Volume 5 No: 15 (2020)

Mobilizing Investments in Fertilizer Production and Distribution in Ethiopia, Nigeria and Uganda

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April, 2020

FARA
Forum for Agricultural Research in Africa

zef
Center for
Development Research
University of Bonn

PARI

ISSN 2550-3359
9 772550 335000

Citation

Olaleye A.O, and Edje, O.T, (2020). Mobilizing Investments in Fertilizer Production and Distribution in Ethiopia, Nigeria and Uganda. FARA Research Report 5(15): Pp 107

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ISSN:2550-3359

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Acknowledgements

This study is part of the research endeavour of the "Program of Accompanying Research for Agricultural Innovation" (PARI) [https://research4agrinnovation.org/]. PARI is the research program of the One World – No Hunger initiative of the Government of Germany and it is coordinated by the Center for Development Research (ZEF), University of Bonn. The funding for PARI and by implication this study was provided by the German Federal Ministry of Economic Cooperation and Development (BMZ). We acknowledge the technical support from Dr. Heike Baumuller and her team in ZEF, Dr. Wole Fatunbi and his team in FARA is also acknowledged for technical reviews and other facilitation efforts

In addition, we would like to specifically thank our team members on the field in Ethiopia (Dr. Solomon Addisu Legese and his team), Nigeria (Mr. Jide Ogunsanya and his team), and Ms. Judith and her team in Uganda. In spite of their tight schedules, they were able to administer questionnaires (or survey instruments) within two months, conduct focus group discussion (FGD) and enter the data into MS Excel and send to us for analyses. Again, special thanks go to Prof. Adetola Adeoti, Agricultural Economics Department, University of Ibadan, Ibadan, Oyo State Nigeria. She was able to share part of her data on fertilizer supply chain in Nigeria. In addition, profound thanks go to Dr. Florence Birungi Kyazze, Makerere University, Kampala, Uganda, who was able to help locate and persuade Ms. Judith to help facilitate the field work. Also, special thanks go to Dr. Oduniyi S. Oluwaseun, University of South Africa, Pretoria, South Africa for his assistance in typing the survey. A special thanks to the Editor, Folake Olayinka Olaleye for the editorial support.

Executive Summary

The problem of inorganic fertilizer demand and supply in sub-Saharan Africa (SSA) is multifaceted as it is being impacted by multiple factors. The literature is replete with data on the demand factors, but sparse data are available on the supply factors. The PARI/FARA research focuses on supply-side factors and seeks to analyse the overarching research questions that guide the study. The study was conducted using a mixed methods approach in each country (i.e. Ethiopia, Nigeria and Uganda), which comprised (i) a review of the literature on fertilizer supply, demand, and use; (ii) interviews with selected key participants in fertilizer import and marketing and (iii) interviews/surveys with smallholder farmers in Ethiopia, Nigeria and Uganda. The data collected were analyzed using (i) multivariate logistic analysis and (ii) Stepwise Discriminant analysis using SAS programs. Results from the desk study and the field survey showed that the government of each of the three countries used a separate approach for regulating the fertilizer sub-sector. Of the three countries, the most successful is Ethiopia for consistently ensuring that smallholder farmers have uninterrupted access to inorganic fertilizers across seasons at the lowest possible prices. On the contrary, Uganda is still far behind when compared to Ethiopia and Nigeria. The most important constraints to increased fertilizer uptake in Nigeria and Uganda are poor road infrastructure and inconsistent policies regarding fertilizer subsidies.

The introduction of subsidies in Nigeria, for example, in certain years, has contributed to the high costs which have added to fiscal burdens. Uganda recently came-up with the national fertilizer policy, hence, the fertilizer supply chain is still affected by several constraints. The fertilizer supply chain in Nigeria is solely in the hands of selected importers with low capacity to facilitate fertilizer supply. This situation is further worsened by inconsistencies in government policies of fertilizer supply. In the three countries, the fertilizer policy environment seems not to be conducive for the development of competitive fertilizer markets at the local, national and regional levels. In the ECOWAS, COMESA and SADC countries, the fertilizer price is affected by the value added tax (VAT) which is about 18% and other levies, which eventually add-up and increase the delivery prices of inorganic fertilizers to the smallholder farmers. In Uganda, our study revealed the poor quality control, hence, inorganic fertilizers are not properly labelled and are often adulterated. Other factors issues found in the three countries include lack of information and poor linkages between suppliers/wholesalers, traders and smallholder farmers. In Uganda and Nigeria, after the cost, insurance, and freight (CIF), the second highest cost of fertilizer prices is the high cost of transportation which is especially high for a landlocked country like Uganda. Increasing attention to supply-side factors in the use of inorganic fertilizer is an important element that require attention in order to help smallholder farmers gain access to inorganic fertilizers at the lowest cost, at the right time, and in the right quantity so as to increase crop production, and reduce poverty.

Background

There are 39 countries in sub-Saharan African (SSA) and is divided into four sub-regions: Central Africa (4 countries), Eastern Africa (10 countries), Southern Africa (9 countries), and Western Africa (16 countries). There are differences in these sub-regions in terms of socioeconomic structure, and the mean income levels which can shed light on the differences that exist in food security. Some of the characteristics that have stagnated the success of Green Revolution in SSA include: (i) predominance of rain-fed agriculture, (ii) infertile soils (i.e. low cation exchange capacity (CEC), deficiencies of nitrogen, phosphorus, and potassium), (iii) lack of functioning competitive markets, (iv) lack of conducive economic and enabling political environment, (v) low and stagnant labour productivity, (vi) low investment in agricultural research and development, (vii) poor infrastructure (i.e. road, railways, electricity, internet and the like) (Binswanger-Mkhize & Savastano, 2014[1]).

In SSA, the population has been projected to more than double from 856 million to about 2 billion in 2050 (Binswanger-Mkhize & Savastano, 2014). The abundant vast resource in Africa offers great potential for increased agricultural productivity (FAO, 1993). However, if the performance of agriculture is estimated in terms of per-capita food production, there has been a great decline in the past decades (World Resources Institute, 1994, p.292). This decline may be attributed to many factors, which may be economic and political; the overall effect of this is the decline in the quality of land resource base in many of these countries (Eswaran et al., 1997; Drecshel, et al, 2001; Tan et al., 2005; Eswaran et al., 2001; Lal et al., 2019). The depletion of soil nutrient is of great concern in SSA as this is directly linked to food insecurity. In most of these countries, the intensification of land for agricultural production has not been adequately backed up with application of external inputs (i.e. inorganic fertilizers) (Henao and Baanante, 1999). The yearly nutrient mining from crop production is exacerbated by increase in soil degradation brought about by wind and water erosion, which have resulted in depleted and degraded soils (Ayoub, 1999; Sheldrick et al., 2002). This has resulted in “declining crop yields under the conditions of low-input and unbalanced fertilization” in many parts of Africa (Lal et al., 2019).

It has been estimated that most countries in Africa grow high-nutrient extracting crops such as maize, cassava, yam, sweet potato, groundnut and soybean (Table 1). These crops have been reported to extract large amounts of basic soil nutrients – N, P and K from the soil on an annual basis, with little or no commensurate inputs such as organic and inorganic fertilizer application (Boxman & Janssen, 1990; Cooke, 1982; Sanchez et al., 1982).

