3. The suppliers provide these inputs to the unions, which supply them to primary cooperatives, which in turn supply farmers.
4. The financial institutions provide farmers with vouchers that they can use to purchase the inputs from the primary cooperatives. The primary coops redeem the vouchers with their cooperative unions, which in turn redeem them with the financial institutions.
5. At the end of the season, the farmers aggregate their produce and sell it to buyers.
6. Instead of paying the farmers directly, the buyers pay the financial institution, which deducts the loan (the value of the voucher) plus a fee, and pays the rest to the farmer.

In Amhara, one of Ethiopia's states, this scheme resulted in 2015 in the sale on a credit basis of over 66,000 tonnes of inputs worth ETB 570 million (about $20 million) to 331,000 smallholders (57% of them women). The loan repayment the same year was an impressive 99.75%; in addition, 270,000 tonnes of other inputs worth ETB 3.6 billion were sold on a cash basis to 2.1 million smallholder farmers.

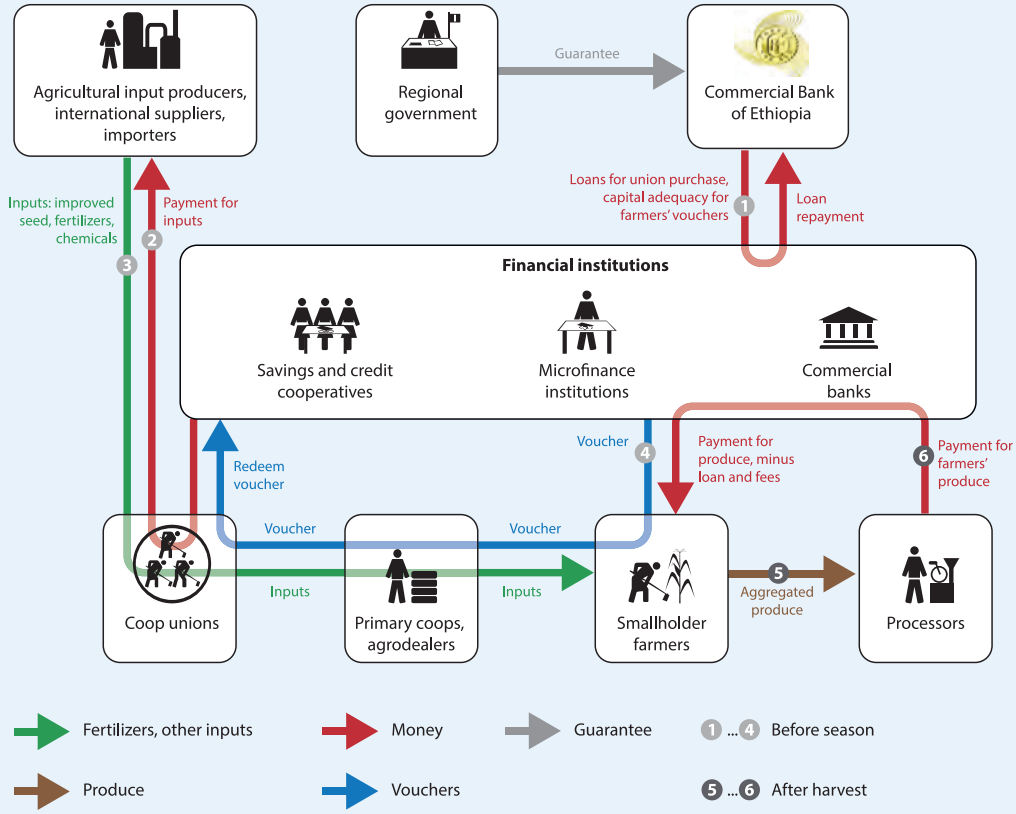


Figure 37: Input Voucher Scheme in Ethiopia

Opportunities

Although they are unsustainable in the long term and are of questionable efficiency, input-subsidy programs are likely to be an important feature of agricultural policy in Africa for the foreseeable future since they enable governments to demonstrate tangible support to their constituents (IFDC and IFA 2017, Jayne and Rashid 2013, Jayne et al. 2015). The focus should therefore be on improving their design, implementation and performance. Governments should aim to make this major expenditure as productive as possible by also investing in complementary measures to raise the productivity of fertilizers (Wanzala-Mlobela et al. 2013).

Subsidy programs should address challenges that have led to market failures and clearly define beneficiaries in accordance with overarching national strategic objectives. As Wanzala-Mlobela et al. (2013) argue, governments could view subsidy programs as an investment in the agriculture sector, contributing towards making the sector self-sustaining.

Private-sector involvement. Today's subsidy programs often rely on the private-sector distribution network. This opens opportunities for greater private-sector involvement. In Ghana and Nigeria, for instance, the state is actively promoting the private sector in the procurement and distribution of subsidized seed and fertilizer (Keyser et al. 2015). Mali and Burkina Faso are also moving to a private-sector approach in their subsidy programs, at least for fertilizer distribution. The coordination framework should integrate both public and private stakeholders through the various tiers and avoid redundancy and delays in procurement and distribution.

Smart subsidies. Smart subsidies also have the potential to support the development of private fertilizer markets and increase the availability and accessibility of fertilizers to smallholders. Some governments are trying to make their subsidies more market-friendly by introducing at least some attributes of smart subsidies (Wanzala-Mlobela et al. 2013). Some distribute vouchers for inputs, while others (such as Kenya and Nigeria) transfer e-vouchers, redeemable at private stockists, to beneficiaries' phones. However, concerns have been raised about delays in government payments, which greatly increase the costs and risks of doing business (Keyser et al. 2015, USAID-EAT 2012).

USAID has proposed a list of key principles for smart subsidy programs (Box 10).

Limitations to implementing smart subsidies should be overcome through fine-tuning or modernizing existing schemes. Basic infrastructure (information technology, banking, storage facilities, road networks, etc.) and financial inclusion exist in countries such as Kenya, Nigeria, Tanzania and Rwanda, making it possible to embrace electronic-based subsidy programs. Given their current infrastructure, Burkina Faso, Ghana, Malawi and Mali would rather strive to improve the efficiency of their current paper-voucher programs.

Supporting and enabling infrastructure. To encourage the private sector to take over fertilizer supply and distribution to smallholders, governments need to increase investment in supporting infrastructure.

Reducing the market price of fertilizers. Governments should seek ways to reduce the market price of fertilizers (thereby eliminating the need for subsidies). Possibilities include reducing port and related charges, cutting non-tariff barriers to trade, improving access to finance, and strengthening the agrodealer network.

Extension and training. Farmers need to learn how to use fertilizers in the appropriate way, in combination with improved crop varieties and other inputs. This is especially important for non-organized farmers who are outside the main production zones (IFDC 2015b). Extension services should be strengthened and cover subjects such as integrated soil fertility, pest management and output marketing.

Complementary measures. Given that fertilizer alone cannot raise crop productivity, complementary measures are needed. These include improved seeds, updated fertilizer recommendations based on soil mapping and testing, soil and water conservation measures, and access to credit and markets.

Exit strategy. To avoid having subsidies being regarded as an entitlement and becoming a permanent drain on the national budget, programs should be designed with an exit strategy built in. Smart subsidies may be the route for doing this. Properly designed in partnership with the private sector, they could encourage farmers to use fertilizers, foster the private-sector distribution network, build relationships between farmers and agrodealers, encourage a gradual shift to a fully private-sector run, subsidy-free fertilizer delivery system, and enhance output market access and stabilize commodity prices. Such strategies are already in use in Nigeria and being piloted in Kenya and Zambia (AGRA 2018).

Analysis

Subsidies have generally increased the consumption of fertilizers and thus agricultural production (UNECA and AFFM 2018, Jayne and Rashid 2013). Some of the recent gains in production in West Africa have been attributed to subsidy programs, although total nutrient use still remains well below the level needed to transform agriculture production (NEPAD 2011).

Box 10. Key principles for smart subsidy programs

Inclusive participation. Promote private-sector development and participation by involving key stakeholders during the design of subsidy programs (public–private partnership).

Specialization. Define and assign the roles of all participating actors on the basis of specialization and comparative advantage to achieve complementarity.

Fair competition. Promote competition between private suppliers to drive down delivery costs and increase quality of services.

Efficiency. Promote economic efficiency (cost reduction, profitability, economies of scale, etc.). Favor market-based solutions. Link subsidies with other input-delivery systems for cash crops (cotton, cocoa, oil palm, coffee, etc.). Link multi-year contracts with performance.

Better targeting/equity. Improve targeting by involving village communities, local authorities and farmer organizations to focus on the right beneficiaries. Minimize the displacement of commercial sales (crowding out) by subsidized fertilizers that distort markets.

Transparency. Ensure transparency in the targeting and distribution system.

Timeliness. Rigorously plan to avoid delays. Reduce influence of political considerations.

Appropriate and quality products. Consider the most recent technical recommendations for each crop and agroecological zone to ensure that the appropriate fertilizer type is supplied. Follow quality specifications for fertilizer types, formulations, weight, labeling, etc.

Proper incentives. Favor market-based measures that do not undermine incentives to private-sector investments. Consider options such as guarantee funds and escrow accounts. Use information technology to track allocations and deliveries.

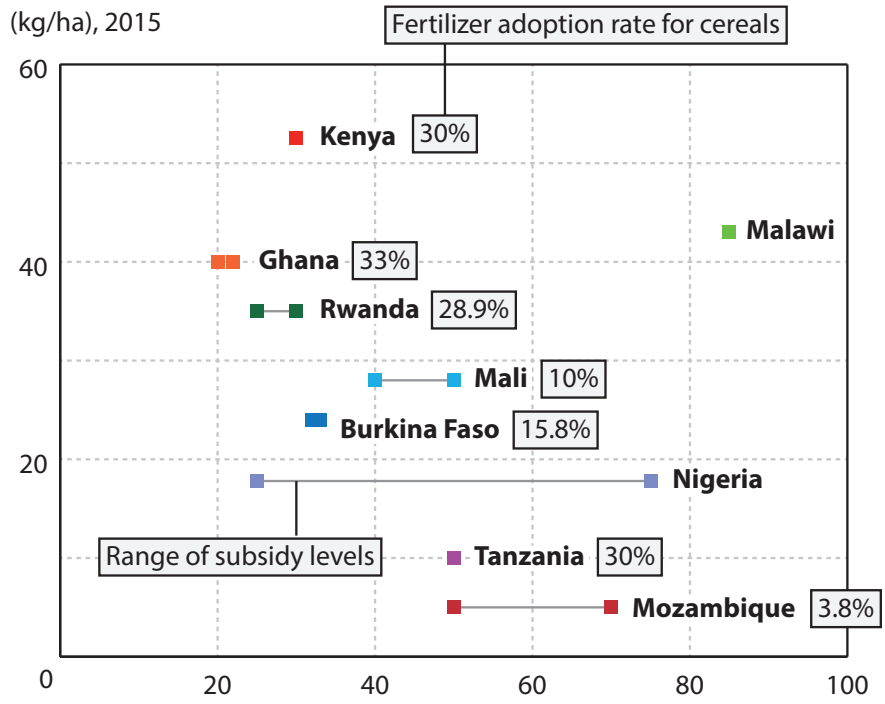
Complementary inputs. Promote fertilizer as part of a wider strategy that includes complementary inputs and strengthening of markets (seeds, equipment, irrigation, etc.), coupled with information and training (e.g., on crop management and integrated soil-fertility management).

Exit strategy. Devise a refocusing and exit strategy that includes clear timeframes and objectives. Shift the program focus from current to future beneficiaries (in terms of producers, areas, crops in need of subsidies). Gradually phase the program out completely.

Sustainability. Tie the subsidy to other public investments (e.g., for research and advisory services). Encourage savings schemes and remove barriers preventing input dealers from accessing loans. Improve physical infrastructure (irrigation, transport, storage, processing, and marketing) to attract the private sector.

Accountability. Monitor the program to gather reliable data based on specific indicators. Evaluate after each season to identify problems and possible improvements.

Source: USAID (2017)



Based on AGRA (2016b).

Figure 38. Fertilizer use, adoption rates on cereals, and subsidy levels in selected countries

Some countries, such as Nigeria, had a fixed range of subsidy rates where prices could fluctuate depending on the location: this allowed for the extra costs in some areas due to remoteness and other factors.

Among countries, there does not appear to be a correlation between the rate of subsidy and the average fertilizer application rate per hectare, or the area of cereals on which fertilizer is used (Figure 38). Indeed, if the Malawi outlier is removed, the correlation even appears negative: the higher the subsidy, the less fertilizer is applied per hectare. It is likely that subsidized fertilizers do not really go to the intended fields. They are often used on other crops or smuggled informally across borders. It is also likely that part of the subsidy funds is diverted by politicians for their own use.

Subsidy programs often reach remote and underserved smallholders who would not have otherwise used fertilizers. They can help to demonstrate the benefits of fertilizers and kick-start market development by raising demand among farmers for inputs at a large scale.

