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Accelerating the Green Revolution in Côte d'Ivoire: Fertilizers Against Undernourishment and Deforestation

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Abstract

Agriculture is the main sector of the economy in Côte d'Ivoire, employing 48.3% of the country's total workforce. It represents more than 70% of exports and accounts for 23.4% of the country's GDP. Côte d'Ivoire is the world's main exporter of cocoa, with a 33% share of global production. Yams, cassava and rice are the population's staple foods, with a total annual production volume of more than 10 million tons.

Despite commercial and food crops being crucial for the country's economy and for people's subsistence, their productivity has declined considerably in the 15 years since 2003. Farmers struggle to support themselves and the country needs to import rice to meet the population's food needs.

One of the reasons must be sought in the extensive agricultural system of Côte d'Ivoire, which exploits soil fertility by harnessing large virgin forest areas, instead of nourishing the soil with fertilizers. The area covered by forests progressively diminished over 25 years, from 24.36% in 1990 to 10.56% in 2015, with agriculture being the main cause.

After many years of soil exploitation, the ground is becoming depleted and productivity is rapidly decreasing.

Crops are not supported with suitable inputs, and in particular mineral fertilizer. The rate of fertilization in Côte d'Ivoire is 40.2 kilograms per hectare (2014 figure), less than one-third the global average of 138 kg/ha.

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As in many other sub-Saharan African countries, several obstacles restrict fertilizer demand, such as the high cost of fertilizers, a lack of access to credit, limited access to output markets, a lack of education and business thinking, and limited engagement between public institutions and private companies. Some measures have been taken already and new initiatives and solutions are emerging and are already leading to change.

This paper provides an overview of the current situation in Côte d'Ivoire and of the progress made thanks to the increasing use of mineral fertilizers. The aim of the paper is to understand what barriers still limit the adoption of fertilizers and what opportunities can arise for private entrepreneurs in the industry to break the barriers down and turn them into opportunities to unlock the potential demand for fertilizers, boost the agricultural sector and ultimately reduce poverty.

The analysis in this paper is based on publicly available information and on information obtained through interviews with government officials and representatives of the key industries in the sector.

Keywords: Fertilizers; Sub-Saharan-Africa; Energy; Agriculture; Credit-Solutions; Productivity

Contents

Executive Summary

Agriculture accounts for 23.4% of Côte d'Ivoire's GDP, more than 70% of its exports and employs 48.3% of its workforce. The primary role of Côte d'Ivoire in the cocoa sector is well known: with 1.5 million tons of cocoa beans produced and a 33% share of the global market, it is the top exporter in the world, with revenues of $3.75 billion. Among the crops destined for internal consumption, yams, cassava and rice are staple foods, with total production exceeding 10 million tons and a gross value of around $4 billion a year.

Despite the prominent role played by both commercial and food crops in the country's economy and in its people's subsistence, these crops' productivity has been declining considerably in the 15 years since 2003, seriously threatening the country's food security. Farmers are struggling to support themselves and the country needs to import rice to meet its people's food needs. The high population growth has put further pressure on the food supply and the number of undernourished people increased from 2.9 million in 2001 to 3.5 million in 2016.

Traditionally, Côte d'Ivoire has been characterized by an extensive agricultural system, which exploits soil fertility by harnessing large virgin forest areas, instead of leveraging inputs and nourishing the soil with fertilizers. After many years of soil exploitation, the ground is becoming depleted and productivity is rapidly decreasing.

Besides representing a threat to the country's food security, this situation has a negative impact in terms of deforestation: the area covered by forests progressively diminished over 25 years, from 24.4% in 1990 to 10.6% in 2015, with agriculture being the main cause.

Although in the years 2002-2014, the use of fertilizer has shown a 30% increase it is still only 40.2 kilograms per hectare (kg/ha), a third the average world rate. Only a few crops – namely, cotton, sugar and bananas – are fertilized at, or almost at, the recommended dosage. For other crops, including those that are most significant for the country's economy and food security, the application rate is as low as 2% of the recommended dosage for cocoa crops and 4% for rice. Why is there proper fertilization only for some crops and not for others?

One approach to evaluate the advisability of a farmer adopting the recommended dosage of fertilizer is to calculate the ratio between the value of the additional yield obtained through the recommended type of fertilization and the additional cost of fertilizer. The theory says that this ratio has to be higher than 2:1 in the case of commercial crops and higher than 3:1 or even 4:1 in the case of food crops for farmers to follow the recommended dosage.

According to this criterion, and based on the current price of fertilizer and the price paid to farmers for their crops, our analysis is that the productivity of cocoa in Côte d'Ivoire should at least double for the recommended type of fertilization to be used. For yams and cassava, productivity should increase by an estimated 35%. Although these increases might seem not so hard to achieve, various constraints – affecting either the input or the output side of the ratio, or even both – can pose unsurmountable barriers.

On the input side, the high price of fertilizer at the farm gate is the main obstacle. As there is no primary production in Côte d'Ivoire, fertilizers are imported in their entirety. Our analysis shows that 48% of the final price of fertilizers results from the distribution process. Transportation, the cost of financing, warehousing, delays and rent seeking along the supply chain all contribute to building up the final price of fertilizers. That is how, for example, urea purchased at $240 a ton on the international market reaches the farm gate at an average cost of $550 a ton. Although

this price might not seem particularly high when compared with prices in other sub-Saharan countries, it is still more than twice the average world price.

The high concentration rate in the distribution sector, although partly explained by the nature of the fertilizer industry, might help explain the high retail price. The main three players have a share of almost 70% of the market. Uncertainty related to political choices, particularly the risk of the procurement and distribution functions being centralized, seems to be one of the strongest deterrents to operators entering the Ivorian market.

Beside high retail prices, the lack of access to credit makes it very difficult for small farms to face the significant up-front expenditure required for appropriate fertilization. The traditional banking sector is unwilling to bear the risk of financing small farmers with unpredictable and unstable incomes and this is why, in a country whose economy is founded on agriculture, very little credit funding is allocated to this sector (10% of all loans).

On the output side, the main barrier appears to be the difficulty in accessing the output market. Losses in production are as high as 10% for yams and 8.4% for fruit and vegetables. Bad storage facilities and, most of all, the lack of a structured value chain depresses the value of some crops and can wipe out any incentive to increase productivity.

A lack of training in the correct use of fertilizers, a lack of tools to predict demand for crops, outdated recommendations and quality issues, such as underweight bags and adulterated fertilizers, are further obstacles affecting both fertilizer costs and crop yields.

Public institutions, nonprofit organizations and private companies – aware of the barriers restricting the adoption of fertilizers in the country – have worked in different ways to try to mitigate some of the difficulties.

In an attempt to increase access to fertilizers and guarantee quality standards, governments in west Africa have been working to create a regional market for fertilizers that could improve the supply chain. A legal framework with harmonized rules for fertilizer trade in the region has been developed with the dual objective of defending farmers' interests against nutrient deficiencies, adulterations, false or misleading declarations and weight deficits and of facilitating inter- and intrastate trade in fertilizers, making it faster, easier and cheaper. In Côte d'Ivoire, even though this regional framework has not yet been fully implemented, some important changes to regulations have been made. Fertilizers do not need to be registered to circulate in the country, as long as import and distribution companies are registered. Instead, the labeling of fertilizer packaging is regulated.

Recognizing the crucial role played by the cocoa sector in the country's economy, the government has supported reform of the sector through different programs and initiatives. These include the foundation in 2012 of the Coffee and Cocoa Board (Conseil du Café-Cacao), which established a guaranteed minimum price for cocoa farmers of 60% of the cocoa price on the international market. This measure is aimed at decreasing the volatility of farm-gate prices, and facilitating the planning of production activities, long-term investment, and access to credit.

In 2012, the World Cocoa Foundation, along with the Coffee and Cocoa Board, established the Cocoa Fertilizer Initiative. The initiative was implemented in partnership with the Netherlands-based IDH (Initiatief Duurzame Handel, or Sustainable Trade Initiative) and brought together important players from the cocoa industry such as cocoa traders, the fertilizer industry, civil society organizations, and government bodies to accelerate learning on best practice in financing and delivering fertilizers. In particular, through a pilot project, the effectiveness of three financing models were tested – cash-and-carry, credit through cooperatives, and fertilizers

for beans. This resulted in partnerships between different stakeholders and innovative financing solutions that continued after the pilot and are still in place.

The increased use of fertilizer that has been witnessed since the end of the civil war in 2011, from 19 kg/ha to 40 kg/ha, seems to confirm the usefulness of the measures taken. As a further upside, the fertilizer supply from west Africa is expected to increase in the near future. By 2020, Nigeria will have two new urea production plants, expanding the country's capacity to 6 million metric tons per year and making it one of the world's main manufacturers and export hubs. Finally, Africa will have African fertilizers and hopefully the procurement cost of fertilizer will fall. However, there are estimates that, by 2020, about 70% of this production will still be exported to other regions, an explicit sign that the huge potential of west African agriculture – and within it Ivorian agriculture – is still waiting to be unlocked. What measures could help overcome the barriers still in place and accelerate the penetration of fertilizer? What solutions could help Ivorian agriculture to move from an extensive to an intensive system?

The expense of fertilizers, currently unaffordable for many farmers, could be lowered by decreasing the minimum size of fertilizer packaging. Yara, one of the leading distributors on the Ivorian market, started to commercialize a kit containing the recommended amount of all the different fertilizers necessary to fertilize just 100 cocoa trees. By applying the recommended dosage of fertilizer on only a small portion of their crops, farmers have a chance to try proper fertilization, observe the effects, and become more confident about purchasing larger quantities. The extra income accrued through the higher yield obtained will finance the purchase of larger quantities of fertilizer.

The production and commercialization of organic fertilizer, for use in conjunction with mineral fertilizer, could offer an alternative solution to the problem of affordability. Lono, for example, is an Ivorian biotechnology start-up company that produces biogas and biofertilizers from raw materials collected by farmers. By rewarding farmers who collect raw materials with points called biocredits, exchangeable for cash (mobile money) or products such as compost, biofertilizers or biopesticides, Lono has found an innovative way to facilitate the collection of raw materials from farmers, offering them at the same time a financing solution to purchase fertilizers and cooking fuel.

In terms of access to credit, the gap between smallholder farmers and financial institutions could be bridged by harnessing mobile money technology and by adopting innovative credit assessment methods, based on the example of what FarmDrive is doing in Kenya. Ivorian agriculture sector has great potential in terms of opportunities for microfinance. It is estimated that the revenues from cocoa earned by farmers in a totally cash system amount to about $2.3 billion. While only 6% of cocoa farmers have a bank account, 53% of them use electronic wallets.

In Ghana, Tulaa has been developing a technological platform that harness the existing network of agrovet stores in the last mile and aims to improve farmers' access to credit and inputs but also to output markets by the direct "smart-matching" of input suppliers, financial institutions, traders and wholesalers with farmers and by removing farmers' dependence on rent-seeking brokers.