Table 1: Nutrient removal by perennial crops in selected African countries

Crops	Yield (kg/ha)	Nutrient removal (kg/ha)			Sources
		N	P	K	
Maize	1000	11-77	2.2-9.7	8-72	(Boxman & Janssen, 1990)
Cassava	8000	30	10	50	Sanchez, et al., (1982)
Yam	11,000	38	3	39	(Cooke, 1982)
Sweet Potato	16,500	175	34	290	Sanchez et al., (1982)
Groundnut	800	30	2.2	5.0	Cooke, (1982)
Soybean	1000	49	7.2	21	Sanchez et al., (1982)

Fertilizer is seen as a bedrock of green revolution accounting for more than 50% of yield increase in Asia and globally (Wigg, 1993). Studies have found that one-third of the cereal production is as a result of increase in fertilizer use and related factors of production (Bumb, 1995; Van Keulen & Breman, 1990). However, most of these studies showed that the quantity of fertilizer applied (i.e. N, P and K) by farmers across SSA is extremely low (i.e. 9kg/ha) compared to other parts of the world (i.e. Asia, Europe, Oceania, North America, South America, and Central America) which apply between 104kg/ha – 142kg/ha (Bumb, 1995; Ciceri & Allanore, 2019; Klutse et al., 2018).

The low use of fertilizer by farmers has been hinged on demand and supply (Ambia & Mandala, 2016; Hernandez & Torero, 2011, 2013; Liverpool-Tasie et al., 2017a; Ngongi, 2016; Sasson, 2012; Sheahan & Barrett, 2017; W. M. Stewart & Roberts, 2012; Van Ittersum et al., 2016) and other factors such as lack of policy and institutional support, weak fertilizer markets, farmers' lack of access to credit and inputs, inappropriate fertilizer packaging sizes, deteriorating soil science capacity, and weak agricultural extension (Chianu et al., 2012).

In a recent study, across selected countries in SSA (i.e. Ethiopia, Malawi, Niger, Nigeria, Tanzania and Uganda), it was observed that Ethiopia unlike other countries in the SSA appears to have better use of agricultural inputs (Binswanger-Mkhize & Savastano, 2014a). It was reported that 53% of farmers in Ethiopia use organic fertilizer, 41% (inorganic fertilizer), and 18% and 23% use improved seeds and agrochemicals. However, in Nigeria, 41% of the households were reported to be using inorganic fertilizer and 34% agro-chemicals. Several measures and policy reforms would be needed to improve access to fertilizer and low use of inorganic fertilizers, especially in the villages. In addition, it is of paramount importance that a proactive approach be adopted by involving and building the capacity of the private sector (i.e. input dealers) especially in the rural areas. Gregory and Bumb (2006) suggested five pillars that are necessary in creating well-functioning fertilizer markets in the rural areas: (i) policy reforms, (ii) building of human capital, (iii) improve finance, (iv) improve market information and (v) improved fertilizer regulations.

Therefore, to improve fertilizer access at the regional/country levels, it is important to remove policy distortions or interventions by the government of many countries in SSA.

Objectives

The problem of fertilizer market in SSA is multifaceted and is affected by multiple factors on both demand and supply. In this context, the study focused on the factors that affect its supply and seek to analyse the overarching research question outlined in the Terms of reference (ToR) (see page Table 2 on page 6).

Materials and Methods

The study involved three countries: (i) Ethiopia, (ii) Nigeria and (iii) Uganda. These countries were chosen based on the terms of reference (ToR) given by the FARA/PARI. Kenya was suggested as one of the countries, but, after several contacts with colleagues from the country, there was no commensurate response; hence, Ethiopia was chosen to replace Kenya. The study involved the examination in detail; the links in the inorganic fertilizer supply chain in each of these countries from import until it gets to the smallholder farmers who use the fertilizer on their crops. In addition, policies and regulations through which the government guides and controls the supply of inorganic fertilizer to farmers were reviewed and a cross comparison was made across these countries. The study set out to answer some of the questions outlined in Table 2. Within Table 2, approaches/methods used are summarized.

Scope of the Study

The investigation focussed on the supply chain of fertilizers in three countries (i.e. Ethiopia, Nigeria and Uganda) in SSA by examining the research questions outlined in the terms of reference (ToR) (Table 2). Attempts were made to study through interviews and focus group discussions (FGDs) the supply chains of fertilizers in these three countries and produce a map, and also to evaluate the performance of the stakeholders in the supply chains through all the actors involved in the fertilizer supply (i.e. Government, producers, importers, distributors, retailers and farmers). The study analyzed the lead-time, cost of logistics, identified some bottle necks/constraints, and examined through a desk study, the policy implications on fertilizer in each country.

Table 2: Research questions and approaches used for the study

S/No	Research Questions	Approach/Methods
1	How efficient are fertilizer supply chains in SSA, especially in remote areas?	Quantitative (Primary data) & Desk study (secondary data)
2	To what extent do the informal fertilizer trade and informal cross-border trade distort local fertilizer markets?	Quantitative (Primary data) & Desk study (secondary data)
3	What policies can be effective in reducing transaction costs for fertilizer dealers?	Quantitative (Primary data) & Desk study (secondary data)
4	Is the public sector's direct engagement in fertilizer markets a viable strategy to increase fertilizer use in SSA?	Quantitative (Primary data) & Desk study (secondary data)
5	What policies are necessary to mobilize private-sector investment in fertilizer production and distribution in SSA?	Quantitative (Primary data) & Desk study (secondary data)
6	To what extent can SSA countries be self-sufficient in fertilizer production, and is this a better option than relying on fertilizer imports?	Desk study (secondary data) and FGD
7	Can regional cooperation between SSA countries help achieve economies of scale and lead to more efficient fertilizer supply chains?	Desk study (secondary data)
8	What sub-regional policies and frameworks will be required to ensure effective production, distribution and marketing of fertilizer?	Desk study (secondary data)
9	What partnership arrangements will be most effective for fertilizer manufacturing and use in Africa?	Desk study (secondary data)
10	What role and what will be the implication of intercontinental partnerships viz, South-South and North-South partnerships in ensuring the manufacturing of fertilizer and use in Africa.	Desk study (secondary data)

Limitation of the study

The supply chain of fertilizer involves several actors/stakeholders from suppliers to farmers; hence, it is beyond the scope of this study to address all of these. The reason is that all stakeholders should have input in the document, and this will require a huge investment of time and money. The study covered three countries in SSA (i.e. Ethiopia, Nigeria and Uganda) in 30 days (i.e. 5th November to 5th December 2019) using questionnaires, interviews and FGDs. In addition, detailed reviews of published documents (i.e. government white papers, conferences and orkshops proceedings, published peer-reviewed journal articles) were assessed and reviewed within 60 days (i.e. 5th November 2019 – December 31st, 2019). As anticipated, some respondents were not willing to be interviewed and further persuasion and prodding had to be employed for them to answer all the questions satisfactorily. Most suppliers and traders were not willing to provide the information required of them, as most of them were apprehensive of the enumerators' affiliation to the Government as they thought they would have to pay more taxes on imported fertilizer.