Conclusions

In general, subsidies increased fertilizer use and agricultural productivity. But they also increased government budget deficits, and were fiscally unmanageable and unsustainable. Governments were forced to discontinue them during the structural adjustment programs of the late 1980s and early 1990s.

The policies did improve the environment for fertilizer businesses and increased the number of farmers using fertilizers, resulting in higher fertilizer consumption and crop production (UNECA and AFFM 2018, Jayne and Rashid 2013). The average fertilizer use in West Africa increased from 5–6 kg nutrients per hectare in 2002 to about 9 kg in 2011 (Keyser et al. 2015) and about approximately 17kg nutrients per hectare in 2019 (AFO 2019). Farmers who had never before used fertilizer on food crops became aware of their benefits. Higher consumption encouraged private importers and local blending companies to exploit economies of scale. Nevertheless, total nutrient use still remains well below the level needed to transform production (NEPAD 2011).

The 2016 launch of the Presidential Fertilizer Initiative enabled Nigeria to increase its crop yields and allowed the government to save $200 million in foreign exchange by increasing the local production of soil- and crop-specific NPK products (IFA 2017, IFDC and IFA 2017, Heffer 2016) (Box 3).

Despite all the challenges and shortcomings, subsidies remain relevant to most countries in

sub-Saharan Africa. In 2016, subsidized fertilizers accounted for 12% of the total volume used in Zimbabwe, 28% in Malawi, 69% in Burundi, 92% in Rwanda and 100% in Ethiopia (IFA and IFDC 2017). This shows that the subsidies programs despite all the constraints are well underway in the continent.

Smart subsidies have the potential to support the development of private fertilizer markets and increase the availability of fertilizers for smallholders. Some governments have attempted to make subsidies market-friendly by introducing at least some attributes of smart subsidies (Wanzala-Mlobela et al. 2013). Some have used input vouchers, while others use electronic transfer or e-wallet systems using mobile phones, redeemable at private stockists

Recommendations

Governments need to adopt a more holistic strategy for raising smallholder crop productivity and income, focusing on sustainably raising the efficiency of fertilizer and improved seed use, including through smart subsidy programs.

What needs to change is the design and implementation of subsidy programs. Their design should address the challenges that have led to market failures and clearly define the beneficiaries in accordance with the overarching national strategic objectives. The institutional framework for coordinating the activities should integrate public and private stakeholders through the various tiers of implementation and avoid redundancy and bureaucratic delays in procurement and distribution. Limitations in smart-subsidy programs should be overcome by fine-tuning or modernizing existing schemes.

Given that subsidies will persist for some time, they should be improved.

- **Exit strategy.** Subsidy programs should be redesigned with an exit strategy that facilitates the phasing over of the market to the private sector.
- **Smart subsidies.** Where communications infrastructure permits, voucher schemes should be converted to smart subsidies. This will reduce corruption and leakage, improve targeting, and ease the eventual phase-over to the private sector.
- **Inclusivity.** Both the private sector and beneficiaries should be involved in the redesign process.

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10. Finance for fertilizers

Marie Claire Kalihangabo, Mahamadou Nassirou Ba and Hedwig Siewertsen

Twelve years after the Abuja Declaration, there is progress in fertilizer financing. The financing options to boost fertilizer supply and demand have increased considerably. Nevertheless, finance remains a major problem in the fertilizer value chain in Africa: its limited availability restricts consumption, particularly among smallholder farmers.

The financing system is plagued with serious challenges. These include limited funding, problems in scaling up existing options and making the financing affordable to beneficiaries, a scarcity of credit guarantees, a lack of awareness of existing financing options, information asymmetry on sources and availability of funding, and a lack of acceptable collateral on the part of smallholders. Potential borrowers, especially agrodealers, farmers and output traders, have limited understanding of financing processes and the preparation of business plans needed for loan applications. As a result, financial institutions regard the fertilizer value chain as relatively risky and shy away from providing funding to it (AFFM 2018a).

Sub-Saharan Africa has been less successful than other developing regions in attracting private investment for the fertilizer sector. The perception of risk often leads to an additional 10–15% risk premium on projects compared to other regions of the world. This raises the cost and reduces the volume of commercial financing and capital investment.

African businesses have difficulty raising the financing needed to buy fertilizer. This problem permeates the entire value chain, affecting importers, wholesalers, distributors, agrodealers, retailers and farmers. This chapter discusses the financing of fertilizer along the value chains of fertilizers and of the crop output – since the two are intimately linked. It describes the sources of financing and the various current financial instruments, and shows which instruments match which value-chain actors. It then outlines various new financing mechanisms being tried by development organizations.

Value-chain actors

To understand the range of potential financing options, we must analyze not just the fertilizer value chain but also part of the value chain of the outputs: the crops that farmers grow (Figure 39). It is necessary to consider both input and output value chains because what happens in one chain affects the other. Farmers' ability to sell their crops affects their ability to buy fertilizers.

- **Fertilizer value chain.** This runs from domestic manufacturers (or importers), through blenders, distributors and agrodealers, to the farmers who apply the fertilizer on their fields.
- **Output value chain.** Farmers sell their crops to traders or anchor buyers, who in turn sell to processors. Non-perishable commodities may be stored in warehouses before they are processed and sold. The products then pass through a chain of wholesalers and retailers before final consumption.

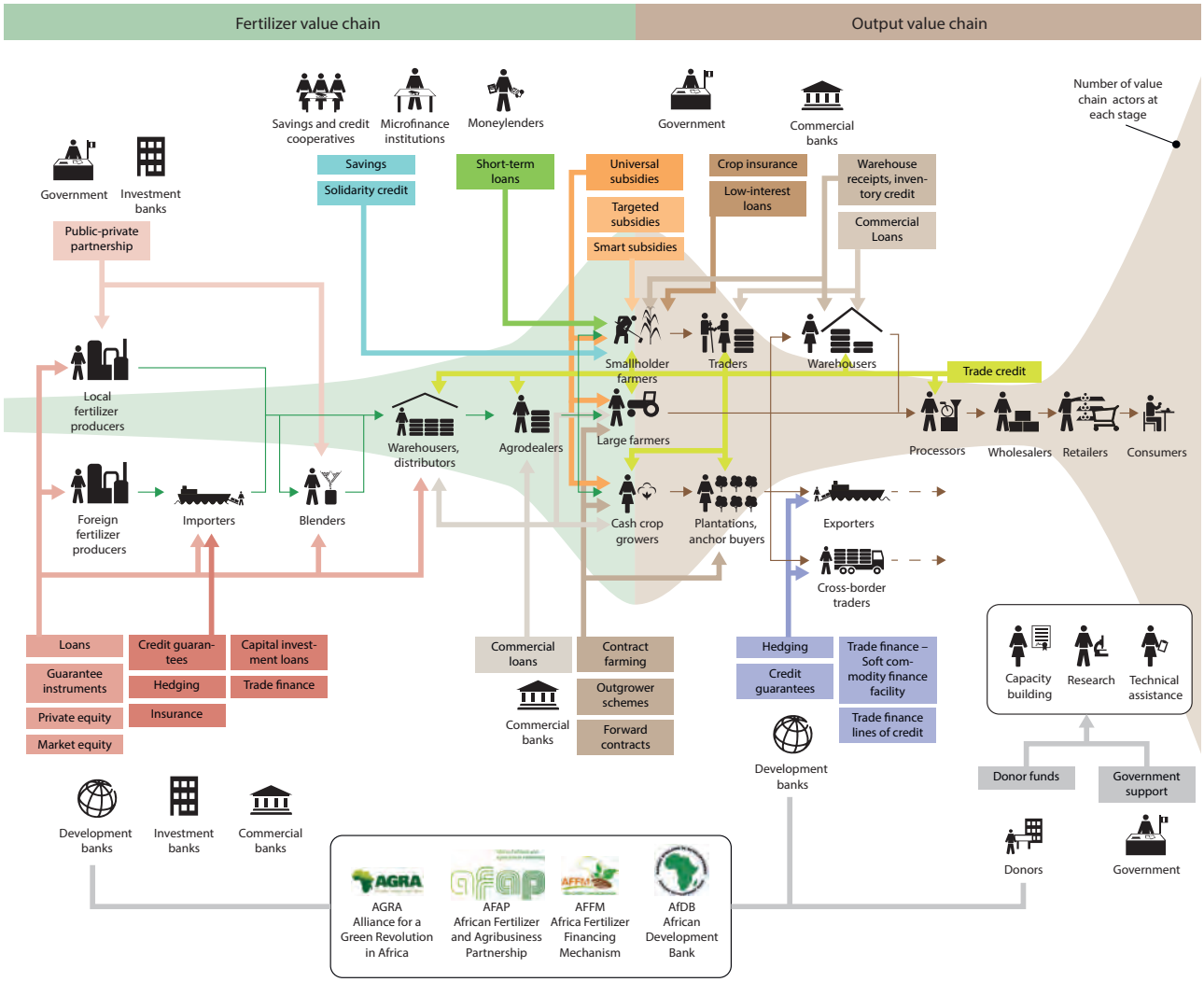


Figure 39. Actual and potential sources of finance for actors in the fertilizer and output value chains.
Source: developed by the authors.

Some of the actors bridge the two value chains. Agrodealers who supply inputs to farmers are also often the same people that buy their output at the end of the season. Farmers' cooperatives may buy inputs in bulk and arrange to market their members' output. Financing could also come from anchor buyers through contract farming. Warehouses may store fertilizers at the start of the season and fill up with sacks of grain at the end.

The number of individual actors varies from one end of the chain to the other (the shading in Figure 38). The fertilizer chain is pyramid-shaped: at the start are a few very large, capital-intensive manufacturing and import corporations. At the end of the chain are a plethora of local agrodealers and millions of farmers, mostly with little capital to speak of. The output chain, on the other hand, is hourglass-shaped. Millions of farmers supply thousands of traders, who sell to a relatively small number of exporters, processors and wholesalers and retailers who in turn supply a multitude of consumers.

Each of the actors in the two chains has specific financing needs, and similar businesses in the two chains need similar kinds of financial services. Fertilizer manufacturers and crop processors need huge amounts of capital to build and run their factories. Fertilizer importers and commodity exporters need funds to finance their trading activities. Distributors and agrodealers (on the fertilizer side) and commodity traders and warehouse managers (on the output side) need credit to buy fertilizer or crops, and to transport and store them.

Farmers are the weakest link in both chains. Most have little capital with which to buy fertilizer, especially at the start of the planting season when they need it. They have resources of little value that a bank would

accept as collateral for a loan: most have no formal title to the land they cultivate, for example. Fertilizer must be applied at the beginning of the season, but farmers have to wait several months for an income after the harvest, when they can sell their crop. Farming is a risky business: pests, diseases, weeds, drought, heavy rain and hail can all ruin a harvest, and low output prices can turn a good harvest into a bad season. With little financial cushion, farmers can ill afford to take risks: a bad season may mean the family going hungry.

This weakness at the bridge between the two value chains affects the functioning of both chains. Farmers who cannot afford fertilizer do not demand it, thus restricting the volumes that can be supplied and the profitability of manufacturing and distributing the product. The time lag between their need for fertilizer and their ability to pay for it is huge. An agrodealer who supplies fertilizers for farmers on credit most of the time has to wait until the end of the season to get paid. The distributor, importer or manufacturer face similar dilemmas.

Farmers' financial weakness trickles down the output value chain, too. Farmers who cannot afford fertilizer and other inputs produce little surplus for sale, limiting output volumes, stifling the processing and wholesale industries, and forcing consumers to rely instead on imported food. Farmers need to be paid as soon as they deliver the harvest; the temporary oversupply at harvest-time causes prices to plummet, thus lowering farmers' income. The farmers cannot afford to hold their output until the prices recover. Traders who buy the output must have cash in hand; low purchasing power means they cannot afford to buy larger volumes. The same situation applies to other value chain actors.

Sources of finance

The financial system mirrors the value chains. It is relatively strong at the start of the fertilizer chain and in the middle of the output chain, where there are relatively few actors to serve. It is much weaker when it comes to serving the needs of the many farmers where the two chains meet. Nonetheless, the financing system still faces various shortcomings at other stages along the chain. Fertilizer producers, importers and distributors find it difficult to get the financial support they need, as do agrodealers crop traders and processors.

Various types of financial institutions operate at different stages along the chains. Where there are few, large-scale value-chain actors, **investment banks, large commercial banks and national or international development banks** such as the African Development Bank provide finance. Big actors can also seek funding from the equity market and rich individual investors.

Commercial banks are the main financial service providers for fertilizer distributors and agrodealers, as well as for commodity traders and processors. These banks are often supported by development banks that help cover their risk and co-finance transactions.

Only large, commercial farmers are likely to qualify for commercial bank loans. Smallholders and small-scale commodity traders must rely on their own **savings, savings and credit cooperatives, microfinance institutions**, and **private lenders** (who often charge very high interest rates). Nonetheless, "proximity lending" by microfinance institutions has developed tremendously in the last two decades, to a point where it is even challenging some mid-level commercial banks.