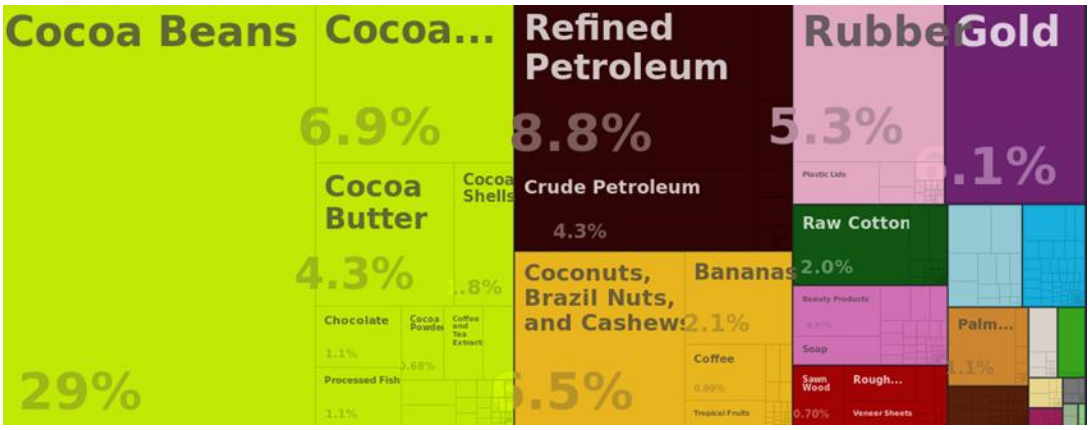
1. Introduction

1.1. Agriculture: the backbone of the Ivorian economy

The agriculture sector is the backbone of the Ivorian economy. It provides employment to 48.3% of the country's workforce,[1] accounts for more than 70% of its exports,[2] and generates 23.4% of GDP.[3]

Côte d'Ivoire's performance in the cocoa sector is well known. With annual production of 1,472,313 tons of cocoa beans (2017)[4], almost completely destined to meet international demand, Côte d'Ivoire is the world's top exporter and has a 33% share of the global market. According to the Observatory of Economic Complexity (OEC), in 2015 exports of whole cocoa beans represented 29% of the country's total exports, with revenues of $3.75 billion. The transformed products derived from cocoa (cocoa paste, butter, shells, chocolate and cocoa powder) add another $1.9 billions of revenues, making the cocoa sector account for 44% of national exports in 2015. (See Figure 1.)

Figure 1
Visualization of Côte d'Ivoire exports in 2015 (OEC)



Source: AJG Simoes, CA Hidalgo. *The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development*. Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence. (2011).[Online]. [Accessed November 2017]. Available from https://atlas.media.mit.edu/en/visualize/tree_map/hs92/export/civ

[1] International Labour Organization, ILOSTAT database. 2017 . [Online]. [Accessed 3 July 2018]. Available from https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=CI

[2] According to Resourcetrade.earth, Côte d'Ivoire exported agricultural products worth $7.8 billion in 2016 (Chatham House. 2018. *'resourcetrade.earth'* [Online]. [Accessed 3 July 2018]. Available from https://resourcetrade.earth/data?year=2016&exporter=384&category=1&units=value). Total exports, according to the Observatory of Economic Complexity, were $10.5 billion in that year (AJG Simoes, CA Hidalgo. The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development. Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence. 2011. [Online]. [Accessed 3 July 2018]. Available from https://atlas.media.mit.edu/en/profile/country/civ/)

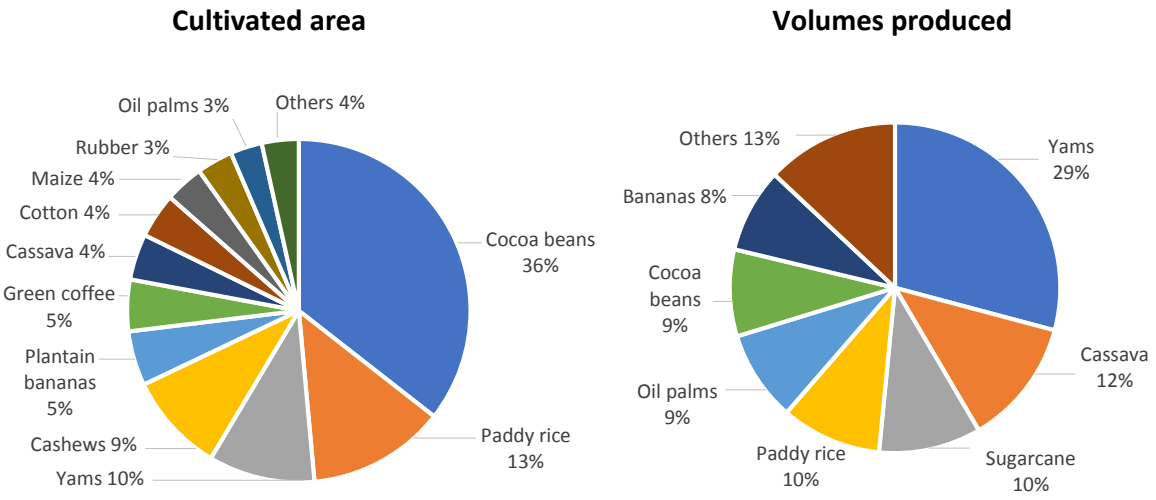
[3] World Bank-OECD National Accounts 2017.[Online]. [Accessed 3 July 2018]. Available from https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=CI

[4] Food and Agriculture Organization © FAO. 2018. FAOSTAT. [Online]. [Accessed 3 July 2018]. Available from http://www.fao.org/faostat/en/#data/QC

Of commercial crops, cashews and other nuts also play an important role for the country, with production of 607,300 tons (2016) and a 6.5% share of national exports, followed by rubber with 310,655 tons produced (2016) and a 5.3% share of national exports, and palm oil, with production of 370,000 tons (2014), and 1.1% of national exports.[5]

Among the crops aimed at meeting the internal demand for food, yams (ignames in French) are the most significant in terms of production volume, with 5,952,685 tons (2016), followed by cassava (manioc), with 3,210,614 tons (2016), and rice with 1,768,121 tons (2016). Cotton, despite not being very significant in terms of the hectares cultivated nor in terms of production volumes, is a strategic crop for the country, being the engine of the economy of the savannah region in the north of the country. Thanks to the application of the recommended amount of fertilizer and the use of animal traction for sowing cotton seeds, cotton growing has a significant impact on the productivity of subsistence crops grown in the same plots. (See Figure 2.)

Figure 2
Main Ivorian crops by cultivated area and volumes produced



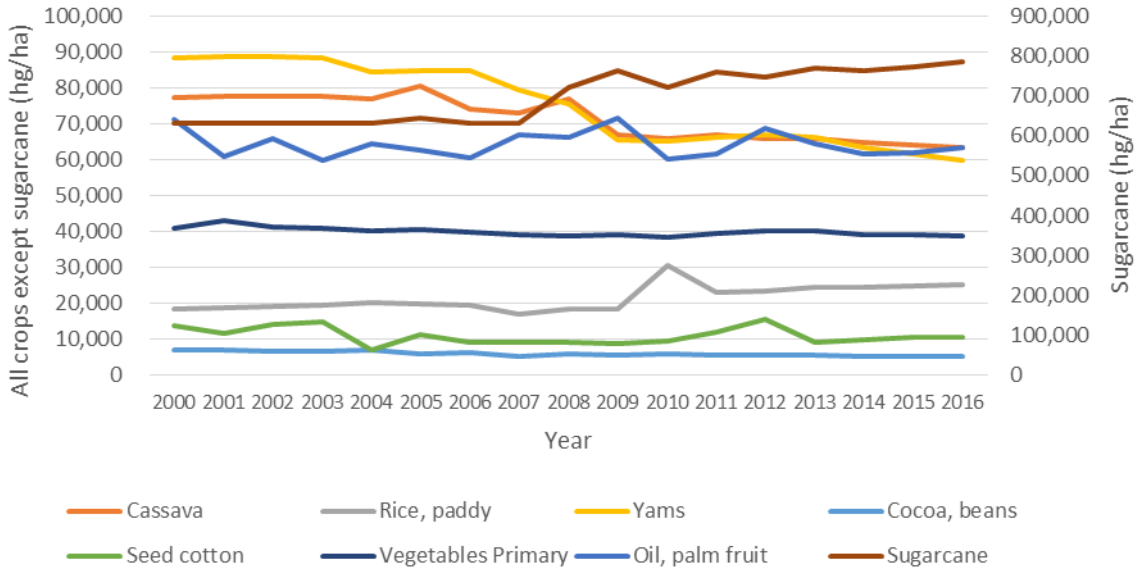
Source: AfricaFertilizer.org. 2015. Etude sur la Consommation d'Engrais par Culture en Cote *d'Ivoire*.[Online].[Accessed 22 May 2018]. Available from http://africafertilizer.org/fr/blog-post/etude-sur-la-consommation-dengrais-par-culture-en-cote-divoire

1.2. An extensive system with falling productivity and threatened food security

Despite the agriculture sector's very significant role in the Ivorian economy, the yield of some of the most important crops – such as yams, cassava, and cocoa – has declined considerably in the 15 years since 2003 and, for most other crops, the yield has remained stagnant. (See Figure 3.) Rice and sugarcane are the only crops for which an increased yield can be observed.

[5] For all data on volumes of production contained in this section the source is the Food and Agriculture Organization © FAO. 2018. FAOSTAT. [Online]. [Accessed 3 July 2018]. Available from http://www.fao.org/faostat/en/#data/QC

Figure 3
Productivity of main crops (hectograms per hectare, hg/ha)



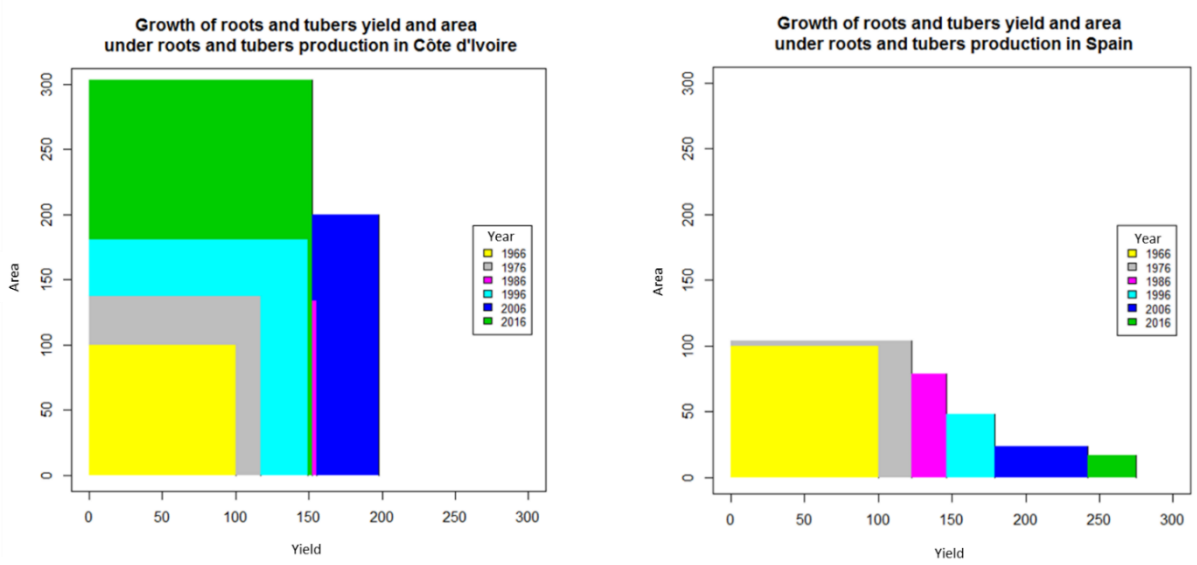
Source: Prepared by the authors based on data from Food and Agriculture Organization © FAO. 2018. *FAOSTAT*. [Online]. [Accessed on 23 March 2018]. Available from http://www.fao.org/faostat/en/#data

One of the main causes of this problem is the depletion of soil fertility, due to the continuous removal of nutrients from the soil without them being replaced through fertilization. After many years of soil exploitation, the ground becomes depleted, and productivity rapidly decreases.

Traditionally, Côte d'Ivoire has been characterized by an extensive agriculture system, where increases in the volumes produced are pursued through increases in the harvested area, rather than through mechanization or the application of fertilizers. Extensive cultivation is often the only accessible option for Ivorian farmers to increase their production, whereby they take advantage of the large virgin forest areas available.

A comparison of trends in the production of roots and tubers in Côte d'Ivoire and Spain provides a good example. In Spain the yield (hg/ha) in 2016 was 2.7 times the yield in 1966, while the cultivated area was 5.8 times smaller. On the other hand, in Côte d'Ivoire, productivity increased to 1.5 times the yield in 1966 while the cultivated area was three times bigger. Over those 50 years, production growth was mainly as result of intensification in Spain, while in Côte d'Ivoire it was mainly because of the expansion of the area under cultivation. (See Figure 4.)