Field Survey

The household panel survey was used in each country (i.e. Ethiopia, Nigeria and Uganda). The following pieces of information were collected: (i) household demographics, (ii) farm/household landholding and assets, (iii) information on a range of economic activities during that agricultural year (i.e. land use, input use and access to farm services, agricultural and livestock production, and nonfarm income activities). Information was also scooped regarding fertilizer use and the survey enumerators collected information on the quantity and source of commercial purchases, fertilizer acquired from wholesalers, cooperatives, farmers' union and such as well as the prices paid for inorganic fertilizers. The surveys also collected information from the farmers on the quantities of fertilizer and other inputs (i.e. seeds, fertilizer, fungicides, insecticides, herbicides) obtained through government subsidy programs, where these were acquired and if there were prices paid for these. Data were also collected from fertilizer suppliers, especially in Uganda and Nigeria. Information was also collected on the broader processes that each country uses in fertilizer marketing and distribution through the use of semi-structured interviews with key individuals in the fertilizer supply chain. These include both the private and public sector actors. In each country, between 105 and 150 questionnaires were distributed to the actors who are involved in fertilizer importation, marketing and utilization (i.e. smallholders). Data were obtained through the small trader and farmer surveys which were collected in each country to permit quantitative descriptive analysis of the multiple facets and constraints to fertilizer supply and use. Target areas used in data collection were selected based on information from local experts in each country in the areas/localities where there is concentration of those that used more fertilizers in the communities/countries sampled (Table 3).

Field Survey/Administration of Questionnaires

Surveying of fertilizer traders was conducted in each country by selecting areas/zones where more fertilizers were used by smallholders (Benson and Mogues, 2018). Retail traders in each of these localities were purposively selected and were interviewed using structured questionnaires. The number of the retail traders ranged from 10 to 15 in Uganda and Nigeria. These data were not collected in Ethiopia as the government is directly in charge of fertilizer purchase and distribution.

Table 3: Survey sites and samples for fertilizer supply study in Ethiopia, Nigeria and Uganda

Parameters	Ethiopia	Nigeria	Uganda
Study areas	W/Gojjam	Benue Abuja Nasarawa	Luwero
Fertilizer trader survey	None‡	Nasarawa Benue	Kibamba Zirobwe Kasana
Farmer survey	Zenzelima Sebatamit Woreb Yibab Robit	Benue Abuja Nasarawa	Naluvule Kyawangabi Bamugolode Kalagala Nabitete Kiyunga Kibamba Gembe Jandab Lukooge Mpangati Ssempa
Survey period	5th Nov-Dec 5th	5th Nov-Dec 5th	5th Nov-Dec 5th
Total Number of Samples	n= 150	n=105	n=120

‡ In Ethiopia, the sale of fertilizer is under the control of the Government of Ethiopia (GoE)

In the results presented, for the trader survey, the sample was disaggregated by scale of operation based on the size of the largest order of fertilizer that the trader reported obtaining from a supplier (Benson and Mogues, 2019). Considerable variability was observed in the scale of operations of the fertilizer traders in the study sample. However, for smallholder farmers, these were interviewed based on their cropping practices along with the amount and types of fertilizer used and how the fertilizer was obtained. Characteristics of smallholder farmers, wholesalers/traders were included as explanatory variables in the models (i.e. gender, marital status, age, household number, household size, and education of the smallholder farmer etc). The differences in gender were captured by a dummy variable: the male takes the value of 1 and female as the value of 0. Age and education are expressed respectively as years of age and number of years of formal schooling completed by the smallholder farmer, household size, household number, farm size, age category, years of farming experience, membership of a cooperative society, and frequency of extension visits. The study also included plot-level characteristics (i.e. plot size, perceived soil fertility etc). The plot size variable were measured in hectares, while age was measured in years.

Data Analyses

Data collected were subjected to: (i) summary statistics using the means procedure (PROC MEANS), (ii) frequency of occurrence of variables using PROC FREQ; (iii) analysis of variance using the general linear model (PROC GLM) to evaluate the means of selected variables across locations/sites/districts, (iv) multivariate logistic regression linked with probit (PROC LOGISTIC), to evaluate factors that will influence use of fertilizers among smallholder farmers and (v) the multivariate stepwise discriminant analysis (PROC STEPDISC) was used to evaluate relative weights of factors that might affect/influence fertilizer utilization among fertilizer suppliers/traders. These statistical analyses were performed using SAS University Edition, 9.4. (SAS Institute, 2017). All tests were two-tailed and $p < 0.05$ was considered statistically significant. Logistic regression has been standard mathematical-statistic method (Garcia et al., 1983; Nerlove and Press, 1973; Schmidt and Strauss, 1975). It is used in many instances to explain that dependent variable is not continuous but binary, and it can only be two values- i.e. do you use fertilizer? The answers can only be yes-"1" or no "0". Thus, Logit analysis is characterized by the prediction of probability of the event that either occurred or not (Nerlove and Press, 1973). Thus, the calculated probability is thus equal to either 1 or 0. It is necessary to realize logit transformation within the logistic regression to establish this condition. This logit transformation is based on “ratio of chances and hopes” (Kollár, 2014).

Review of Fertilizer Issues in Ethiopia, Nigeria and Uganda

The section deals with the following sub-topics across the countries under consideration: (i) fertilizer use patterns, (ii) fertilizer supply chains, (iii) fertilizer cost structure, (iv) transportation, (v) fertilizer taxes and levies and (vi) fertilizer subsidies.

(i). Fertilizer Use Patterns

Ethiopia Inorganic fertilizer (uea and di-ammonium phosphate) (Figure 1) in Ethiopia is used primarily for cereal production and the consumption has increased steadily over the years according to Ethiopian Statistical Agency (CSA, 2019). Following the same trend is the fertilizer nutrients (N, P_2O_5, and K_2O) applied per/hectare which has been increasing (Figure 2).