Actors within the chain also get finance from their **trading partners**. This is known as "chain liquidity" (KIT and IIRR 2010) or "trade credit". An example is the agrodealer who supplies fertilizer to a farmer on credit, and gets paid in cash or with a portion of the crop at the end of the season. Similarly, farmers who deliver grain to a trader may agree to wait for payment until the trader has sold the grain on to a processor. Of course, both sides in such deals may have little choice: they may have to either wait for their payment or forgo the trade completely.

The **government** may be act as a source of finance throughout the chain, either alone or in conjunction with other actors. Perhaps the most obvious example is subsidies (Chapter 9), where the government purchases fertilizers in bulk for sale to farmers at a lower-than-market price. Other examples are support for commercial banks to offer low-interest loans to farmers, and public–private partnerships to build fertilizer plants. Government-owned parastatals may operate or control parts of the value chain for export commodities such as cacao, coffee, cotton, tea, maize, rice or wheat.

Development banks and donors may also intervene at various stages in the value chain. They often operate through commercial banks, for example by providing credit guarantees and lines of credit that the commercial partners can draw on to lend out. The major development bank working on fertilizer in Africa is the African Development Bank. Major donors or conduits of donor funds include AGRA, the African Fertilizer and Agribusiness Partnership, and the African Fertilizer Funding Mechanism. They generally aim to stimulate or leverage commercial investments, cover areas neglected by commercial financial sources, such as the development of agrodealer networks, and support research, technical assistance, and feasibility studies.

Financial instruments

Because the scale and needs of the actors vary along the two chains, the appropriate financial instruments also vary. They fall into seven broad categories: savings, mobile/digital lenders, subsidies, prepayment, loans, risk management, and ownership. The typical beneficiary, source of funds and intermediary institutions also vary.

Financial transactions can be very complicated, especially when large sums are involved. Many transactions involve multiple partners and bundle several financial services into a single package. Below we discuss each of the main categories in turn.

Savings

This is the simplest source of finance: the buyer saves up enough money to buy an item. The savings may be held in a bank or credit institution, or held in some other form. Farmers frequently use livestock as a form of savings: they will sell a cow or a couple of goats when they need cash to buy fertilizer.

Relying on savings has severe limits: few farmers have enough savings to pay for fertilizer at the start of the season. Even large companies cannot afford to pay for a fertilizer shipment or a new factory out of their own savings.

Subsidies

Subsidies can be implemented within various stages of the two value chains. Governments try to reduce the price of fertilizers and persuade farmers to use them by subsidizing their price. They do this for various interrelated reasons: to boost agricultural production, increase farmers' incomes, promote rural development, achieve national food security, and increase earnings from agricultural exports. Subsidies are discussed in detail later in Chapter 9.

Prepayment/Contracts

Buyers and agrodealers are aware that farmers cannot afford to buy fertilizers and other inputs when they need them, they therefore sign contracts with the farmers to buy their crop at a particular time (before, during or after harvest), and facilitate access to the required inputs. Various forms of contract exist. The buyer may pay for all or part of the harvest beforehand, or may provide the required inputs (fertilizer, seed, etc.) at the start of the season. The contract typically specifies the crop type and variety, agronomic practices the farmer must use (such as what pesticides to use or to avoid), and the quantities, grades and delivery dates. The final price may be agreed beforehand, or a floor price may be set: the buyer agrees to pay at least this amount or more, depending on the market price at harvest time.

Out-grower schemes and contract farming. These are commonly used for horticultural and other commercial crops. The contractor (a large-scale agribusiness such as a plantation or anchor buyer) provides inputs on credit and perhaps technical advice to the farmer, takes delivery of the produce and deducts the value of the loan from the payment to the farmer at the end of the season (CGAP 2005). Inputs are often provided via farmers' organizations. The inputs tend to move through the agribusiness, so fertilizer dealers do not deal directly with farmers.

Forward contracts. In a forward contract, the farmer agrees to deliver a certain quantity of the commodity to the buyer in the future for a specified price (or in accordance with specified pricing formula) (Kang and Mahajan 2006). Such contracts insure against adverse price movement for both the buyer and the seller.

Warehouse receipts and inventory credit. A warehouse receipt is a document issued to someone (a farmer or trader) who deposits a commodity in a warehouse. The depositor can then use the receipt as proof of ownership – for example to get a loan

from a bank. Depending on the type of receipt, the depositor may be able to sell it to someone else, who then becomes the owner of the commodity (CTA and EAGC 2013).

Loans

A loan normally requires some kind of collateral to cover the risk that the lender incurs, and an interest rate on the loan. The interest rate depends on the current market rates, as well as the lender's estimate of the cost and riskiness of the loan. Various types of loans are intended for different purposes; the amount and repayment conditions will depend on the purpose.

Investment loans. These are loans intended to pay for major investments such and manufacturing plants or equipment. Larger actors in the fertilizer value chain (fertilizer manufacturers, distributors, large farmers, crop processors, etc.) can qualify for investment loans; smaller actors (local agrodealers, smallholders, crop traders) often cannot.

Trade finance. Loans that provide working capital for buying fertilizers or commodities are usually called trade finance. They may take on different forms depending on the financial institution that issue them.

- **Line of credit.** This is an agreement between a lender and a borrower, where the borrower can access funds up to an agreed maximum (the credit limit), as long as they meet the other requirements (such as making timely repayments). This avoids having to make separate agreements for each new loan. Lines of credit are particularly useful for importers, exporters and others who need to buy and sell fertilizer or crops repeatedly during the year.
- **Trade credit.** This is where one partner in a trade agrees to defer payment for a short time until the other partner can pay. For example, an importer may agree to provide fertilizer on credit to an agrodealer, who will pay at an agreed later time.
- **Short-term loans.** Because they cannot get commercial loans, smallholders, local agrodealers and small-scale traders often rely on short-term loans from relatives or moneylenders. Loans from relatives may be interest-free, but moneylenders often charge high rates of interest.
- **Low-interest loans.** To give farmers access to loans at affordable rates, some governments mandate commercial banks to offer them low-interest loans. The government (or donor agencies) may also provide credit guarantees or supplementary funds to protect the banks from the additional risk.
- **Solidarity credit.** Microfinance institutions and savings and credit cooperatives also offer low-interest loans to their members. Instead of requiring the borrower to pledge collateral, they rely on "social collateral": pressure from the other members of the cooperative or farmer group to ensure that individual borrowers use the loan wisely and repay it on time.

Managing risk

Various types of financial instruments are used to manage risk in the fertilizer and output value chains. Insurance protects a person or organization from financial loss: the party wanting protection pays a relatively small fee to the insurer; if the loss occurs, the insurer will pay out the value of the amount covered. Hedging and credit guarantees also help manage risk.

Crop insurance covers farmers for the expected value of their crop in case the crop is damaged or lost, for example due to bad weather, such as drought. Recently, some providers have introduced insurance policies that pay farmers if drought occurs (as reflected by rainfall measurements), regardless of any actual losses the farmers may have incurred. This frees insurers from having to check on the level of damage caused. Farmers can buy policies using a mobile-phone application. Such policies have considerable promise in drought-prone areas of Africa.

Hedging. This protects an importer or exporter from changes in the exchange rate. If fertilizer is priced in dollars but the exchange rate rises or falls between when the price is agreed and payment is made, the insurer (usually a bank) will cover the difference.

Credit guarantees. These reduce the risk to manufacturers or blenders, importers, exporters and others when trading. A government credit agency or development bank pays part of the cost of a loss if a trading transaction fails, for example if the buyer goes bankrupt or fails to pay for a shipment of fertilizer or grain. Different types of guarantee exist depending on the guarantor institution and the covered risk. Some of these are explained under the new financing mechanism section in this chapter.

Ownership

Some types of financial transactions involve taking partial ownership of the firm that needs funds.

Public–private partnerships. Partnerships between governments and the private sector can take many forms. One is for the government and a private-sector firm to invest jointly in a factory. Another is for the government to contract a firm to perform certain services for it, such as distribute fertilizers or handle the export of crops.

Market equity. This is where a company sells shares on the stock market to pay for an investment such as the construction of a new fertilizer plant. The shareholders become part-owners of the company.

Private equity. This is similar to market equity, except that the shares are not publicly traded. The shares are typically sold to investors such as pension funds or "high-net-worth individuals" (i.e., rich people).

Matching instruments and beneficiaries

Different items within this arsenal of financial instruments are appropriate for different needs for the various actors in the value chain (Table 14).

Table 14. Financial instruments used in the fertilizer and output value chains

Value chain actor	Sources of financing	Financial instruments
Fertilizer manufacturers, blenders	National/international development banks Local, regional, international commercial banks Private investors Government	Bank loans Investment loans Credit guarantees Trade finance Private equity Public–private partnerships Insurance
Fertilizer importers, distributors, agrodealers	Development banks Local, regional, international commercial banks Manufacturing/blending companies Donors Public or private mechanisms Government	Credit guarantees Investment loans Trade finance (lines of credit or structured finance) Hedging Insurance
Farmers, Farmer groups, cooperatives	Local banks Microfinance institutions Savings-and-credit cooperatives Aggregators, off-takers Donors Public or private mechanisms Government Money lenders Family members	Short-term loans Solidarity credit Crop insurance Mobile banking loans Contract farming Crop insurance Outgrower schemes Forward contracts Inventory credit, warehouse receipts Savings Grants Subsidies Low-interest loans

Fertilizer manufacturers and blenders

Setting up fertilizer manufacturing and blending plants requires significant capital. Private-sector financing is vital, with investment banks, large national and international commercial banks, and development banks providing loans, guarantee instruments, trade finance and insurance. Market equity (from the stock market) and investment from rich individuals and institutions (private equity) are also a source of investment capital (UNECA and AFFM 2018). Governments may also invest in such plants, either directly or through parastatal organizations, or through public–private partnerships.

Fertilizer importers, distributors and agrodealers

Guarantee instruments (through development banks, and other public-private mechanisms) are most appropriate for this section of the fertilizer value chain. Local, regional, international commercial banks could also finance the import and distribution of fertilizer by providing loans for capital investment, lines of credit for trade finance, insurance and others. Governments can partner with commercial banks to provide credit, while donor funds should focus on capacity building and technical assistance.

Farmers

The most appropriate financing instruments for farmers are those that will allow them to sustain their businesses, build relationships with financial institutions, and finance part of their inputs with revenues from their produce (savings).

Local banks, microfinance institutions and savings and credit cooperatives can finance farmers to the extent that they have built relationships of trust with them. Farmers can also negotiate with buyers of their output to finance their inputs. Financing options include contract farming, crop insurance, forward contracts, inventory credit and warehouse receipts.

Guarantee facilities may also be appropriate for large farmers and cooperatives. Governments often intervene by subsidizing agricultural inputs. Funds from development agencies should focus on capacity building for farmers and agricultural research.

Box 11. Examples of financing the fertilizer value chain

Manufacturing and blending plants

- **Development banks.** The African Development Bank financed $100 million for the Indorama urea plant and $300 million for the Dangote plant (also for urea) in Nigeria. Discussions are ongoing with Notore. It approved $200 million for OCP's Jorf Lasfar Phosphate Hub Expansion Program in Morocco.
- **Commercial bank** lending to agriculture is about $660 million per year (just 4.8% of their total annual lending) in sub-Saharan Africa.
- **Private equity/market funds.** Dangote intends to invest in the largest fertilizer plant in Nigeria with a capacity of 2.8 million tons of urea. The Notore Urea Plant II project, worth $2 billion, will have 30% financing from private equity. Indorama has signed a financing package to construct a green field urea project in Nigeria: out of $1.2 billion, $400 million is in equity.
- **Public–private partnerships.** The Nigeria Incentive-Based Risk-Sharing System for Agricultural Lending (NIRSAL) has a $300 million risk-sharing facility. Up to 2018, it had provided credit guarantees for agricultural projects valued at $199 million.

Importers, distributors and agrodealers

- **Credit guarantees.** NIRSAL, African Guarantee Fund, GAPI, BDF and many other specialized facilities guarantees up to 75% of bank loans to agriculture. It pays about 50% of losses incurred by large farmers and roughly 75% of those incurred by small and medium-scale farmers.
- **Development banks.** In 2018, the African Development Bank extended a soft commodity-finance facility of $100 million to Export Trading Group (a fertilizer importer based in Kenya). This loan provides pre- and post-shipment finance along various stages of ETG's commodity value chain operations in 17 countries. It finances the procurement of commodities from over 600,000 farmers (African Development Bank 2018a).
- **Donor funds.** The Bill and Melinda Gates Foundation has offered a $10 million guarantee fund to the African Fertilizer and Agribusiness Partnership (AFAP) through AGRA.

  AFAP has activated a $9 million dedicated guarantee holding facility. This facility is ready for use through agribusiness partnership contracts with the private sector requiring credit guarantees, pending beneficiaries' seasonal requests.
- **Low-interest loans.** AGRA works with financial institutions to develop financial products whereby risks are shared among the various stakeholders (farmers, input dealers, seed and fertilizer suppliers, off takers and financial institutions).