Figure 4
Cultivated Area and Yield of roots and tubers in Côte d'Ivoire and Spain (1966-2016)



Source: Prepared by the authors based on data from Food and Agriculture Organization © FAO. 2018. *FAOSTAT*. [Online]. [Accessed on 23 March 2018]. Available from http://www.fao.org/faostat/en/#data

This situation represents a serious threat for food security in Côte d'Ivoire and has a highly negative impact on the environment.

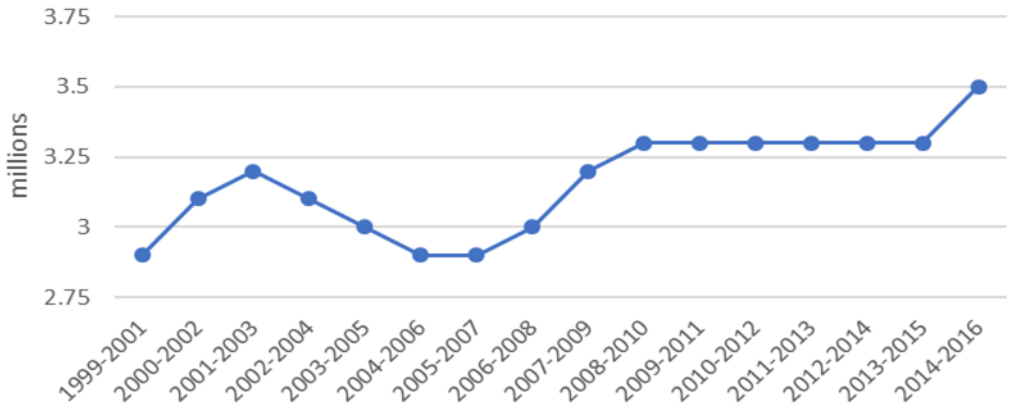
a. Deforestation

To increase production volumes, Ivorian farmers extend their cultivation areas by taking land right up to the forest and exploiting its fertility, instead of fertilizing the land they already have. In this way, agriculture represents the first cause of deforestation.A study by the National Bureau of Technical and Development Studies (Bureau National d'Études Techniques et de Développement) (BNETD, Etc Terra and Rongead, 2016), shows that, in the 25 years from 1990 to 2015, the area covered by forests decreased from 24.36% (7.8 million hectares) to 10.56% (3.4 million hectares). In a survey carried out as part of this study, the expansion of agriculture was identified as the main cause of deforestation (by 62% of people interviewed) followed by logging and infrastructure development. Within the category of the expansion of agriculture, cocoa farmers in particular are identified as those most responsible (indicated by 38% of people interviewed), followed by rubber-tree (hévéa) farmers (23%) and oil-palm farmers (11%).

b. Food security

Over the period 2000-2015, the rate of undernourishment in Côte d'Ivoire declined from 17.6% in 2000 to 15.4% and it is now well below the 21.3% average rate for sub-Saharan Africa (FAOSTAT, 2018). However, due to the strong growth of the Ivorian population (up 45%, from 16.3 million people in 2000 to 23.7 million in 2016), the number of undernourished people increased from 2.9 million in 2001 to 3.5 million in 2016. (See Figure 5.)

Figure 5
Number of undernourished people (millions) (three-year average)



Source: Prepared by the authors based on data from Food and Agriculture Organization © FAO. 2018. FAOSTAT. [Online]. [Accessed on 23 March 2018]. Available from http://www.fao.org/faostat/en/#data

In particular, with rapid urbanization, rice has become the main food for the majority of people in Côte d'Ivoire. However, the country's own production of rice supplies only 60% of domestic demand. To make up for the deficit, Côte d'Ivoire needs to import a large quantity of rice. In 2015, the amount imported was 1,338,019 tons, which cost nearly $477 million (OEC, 2015).

Although the improvement of the outputs and, ultimately, the improvement of the farming families' lives depends on several factors (from the country's continuous economic growth to access to inputs and modernization of agricultural techniques), proper fertilizer usage can accelerate the process.

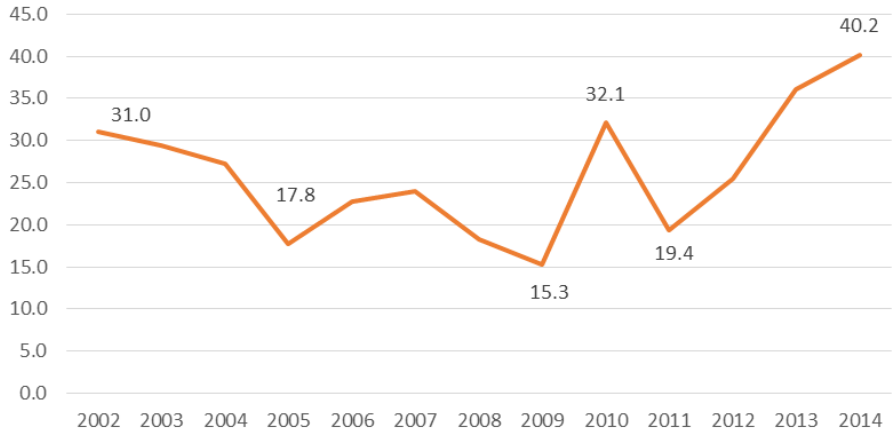
Notwithstanding the great potential of the Ivorian agricultural sector, the country's production volumes will continue to be restricted unless the decline in soil fertility is addressed properly.

2. Fertilizer Consumption

Fertilizer consumption[6] showed a positive trend over a 12-year period, increasing from 31.02 kg/ha in 2002 to 40.2 kg/ha in 2014, although with significant fluctuations. In particular, we can see an acceleration from 2011 onward (see Figure 6), when the civil war ended and the country entered a period of rapid economic growth. Although this represents a very good achievement in the context of sub-Saharan Africa, where the average rate of fertilization is 15.9 kg/ha (2014), fertilizer consumption in Côte d'Ivoire is still less than a third of the world average (138 kg/ha) and much lower than the rate in emerging economies. Over the same 12-year period, for example, India increased its consumption by 65% from 100.3 to 165.1 kg/ha and Brazil by 45%, from 120.8 to 175.2 kg/ha. (See Figure 7.)

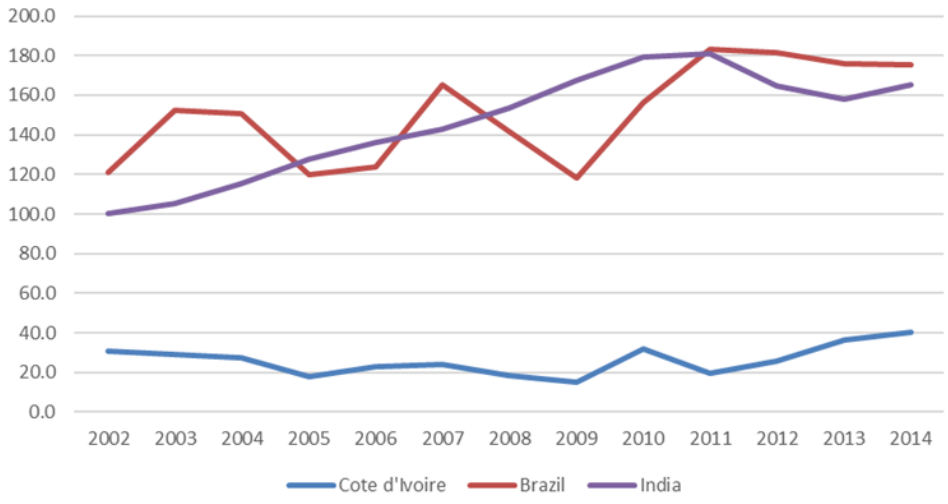
[6] Fertilizer consumption is calculated by the World Bank as kilograms of fertilizer per hectare of arable land.

Figure 6
Fertilizer consumption in Côte d'Ivoire from 2002 to 2014 (kg/ha of arable land)



Source: Prepared by the authors based on World Bank elaboration of data from Food and Agriculture Organization © FAO electronic files and website. 2018. [Online]. [Accessed on 23 March 2018].
Available from https://data.worldbank.org/indicator/AG.CON.FERT.ZS

Figure 7
Fertilizer consumption in Côte d'Ivoire and selected emerging countries from 2002 to 2014 (kg/ha of arable land)

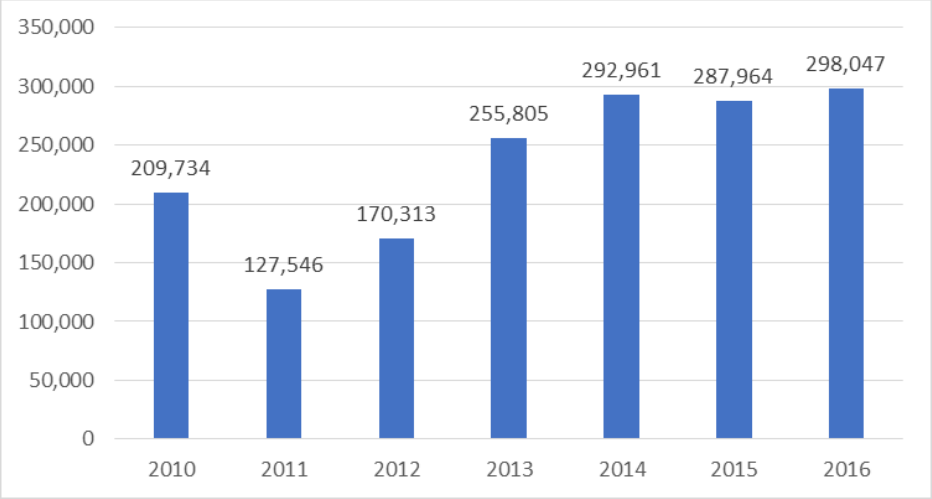


Source: Prepared by the authors based on World Bank elaboration of data from Food and Agriculture Organization © FAO electronic files and website. 2018. [Online]. [Accessed on 23 March 2018].
Available from https://data.worldbank.org/indicator/AG.CON.FERT.ZS

2.1. Demand for fertilizer by crops

In terms of volume, Côte d'Ivoire's aggregate demand for fertilizers was 298,047 tons in 2016. (See Figure 8.)

Figure 8
Apparent fertilizer consumption[7] from 2010 to 2016 (tons)



Source: AfricaFertilizer. 2017. *Statistiques sur les Engrais*. [Online]. [Accessed on 23 March 2018]. Available from http://africafertilizer.org/fr/statistics

Demand for fertilizer in Côte d'Ivoire is driven by cotton, with 46% of the total demand. (See Figure 9 and Table 1.) Cotton is the crop with the country's highest rate of fertilization (Table 1) and the reasons for this situation seem to be the following:

- Fertilizer for cotton is subsidized by the government, at a rate that varies according to the area cultivated each year. From 2008 to 2013 the subsidy level fell from 50% to 19.2% (AfricaFertilizer.org, 2015). The government's decision to subsidize fertilizer for cotton is probably driven by the fact that cotton plantations are concentrated in the north of the country, the savannah, a poor region where the plantations constitute one of the few economic activities for the population.
- The value chain for cotton is the most organized agricultural sector in Côte d'Ivoire. Thanks to the supervision of the cotton companies (Ivoire Coton, COIC, CIDT and SECO) and the active involvement of the cotton association (INTERCOTON) and of the Cotton and Cashew Board (Conseil du Coton et de l'Anacarde), cotton farmers have easier access to financing.
- Fertilizers and pesticides are crucial for the cotton harvest. Not using them could completely compromise the harvest.

[7] Apparent consumption = production + imports – exports – nonfertilizer use.

Similarly, the sugarcane sector, led by two agroindustrial companies (SUCAF and SUCRIVOIRE), and the banana sector, consisting mainly of four main groups of producers, are characterized by well-organized value chains and enjoy a very high rate of fertilization.