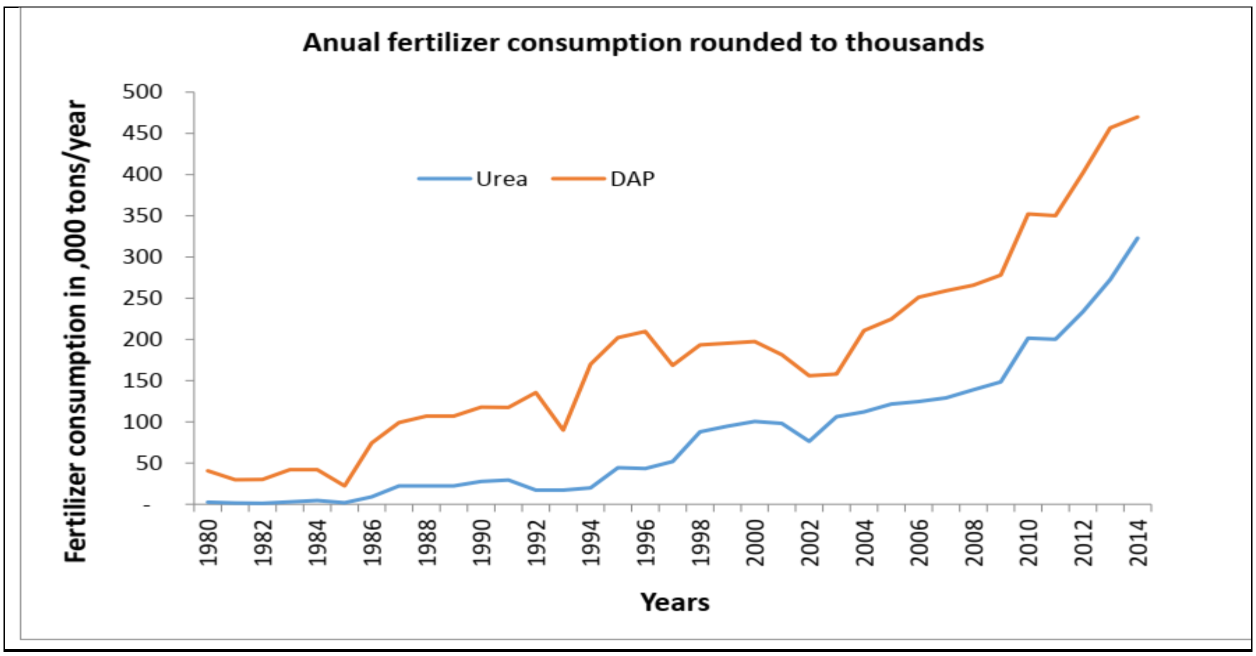


Figure 1: Annual fertilizer consumption in Ethiopia (1980-2014)

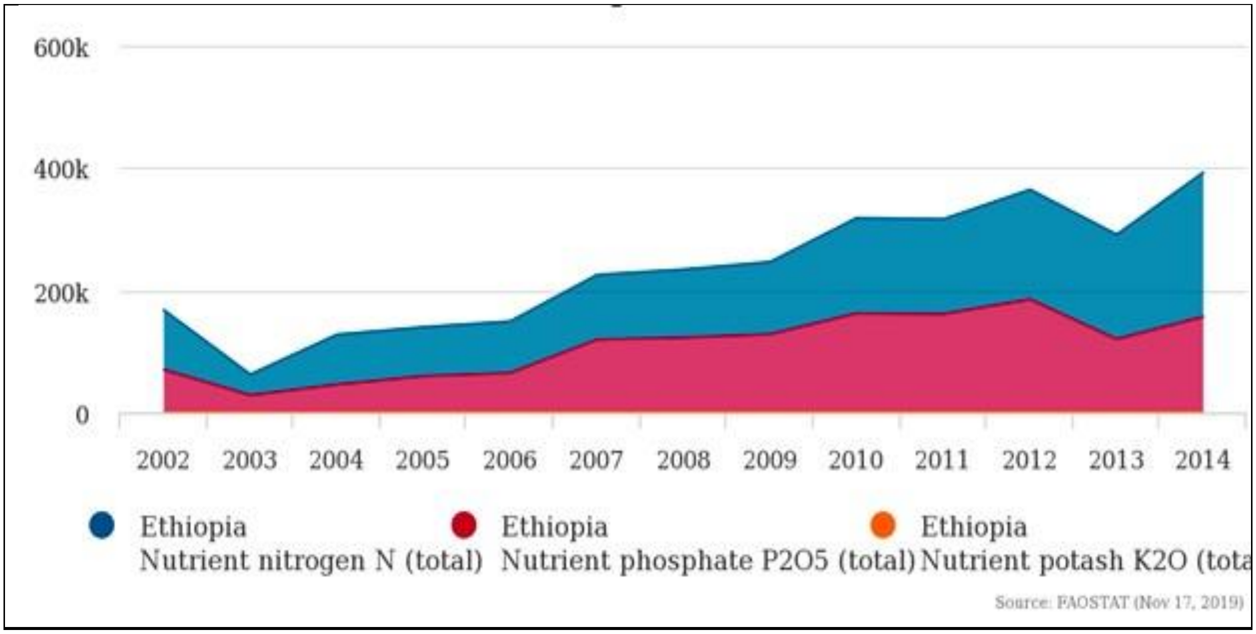
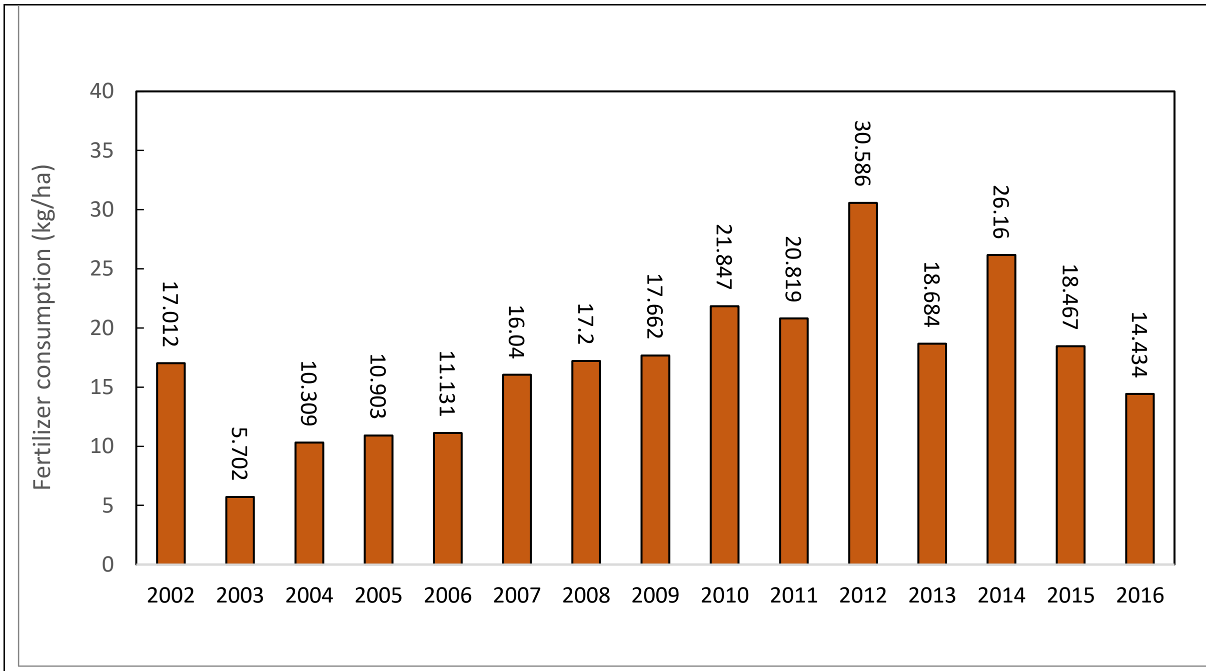


Figure 2: Fertilizer consumption in nutrients (2002-2014).