Farmers

- **Governments.** The government of Mali established a fund through the Malian National Agricultural Development Bank from public and private banks to finance agricultural activities (for cotton and inputs).
- **Development partners.** AGRA, in partnership with Equity Bank (a Kenyan bank), the International Fund for Agricultural Development and the Kenyan Ministry of Agriculture, has created a loan facility of $50 million, was backed with a $5 million cash guarantee fund. It has made affordable credit available to 2.5 million farmers and 15,000 agricultural value chain operators.

There has been substantial progress in finding innovative options for fertilizer financing. Several sources and financing instruments are available to be used by the sector. Nevertheless, financing remains a major challenge along the fertilizer value chain, hindering the increased consumption of fertilizer, particularly among smallholders.

One problem is the limited understanding by potential beneficiaries of the financing process and how to prepare the business plans that financial institutions need. Other problems include the affordability of financial instruments, poor awareness of existing options, and the inappropriateness of those options.

Innovative financing mechanism

The Africa Fertilizer Financing Mechanism

The Africa Fertilizer Financing Mechanism has a mandate is to serve as a vehicle for financing the fertilizer value chain. Formally established in 2007 as a result of the Abuja fertilizer summit of 2006, it is supported by the United Nations Economic Commission for Africa and the African Union Commission; it is hosted by the African Development Bank. It has been slow to become operational; it took 11 years to mobilize the initial seed capital of 10 million euros required to start operations. It was only in 2018 that the AFFM secretariat was provided with substantive human resources and started implementing its activities.

AFFM has selected 13 strategic commodities with high market demand and therefore the potential for increased fertilizer use: cocoa, coffee, cotton, horticulture, palm oil, sorghum, millet, cowpea, maize, soybean, wheat, cassava and rice. It has chosen nine countries for its initial interventions: Chad, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Mozambique, Nigeria, Tanzania and Zambia) (AFFM 2018a).

AFFM aims to provide finance and create an enabling environment to unblock bottlenecks to the use of fertilizers in Africa. The main focus is to support credit guarantees and other financial solutions along the fertilizer supply chain and at leverage points in output value chains. These aim to reduce the risk of lending money, making it easier for the private sector to invest in the chain. AFFM proposes to support three types of credit-guarantee schemes for importers, distributors and agrodealers (AFFM 2018b):

- Portfolio credit guarantees
- Portable credit guarantees
- Trade credit guarantees.

Portfolio credit guarantees. This scheme is ideal for mitigating the risk of working capital. It targets wholesalers, distributors, agrodealers and retailers. It gives a participating financial institutions permission to attach a partial credit guarantee to any beneficiary that meets the eligibility criteria and for which the partnering financial institution has decided to provide a working capital loan or credit facility. The AFFM guarantee covers 50% of the unpaid part of the loan principal, plus interest payable at the moment the guarantee is called by the financial institution.

Portable credit guarantees. These are suitable for investment capital. This scheme targets private importers, blenders, wholesalers and distributors. Through a local implementing partner, AFFM decides whether to provide a commitment agreement for a guarantee to the target beneficiary. The commitment agreement offers a confirmation by AFFM that a portion of a potential loan can be guaranteed. The beneficiary can therefore use it to shop for competitive interest rates at various financial institutions. Once the financing is secured, AFFM will provide a partial guarantee to cover up to 50% of the unpaid part of the loan principal, plus interest payable when the guarantee is called by the financial institution.

Trade credit guarantees. The trade credit guarantee model proposed by the African Fertilizer and Agribusiness Partnership (AFAP) operates at two levels. The first level entails upstream suppliers to hub agrodealers, while the second level is hub agrodealers to retail agrodealers. In both cases, the hub agrodealers are pivotal: they are the channel for the upstream actors and source of product and credit for the downstream actors. Under this model, a fertilizer importer, manufacturer or supplier provides fertilizer to hub agrodealers on credit; AFFM shares the credit risk involved in the transaction on an equal footing with the supplier. The hub agrodealer provides the product on credit to distributors, and the chain will continue until the fertilizer reaches the smallholder farmers. The model can also be applicable to farmer cooperatives.

In 2018, AFFM announced a call for qualified financial institutions and implementing partners to offer loans to fertilizer importers, wholesalers, distributors and agrodealers in Nigeria and Tanzania. AFFM will provide these partners with a €4 million partial credit guarantee for loans to borrowers that meet certain eligibility criteria.

AFFM also envisages assisting private traders to obtain lines of credit, hedging and equity investments from local banks, and developing new financial solutions for farmers.

Other AFFM activities include:

- Playing an advocacy role by disseminating information about the existence of various financing instruments, and communicating to financial institutions and development bank the financing needs of the sector so they can develop customized instruments.
- Providing policy and technical assistance advice to governments to address obstacles in the fertilizer chain.
- Improving the economies of scale of fertilizer production, procurement and distribution.
- Disseminating information about returns on investment in fertilizer, so boosting demand at the wholesale and retail levels.
- Helping the public and private sectors conduct feasibility assessments and secure financing for fertilizer-production ventures.

Other African Development Bank initiatives

In addition to managing and financially contributing to AFFM, the African Development Bank (AfDB) has financed fertilizer blending and distribution through companies such as Indorama, ETG and Dangote. Other funding initiatives are in pipeline.

Partial risk guarantees. A partial risk guarantee is a financial guarantee which covers commercial-debt service defaults. Such guarantees are normally for private-sector projects, to cover (for example) a default caused by a government or government-owned entity's failure to meet its specified contractual obligations. A partial risk guarantee can be used to cover the risk involved in construction of fertilizer plant in a country. The risks covered include currency inconvertibility and non-transferability, political force majeure, expropriation, confiscation, nationalization and deprivation and breach of contract. It does not cover things like currency depreciation, devaluation or pre-existing restrictions on conversion or transfer.

Trade finance. These are short-term loans to facilitate trade; they are of vital importance for the fertilizer value chain – but are expensive in Africa. The AfDB has several financial instruments that can be used to support access to finance for the fertilizer value chain. It is discussing with AFFM how best to deploy these.

- **Risk participation agreement.** This facilitates transactions between an importer's bank (the "issuing bank") and an exporter's bank (the "confirming bank"). It allows banks to reduce their exposure to risk. The AfDB approves a credit limit for the issuing bank, following the confirming bank's proposal. The confirming bank and the AfDB share the risk of the transaction through a 50:50% risk-sharing agreement. No transaction approval is required, but the confirming bank submits monthly reports detailing the AfDB's exposure.
- **Trade finance lines of credit.** An importer or exporter requests for pre- or post-export funding to its African financial institution. The financial institution submits the requisite documentation on its operations to the AfDB, which provides financing and assumes the financial institution's risk (not the importer's risk). The local financial institution can then on-lend the money to the exporter or importer.
- **Soft commodity finance facility.** The AfDB uses this facility to provide input and post-harvest financing through aggregators. Farmers or purchasing agents buy inputs commodities from a commodity aggregator (or sell commodities to it). The aggregator submits documentation detailing the proposed transaction(s) to the AfDB, which provides financing and assumes the aggregator's risk (not the farmers' risk). The aggregator uses the finance to pay the farmers, or to lend the money on to them.

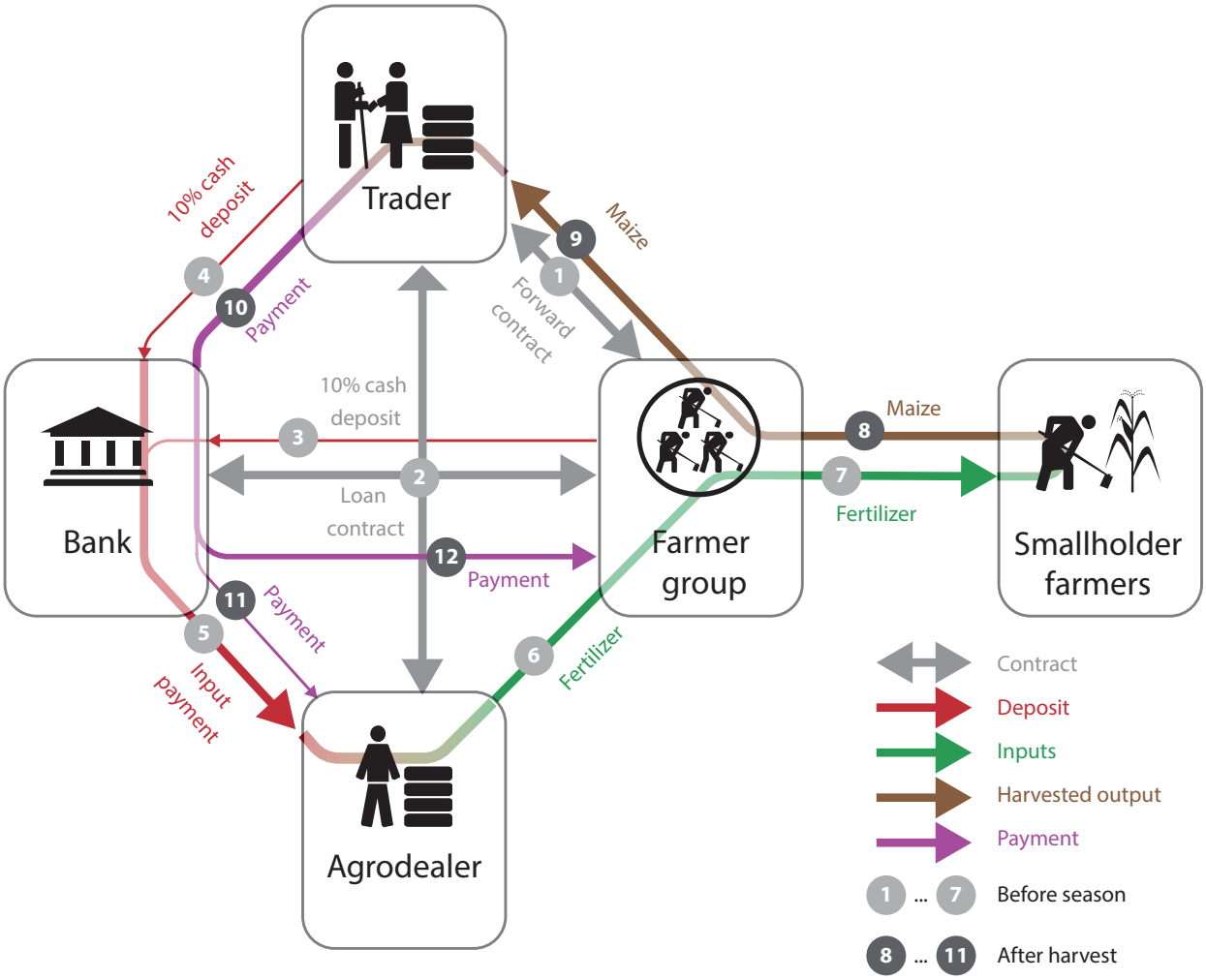
AGRA's input-financing model

AGRA has developed a model for financing inputs that shares risks among a farmer group, an agrodealer, an output buyer, and a bank. It requires the first three to make an initial 10% deposit of the value of a shipment of fertilizer with the bank in order to facilitate a loan.

Suppose a farmer group wants to buy a truckload of fertilizer for its members in order to grow maize. The group first signs a forward contract with a buyer who will buy the maize at the end of the season (1 in Figure 40). The group, trader, agrodealer and bank sign a four-way contract to govern the deal (2). The group deposits 10% of the value of the fertilizer with the bank (3). The output buyer also makes a term deposit of 10% of the value of the fertilizer with the bank to serve as an additional guarantee for the loan (4).

The bank then pays 90% of the value of the fertilizer to the agrodealer (5), withholding the remaining 10% in case of a default. The agrodealer delivers the fertilizer to the farmer group (6), which distributes it among its members (7).

At the end of the season, the farmers harvest the maize and deliver it to the group (8), which bulks it and delivers to the buyer (9). The buyer deposits the payment with the bank (10), which deducts the value



Adapted from AGRA (2017)

Figure 40. AGRA's financing model for fertilizer supply

of the loan plus interest, pays off the agrodealer (11), and credits the farmer group with the profit (12).

This model is supported by the participation of all the value chain actors. All will lose part of their profit in case of a loan default, so they will be highly committed to make sure the model works. The model has been used successfully for rice production in Ghana and is now being tested in Burkina Faso.

AGRA/Mastercard Foundation access to finance for smallholder farmers

With the financial support of Mastercard Foundation, AGRA has formed 15 partnerships to reduce the risk and cost of delivering financial services to smallholders, and a further three partnerships to give farmers access to mechanization services. The arrangements reduce the financial risks through in-kind contracts and service delivery, buyback guarantees, the use of supply chain data, insurance schemes, the e-verification of seeds, and risk sharing with value-chain actors and pre-payment schemes. The costs of delivering financial services are reduced through the use of mobile money and agents as delivery channels. The mechanization services are offered through entrepreneurs by aggregating demand from farmers and facilitating access to equipment. These schemes operate in Ghana, Kenya and Tanzania, but the approach could be replicated in other countries (AGRA 2018c).