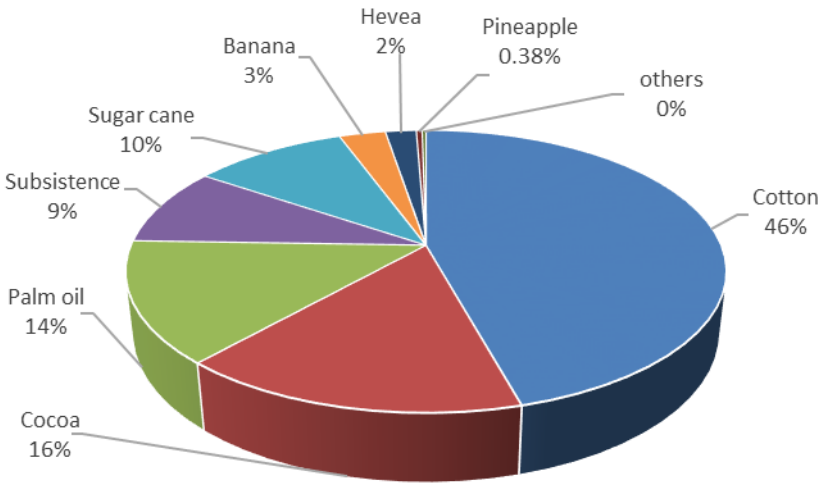
On the other hand, despite the great importance of cocoa cultivation for the country's economy – in terms of people making a living from it (600,000 small farms and 6 million people), of its high proportion of the country's exports, and of the land usage (36% of cultivated land) – cocoa crops account for only 47,000 tons of fertilizers, just 16% of the overall demand.

Cocoa is produced by small, family-run farms in small plots, with the average cocoa farm size being 3 to 4 hectares. These small farms traditionally grow cocoa trees by harnessing the soil fertility of the large virgin forest areas in the south of the country, where most of the cocoa farms are located. The fertilization rate for cocoa crops is therefore very low.

Palm oil accounts for 14% of the total fertilizer demand. In Côte d'Ivoire there are two types of palm-oil cultivations. There are the industrial plantations, which are characterized by a very well-organized value chain and managed by structured palm-oil companies (PALMCI, Palmafrique, SIPEF-CI, etc.) and whose production is destined for export. Then there are the village plantations, whose production is destined for local food needs. The industrial and the village plantations have yields of 10 and 5 tons per hectare respectively, a difference that is probably and at least partially explained by the different fertilization rates of the two types of crops.

Subsistence crops, such as cereals, rice, cassava and yams, account for just 21,800 tons or 9% of the fertilizer demand. These crops are traditionally cultivated by farmers in addition to commercial crops, and they are for household consumption. Since there is usually no organized output market in which to sell these food crops, their input value chain is not at all structured. In the north of Côte d'Ivoire, where farmers can count on the technical and financial support of cotton companies, food crops benefit to some extent from the application of fertilizers but, in the rest of the country, farmers can rely only on government national food-security programs.

Figure 9
Share of fertilizer consumption by crop (2011-2013)



Source: AfricaFertilizer. 2015. *Etude sur la Consommation d'Engrais par Culture en Cote d'Ivoire*. [Online].[Accessed 22 May 2018]. Available from http://africafertilizer.org/fr/blog-post/etude-sur-la-consommation-dengrais-par-culture-en-cote-divoire

Table 1
Fertilization rate per crop and per nutrient (year 2013 + 2013/14)

	RECOMMENDED application (kg/ha)			ACTUAL application (kg/ha)			Application rate		
Crop	**N**	**P_2O_5**	**K_2O**	**N**	**P_2O_5**	**K_2O**	**N**	**P_2O_5**	**K_2O**
Cocoa	37.5	115.0	95.0	0	2	2	0.3%	2.1%	2.1%
Rice	68.5	22.5	22.5	2	1	1	2.3%	4.4%	4.4%
Rubber tre	28.0	20.0	36.0	2	2	3	8.6%	8.5%	8.3%
Cotton	53.0	30.0	30.0	58	32	32	108.5%	105.7%	105.7%
Sugarcane	179.8	499.2	288.0	127	85	155	70.3%	17.0%	53.8%
Banana	139.2	147.6	547.2	108	35	241	77.4%	23.4%	44.1%
Oil palm	107.0	78.0	158.0	4	6	37	3.5%	7.3%	23.4%

Source: AfricaFertilizer. 2015. *Etude sur la Consommation d'Engrais par Culture en Cote d'Ivoire*. [Online].[Accessed 22 May 2018]. Available from http://africafertilizer.org/fr/blog-post/etude-sur-la-consommation-dengrais-par-culture-en-cote-divoire

2.2. Main types of fertilizer consumed

Fertilizers are subdivided into four broad categories:

1) Nitrogen-based (N), derived from natural gas.

   The most common types are urea and ammonia. Côte d'Ivoire consumes 59,157 tons of urea and 20,170 tons of ammonium sulfate (AS) (2016 figures).

2) Potash-based (K), derived from sulfur and potassium salts.

   The most-consumed potash fertilizer in Côte d'Ivoire is potassium chloride (also called muriate of potash, or MOP), with 80,401 tons being consumed.

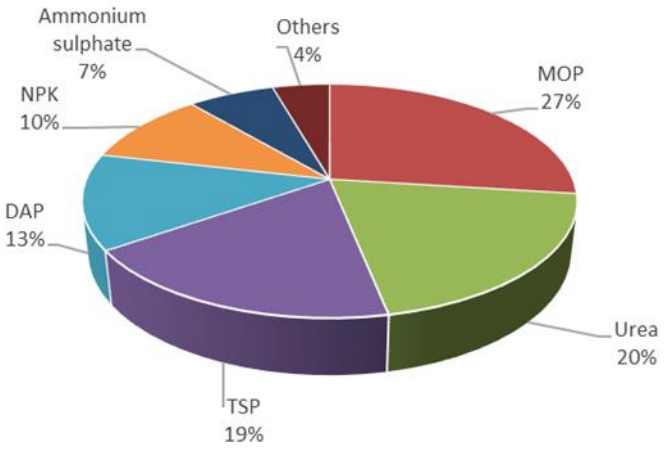
3) Phosphate-based (P), derived from phosphate rock.

   The most-consumed phosphate fertilizer in Côte d'Ivoire is triple superphosphate (TSP), with 55,348 tons being consumed.

4) Complex fertilizers, combining the three nutrients listed above (where the concentration of each nutrient depends on the specific characteristics of the different crops and soils).

   Diammonium phosphate (DAP), with 39,298 tons being consumed, and NPK, with 30,353 tons being consumed, are the most common complex fertilizers in Côte d'Ivoire.

Figure 10
Types of fertilizer used (2016)



Source: AfricaFertilizer. 2017. Fertilizer Statistics Overview. Cote d'Ivoire. 2013-2016. Edition 2017. [Online]. [Accessed 22 May 2018].
Available from http://africafertilizer.org/blog-post/fertilizer-statistics-overview-cote-divoire-2013-2016

3. Fertilizer Industry: Imports and Distribution

Côte d'Ivoire, like most other west African countries, has historically been an importer of fertilizers, since there is no primary production[8] of fertilizers in the country.

In 2016, a total of 332,320 tons of fertilizers were imported, mainly from Morocco, Russia and Belarus and to a lesser extent China, Lebanon and European countries. (See Table 2 and Figure 11.)

Nitrogen fertilizers, particularly urea, are imported mainly from Russia (72% of urea), while phosphate fertilizers (TSP) come mainly from Morocco (53%), Lebanon (34%) and to a lesser extent from China. Potash fertilizers (MOP) come mainly from Belarus (64%) and Russia (27%). Complex fertilizers (NPK and DAP) are imported from Morocco, Russia and to a lesser extent from China.

Part of the imported fertilizers (34,363 tons) are subsequently re-exported to neighboring countries – mainly to Burkina Faso and Mali, landlocked countries that are important consumers of fertilizers in the region (together they use around 450,000 tons annually), and Togo. The port of Abidjan is one of the six major ports in west Africa through which fertilizers are shipped across the region.

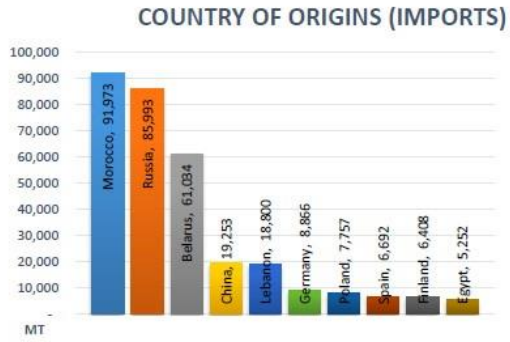
[8] Production defined as an activity that involves mining or some type of chemical reaction.

Table 2
Imports, exports and consumption of fertilizers (2016)

Product	Imports (tons)	Exports	Consumption
MOP	82,073	1,672	80,401
Urea	66,682	7,525	59,157
TSP	55,348		55,348
DAP	39,881		39,298
NPK	54,224	23,871	30,353
Ammonium sulfate	20,175		20,170
Others	13,937	1,295	13,321
Total	**332,320**	**34,363**	**298,048**

Source: AfricaFertilizer. 2017. *Fertilizer Statistics Overview. Cote d'Ivoire*. 2013-2016. Edition 2017. [Online].[Accessed 22 May 2018]. Available from http://africafertilizer.org/blog-post/fertilizer-statistics-overview-cote-divoire-2013-2016

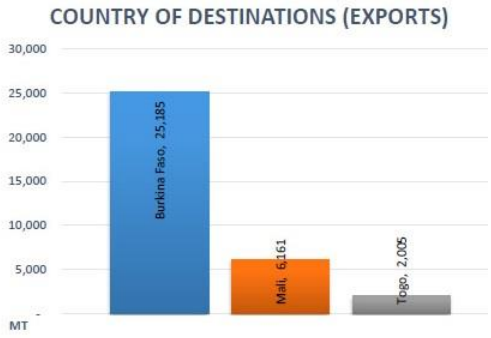
Figure 11
Countries of origin and destination of fertilizers (2016)



2016 product imports per origin

Countries of Origins	Morocco	Russia	Belarus	China	Lebanon	Others
MOP	-	27%	64%	-	-	8%
Urea	-	72%	12%	1%	-	14%
TSP	53%	-	-	13%	34%	-
NPK	85%	-	-	-	-	15%
DAP	41%	38%	-	14%	-	8%
Ammonium sulphate	-	-	-	27%	-	73%
Other fertilizers	-	1%	-	3%	-	96%

Source: FTWG-CIV



2016 product exports per destination

Countries of Destinations	Burkina Faso	Mali	Togo	Others
NPK	74%	17%	8%	0%
Urea	76%	23%	-	1%
MOP	48%	2%	0%	50%
Other fertilizers	73%	21%	0%	5%

Source: AfricaFertilizer. 2017. *Fertilizer Statistics Overview. Cote d'Ivoire. 2013-2016*. Edition 2017. [Online].[Accessed 22 May 2018]. Available from http://africafertilizer.org/blog-post/fertilizer-statistics-overview-cote-divoire-2013-2016

In terms of value, the Observatory of Economic Complexity (OEC) indicates that in 2015 Côte d'Ivoire imported fertilizers worth $135.9 million, divided as follows:

- Nitrogenous fertilizers (N) $33.7 million
- Potassic fertilizers (K) $27.1 million
- Phosphatic fertilizers (P) $18.5 million
- Mixed fertilizers $56.6 million

3.1. Main players

In Côte d'Ivoire, the same companies perform both the import and distribution functions. The sector shows a high concentration rate, with the main importer Louis Dreyfus Commodities Côte d'Ivoire (LDC-CI) having a share of 46% of the market in 2013. Yara was next with 12.8% and Agri Plus with 10.3%. The top three importers together have almost 70% of the market. (See Table 3.)