Data presented by the World Bank showed that the amount of fertilizer applied (i.e. kg/ha) to arable land has been fluctuating and this is between 17.012kg/ha (2002) and peaked at 30.586kg/ha in the year 2012 (Figure 2). According to the statistics from the Ministry of Agriculture and Rural Development (MoARD), the quantity of fertilizer applied showed that 72.40% of the inorganic fertilizers from the 2005/2006. to 2010/2011 cropping seasons were consumed by only two regions – Oromia and Amhara, while the Southern Nations, Nationalities and Peoples' Region (SNNPR) and Tigray accounted for only 15.54 and 6.86%, respectively as shown in Table 4 (Rasid et al., 2013; IFDC, 2015). There is a great variability in the fertilizer types consumed across the 10 regions by nutrient types (Table 5). The diammonium phosphate (DAP) is gradually being replaced by NPS in order to meet the sulfur demand of the soils in the country, and this is based on the soil fertility mapping and crop response information which is the result of the collaboration among the Regional Federal Research, Ministry of Agriculture and the Agricultural Transformation Agency (AATA).



Source: World Bank, (2019)

Figure 3: Fertilizer consumption per unit of arable land in Ethiopia (2002-2016).

Table 4: Average fertilizer consumption (MT) trends by regions (2010/11 – 2015/2016)

Region	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	% Share
Oromia	205,874	188,666	255,136	279,300	291,368.2	289,423	36.59
Amhara	198,535	201,570	228,226	244,181	296,756.7	308,343	35.81
SNNPR	81,376	96,077	66,065	114,901	166,413.1	116,548	15.54
Tigray	29,270	35,226	51,620	58,014	61,373.9	47,670	6.86
Hareri	0	0	0	0	0	0	0.00
B/Gumuz	393	0	0	0	0	0	0.01
Gambella	400	0	0	0	0	0	0.01
Somali	443	0	0	0	0	0	0.01
Others	37,594	29,040	34,297	32,848	42,913	36,707	5.17
Total	**553,885**	**550,579**	**635,343**	**729,244**	**858,825**	**798,691**	**100.00**

Source: IFDC, (2015)

Table 5: National fertilizer consumption (MT) trends by nutrient types (2010/11-2015/16)

Fertilizer type	2010/11	2011/21	2012/13	2013/14	2014/15	2015/16
Urea	201,576	200,345	233,526	272,625	322,930	290,080
DAP	352,309	350,234	401,817	456,618	469,793	64,440
NPS (19-38-0+7S	0	0	0	0	66,102	194,172
NPS(17.7-35.5-0+7.6S+2.2n)	0	0	0	0	0	50,000
NPS(18.9-37.7-0-6.95S+0.1B)	0	0	0	0	0	200,000
Total	**553,885**	**550,579**	**635,343**	**729,244**	**858,825**	**798,691**

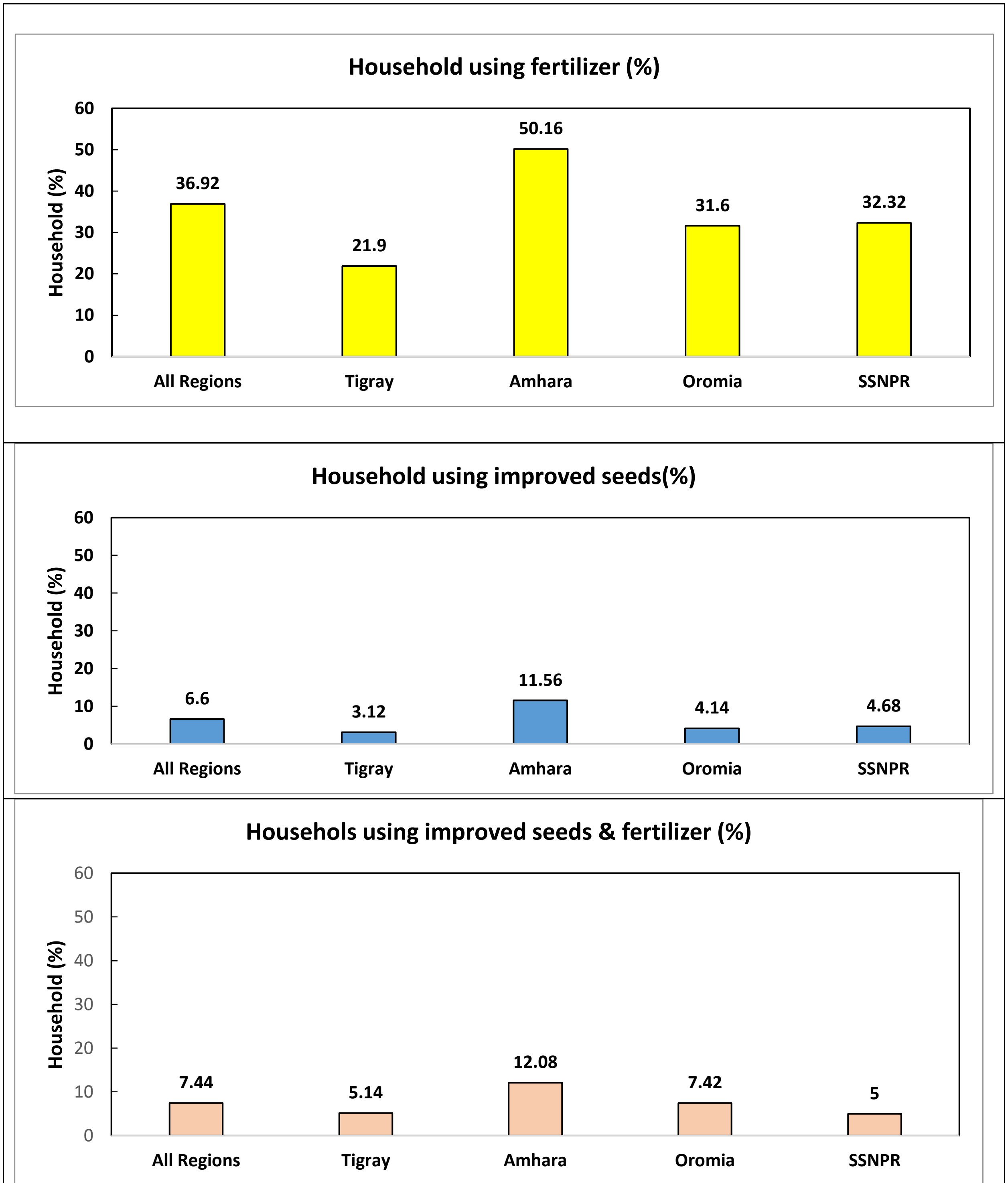
DAP = Di-ammonium phosphate; Source: IFDC, (2015).

Details of the areas planted to crops (Table 6), area fertilized and the respective percentages across major crops and cropping seasons showed that the area fertilized vary across regions (Rashid et al, (2013). A close observation of the table showed that more fertilizer is applied to *teff* compared to other cereals (i.e. maize and wheat), this is because, the price of teff has been on the increase over the years (Rashid et al., (2013) Data shown above only referenced urea and di-ammonium phosphate (DAP), though there is increasing use of organic fertilizers across these regions. In a survey conducted by the Ethiopian Agricultural Household and Marketing Surveys (EAHMS) and IFPRI in collaboration with the Ethiopian Development Research Institute (EDRI) in 2008, data from about 2,000 households showed that highest households that used inputs (i.e. fertilizer, seeds and improved seeds) was in the Amhara region.(Figure 4) (Rashid et al., 2013; Spielman et al., 2013).