Recommendations

- **Public–private partnerships** are most appropriate for investment in fertilizer manufacturing and blending.
- **Credit guarantees** are effective for de-risking commercial banks and attracting private investment.
- **Donor support** should focus more on building the capacity of smaller value chain actors to become finance-able and to deploy

in-kind input financing schemes involving agrodealers, off takers and farmer

- **Financing that farmers and agrodealers can afford** must be made available for their specific needs. Digital tools including lay away schemes and specialized products like income smoothening credits, can help those actors bridge their irregular cash flows

- The best source of financing for farmers is **access to output markets** combined with a financial facility where risks are shared between financial institutions and value chain actors that benefit from improved productivity

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11. Fertilizers and the environment

Assan Ng'ombe, Abednego Kiwia, Shamie Zingore and Abdoulaye Mando

Evidence from around the world shows that both synthetic and organic fertilizers are central to the growth of agricultural productivity. This is especially important for Africa, with its infertile soils, growing population and chronic food deficit. Fertilizer use in Africa is still very low – though it is on the rise. African soils need fertilizers if they are to meet the productivity levels needed to feed the continent's growing population.

African agriculture systems face threefold challenges:

- Meeting an ever-increasing and changing food demand from a larger and a more affluent population.
- Ensuring that the region's poorest are no longer hungry and have sufficient and permanent access to nutritious food that meets their dietary needs for an active and healthy life.
- Doing so in a way that is environmentally and socially sustainable, amid a changing and an unpredictable climate.

Environmentalists have raised concerns about the increased use of fertilizers and the negative effect this has on the environment. Fertilizers are frequently criticized as harming the environment: misused or overused, they can damage the soil, pollute surface water and groundwater, reduce biodiversity, and lead to the emission of greenhouse gases that cause climate change. Some parts of the world indeed appear to overuse fertilizer, leading to such problems.

But not Africa. African agriculture is generally extensive, with very limited intensification. Production increases are often achieved by expanding the area cultivated rather than increasing the yield per hectare. That means converting more and more land from natural vegetation or grazing to arable use. This reduces the environmental services that such land provides: water conservation, prevention of erosion, maintenance of biodiversity, acting as a carbon sink, etc., as well as depriving livestock keepers of their traditional grazing lands. The judicious use of fertilizers on existing cropland can raise yields and restrict the area of land that would have to be brought into crop production in order to increase food output. Fertilizers can benefit the environment if they are appropriate to the needs of the particular soil and plant requirements; and are applied are applied according to integrated soil management principles.

To minimize environmental concerns and to maximize the benefits, farmers and other actors in the fertilizer value chain must understand the nature of soil nutrient deficiencies and crop-specific nutrient needs. Building their capacity, and generating the knowledge needed, will be necessary to do this.

This chapter discusses the effects of fertilizer use on four aspects of the environment: the soil, water, biodiversity, and the climate. We discuss three situations:

- **Too little:** where low or no use of fertilizer contributes to continued soil nutrient depletion, a decrease in soil cover and organic matter and low production, leading to the encroachment of new forest areas or marginal areas for food production.
- **Too much:** where too much use of fertilizer will jeopardize some ecosystem services
- **Just right:** where an appropriate use of fertilizer brings benefits to both agricultural productivity and most ecosystem services.

Too little fertilizer

Sub-Saharan Africa's population is predicted to grow from 1 billion in 2019 to 2.1 billion in 2050 and 3.9 billion by 2100 (United Nations 2015). By 2100, the global population is forecast to be 11.2 billion: in other words, one in every five people will live in sub-Saharan Africa. This will pose huge challenges to food production, especially if the region's people are to enjoy better nutrition and a higher standard of living than they do today.

Many of Africa's soils are commonly referred to as "tired" (Tully 2015). Some 95 million hectares (nearly the size of Liberia), and probably more, have already been degraded through soil erosion, leaching of nutrients, and nutrient mining by crop harvests (AGRA 2016). The continued low or imbalanced use of fertilizers will lead to serious environmental impacts (Figure 41). Indeed, Mavuthu (2017) regards the low use of inorganic fertilizer as one of the main causes for environmental degradation in Africa.

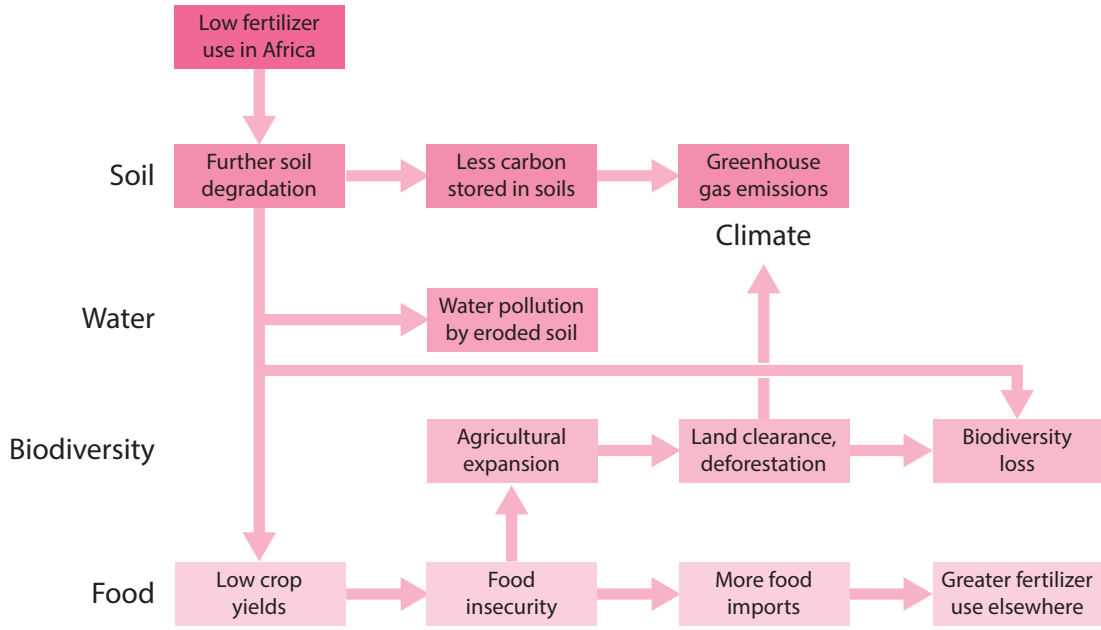
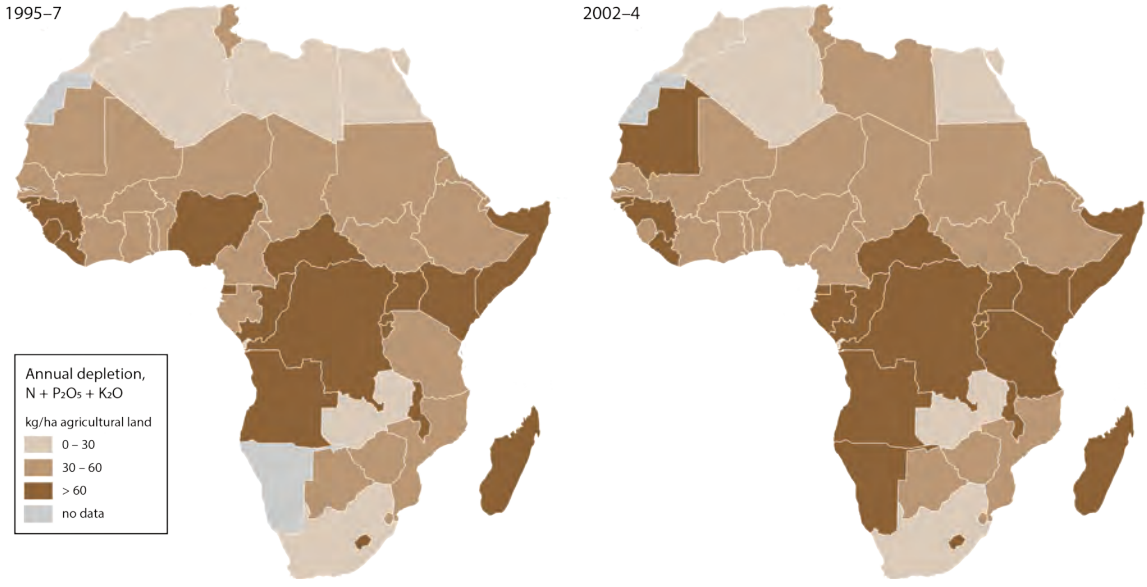


Figure 41. Effects of low use of fertilizer on the environment and food security

Note that all of the effects of depicted in Figure 41 are negative: there are no positive environmental consequences of continuing the low use of fertilizer on agricultural land in Africa.

Soils

Low fertilizer use is leading to the depletion of soil nutrients all over Africa (Figure 42). The combination of nutrient exports from the soil when the crop is harvested, and losses through volatilization, leaching and erosion, far exceed nutrient inputs. This nutrient mining is worsening over the time and is a fundamental cause of soil degradation. Depleted soils produce less biomass, leaving the surface exposed to crusting and erosion, and harming the soil structure because of a decline in organic matter. Over time, the continuous mining of nutrients alters the health of soils by increasing their acidity, triggering reactions that degrade the soil chemistry and structure, and



Source: Henoa and Banaate (2006)

Figure 42. Nutrient mining in agricultural land in Africa in 1995–7 and 2002–4

rendering the soil less productive. This process can be irreversible (Boyle 2014, Martini et al. 2015).

Applying an unbalanced mix of nutrients can also be very detrimental to the soil. Too much of one nutrient and not enough of the others means crops cannot use up all of the excess nutrient, while depleting nutrients that are in short supply.

Water

Soils where the nutrients have been depleted can support only a limited level of vegetation. Bare soil is eroded easily by the wind or rain; it washes into rivers and lakes, polluting water sources, killing aquatic life, and silting up rivers, reservoirs and irrigation systems. The low use of fertilizers can thus result in a reduction in the quality of water.

Biodiversity

Poor soils not only produce lower crop yields; they also generate little organic matter and can support fewer soil organisms. Biodiversity is low on such soils.

Where fertilizer use is low, soils are typically too poor to produce enough to meet the demand for food. To compensate for this, farmers need to cultivate a larger area. Indeed, Africa's agriculture systems are generally extensive in large part due to soil infertility. The clearing land for agriculture means large-scale deforestation, thereby reducing biodiversity and emitting large volumes of greenhouse gases. The deficit in food production also requires food imports, which in turn stimulate environmental degradation elsewhere, either through extensive agriculture or the excessive use of fertilizers – both of which reduce biodiversity.

Climate

Nutrient mining leads to the gradual, and in some cases irreversible, loss of organic matter in soils. Carbon is released into the atmosphere as carbon dioxide, where it fuels climate change. Under such conditions, low fertilizer use therefore does not help mitigate against climate change; rather, it exacerbates it.

Too much fertilizer

Overuse or misuse of fertilizer has had negative consequences for the environment in other parts of the world: in Asia, Europe and some parts of Latin America. As Africa increases its use of both inorganic and organic fertilizer, this will require close attention in application and management.

Even with skillful fertilizer management, the most plants can take up from a soil is about 50% of the nitrogen that is applied, 10 to 20% of the phosphorus,

and 50% of the potassium. The rest is lost to the environment, loading the soil, rivers and atmosphere. If not checked, extensive damage to the environment can happen when there is a high use of fertilizers.

Soils

If not checked, the high use of fertilizer can over time increase the level of toxic elements in the soil. Many African soils are already acidic, or are vulnerable to becoming so when they are cultivated. Fertilizers may aggravate this process. Long-term trials in semi-arid West Africa and humid savannah zones show that cultivation with acidifying fertilizer applications (or without any inputs) leads to a decline of pH of one unit in 5 to 10 years (Bado et al. 1997, Vanlauwe and Giller 2006). Not all fertilizer sources are acidifying; applying manure, for example, will mitigate the acidification process, while the use or application of lime or dolomite will correct acidification.

While pollution due to fertilizer is a problem in some parts of the world, the low application rates of fertilizer in Africa mean it is unlikely to be a widespread concern there.

Water

High rates of fertilizer applications can contaminate surface and groundwater with excessive nitrates and phosphorus, which can cause the eutrophication (nutrient over-enrichment) of rivers and lakes. This results in algal blooms, oxygen depletion in the water, and the die-off of fish. Excessive nitrates in drinking water also cause human health problems.

African soils are prone to leaching, so the risk of groundwater contamination is real in cultivated areas (Barreto et al. 2017). This is already a problem in a few areas in Africa. Intensive horticultural production, and to a lesser extent, smallholder farming, along with urban growth around Lake Naivasha in Kenya, for example, has led to increased discharge of nitrates and phosphorus into the lake (Mavuti et al. 2001), especially during storms.

Biodiversity

The use of fertilizer makes it possible to use existing agricultural land more intensively, producing higher yields from the same area, or even reducing the area cultivated. With a few exceptions in densely populated areas, African agriculture is currently very extensive: low yields per hectare force farmers to cultivate larger areas in order to produce enough food to eat and sell. Newly cultivated areas are often marginal from a soil or climatic point of view.

A key risk to biodiversity from high levels of fertilizers is creating the dominance of certain species and organisms. For example, certain weeds or invasive plants may become dominant. High levels of fertilizer use may also create toxic conditions that can kill microorganisms that support biodiversity.