The Herfindahl-Hirschman Index (HHI) – a measure of market concentration – is higher than 2,500, providing evidence that the import sector is not a competitive marketplace in Côte d'Ivoire. The lack of competition can be explained in part by the nature of the fertilizer industry. Fertilizer is a bulk commodity and therefore subject to economies of scale at every stage of the supply chain. This represents a particular challenge in sub-Saharan countries – such as Côte d'Ivoire – where domestic demand is low. Furthermore:

"In comparison to more developed fertilizer markets, importing in West Africa (as is true generally in Sub-Saharan Africa) is expensive because of the high costs of finance, high cost of sea freight to the region, delays and slow operations at the ports, poor bagging operations, and high cost of warehousing. Companies participating in subsidy programs also complain about delays in government payments, which they say greatly increase finance costs and risks of doing business" (Maur and Shepherd, 2015, 104).

For economic reasons, fertilizers are mostly imported in bulk and bagged at the port of destination. Part of the basic fertilizers imported is subsequently blended to make complex fertilizers. This process involves mixing macronutrients (N, P and K) and micronutrient products to obtain a final, ready-to-use product.[9] Five distributors are involved in blending activities. (See Figure 12.)

[9] This process is often referred to as "secondary production."

Table 3
Imports per company in Côte d'Ivoire (2013)

Importer	Tons
LOUIS DREYFUS COMMODITIES	148,364
YARA CÔTE D'IVOIRE S.A	41,117
AGRI PLUS	33,098
AGRO WEST AFRICA ABIDJAN	25,732
SECO (OLAM)	24,990
WILMAR AFRICA AGRI BUSINESS	21,747
AF-CHEM SOFACO	14,059
OTHERS	13,102
TOTAL	**322,209**

Source: AfricaFertilizer. 2015. *Etude sur la Consommation d'Engrais par Culture en Cote d'Ivoire*. [Online].[Accessed 22 May 2018]. Available from http://africafertilizer.org/fr/blog-post/etude-sur-la-consommation-dengrais-par-culture-en-cote-divoire

Figure 12
Distributors involved in blending activities (2016)

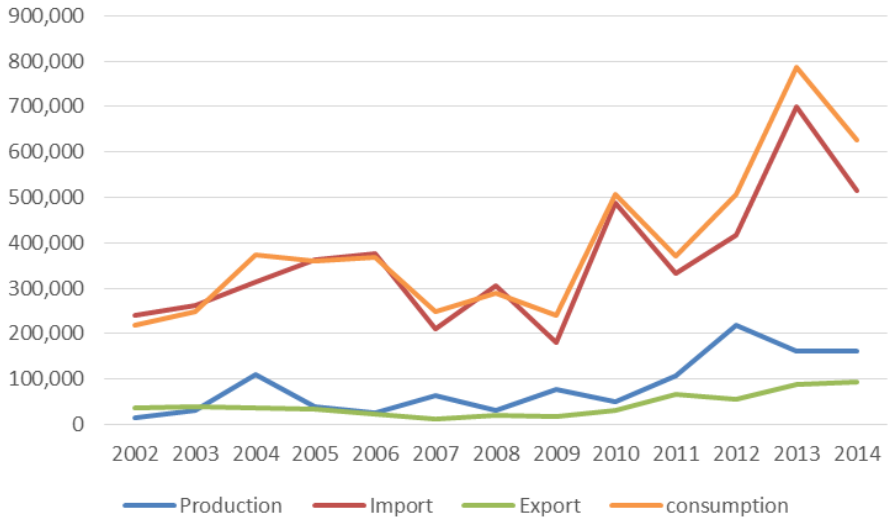
- **Louis Dreyfus Commodities:** two blending plants with a capacity of 100 metric tons per hour (mtph) and 20 mtph.
- **Sea Invest:** one blending plant with a capacity of 100 mtph
- **Yara:** one blending plant with a capacity of 60 mtph
- **Agro West Africa:** one blending plant with a capacity of 50 mtph
- **Société d'Engrais d'Amendement et Phytosanitaire (SEAP):** one blending plant with a capacity of 40 mtph

Source: United States Agency for International Development West Africa Fertilizer Program. 2017. *West Africa Fertilizer Business Information Map.* [Online].[Accessed 22 May 2018]. Available from wafafertilizer.org/documents/3/Final_WAFBIM-EN.pdf

3.2. Regional production: toward "African fertilizer for Africa"

Historically, nitrogen fertilizers, and in particular urea, have been imported into west Africa mainly from Russia. New investments in plants in Nigeria have increased the production of nitrogenous fertilizers in west Africa since 2009. However, despite the growth in local supply, fertilizer consumption in all of west Africa remains heavily dependent on imports. (See Figure 13.)

Figure 13
Production, imports, exports and consumption of nitrogen in West Africa (in tons)



Source: Prepared by the authors based on data from Food and Agriculture Organization © FAO. 2018. FAOSTAT. [Online]. [Accessed on 23 March 2018]. Available from http://www.fao.org/faostat/en/#data

As of the start of 2018, west Africa had only two urea production facilities – Notore Chemical Industries and Indorama Eleme Fertilizers & Chemicals. Both plants are in Nigeria and rely on local natural gas resources. They have a joint capacity of 1.9 million tons per year of urea.

However, two new plants are expected to begin operations in the near future. A first plant, at the Dangote Refinery and Petrochemical Complex,expected to be completed by December 2018. Its expected capacity of 2.8 million tons per year would make it the world's second largest urea plant. A second plant, Brass fertilizer, due to be completed by Marchy 2021, has an expected capacity of 1.3 million tons per year. With the new additions, Nigeria will expand its production capacity to 6 million tons of urea per year, making it a main manufacturer and export hub[10] (West Africa Fertilizer Program, 2017).

Phosphate fertilizers arrive in west Africa mainly from Morocco (53%). The Moroccan company Office Chérifien des Phosphates (OCP) is the world's largest phosphate producer. Industries Chimiques du Sénégal (ICS) is the largest producer of phosphate in the region (West Africa Fertilizer Program, 2017).

[10] AfricaFertilizer. 2018. Register of Fertilizer Manufacturing & Processing Facilities in Sub-Saharan Africa. [Online]. [Accessed 9 July 2018]. Available from https://docs.google.com/viewerng/viewer?url=http://africafertilizer.org/wp-content/uploads/2018/02/2018_AFO_SSA_Fertilizer_Plants_Register-min-ilovep.pdf&hl=en_US

Complex fertilizers (NPK and DAP) arrive to a large extent from Morocco as well. OCP is expected to increase its presence in this segment as well, through the construction of blending facilities all across west Africa. In May 2017, the news website 360Afrique reported that OCP had met with the Ivorian port authorities to discuss the acquisition of premises to develop a blending and storage unit in Abidjan that would serve as a hub for west Africa.[11]

Finally, there will be African fertilizers for Africa. However, the increase in local production by itself doesn't seem to be a determinant factor to unlock the huge potential demand in the region. Most of the forecast growth in urea production in Nigeria over the next few years will be absorbed by markets outside the region. It is estimated that, since 2010, 25% of the urea produced was exported to other regions (mostly to South America) and that the percentage will grow to 70% by 2020.[12] This is an evidence that other barriers - not necessarily related to local production - still need to be overcome for fertilizers demand to expand.

4. Constraints on Fertilizer Market Development

One approach to evaluate the advisability of a farmer adopting the recommended dosage of fertilizer is to calculate the value-cost ratio (VCR)[13]. This ratio is a simplification of a more complex function of a profit-maximizing decision and can defined as follows:

$$\text{VCR} = \frac{\text{Value of additional yield obtained through recommended fertilization}}{\text{Additional cost of recommended fertilization}}$$

The VCR ratio can identify fertilizer recommendations that are unlikely to be adopted by farmers. As ann easy rule of thumb, farmers tend to follow the recommended dosage of fertilizers if VCR > 2, in the case of commercial crops, or if VCR > 3 or even 4, in the case of food crops.

That means that, for commercial crops such as cocoa or bananas, farmers should adopt the recommended dosage of fertilizers only if the value of the additional yield obtained is at least twice the cost entailed by purchasing the additional quantity of fertilizer. When it comes to food crops, this ratio rises to three or even four times.

Even though these ratios might seem high, they are considered necessary to cover for the additional costs associated with fertilizer use (including, for example, labor costs) and for the higher risk entailed by investing more money in fertilizers (including not having perfect knowledge about the price of crops and about yield response).

Based on the data available on the cost of fertilizers, yields and prices paid to farmers for some crops, the increased yield required to reach VCR = 2 or 3 has been estimated for different crops. (See Table 4.) For cocoa, the increase required for a farmer to follow the fertilizer recommendation is estimated at around 105%, meaning that the additional cocoa crops produced should at least double in value.

[11] "Côte D'Ivoire: Le Groupe OCP Prépare Son Installation à Abidjan." Le360 Afrique, 30 May 2017, afrique.le360.ma/cote-divoire/economie/2017/05/30/12210-cote-divoire-le-groupe-ocp-prepare-son-installation-abidjan-12210.

[12] Sean Mulholland, AFAP Industry Brief http://www.afap-partnership.org/resources/industry-briefs/ last access on 27 January 2018

[13] Kelly, V., Jayne, T. and Crawford, E. 2005. Farmers demand for fertilizer in Sub-Saharan Africa. [Online]. [Accessed 10 April 2018]. Available from http://www.tanzaniagateway.org/docs

However, for food crops such as yams, cassava and vegetables, the required increase is much lower, at 32% to 36%. This indicates that the additional crops produced as a result of the recommended fertilization should increase in value by about one-third. Although this might not seem a difficult goal to achieve, for the current conditions of the Ivorian market it actually is.

What are the barriers that make these ratios so difficult to achieve and prevent farmers from adopting the recommended dosage of fertilizer?

Table 4
Estimate of increased yield needed for VCR = 2 and VCR = 3 (2013 data)

Crop	Increased yield needed to reach VCR = 2 (% of current production)	Increased yield needed to reach VCR = 3 (% of current production)
Cotton	0.0%	0.0%
Cocoa	104.8%	157.3%
Bananas	1.5%	2.3%
Rice	29.5%	44.2%
Yams	22.4%	33.6%
Cassava	23.9%	35.9%
Vegetables	21.8%	32.7%

Source: Prepared by the authors based on data from Food and Agriculture Organization © FAO. 2018. *FAOSTAT*. [Online]. [Accessed on 23 March 2018]. Available from http://www.fao.org/faostat/en/#data, and from AfricaFertilizer. 2015. *Etude sur la Consommation d'Engrais par Culture en Côte d'Ivoire*. [Online].[Accessed 22 May 2018]. Available from http://africafertilizer.org/fr/blog-post/etude-sur-la-consommation-dengrais-par-culture-en-cote-divoire

The following paragraphs analyze the main constraints encountered in the Ivorian market, constraints that affect either the input or the output component of the ratio, or both.

4.1. Barriers associated with the input side

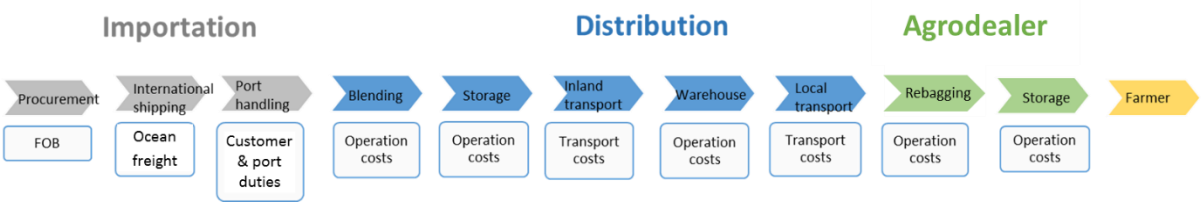
There are three main barriers that directly affect the cost of fertilizer:

- Fertilizer value chain
- Access to credit
- Regulatory uncertainty

4.1.1. Cost of fertilizer building up along the value chain

Along the fertilizer value chain, various activities contribute to building up the final cost of fertilizers. Based on the information collected during our interviews with some of the importers and distributors operating in the Ivorian market and on publicly available fertilizer prices, we reconstructed the urea supply chain. (See Figure 14.)

Figure 14
Operations and costs along the fertilizer value chain



Source: Prepared by the authors.