Table 6: Planted and fertilized area ('000 ha) by region and crop, (2000/01-2010/11) in Ethio

		2003/04			2007/08			2010/011		
Region	**Crops**	**Planted**	**Fertilized**	**Fertilized (%)**	**Planted**	**Fertilized**	**Fertilized (%)**	**Planted**	**Fertilized**	**Fertilized (%)**
Amhara	**Cereal**	**2,402**	**345**	**14.4**	**2,923**	**646**	**22.1**	**3,271**	**925**	**28.3**
	Maize	258	82	31.8	387	168	42.29	472	241	51.1
	Wheat	333	94	28.3	427	154	36.2	499	243	48.7
	Teff	826	144	17.4	1,047	292	27.9	1,014	387	38.2
	Others	985	25	2.6	1,052	31	3.0	1,286	54	4.2
Oromia	**Cereal**	**3,168**	**583**	**18.4**	**4,052**	**771**	**19.0**	**4,576**	**961**	**21.0**
	Maize	786	150	19.0	969	151	15.6	1,109	249	22.5
	Wheat	556	138	24.8	769	240	31.2	816	217	26.6
	Teff	820	238	29.1	1,083	345	31.9	1,289	447	34.6
	Others	1,006	57	5.7	1,231	35	2.8	1,362	48	3.5
SNNPR	**Cereal**	**668**	**72**	**10.4**	**785**	**92**	**11.7**	**857**	**191**	**22.3**
	Maize	216	17	8.1	249	38	15.2	237	55	23.0
	Wheat	115	28	24.1	119	26	22.1	131	47	35.9
	Teff	183	23	12.6	235	24	10.0	265	76	28.8
	Others	174	4	2.1	183	4	2.3	224	13	5.9
Others	**Cereal**	**741**	**130**	**17.6**	**970**	**141**	**14.5**	**986**	**233**	**23.7**
	Maize	106	11	10.7	152	13	8.8	144	20	14.0
	Wheat	95	29	30.9	111	26	23.9	107	49	45.8
	Teff	180	54	33.8	200	58	28.7	192	71	37.1
	Others	380	35	9.3	507	44	8.6	542	93	17.1
National	**Cereal**	**6,999**	**1,130**	**16.1**	**8,730**	**1,649**	**18.9**	**9,691**	**2,310**	**23.8**
	Maize	1,367	260	19.0	1,767	371	21.0	1,963	565	28.8
	Wheat	1,099	289	26.3	1,425	447	31.4	1,553	556	35.8
	Teff	1,989	459	23.1	2,565	718	28.0	2,761	981	35.5
	Others	2,544	122	4.8	2,973	114	3.8	3,413	207	6.1

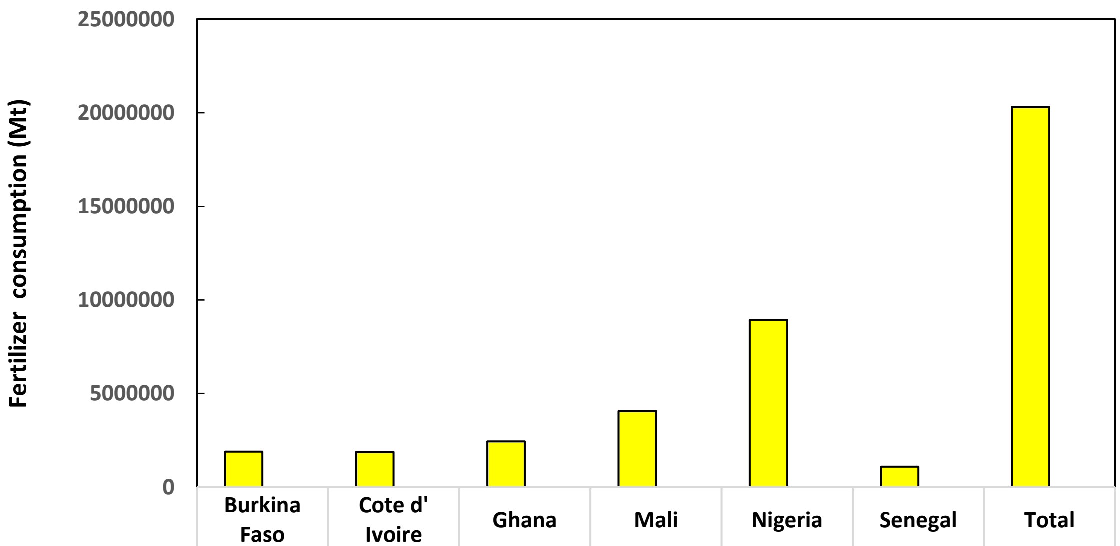
Source: Rashid et al., (2013); SNNPR, Southern, Nationalities. & Peoples Region



Source: Rashid et al., (2013).

Figure 4: Percentages of households using fertilizers and improved seeds, in Ethiopia (meher seasons/2007/2008).

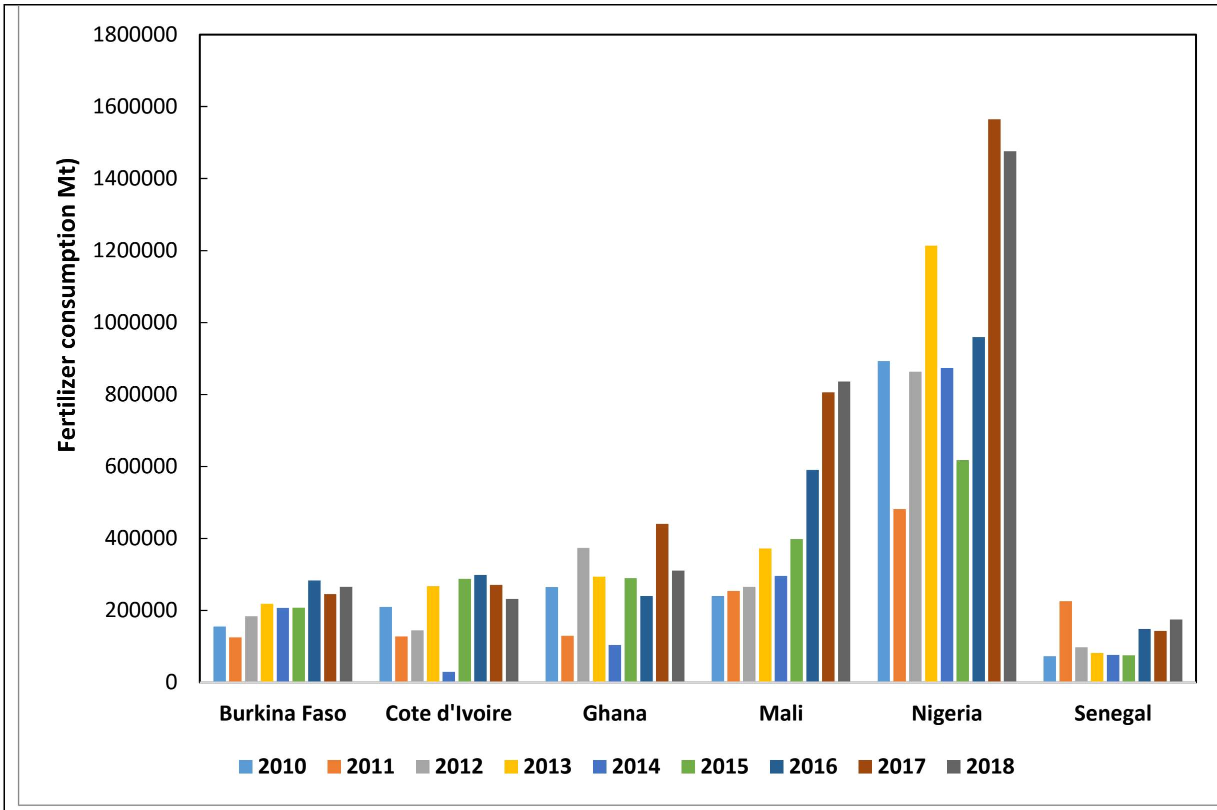
Nigeria Fertilizer market in West Africa – selected ECOWAS countries, showed that between 2010 and 2018, Nigeria consumed the largest share (i.e. 44.05%) of all imported fertilizer, followed by Mali and Ghana with 19.98 and 12.06%, respectively (Figures 5 and 6). The types of fertilizer consumed by each country is shown in Table 7. Countries with the highest consumption of NPK fertilizer were: Ghana, Burkina Faso, Senegal, Nigeria and Cote d'Ivoire. Urea is consumed mostly in Nigeria, followed by Senegal, Mali, Cote d'Ivoire and Ghana. The muriate of potash (MoP) is consumed mostly in Cote d' Ivoire and Nigeria, respectively (Table 7).