Climate

Inorganic fertilizers contain, or break down into, gaseous substances such as methane, carbon dioxide, ammonia and nitrous oxide. Methane, carbon dioxide and nitrous oxide are greenhouse gases; ammonia reacts to form nitrous oxide (De Urzedo et al. 2013). Nitrous oxide also depletes the ozone layer in the stratosphere that protects the earth from the harmful ultraviolet rays of the sun.

The production of fertilizers, especially those that contain nitrogen, uses large amounts of energy and also results in greenhouse gas emissions. However, the low fertilizer usage in Africa means that the continent's agriculture is a very minor contributor to global greenhouse gas emissions.

Nevertheless, Africa still needs to pay attention to its fertilizer use to avoid contamination and negative effects on the environment.

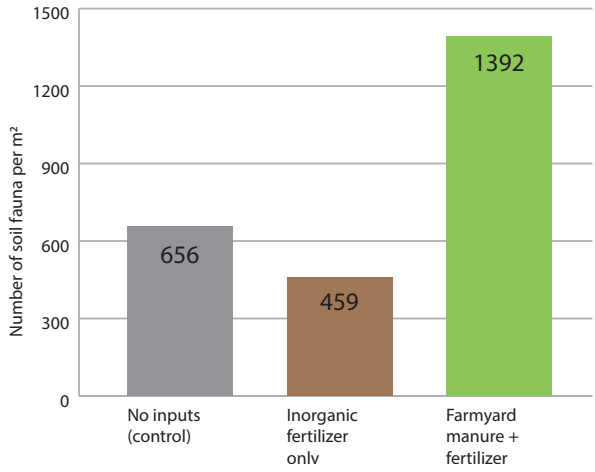
Just right

Whereas in the developed world, excess applications of artificial fertilizer and manure damage the environment, Mavuthu (2017) advocates increasing the use of inorganic fertilizer in Africa. This would not only raise productivity; it would also benefit the environment in various ways.

Soils

The sound use of fertilizers increases the biomass production both above and below ground. This in turn raises the amount of organic matter in the soil. The additional biomass generates more soil cover and reduces erosion and water losses through runoff and evaporation (Zougmoré 2003). It provides enough food sources to sustain soil biodiversity.

Both organic matter and biological activity in the soil are essential to maintain and improve the soil structure and for ecosystem services such as nutrient cycling. In a long-term experiment (>40 years), the application of farmyard manure in combination with inorganic fertilizer significantly increased the abundance of soil fauna compared to both the no input control and inorganic fertilizer alone (Figure 43) (Ayuke et al. 2011).



Source: Ayuke et al. (2011)

Figure 43. Soil fauna abundance across different treatments in Kabete, Central Kenya.

Water

Boosting fertilizer use within limits would improve water quality in various ways. More biomass would mean more soil cover and less erosion. Higher organic matter in the soil would also help prevent erosion (as organic matter binds soil particles together), as well as retain more moisture in the soil.

As mentioned above, there is a danger of pollution of water bodies and groundwater by nitrogen and potassium due to the local overuse of fertilizers.

Biodiversity

The right amount of fertilizer benefits biodiversity both directly, by increasing the level of organic matter in the soil (and hence soil life), and indirectly, by reducing the pressure to convert forests and other fragile lands to agricultural uses (Figure 44).

Climate

Intensifying production would reduce the pressure to encroach on forests, avoiding the release of large amounts of carbon dioxide into the atmosphere. It would also reduce pressure to expand cropping into grazing land, where crop production is often marginal at best. Below is an analysis based on Vlek et al. (2017)

The effect of fertilizer on the climate can be divided into two categories: the additional greenhouse gas caused by the production and use of fertilizer, and the carbon sequestered by the regeneration of forests and grasslands that are taken out of production because fertilizer permits more intensive cropping. Figure 44 shows these two effects: the additional emissions are shown below the horizontal axis, while the potential sequestration is above the axis. The degree of regeneration – and therefore the amount of carbon sequestered – depends on many factors, so the figure shows three scenarios: high, average and low regeneration.

Increasing the fertilizer use in Africa by 20% would increase greenhouse gas emissions by only 0.37 million tonnes of CO_2 equivalent a year. In South Asia, where fertilizer applications are already much higher, boosting fertilizer use by 20% would raise emissions by 6.54 million tonnes per year. To put the African figure into perspective, 0.37 million tonnes is just one-fifteenth of the annual CO_2 emissions of the United Kingdom's agricultural sector, or less than one-300th of the emissions from the UK's transport sector (BEIS 2019).

Boosting fertilizer use in Africa by 20% is predicted to raise yields of rice by 5.1%, wheat by 11%, and maize by 9.9%. This would potentially permit 2 million hectares of currently cultivated land to be set aside for reforestation, thus sequestering carbon. This is shown by the blue circle in Figure 44. Similar increases in fertilizer use in other parts of the developing world would free up more land for reforestation, but this is because these regions already consume more fertilizer than sub-Saharan Africa.

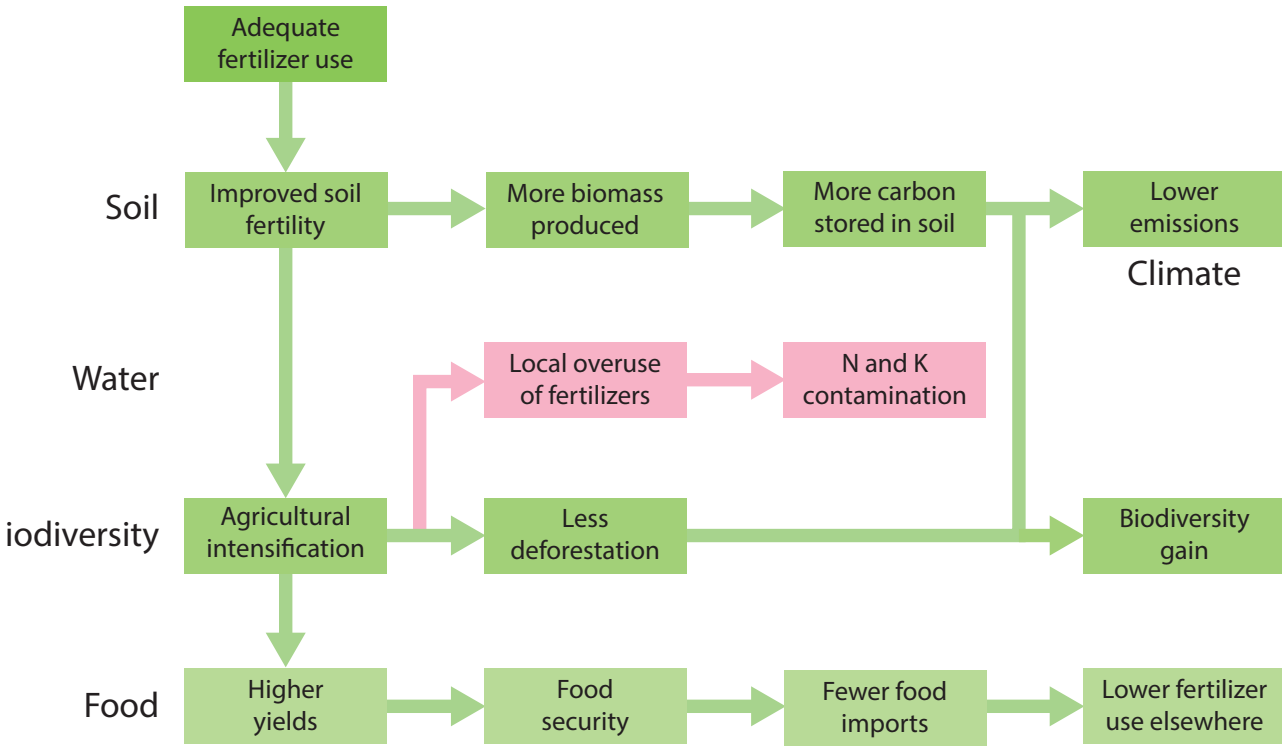


Figure 44. Effect of adequate fertilizer use on the environment and food security

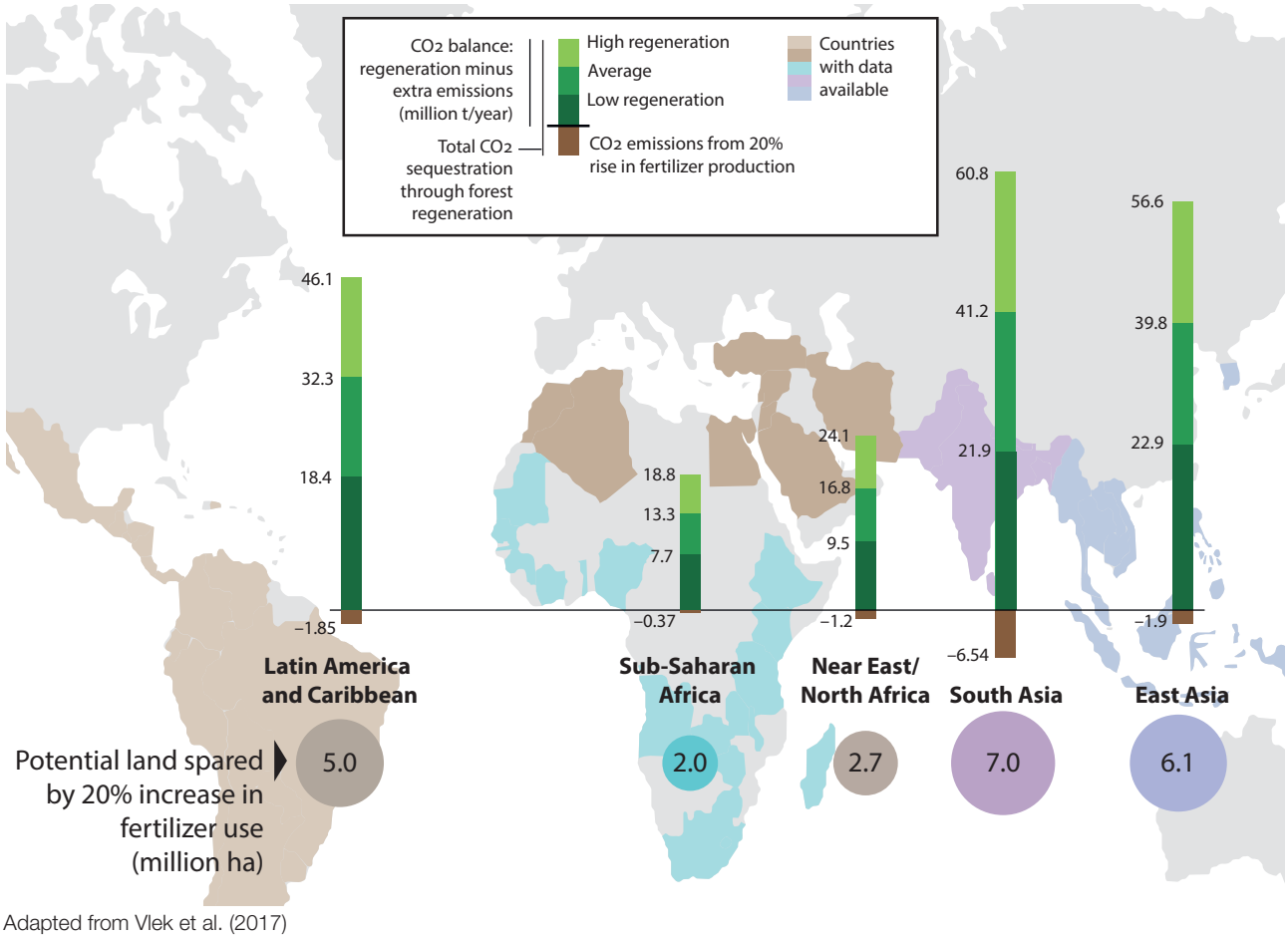
The amount of carbon that would be sequestered depends on the rate of forest regeneration. For sub-Saharan Africa, estimates range from a low of 7.7 million tonnes of CO_2 per year to a high of 18.8 million tonnes. These are represented by the green bars in Figure 45. For all regions considered in the figure, the potential sequestration is far larger than the amount of additional emissions caused by the fertilizer production and use.

Because fertilizer use in sub-Saharan Africa is currently so low, there is considerable scope to use more fertilizer than the 20% increase considered by Vlek et al., and thus boost yields further, without significantly increasing CO_2 emissions (Vlek et al. 2017).

Nonetheless, to achieve the carbon-sequestration benefits indicated in Figure 45, land must actually be taken out of agricultural production and reforested. Appropriate policies would have to be to put in place – and implemented – in order for this to happen.

Conclusions and recommendations

Overall, for fertilizer, the picture is mixed (Martini et al. 2015:176–7). On one hand, the production and transport of fertilizers (especially nitrogen) produces greenhouse gases. The overuse of fertilizer can pollute groundwater and surface water. But fertilizers also enable more vigorous crop growth and the fixation of carbon dioxide from the air as biomass, which (with appropriate agronomic techniques) can be added to the soil as organic matter. For these reasons, increasing fertilizer use to an adequate level in sub-Saharan Africa would be beneficial to the environment.