Each stage of the supply chain represents a cost component:

1. Procurement from manufacturers. The fertilizer distribution process begins with the purchase of fertilizer at the free-on-board (FOB) price. FOB is a term of sale under which the price quoted by a seller includes all charges up to placing the goods on board a ship at the port of departure specified by the buyer. Urea's FOB, for example, is currently $240 a ton.[14]

2. International shipping. Ocean freight to Côte d'Ivoire adds on average $45 a ton to the FOB cost of fertilizer. Fertilizers are usually shipped in bulk and bagged at destination, since this process is generally cheaper than buying and shipping bagged fertilizer.

3. Customs and port duties. Custom duties amount on average to 2.5% of the FOB price. In the case of urea, customs and port duties amount together to $20 a ton.

4. Unloading and trucking from quay/bagging. Fertilizer is discharged from the vessel and bagged (if imported in bulk), adding another $15 to $26 a ton to the cost.

5. Inland transportation. Internal transportation represents a large component of the cost and varies depending on the distance, with a minimum of $30 to $40 a ton. Transport costs are not level throughout the region, so the final price of fertilizer is not the same in Abidjan as in other areas in the north of the country, where transportation is more difficult and costly. Other factors that add to the cost of transportation are long distances between the port and the consuming areas, roads in poor condition with potholes and damaged paving, rent seekers, and a lack of competition among the trucking companies.

6. Other distributor costs and margin. Distributors support several other costs along the supply chain, including the cost of financing, warehouse and delays. The distribution margins vary but generally at least another $90 a ton needs to be added along the distribution chain before fertilizer reaches the agrodealers. The lack of competition – given the nature of the business, with fertilizer being a bulk commodity subject to economies of scale – could contribute to increases in the distribution margins and ultimately fertilizer retail prices. After adding on all the costs that arise along the import and distribution chain, urea reaches the agrodealer market at a price of about $460 to $480.

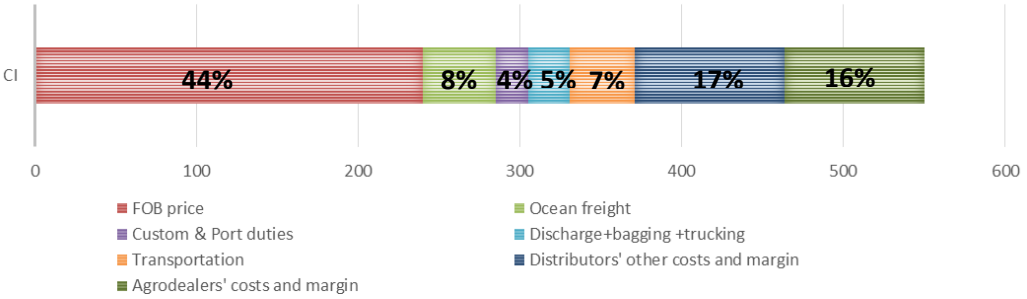
7. Agrodealers. Independent agrodealers buy fertilizers at the wholesale price from distributors and sell them to the farmers. Further costs for rebagging, warehousing, financing and transportation add another $85 to the price of urea. It is important to note

[14] Urea's average FOB (Arabian or Persian Gulf) for November 2017.

that VAT is not applied to fertilizer products in Côte d'Ivoire, a policy aimed at containing the final prices and ultimately incentivizing fertilizer use. At the end of the supply chain, a ton of urea, purchased at $240 on the international market, reaches the farm gate at a cost of $550, equivalent to 2.3 times the import cost.

As can be observed, the cost of importing urea into Côte d'Ivoire accounts for 52% of the final retail price (44% in procurement costs and 8% for international shipping). The other 48% of the final price arises along the second part of the supply chain, after the fertilizer reaches the Ivorian port.

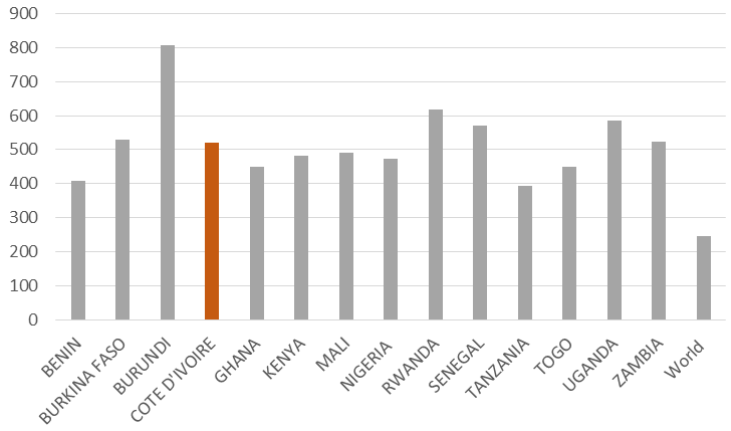
Figure 15
Cost build-up for urea



Source: Prepared by the authors based on interviews and fertilizer prices from Africa Fertilizer. 2017. *National Fertilizer Prices* [Online].[Accessed 10 March 2018]. Available from http://africafertilizer.org/national

Although the final price is not particularly high, when compared with prices in other sub-Saharan countries, it is still far higher than the world average. (See Figure 16.)

Figure 16
Commercial prices for urea in different sub-Saharan countries (2017 average in U.S. dollars per ton)



Source: Africa Fertilizer. 2017. National Fertilizer Prices [Online].[Accessed 10 March 2018]. Available from http://africafertilizer.org/national

It should be noted that retail prices vary significantly across Côte d'Ivoire. Data collected in different areas of the country in November 2017 show that urea sells for 15,100 CFA francs (FCFA) per 50 kg

bag ($540.19 a ton) on average. However, the sale price varies from 14,000 FCFA to 16,000 FCFA for 50 kg ($501 to $572 a ton) (AfricaFertilizer.org).

According to information collected directly by the authors,[15] urea can reach 17,500 FCFA for 50 kg ($650 a ton), and the NPK 15-15-15 price varies from 15,000 FCFA to 19,000 FCFA for 50 kg ($557 to $706 a ton).[16]

4.1.2. Access to credit

Fertilizers need to be bought and paid for and used many months in advance of the crop harvesting and selling period. This means a significant up-front expenditure that most small farmers cannot meet with their own resources. The traditional banking sector is unwilling to bear the risk of financing small farmers, many of whom are living in poverty, with limited assets and little or no savings, unpredictable and unstable incomes, and most of the time with no bank account.

Although credit to agriculture increased from $79.3 million in 2011 to $272.4 million in 2015, it still represents just 3.6% of the total credit allocated in the country (FAOSTAT, 2018). This is a very small amount for a country where 20% of GDP is generated by agriculture.

While innovative credit solutions are starting to be implemented for commercial crops, especially those with global demand, the situation is much more difficult for noncommercial crops, such as cassava, rice, and vegetables – especially because these crops do not have a structured output market where they can be sold, meaning fewer guarantees of income to pay back a hypothetical loan.

4.1.3. Regulatory uncertainty

Uncertainty related to political choices is one of the main risks faced by companies operating in all sectors in most sub-Saharan African countries. In particular, the allocation of fertilizers could be used as a political instrument. The Ivorian fertilizer industry operates with little or no government market intervention. Unlike in other African countries where the government is in charge of the procurement and distribution of fertilizers, in Côte d'Ivoire administrative interference in the fertilizer industry is limited to the subsidizing of cotton, quality controls, and a lack of taxation on fertilizers. Even so, the importers and distributors in the country remain cautious about the future, pointing out that a hypothetical decision to centralize activities – as happened in Ghana, Kenya, and Tanzania – was unlikely but would entail the risk of high costs.

4.1.4. Quality

In 2013, a report by the Economic Community of West African States (ECOWAS), the West African Economic and Monetary Union (UEMOA) and the International Fertilizer Development Center (IFDC) (Sanabria, Dimithe, and Alognikou, 2013) assessed fertilizer quality in Côte d'Ivoire, Ghana, Nigeria, and Togo. The study found serious problems with the quality of fertilizers in all the countries studied. For example, 51% of the 106 samples of the 15-15-15 blend analyzed did not comply with tolerance limits for nutrient content set by ECOWAS. Compound fertilizers

[15] Prices collected from calls to agrodealers and on-site visits.

[16] The highest price obtained in January 2018 during visits to fertilizer shops.

performed better: only 15% of the samples were found to be deficient in nutrients, although problems with underweight bags and inadequate storage were still common.

For Côte d'Ivoire, the study reports evidence of adulteration in 23% of the samples (31 of 134 samples), and the overall out-of-nutrient content compliance was 87% for the 15-15-15 blend. The results also indicate that short-weight fertilizer bags are common in the market and that there is a 41% chance of the bag weight failing to comply with the ECOWAS tolerance limit in Nigeria, a 28% chance of this occurring in Côte d'Ivoire, 13% in Senegal, 12% in Ghana and 7% in Togo.

Another interesting finding was that quality was affected by the characteristics of the fertilizer dealer such as type of customers, fertilizer knowledge and training, type of distributor, and possession of a license to sell fertilizers. Unlicensed retail dealers who sell mainly to small-scale farmers and have no fertilizer knowledge or training showed a higher frequency of samples of out-of-nutrient content compliance.

One main challenge with the fertilizer trade is that quality problems can arise anywhere along the supply chain. Moreover, the quality of farm inputs may become apparent only long after they have been used (normally at harvest time). Even then, there will be some degree of uncertainty because of other factors affecting the output, such as rainfall, soil type, and the timeliness or appropriateness of fertilizer use.

4.2. Barriers associated with the output side

There are two barriers that directly affect the value of what is produced with the use of fertilization:

- Difficulties in accessing the output market for noncommercial crops
- Fluctuations in demand and a lack of tools to predict demand

4.2.1. Difficulties in accessing the output market for noncommercial crops

The quality of the agricultural production is very low and a large part of the production is wasted because of bad storage, humidity, or because it simply cannot reach the market. Food-crop farmers are not organized through cooperatives, and production is scattered, making it difficult to collect it for sale.

Food crops such as yams, cassava and vegetables are highly perishable and so have to be sold at harvest time and disposed of quickly to prevent spoilage. This depresses their price, and leads to losses. Insufficient and inappropriate storage facilities affect the quality and the quantity of production that reaches the market.

Data on supply of and uses for different crops show that, for yams, losses account for 10% of the country's production, while another 4% consists of production destined to feed animals. For fruit, the percentage of wasted production accounts for 8.3%. For vegetables, where the country needs to import 14.7% of the total domestic supply, 8.4% of the total supply is registered as losses. (See Table 5.)

Table 5
Supply of and uses for different crops (2013 data: thousands of tons)[17]

Crop	Production	Import quantity	Domestic supply	Animal feed	Losses	Food
Cassava	2,436	0	2,436	115	122	2,199
Yams	5,732	0	5,732	229	573	3,783
Vegetables	664	114	775	0	65	710
Fruit	168	3	157	0	13	135

Source: Prepared by the authors based on data from Food and Agriculture Organization © FAO. 2018. *FAOSTAT*. [Online]. [Accessed on 23 March 2018]. Available from http://www.fao.org/faostat/en/#data/BC

4.2.2. Fluctuations in demand and a lack of tools to predict demand for crops

Decisions on the quantities of fertilizers to purchase have to be made in advance, when farmers still do not know what the market demand and prices for their crops will be. The inability to forecast demand and prices and to manage risks has a negative impact on the quantities of fertilizers purchased. There is a strong need for market information assistance to help make sound decisions.

4.2.3. Other barriers

Several other barriers can affect both the cost of fertilization and the value of production, particularly:

- Lack of training
- Outdated recommendations
- The connections between the public and private sectors

4.2.4. Lack of training

Poor knowledge about the correct use of fertilizers can lead to a waste of resources. Moreover, incorrect dosage can lead to the crops being damaged. In addition, farmers who are not used to the benefits of applying fertilizers often mistake them for pesticides or believe there is a risk of poisoning their crops.