	Burkina Faso	Cote d' Ivoire	Ghana	Mali	Nigeria	Senegal	Total
Total	1892576	1868926	2448160	4058513	8944334	1095365	20307874
Percentage (%)	9.32	1.14	12.06	19.98	44.05	5.39	

(Source: AfricaFertilizer.org)

Figure 5: Fertilizer consumption by selected countries in West Africa region



(Source: Source: AfricaFertilizer.org

Figure 6: Annual fertilizer consumption in West Africa: 2010 – 2017

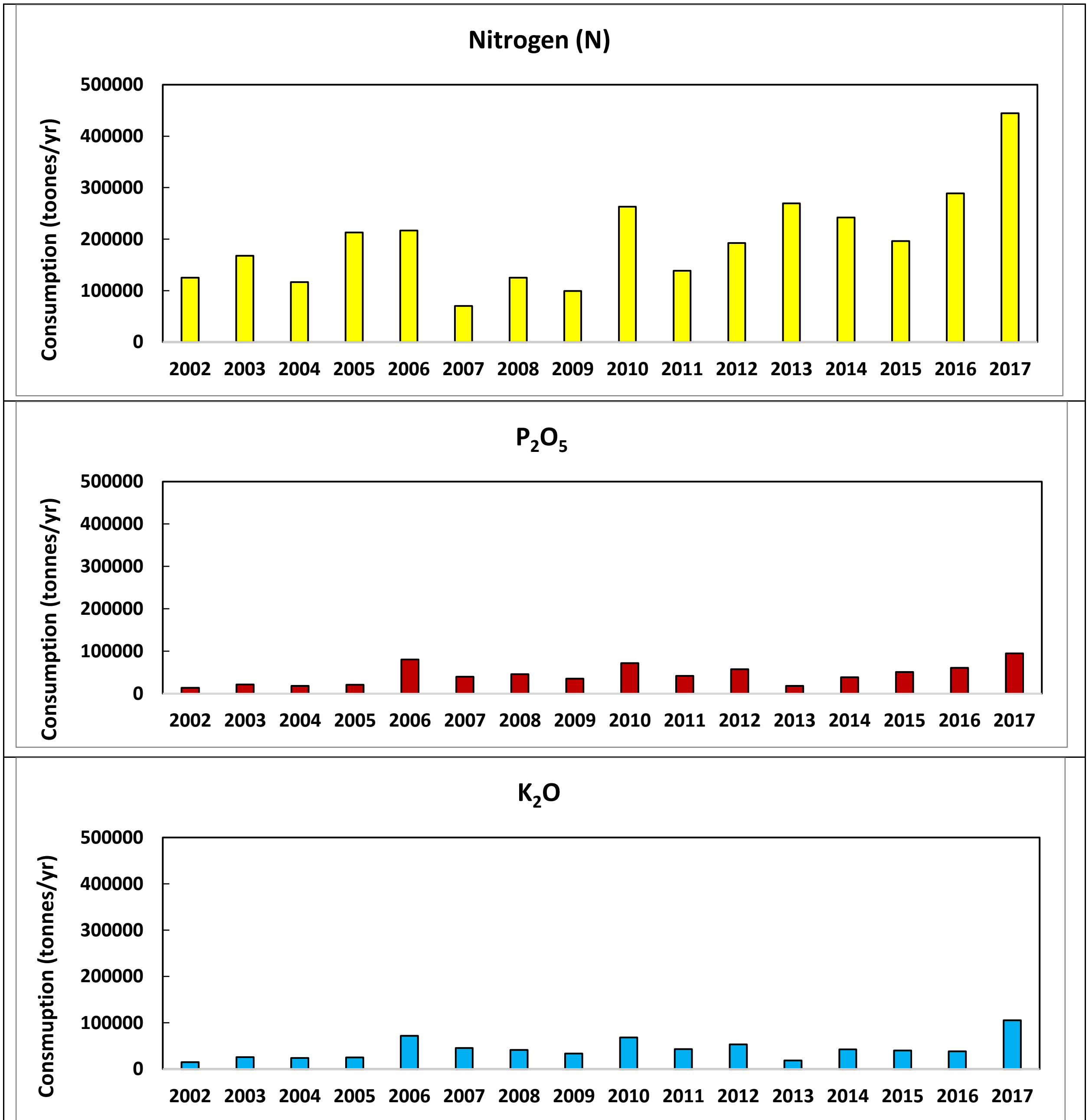
Table 7: Fertilizer types consumed as a percentage of total consumption in selected West African countries (2010 – 2018)

	NPK	Urea	MOP	SoA	TSP	DAP	SSP	NP	PK	Organic	Others
						%					
Cote d' Ivoire	21	17	27	6	7	7	0	0	0	7	4
Mali	0	28	18	11	0	10	0	0	0	8	1
Senegal	48	36	2	0	0	10	0	0	0	3	1
Burkina Faso	62	0	3	0	0	2	0	0	0	4	2
Nigeria	24	51	7	0	0	6	0	0	0	0	0
Ghana	71	14	5	3	3	0	4	8	4	0	4

MOP= Muriate of Potash; TSP= Triple Super Phosphate; DAP= Di-ammonium phosphate; SSP= Single Super Phosphate; NP= Nitrogen and Phosphorous; PK= Phosphate & Potash; Organic = Organic fertilizer