Adapted from Vlek et al. (2017)

Figure 45. Potential carbon sequestration from reforestation of agricultural land spared by increasing fertilizer use by 20%

Adequate fertilizer use means following an integrated soil fertility management framework and the "four rights" of nutrient stewardship: right rate, right source, right time and right place (Chapter 2). Complementary measures include soil and water conservation, liming of acidic soils, conservation agriculture, appropriate irrigation and mechanization, improved crop varieties, integrated pest and weed management, and improved harvesting, processing and storage techniques. Such techniques are necessary to reduce or avoid the negative effects of fertilizer on the environment.

There is unanimous agreement among scientists that fertilizers are indispensable to feed the world. But the myth that fertilizer is bad is very hard to eradicate (Smaling et al. 2006) especially among environmental activists. Yes, fertilizers sometime cause environmental problems, but when this happens, a careful look indicates that it is the policies and management surrounding fertilizer use that are responsible of the environmental issues – not the use of fertilizers per se. The use of fertilizers must be tailored to the soil conditions, climatic potential, crop requirements to achieve the desired yield. The best situation is where both yields and nutrient-use efficiency are high, and where land encroachment on marginal land or forest land is minimal. Achieving the above will require carefully thought-out policies and techniques.

Fertilizer recommendations

There is a need to develop and scale-out site-specific fertilizer recommendations in each country. These would replace the current, outdated blanket recommendations still in use in many countries that fails to address the specific climatic and soil conditions in each location and the nutrient requirements of each crop.

Integrated soil fertility management

Improved soil management practices should be scaled-out, covering the use of fertilizer, organic inputs and improved germplasm, combined with knowledge on how to adapt these practices to local agronomic and economic conditions. Regulatory frameworks are also needed to prevent pollution and soil degradation.

Research and development

While much research has been done worldwide on fertilizers and the environment, this must be extended to the specific trends, effects and needs in Africa. The use of bio-products that are deemed to be eco-friendly is one growing area where research is needed. Investment in research and development will spur the development of more efficient and environmentally appropriate fertilizers for Africa and the accompanying institutional and regulatory structures.

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4 Synthesis

12. Lessons and prospects

Rebbie Harawa

Despite its vast arable land, water and manpower resources, the African continent is largely food-insecure and is a net food importer. It is also one of the regions of the world with the lowest agricultural productivity. Better technologies, including the adoption of fertilizers, are essential to improve this situation, especially among smallholder farmers. History shows that no region of the world has been able to increase its yields and ensure food security without using fertilizers to replace nutrients removed from the soil through successive harvests and associated losses.

African governments recognize the need to increase fertilizer use to improve food security by investing heavily in agriculture. However, in the 1980s and 1990s, budget deficits, the associated structural adjustment programs prescribed by the World Bank, along with donor pressure, brought about a change in course regarding fertilizer promotion strategies.

This book reflects on the status of fertilizers in Africa's agricultural transformation and chronicles the collective efforts across the continent. In this final chapter, we bring out the key lessons and emerging opportunities in promoting fertilizer use that can guide public- and private-sector actors, donors, development partners, policymakers and stakeholders who are engaged in creating sustainable food and land-use systems.

1. Fertilizer is critical for closing the yield gap in Africa

At the time of decolonization in the 1960s, Africa was not just self-sufficient in food but was actually a net food exporter, its exports averaging 1.3 million tons a year between 1966 and 1970 (Walden Bello 2008). Today, the continent has an annual food import bill of $35 billion, which is estimated to rise to $110 billion by 2025 (President of the African Development Bank, Akinwumi Adesina, 2017). Declining agricultural productivity (largely contributed by low input use and climate change) and increased population growth are the main culprits of the food deficits in Africa.

By 2050, the region will be self-sufficient on existing farmland only if the yield per hectare rises to about 7 t/ha, equivalent to 80% of the yield potential. That translates to an annual yield increase of 130 kg/ha (Van Ittersum et al. 2016). To close yield gaps there is need to augment various inputs such as soil nutrients from both organic and inorganic fertilizers, improved germplasm (seeds), efficient agronomic and water management practices.

Adding fertilizers is of prime importance because many soils are not able to supply all the required nutrients in the required proportions, due to their inherent characteristics and continuous nutrient depletion. Today, there are debates on whether African farmers should use organic and/or inorganic fertilizer. The answer is that they should consider these sources of nutrients as complementary rather than mutually exclusive. Although it is well understood that organic fertilizers play an important role in raising soil fertility, many African soils are extremely degraded and cannot produce enough organic fertilizer to improve soil fertility – even using approaches such as nitrogen-fixing legume trees and grain legumes.

Organic and inorganic fertilizers play a complimentary role in improving and sustaining soil health. It is a misconception that Africa can produce the food it needs by relying on organic fertilizer, while the rest of the world is fed using inorganic fertilizers.

2. Fertilizer types

Chapter 2 details inorganic and organic fertilizers, along with soil amendments such as lime and bio-stimulants. Extension workers and farmers need to understand what types of fertilizers are available and how to use them appropriately. Tools such as the "4Rs" of nutrient stewardship (right source of fertilizer, to be applied at the right rate, at the right time, in the right place) (IPNI 2012) should be emphasized during farmer training. Policymakers also need to recognize that different types of fertilizers are effective for different regions and crops, and that subsidies (if they are used) are allocated appropriately. Fertilizer use must be guided by soil tests and mapping to ensure the right types and quantities are recommended.

Key lessons and opportunities

- Extension programs should ensure that farmers understand the uses and applicability of various fertilizer types (including soil amendments such as lime and biostimulants). This will help them choose the products that suit their needs.
- Countries need to develop their in-country expertise – in soil testing, mapping, fertilizer formulation and blending.
- Various decision-support tools exist that make it easier to determine appropriate types and dosages of fertilizer. These include the Fertilizer Optimization Tool from the Africa Soil Health Consortium, and the Nutrient Expert from the International Plant Nutrition Institute.
- It is encouraging that multiple institutions and the private sector are supporting capacity development on fertilizers issues.

3. Abuja Fertilizer Summit declaration

At the Abuja Fertilizer Summit in 2006, African governments pledged to increase their fertilizer use to 50 kg nutrient per hectare by 2015. The average in sub-Saharan Africa has risen from less than 10 kg/ha to an average of 16 kg (Crawford et al. 2006; World Bank, 2016). Some of this increase is the result of fertilizer subsidy programs implemented across the region. The number of countries that consume less than 10,000 tonnes of NPK nutrients fell from 17 in 2006 to eight in 2015, while the number of those in the range 30,000–50,000 tonnes rose from five to 13. The subsidy program in Malawi pushed use up from 14,000 tonnes in 2005 to 217,000 tonnes in 2009 (IFDC 2013).

Other factors that have contributed to increased consumption include the liberalization of the market and improved delivery networks. Kenya has witnessed a rapid investment in private distribution networks and an increasingly dense network of fertilizer retailers in rural areas. The mean distance of small-scale farmers to the nearest retailer declined fell from 8.4 km to 4 km in 2017.

Nevertheless, the implementation of the 12 declarations made at the summit has been lagging

(Chapter 3). For example, Resolution 11 resolved to establish an Africa Fertilizer Financing Mechanism to promote the use of fertilizers. This mechanism was established by the African Development Bank in 2017, but it is still to have a major impact. Progress is rated as "good" for only three of the 12 resolutions: reducing the distance travelled to purchase fertilizer, providing subsidies for smallholders, and promoting fertilizer production and trade.

Key lessons and opportunities

- Increased public investments are needed, particularly to reduce the purchasing price for farmers. About two-thirds of African countries now have some type of subsidy program in place. However, more investment is required in infrastructure and delivery networks to reduce the cost of fertilizers.
- Improvements are needed in regulatory frameworks at both the national and regional levels. Frameworks that have been agreed must also be implemented if they are to have an effect.
- Greater private-sector participation is required in fertilizer systems. The number of market actors has increased at all levels in the supply chain. This is especially true for agrodealers, resulting in a big drop in the distance farmers need to travel to buy fertilizers, as well as much lower market margins.
- Industry interest is increasing. Given its low level of fertilizer use (Africa accounts for just 2% of world consumption), Africa has the highest potential for fertilizer industry expansion. Fertilizer producers have made considerable investments in manufacturing and blending in various countries.
- Renewed donor interest is required to support the development of fertilizer systems, with a focus on the private sector as the driver of the value chain, and government playing a regulatory role. An "Abuja II" summit with an inclusive, comprehensive and integrated approach is being proposed.
- The declaration at the African Union Summit in Malabo, Equatorial Guinea, in June 2014 called for the doubling of agricultural productivity by 2025. This should be the basis of re-launching fertilizer use in Africa.

4. Institutional landscape

Over the last decade, a wide range of actors have made tremendous efforts to develop the fertilizer system (Chapter 4). These actors have included the public sector (governments and intergovernmental organizations), private sector (fertilizer producers, importers, distributors, dealers and users), non-profit actors (international organizations and NGOs) and banks (investment, commercial and development banks) and donors. The most iconic was the 2006 Fertilizer Summit (Chapter 3). Large-scale investments in fertilizer production and blending are also growing in the region (Chapter 5). However, the high cost of fertilizers, poor government support and hindrance to agriculture sector growth still create obstacles for increased fertilizer consumption.

Key lessons and opportunities

- Significant cost-savings can be achieved if the institutional set-up supporting fertilizer production and consumption in Africa is restructured and made to work for smallholder farmers. A systems approach will be needed to achieve the projected annual increase in fertilizer use in Africa: as high as 6.8 percent by 2020.
- Higher demand for fertilizer by smallholders and the evolution of continent-wide fertilizer-financing initiatives represents a big opportunity to scale up the production of blended multi-nutrient fertilizers.
- More private investment in area- and crop-specific fertilizers is needed to improve fertilizer-use efficiency.
- Smallholder cereal yields need to reach 3 tonnes/ha for fertilizers to become an economic imperative. Governments need to work with farmers and put in place the infrastructure needed to get to this point.

5. Supply

African as a whole (including North Africa) is a net exporter of fertilizers, particularly phosphate and nitrogen. The paradox still is that most fertilizers (including raw materials and intermediates) produced in Africa are exported to other continents, yet Africa still imports most of the finished fertilizer products it needs (Chapter 6).

Sub-Saharan Africa is endowed with mineral reserves needed to produce fertilizers containing the three major plant macronutrients; nitrogen (N), phosphate (P) and potash (K). Fertilizer production in Africa

is concentrated in six countries: Algeria, Egypt, Morocco, Nigeria, South Africa and Tunisia. With the exception of Nigeria, these countries also have high levels of fertilizer use. New investments are expected to increase the production of nitrogen and phosphorus in the next few years. As of 2017, sub-Saharan Africa (outside South Africa) had a total of 59 fertilizer blending plants, 17 of which were in Nigeria. A further 30 bulk-blending projects are planned – 19 in Nigeria and four in Tanzania (Chapter 5).

Key lessons and opportunities

- The growing interest in developing fertilizer production in the region faces a number of challenges: the high costs of capital financing, the difficult and highly competitive international fertilizer market environment, problems in financing mega-projects, the low incentives for suppliers due to low demand from smallholders, and poor production and distribution infrastructure.
- Substantial deposits of phosphate-bearing rock and natural gas are found in various locations in sub-Saharan Africa. Those located near the coast or in areas with adequate infrastructure are particularly attractive for exploitation.
- Fertilizer plants are large-scale investments. Developing proactive and effective high-level financial arrangements and mechanisms is key to increasing production and procurement capacity in Africa. Large investments currently being made by an emerging private sector promise to increase the production of urea and ammonia-based fertilizers and will diversify the potential sources of products.

6. Distribution

Three main system of distributing fertilizer exist, each serving different categories of farmers (Chapter 6). Distribution systems run by the private sector serve individual farmers; government-run bulk-procurement systems deliver fertilizers to known farmers or farmer group; bulk-procurement schemes operated by plantations or large crop-buyers serve the farmers who supply the operator of the scheme (IFDC and AFAP 2018). In many countries, the government is a major actor in the fertilizer value chain. It procures fertilizer from foreign manufacturers, importers or domestic producers and distributes it to farmers, often at a subsidized price.

Various factors hamper the supply of fertilizers from the manufacturer or port to farmers. These include poor infrastructure, bureaucratic hurdles and costs, adulteration of the product by unscrupulous parties, price racketeering, and problems in financing. All these raise the cost of fertilizers for farmers, reduce volumes, and cause delays in deliveries.