Farmers' level of education depends on the type of crop. In organized sectors, such as cotton and oil palms, large offtake companies (the companies buying the crops produced) are very much involved in educating their customers. The companies have a strong incentive to do so as they want the farmers to use their production capacity to the full to obtain good quantities of quality raw materials.

For food crops, farmers' education is limited to knowledge passed down from generation to generation. Moreover, with such farmers being more scattered geographically, they are more difficult to reach by the institutions and companies offering training, such as NGOs and fertilizer distributors and agrodealers.

[17] Discrepancies between the supply and the uses of yams and fruits are due to other elements not reported in the table (stock variations, exports, use for processing and use as seeds).

4.2.5. Outdated recommendations

Fertilizer recommendations are not updated regularly. For example, as of 2017, the recommendations for fertilizing cocoa dated back to the 1970s and were based on soil maps from that period. In 2012, the National Center for Agronomic Research (Centre National de Recherche Agronomique, CNRA) was commissioned by the Cocoa Fertilizer Initiative to map the soil of the country's cocoa-growing regions, to allow the sector to give farmers precise guidance on the fertilizers needed to improve their soil. The mapping has been completed and has enabled six soil types to be identified in the cocoa-growing region as well as the nutrient requirements to be calculated and recommendations made (Kassin et al., 2017). For some crops (with less commercial interest), the recommendations are based on international standards, not customized to the country's soil types.

4.2.6. Engagement between the public and private sectors

It is necessary to increase the dialogue and collaboration between public and private stakeholders to improve the business environment and push forward initiatives that can benefit the sector. For example, public institutions and private players need to find compromises between specificity and business efficiency. The CNRA mapped the soil and made recommendations for cocoa for six out of eight types of different fertilizer compositions (mixes), depending on the specific areas across the country. From a technical perspective, the optimal solution would be to apply specific nutrient quantities, for distributors and agrodealers. However, making available such a range of customized blended fertilizer products or dedicating resources to train farmers to use the quantities of N, P and K differently in each region would be difficult and expensive, as this would reduce the economies of scale needed to operate efficiently.

5. Breaking Down Barriers: What Has Been Done so Far

Public institutions, nonprofit organizations and private companies, aware of the barriers restricting the adoption of fertilizers in Côte d'Ivoire, have acted in different ways to try to mitigate some of the difficulties.

Some progress has been made, and the stable increase in the fertilization rate witnessed over the years from 2011 to 2014 seems to confirm this.

5.1. A regional regulatory framework and new national policies

In 2006, at the African Union Special Summit of the Heads of State and Government, the member states' leaders declared fertilizer to be a strategic commodity and resolved to accelerate the adoption of fertilizers by farmers. On that occasion, the leaders adopted the Abuja Declaration on Fertilizer for the African Green Revolution, committing themselves to increase fertilizer use from 8 kg/ha at that time to 50 kg/ha by 2015.

In an attempt to increase farmers' access to fertilizers and guarantee quality standards, west African governments have been working through ECOWAS and UEMOA to create a regional market for fertilizers that could improve the supply chain. ECOWAS and UEMOA developed a legal framework that contains harmonized rules for the fertilizer trade in the region. Regulation

C/REG. 13/12/12 Relating to Fertilizer Quality Control in the ECOWAS Region was approved in December 2012 and its main goals are:

- To defend farmers' interests against nutrient deficiencies, adulterations, false or misleading declarations and weight deficits and ultimately to increase farmers' confidence
- To facilitate inter- and intrastate trade in fertilizers, through the implementation of principles and rules – mutually agreed at regional level – to dismantle trade barriers and to make the fertilizer trade faster, easier and cheaper. (See Box 1.)

Box 1
Key provisions of the ECOWAS fertilizer regulations

The ECOWAS fertilizer regulations include the following provisions:

- **Standard quality definitions and labeling requirements**: Countries shall observe standard definitions of fertilizer terms and ensure that all fertilizer containers are clearly labeled with a minimum set of information, including guaranteed nutrient content.
- **No product registration**: The regional framework for fertilizer is built around the principle of truth in labeling. Therefore, countries must not maintain approved lists of fertilizer types that can be sold to farmers or require product registration tests.
- **Free movement of fertilizers**: Fertilizers that comply with the prescribed quality standards shall be entitled to free movement throughout the ECOWAS region. Prior notification to the competent authority in the concerned countries should be the only requirement to import or export fertilizer.
- **Requirements for inspection and analysis**: Member states are required to develop inspection and analysis manuals based on AOAC International, International Organization for Standardization, and European Union standards that describe the modalities and procedures for fertilizer sampling and inspection and business inspection.
- **Tolerance limits**: The regulations set out specific tolerance limits for nutrient deficiency and weight and maximum allowable heavy metal limits. Any product that exceeds the prescribed tolerance limits or contains other materials that are injurious to plant health shall not be allowed for sale.

Source: Maur, J.C,.Shepherd,B. 2015. *Connecting Food Staples and Input Markets in West Africa A Regional Trade Agenda for ECOWAS Countries.*World Bank. Report No. 97279-AFR

To support the regional regulation, four implementing regulations based on international best practices were also developed but apparently, six years later, none of those implementing regulations needed to support the system has been adopted in full. Implementation at national level of regional trade rules can be a complex and expensive process, and this could require many years to complete.

However, even before full implementation has begun, several governments have made important changes to their regulations.

In Côte d'Ivoire, companies are required to register in order to import and distribute fertilizers. (Registration is valid for one year.) Fertilizers do not need to be registered to circulate in the country but, instead, their package labeling is regulated.[18]

The CNRA is the institution in Côte d'Ivoire in charge of overseeing fertilizer quality and it tests fertilizers to see their effect in the specific soil conditions, recommending a dosage and period of application in each case. The center is also in charge of selecting the best varieties of seedlings, in terms of quality and productivity.

5.2. Reforms in the cocoa sector

The government of Côte d'Ivoire has recognized the crucial role played by the cocoa sector in the country's economy and has supported reform of the sector through different programs and initiatives.

In particular, in 2012 the government founded the Coffee and Cocoa Board (Conseil du Café-Cacao).[19] One of the most important measures taken by the board has been to set a guaranteed minimum price for cocoa farmers: the price paid to farmers must be more than 60% of the price of cocoa on the international market. This measure aims to decrease the volatility of farm-gate prices and to facilitate the planning of production activities, long-term investments, and access to credit.

5.3. Testing new financing models

In 2012, the World Cocoa Foundation, along with the Coffee and Cocoa Board, established the Cocoa Fertilizer Initiative, implemented in partnership with the Netherlands-based IDH (Initiatief Duurzame Handel, or Sustainable Trade Initiative). The initiative brought together important players from the cocoa industry such as cocoa traders, the fertilizer industry, civil society organizations, and government bodies in a mainstream public-private consortium to accelerate learning through constructive dialogue on best practices and ultimately to mitigate some problems relating to fertilizer accessibility and affordability.

In particular, the Cocoa Fertilizer Initiative focused on analyzing the effectiveness of three models of financing and delivering fertilizers: cash-and-carry, credit through cooperatives, and fertilizers for beans[20].

5.3.1. The traditional cash-and-carry model

In the classic model of delivering fertilizer, companies work to make fertilizer more available in remote locations, where it can be purchased by farmers. The cash-and-carry model increases access to the product, is very low-risk and therefore widely used. However, the uptake is weak when farmers do not have sufficient access to funds at the start of the season.

[18] AfricaFertilizer.org http://africafertilizer.org/fr/cote-divoire accessed on 27 January 2018.

[19] "COFFEE-COCOA BOARD."
Accueil, www.conseilcafecacao.ci/index.php?option=com_k2&view=item&id=77%3Acoffee-cocoa-board

[20] Cocoa Fertilizer Initiative and IDH Sustainable Trade. 2017. *Initiative Engrais Cacao 2012-2017*. [Online].[Accessed 23 May 2018]. Available from https://www.idhsustainabletrade.com/uploaded/2017/04/Initiative-Engrais-Cacao_Retour-sur-le-pass%C3%A9-regard-vers-l%E2%80%99avenir.pdf

5.3.2. Credit-through-cooperatives model

In this model, farmers make a partial up-front payment to the cooperative in the form of savings. Then the cooperative orders, receives, and distributes fertilizer, with assistance from a microfinance institution (lender) and a cocoa exporter (guarantor). After the harvest, the farmers repay the cooperative, which in turn repays the lender. A crucial factor in the success of this model has been the partnership with the microfinance institution Advans, which finances farmers in an innovative way. (See Box 2.)

Box 2
Advans

Advans adapted the traditional lending method to the characteristics of cocoa farmers by:

1. Creating new credit schemes that match the seasonal nature of their incomes
2. Digitizing the accounts, allowing farmers to have sales revenues paid directly into their saving accounts, thus eliminating cash transfers and therefore the risk of theft and increasing the transparency of transactions
3. Linking the farmers' bank accounts to MTN Mobile Money accounts, so that farmers can withdraw cash through the MTN agent in their village

As well credit for fertilizers, Advans also offers farmers credit for education, with the dual objective of improving their knowledge of and ability to apply fertilizers and improving their credit management skills, with the ultimate goal of increasing farmers' revenues and consequently Advans' turnover.

Over the five-year period 2012-2017, Advans benefitted 30,000 farmers, delivering more than $18 million (FCFA 10 billion) of credit for fertilizers with a 100% payback rate.

Source: Prepared by the authors based on Advans Cote D'Ivoire ™. 2018. Advans website. [Online]. [Accessed 10 April 2018]. Available from www.advanscotedivoire.com and on Advance Cote d'Ivoire. La microfinance au service de l'agriculture ivorienne. [Online]. [Accessed on 15 November 2017]. Available from https://www.advanscotedivoire.com/index.php?id=238

The partnerships started by the Cocoa Fertilizer Initiative led to financing solutions that were continued after the pilot stage and are still in place. For example, Ellen Cathrine Rasmussen, country manager at Yara, explained to the authors in an interview that 25% of her company's sales are made using this form of microfinance: Yara selects some cooperatives that work well, and the cooperatives in turn select the farmers. Advans finances the farmers and then cocoa companies, such as Cargill and Olam, which have a strong interest in guaranteeing their cocoa supplies, play the role of guarantor for the farmers.

5.3.3. "Fertilizer for beans" and "beans for fertilizer"

In this model, cooperatives or exporters take on high levels of risk by providing and financing fertilizer in advance and they receive repayment later in the form of deliveries of beans.

Some projects had moderate success with this approach, particularly where a premium was offered for quality beans. Others had difficulty in selecting the farmers and had high farmer-default rates, which prevented this kind of scheme from scaling up. There are two main reasons for the high default rate:

- Lenders are not protected by any specific law. As most of the farmers are illiterate, written contracts have no legal force. (In Côte d'Ivoire, as in many countries, the law protects farmers in this situation by considering these contracts as legally null.) However, verbal contracts are difficult to demonstrate. Consequently, farmers can sell their crops to other parties and easily avoid paying their debt.

- Some farmers do not use the fertilizer on their cocoa crops as agreed. As result, they might end up not having a crop to pay back. Sometimes, farmers resell the fertilizer they received to another farmer to make some easy money. (Considering that many farmers live in poverty, this can be a good opportunity to cope with an immediate need, such as buying some urgently needed goods, food or medicine.) At other times, they apply the fertilizer to different, more profitable crops (for example, on coffee plants instead of cocoa trees).

For the above reasons, the "fertilizer for beans" model has subsequently turned into a "beans for fertilizer" model in which the farmers have part of the fertilizer cost paid into a reserve fund initially and they later pay the difference with cocoa beans in the following season.

There are similarities between the financing solution currently adopted by PALMCI, for example, and the "beans for fertilizer" model. Ouattara told the authors:

"At each monthly collection of palm fruit from the farmers (palm-oil harvesting takes place every month), the palm-oil company retains 10% of the payment due to the farmers and builds up a reserve aimed at purchasing fertilizers on behalf of the farmer. At the beginning of the following year, when fertilization is due, the farmer has accumulated enough money in the reserve to purchase the fertilizer needed."

Palm-oil companies have a strong interest in helping farmers get an increased yield of oil-palm fruit, to guarantee the companies get the supplies of raw materials they need to use when operating at their full processing capacity.

6. Alternatives and Opportunities

Investment in production capacity in west Africa is increasing the supply and it is hoped that the procurement cost of nitrogen, phosphate and complex fertilizers will fall as a result. West African governments are making important changes to their regulations to guarantee quality standards and are advancing toward the creation of a regional market that should make trading in fertilizers easier, faster and cheaper.

On the demand side, the importance of creating a market for the crops and the key role of a well-structured value chain have finally been recognized. Public institutions, fertilizer companies and banks are collaborating to find innovative ways to improve access to credit.

What are the next steps that need to be taken to accelerate the penetration of fertilizer and ultimately help Ivorian agriculture to move from an extensive system to an intensive one? What innovations, already adopted by other countries, could be explored in Côte d'Ivoire?

6.1. Harnessing technology to create new credit assessment systems

To increase access to fertilizers, credit access is as important as decreasing the price. For those crops where credit facilities are already in place (such as cotton, sugarcane, bananas and palm fruit) a higher rate of fertilization is noted.

Thanks to the partnerships between different operators in the sector started by the Cocoa Fertilizer Initiative, there are now some innovative models in place to finance fertilizers and deliver them to farmers. Yara and PALMCI provide two good examples.

The Ivorian agricultural sector shows some features that could represent an opportunity for microfinance institutions. Advans reports the following data regarding the cocoa sector[21]:

- $2.3 billion in revenues from cocoa earned by farmers with a 100% cash system
- 35% of farmers have some form of savings
- Only 6% of cocoa farmers have a bank account
- 53% of farmers use electronic wallets (MTN Mobile Money)

While the traditional banking sector fails to consider them, farmers are dealing with challenges such as the seasonality of their income, the risk of theft, and the inability to manage cash.

Implementing innovative credit systems adapted to farmers' needs, building on what has been tried so far, could help overcome the barrier posed by the lack of credit access.

In Kenya, for example, the social enterprise FarmDrive uses mobile phones, "alternative data," and machine learning "to bridge the gap between smallholder farmers and financial institutions." (See Box 3.)

[21] Advance Cote d'Ivoire. La microfinance au service de l'agriculture ivorienne. [Online]. [Accessed on 15 November 2017]. Available from https://www.advanscotedivoire.com/index.php?id=238

Box 3
FarmDrive

In 2014, Rita Kimani and Peris Bosire launched FarmDrive, an alternative credit-scoring model for assessing the creditworthiness of smallholder farmers.
FarmDrive collects and aggregates alternative dataset from multiple sources, such as income, expenditure and yields as well as agronomic, environmental and satellite statistics, including rainfall and the fertility of the farm's location. such as the farmer's social-media interaction and literacy (based on their SMS interaction), also enable FarmDrive to better understand the skills level of the applicant.
These inputs are then analyzed by an algorithm that generates credit scores for smallholder farmers, and provides decision-making tools that enable financial institutions to develop small-scale agricultural loan products.

With this solution, FarmDrive is unlocking thousands of dollars of previously risk-averse capital for smallholder farmers. After starting with a pilot project that involved 50 farmers, now FarmDrive includes hundreds of thousands of farmers in its database. Of those, 830 have received financing. FarmDrive is now planning to scale up building solutions for farmers in Asia.

Source: Prepared by the authors based on FarmDrive. 2018. FarmDrive website. [Online]. [Accessed 10 April 2018]. Available from https://farmdrive.co.ke

6.2. Investing in near-farm storage and output marketing

The crops that are fertilized less are those that are not exportable and whose value chains are not very structured, like root vegetables and other vegetables. This is not because there is no market for these – in fact, there is strong demand for agricultural products for use as food and in agro-industry and other types of industry. Mostly the problem is that there are difficulties in getting supply and demand to meet.

However, things are starting to change. The market is increasingly demanding in terms of quality and large retail chains, such as Carrefour, have started building a value chain for food crops.

Investments in near-farm storage and output marketing would help reduce losses and sustain prices and could drive the expansion of fertilizer use by farmers.

In Ghana, the mobile-commerce start-up Tulaa aims to improve farmers' access to output markets through a technological platform that directly connects farmers with output traders and wholesalers. (See Box 4.)

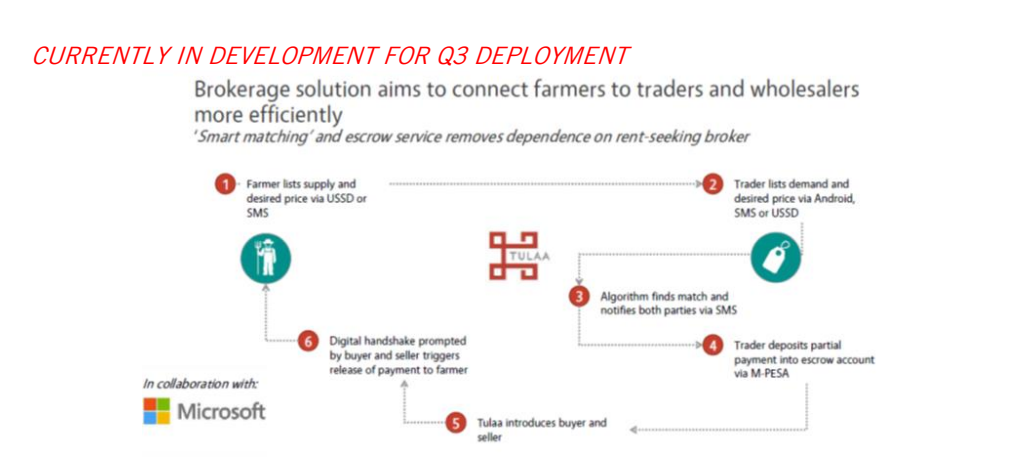
6.3. Adopting innovative solutions to reduce up-front costs

The investment required to apply fertilizer to the cultivated land of a whole farm is often too much for a small farmer. For example, fertilizing a hectare of land cultivated with cocoa crops would require $270 to $300. Other than a decrease in the fertilizer price, the up-front investment could be reduced by reducing the minimum size of fertilizer packaging on sale.

For example, Yara started to commercialize an innovative kit that containing all the necessary inputs to fertilize cocoa crops, with just the right amount of everything to fertilize 100 trees. The idea behind this innovative solution is that, instead of purchasing larger bags of each type of fertilizer to be applied across the cultivated land of the whole farm, cocoa farmers can buy the Yara box and start to fertilize just a small portion. By gradually increasing productivity and by directly observing the effect of proper fertilization on the yield, the farmer will become more confident about purchasing larger quantities of fertilizers, and can use the extra income accrued in the fertilized part of the land to pay for them.

Box 4
Tulaa

Tulaa saw in the fragmentation of the agrivalue chain in African countries a significant market opportunity. The company developed an end-to-end platform that connects farmers to input providers, financial institutions and output traders. Acting as a layer on the existing network of agrovet shops in the last mile, Tulaa's solution enables credit-backed input sales at the retail point. On the output market side, Tulaa has been developing a brokerage solution that directly matches farmers with traders and wholesalers, increasing farmers' access to the crop market and removing the dependence on rent-seeking brokers.



Source: Prepared by the authors based on Tulaa. 2018. *Tulaa website*. [Online]. [Accessed 10 April 2018]. Available from https://www.tulaa.io

6.4. Investigating the feasibility of fertilizer plants in Côte d'Ivoire

Côte d'Ivoire has reserves of natural gas that could be used to produce nitrogenous fertilizers, such as ammonia and urea. In 2016, Côte d'Ivoire flared an estimated 106 million cubic meters of natural gas.[22] At a conversion rate of 0.0018 tons/m3 this could provide 190,800 tons of fertilizer. This amount of

[22] Estimate based on satellite observation by the Global Gas Flaring Reduction Partnership.

fertilizer would be enough to meet the current demand of 80,000 tons, leaving 110,800 tons available for export to neighboring countries (Gregory and Bumb, 2006).

However, a preliminary evaluation suggests that this option presents some obstacles:

- The potential quantity of nitrogen fertilizer produced using the amount of natural gas currently flared in the country does not seem to justify the investment in a urea or ammonia plant. The annual minimum required to invest in a fertilizer plant is in the order of 300,000 to 500,000 tons of a single product.
- Natural gas is currently flared in offshore wells, apparently for security and technical reasons. Further studies are necessary to assess the technical and economic feasibility of capturing and using this gas. Moreover, the national power sector is heavily reliant on domestic natural gas to produce electricity, and the increasing demand for electricity will require more and more gas in the coming years. Therefore, the opportunity cost of using natural gas to produce fertilizer rather than electricity should be assessed too.
- In the near future, Nigeria is expected to saturate the market with 6 million tons of nitrogen fertilizer per year, with an oversupply to last for an estimated five years at least.
- The price structure of urea along the supply chain seems to be the major driver of high fertilizer prices in the second part of the value chain, from the port to the farm. This seems to be where innovation is needed most and so this is where attention should be focused.

6.5. Innovative ways to produce and commercialize organic fertilizer

Organic fertilizers seem to be less efficient than mineral ones if applied alone because they are rarely able to contain the same quantity of nutrients as mineral fertilizers contain. However, using them in conjunction with mineral fertilizers is highly recommended because of their long-term effect on soil fertility.

So far organic fertilizer manufacturing activity in Côte d'Ivoire has been very limited. Of the companies involved in this activity, it is worth mentioning Lono, a start-up biotechnology company that converts organic waste into electricity and fertilizer. (See Box 5.)

Box 5
Lono

Lono is a biotechnology company based in Abidjan. It produces biogas and biofertilizers from raw materials left over from agricultural and household activities in farming communities. Lono has found an innovative way to facilitate the collection of raw materials from farmers.
Lono rewards farmers who collect raw materials with points called biocredits, exchangeable for cash (mobile money) or products such as compost, biofertilizers or biopesticides. On the one hand, biocredits are an incentive for farmers to collect raw materials and, on the other hand, they are a financing solution to purchase fertilizers and cooking fuel.

Source: Prepared by the authors based on Lono. 2018. *Lono's website.* [Online]. [Accessed 10 April 2018]. Available from https://lonoci.com/fr

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Exhibit
Retail Prices in 2017

Type of fertilizer	International spot price ($/ton)	Average retail price ($/ton)	Average retail price by region (FCFA/50 kg)			
			Ouangolodougou	Tiémé	San-Pédro	Méagui
MOP	NA		NA	NA	NA	NA
Urea	**219.9**	**521**	**16,000**	**15,000**	**15,000**	NA
DAP	**351.5**	NA	NA	NA	NA	NA
TSP	**276.1**	NA	NA	NA	NA	NA
NPK 15-15-15	NA	**537**	**15,000**	**15,000**	NA	NA
MAP	NA	NA	NA	NA	NA	NA
Calcium nitrate	NA	NA	NA	NA	NA	**8,500**
NPK 12-22-22	NA	NA	NA	NA	**17,500**	NA

Type of fertilizer	Average retail price by region (FCFA/50 kg)						
	Guiglo	Touba	Abengourou	Bouaké	Daloa	Yamoussoukro	Bouaflé
MOP	NA	NA	NA	NA	NA	NA	NA
Urea	**16,000**	**16,000**	**14,500**	**15,000**	**14,500**	**14,000**	**15,000**
DAP	NA	NA	NA	NA	NA	NA	NA
TSP	NA	NA	NA	NA	NA	NA	NA
NPK 15-15-15	NA	**15,500**	**16,500**	**15,000**	NA	NA	**15,500**
MAP	NA	NA	NA	NA	NA	NA	NA
Calcium nitrate	**9,000**	NA	**8,000**	NA	NA	NA	NA
NPK 12-22-22	**16,000**	NA	NA	**17,000**	**17,000**	**17,000**	**NA**

Source: Prepared by the authors from Africa Fertilizer. 2017. *National Fertilizer Prices* [Online].[Accessed 10 March 2018]. Available from http://africafertilizer.org/national