Key lessons and opportunities

- While some of the problems (such as transport) beset all distribution systems, private-sector distribution serving individual farmers is inherently more efficient. This is because it is subject to competition among firms, and farmers can buy from the supplier that offers the best price and service.
- Bulk-procurement systems are a legacy of efforts to kick-start the provision of fertilizers, but they tend to serve their implementers – government agencies, processors or plantations – rather than farmers.
- Anchor programs – where a commodity processor provides fertilizers to farmers who sell it their crops – may be an income trap for farmers if they have no alternative outlet for their produce.
- The further downstream in the chain, the weaker the actors tend to be. Wholesale and retail dealers – the “last mile” in the chain – can be strengthened by linking them more strongly to suppliers, for example by fostering hub agrodealers and village outlets, facilitating credit, building distribution associations, improving the exchange of information on supply and demand, and capacity building, training and certification.
- The development of brands can help overcome problems of adulteration. It is in the interests of brand owners to protect their image and guarantee the quality of the product that is sold under their brand. New products such as blends lend themselves to branding better than generic single-nutrient fertilizers.
- Competition should be encouraged in the supply and distribution of fertilizers. This promises to reduce costs, improve service, and help guarantee quality.

7. Demand

Increasing demand is fueled in part by the subsidy programs in place in many countries. But fertilizer use generally remains low, though it is on the increase.

Precisely because use is currently so low, Africa has potential in the long term to become a major fertilizer market.

Key lessons and opportunities

- A large majority of smallholders do not use fertilizer (or use only a little) for various reasons. They have little or no knowledge and benefits of fertilizers, and do not know what types of dosages to apply because of a lack of soil-testing information. Fertilizers are expensive, and smallholders cannot afford to buy them. Without reliable, profitable markets, they have little incentive to use fertilizers to boost their production. The policy environment does not facilitate the supply of affordable fertilizers to suitable locations where farmers can buy them.
- Demand can be created through awareness creation on available new blends and fertilizer use: demonstrations and smaller packs (available through village-based advisors, agrodealers and fertilizer companies), and farm-level soil-testing services (e.g., the soilDoc testing kit developed by Columbia University, mobile laboratories that provide testing services).
- Improvements in the marketing of crops would give farmers an incentive to invest in the fertilizers they need to grow more to sell.

8. Policy

A series of high-level policy decisions have led to an increased focus on strengthening the fertilizer system in sub-Saharan Africa in order to raise the productivity and incomes of smallholders. These include the 2003 Maputo Declaration that endorsed the Comprehensive Africa Agriculture Development Programme (CAADP), the 2006 Abuja Declaration on Fertilizer for an African Green Revolution, and the 2014 Malabo Declaration on Accelerated Agricultural Growth.

Nonetheless, African agriculture faces a number of challenges that require major policy reforms along the fertilizer value chain to deal with food insecurity, soil nutrient depletion, low agricultural productivity, declining arable land per capita, and the effects of increased global demand for food, feed, fiber and fuel resulting from population growth (USAID and IFDC 2015). The major challenges include:

- **Quality control:** the lack of suitable policies and laws, and the poor implementation and enforcement of laws that do exist.
- **Licensing:** Lengthy processes for licensing new fertilizers and actors
- **Inefficient subsidies:** problems include pricing, product types and distribution controls and private sector exclusion

Chapter 8 addresses these policy issues and interventions in detail.

Key lessons and opportunities

- Governments intervene in fertilizer systems to address market, institutional and regulatory failures. Market failures include asymmetric information, substandard products, high transaction costs, a lack of purchasing power among farmers, imperfect competition among suppliers, and the government's own intervention in the market. Institutional and regulatory failures result from poorly designed or implemented interventions.
- The process of policy development is non-linear. It involves numerous stakeholders and may become stuck at various points in the design and legislation process.
- Policies that make it easier for smallholders to buy fertilizers and sell their crops are likely to increase the use of mineral fertilizers, improve soil fertility management and boost agricultural productivity.
- Governments should develop and harmonize their policy and regulatory frameworks (including trade policy to establish regional markets). They should do this through existing continental and regional entities, including the newly signed African Continental Free Trade Area.
- Countries would benefit from the development of regional fertilizer markets by lowering barriers to trade, including non-tariff barriers, and harmonizing rules and standards.
- More attention and resources need to be put into developing and enforcing regulations – for example, to prevent adulterated or mislabeled product from being sold.
- Policies should encourage fertilizer manufacturers to serve farmers directly – in terms of supplying them with balanced formulations and training them how to use them in an appropriate way.

9. Subsidies

Input-subsidy programs are gaining momentum in some countries. They generally provide substantial discounts on fertilizers, making them more affordable for smallholders. But they suffer from drawbacks: the distribution systems are inefficient, and they struggle to target farmers and supply quality products on time. They need to be reformed to overcome these problems.

Key lessons and opportunities

- Having the private sector lead the distribution, with the government focusing on the policy and regulatory environment. Private and public platforms are needed to develop and enforce regulations.
- Funds used for subsidies could be better used in other ways: to support credit provision, improve infrastructure, boost extension services, expand irrigation, etc. Subsidies could also be used in a more judicious way, for example to increase consumption in areas where use is currently low.
- Despite their shortcomings, fertilizer subsidies are probably still necessary to boost fertilizer consumption and crop yields. If they are continued, they should move away from supporting commodity NPKs towards balanced blends that produce better yields.
- Governments should not be in the forefront of subsidy schemes. Schemes should be led by the private sector, with the government providing the framework and playing a regulatory role.
- Smart subsidies based on electronic vouchers and mobile phones can improve targeting and prevent abuse. They rely on farmers having mobile phones (and knowing how to use them) and the availability of reliable mobile phone networks. Where this is the case, they can be a significant improvement over paper-based systems.
- Subsidies must be accompanied by supporting measures such as capacity building, infrastructure improvements and a reliable enabling environment.

10. Finance

Smallholders' use of fertilizers is constrained by their lack of purchasing power and the high cost of fertilizers. Fertilizers cost $600–800 per tonne at the farm gate in most parts of sub-Saharan Africa. Loans are hard for smallholders to get, and the cost of credit is high, with interest rates typically between 20 and 40% a year. Agrodealers face similar problems: limited capital and an unavailability of credit.

The fertilizer value chain (from manufacturers through agrodealers and farmers) is linked to the output value chain that channels the crops that farmers grow to buyers, processors and eventually to consumers. What happens in one chain affects the other: a lack of fertilizer means low yields and low quantities of crops to sell; conversely, a lack of markets for crops discourages farmers from buying fertilizers.

Affordable, inclusive financing models are needed for all key actors in the fertilizer and output value chains. Chapter10 discusses the various options implemented by governments, private financing institutions, donors, development agencies and NGOs.

Key lessons and opportunities

- Improve the availability of working-capital finance for agrodealers, farmer groups and microfinance institutions. This can be done initially through loan-guarantee schemes, which are then weaned off to the private sector. An essential part of this program would be to make the flow of fertilizers more transparent through management information systems.
- Financing for farmers and agrodealers should take advantage of digital technologies, both for money transfer and to access and exchange information.
- The fertilizer and crop-output value chains are linked. Improvements in the financing of one chain will help boost the other.
- Technical assistance should be provided to entrepreneurs, smallholder groups and financial service providers to improve the provision of financing to the fertilizer value chain, as well as farmers' and agrodealers' ability to access the funds available.
- Various organizations, including AFAP, AGRA and the African Development Bank, and governments (including Kenya and Nigeria) have developed innovative financing models. These should be evaluated, continued and scaled up.

11. Environment

Scientists agree that fertilizers are indispensable for feeding the world, and that consumption in Africa must increase significantly if the continent is to feed itself. But the injudicious use of fertilizers can harm the environment. Organic and inorganic fertilizers should be used in conjunction with each other and combined with other improved technologies: improved seeds, good agronomic practices, irrigation, mechanization, pest and disease management, soil and water conservation measures, etc.

Appropriate fertilizer use will make it possible to increase yields on current cropland, limiting the need to convert ever more land from forest or grazing into crop fields, destroying fragile landscapes and

releasing carbon into the atmosphere. It might even be possible to return some land to its natural state.

Boosting fertilizer use in Africa by 20% would raise yields of rice by 5.1%, wheat by 11%, and maize by 9.9%. This would permit 2 million hectares of currently cultivated land to be set aside for reforestation, thus sequestering carbon (Vlek et al. 2017). The myth that fertilizer is bad must be debunked.

Key lessons and opportunities

- Fertilizer use must be tailored to the soil conditions and the crop needs so as to achieve optimum yields, boost production and avoid the need to bring more land into production.
- Because many African soils are degraded, applying fertilizers in judicious quantities is actually beneficial to the soil and the environment. By increasing the amount of biomass produced, they add to the level of organic matter in the soil. This in turn fosters soil life, improves water retention, and sequesters carbon.
- Fertilizer applications need to follow the 4Rs: right rate, right source, right time and right place.
- Farmers' ability to apply appropriate levels of fertilizer will depend on the availability of information on their soils and crop types. This in turn depends on soil testing and mapping, the development of site- and crop-specific recommendations, and the provision of this information to agrodealers and farmers.

Prospects

Demand for fertilizer is projected to grow by 8% annually to reach 5.5 million tonnes of nutrients, or 2.8% of world demand, by 2021. Nigeria and Ethiopia are expected to contribute 28% and 18% respectively of this increase. For Africa as a whole, demand is projected to rise by 37% from 2016 to 2021, or by 2.2 million tonnes of nutrients to reach 8.1 million tonnes of nutrients (IFA 2018). However, this growth will only be realized if smallholders have an incentive to use the fertilizer. For fertilizer use to be an economic imperative, their cereal yields must reach 3 tonnes/ha. Africa's governments need to work with various partners including donors, development organizations and the private sector to exploit every opportunity to make fertilizer use profitable for farmers.

With the African Continental Free Trade Area and the current proliferation of fertilizer production and blending plants around Africa, countries should take advantage of economies of scale, complementarity and vertical integration to reach fertilizer security and self-sufficiency. This is in turn should increase smallholders' productivity and incomes, thereby boosting the continent's food security.

Improved infrastructure will be key – to get fertilizers to agrodealers and farmers, and to enable farmers to get their output to market (not to mention the many other economic and social benefits these will have). Current or planned road and railway projects include roads across the Sahel and to link the eastern Maghreb with Central, Eastern and Southern Africa. These projects need to be implemented without delay.

The fertilizer industry in Africa is evolving from one dominated by governments to one run by the private sector, with international and local manufacturers' distribution channels supplanting the public system. Brands and blends are becoming more important as firms try to manage downstream activities. The development of competition among suppliers will expand opportunities to take advantage of international manufacturers' expertise and assets.

Farmers need advice on what types of fertilizer to use and how to apply them. Promising approaches include using village-based advisors, agrodealers, public–private extension models, digital platforms, demonstrations and field days, and radio programs. Messages need to cover topics such as microdosing, slow-release fertilizers, fertilizer optimization, deep placement, the 4Rs, and the use of lime and biostimulants. As the climate changes, farmers will need to learn how to adapt. Climate-smart practices include improved seeds, crop and weather insurance, integrated soil fertility management and conservation agriculture. The type of advice needs to be adapted to the specific needs of farmers in each locality.

Such advice needs to be based on accurate assessments of the soil nutrient status and the needs of each crop. Several countries are already making significant progress in testing and mapping their soils. Tools include spectral analysis, satellite imagery, and portable or mobile field-testing methods. More and more fertilizer companies and private labs are offering testing and mapping services, and are translating the results into balanced fertilizer products. Dissemination messages on fertilizer use should include judicious use to avoid environmental pollution.

Inclusive financing will remain crucial for all actors in the fertilizer chain. Subsidies are still needed to assist Africa Green Revolution. But they need to be

redesigned to be “smart”. Policies are needed to encourage private-sector investment in order to meet the Abuja target of 50 kg/ha by 2025.

Africa’s governments and their continental and regional groupings should develop and harmonize policies and regulatory frameworks to stimulate trade and foster competition among suppliers. Standards should be harmonized within regions. Inefficiencies at the port, in transportation and logistics, and at borders need to be addressed. Trade within Africa must be fostered to overcome the paradox that most of the fertilizer produced in Africa is currently exported outside the continent.

Public–private partnerships can be used to enhance the private sector’s capacity to develop cost-effective procurement and distribution systems. The private sector in each country should improve its existing inefficient business links, with new agrodealers and rural entrepreneurs working to trigger farmers’ demand for new fertilizer products, especially blends.

Fertilizer has a key role to play in helping Africa cope with climate change. By increasing production on current arable land, it will make it possible to avoid expanding farming into more marginal areas.

Conclusions

This book draws on research and long-term experience from an extensive array of organizations, including AGRA, IFDC, the African Development Bank, the African Union, AFFM, IFA, the UN Economic Commission for Africa, FAO, etc. It draws conclusions and recommendations on the status of fertilizer markets, key challenges and potential opportunities, and highlights key policy recommendations needed at the continental, regional and national levels to create competitive and sustainable fertilizer markets and to increase farmers’ access to fertilizers.

While fertilizer consumption among smallholders has grown in the last decade, it is still far below what is needed. Their willingness to invest in fertilizers will be driven by improved knowledge and information, better availability of fertilizers, and better market opportunities for their farm output. The challenges facing the fertilizer sector should be addressed holistically, with governments providing an enabling environment in which the actors in the fertilizer value chain can pursue their own interests in increasing their efficiency and profits. This is what will lead to an African Green Revolution.

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