Source: AfricaFertilizer.org

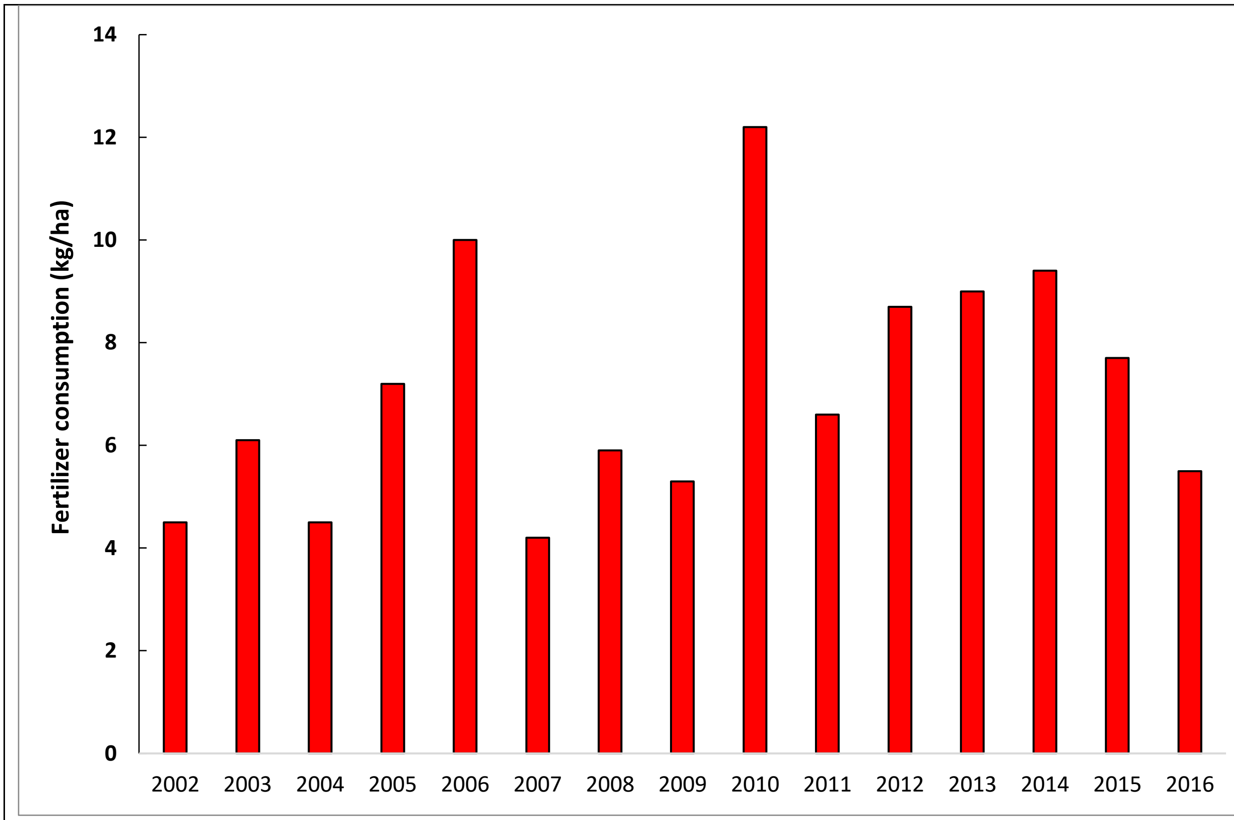
An observation of Table 7 showed that only selected countries – consumed organic fertilizers and these are- Mali > Cote d' Ivoire > Burkina Faso > and Senegal. The amounts of nutrients consumed in Nigeria (i.e. N, P_2O_5 and K_2O) showed that nitrogen is the most consumed fertilizer nutrient (Figure 7).



Source: FAOSTAT, 2018

Figure 7: Fertilizer consumption by each of the nutrients in Nigeria (2002-2017) Title is not clear. Needs rewording

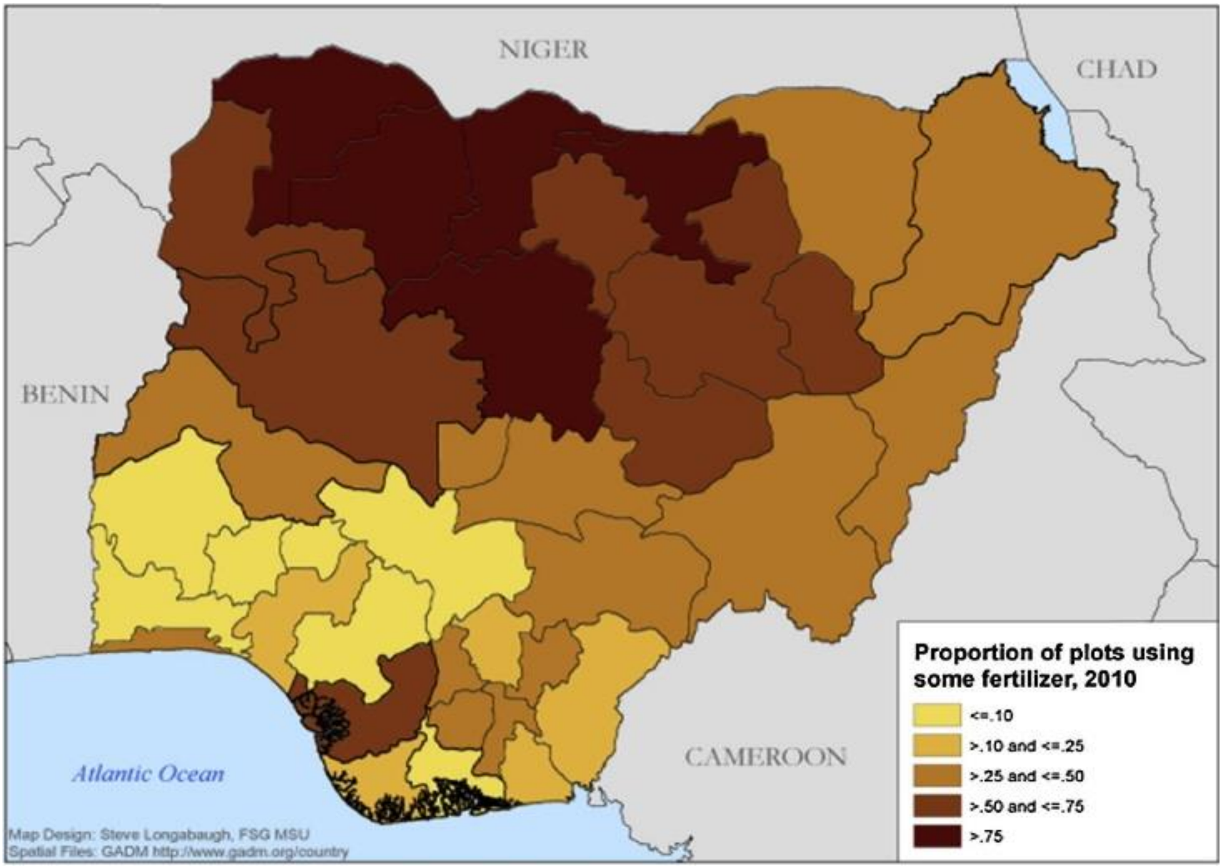
Despite these statistics, Nigeria is one of the countries where farmers still use below 50kg nutrients per hectare after the Comprehensive Africa Agricultural Development Programme (CAADP) goal that was set in 2003. The amount of fertilizer nutrients consumed in Nigeria between 2002 and 2016 was between 4.20 and 12.20kg/ha (Figure 8).



Source: FAOSTAT, 2018

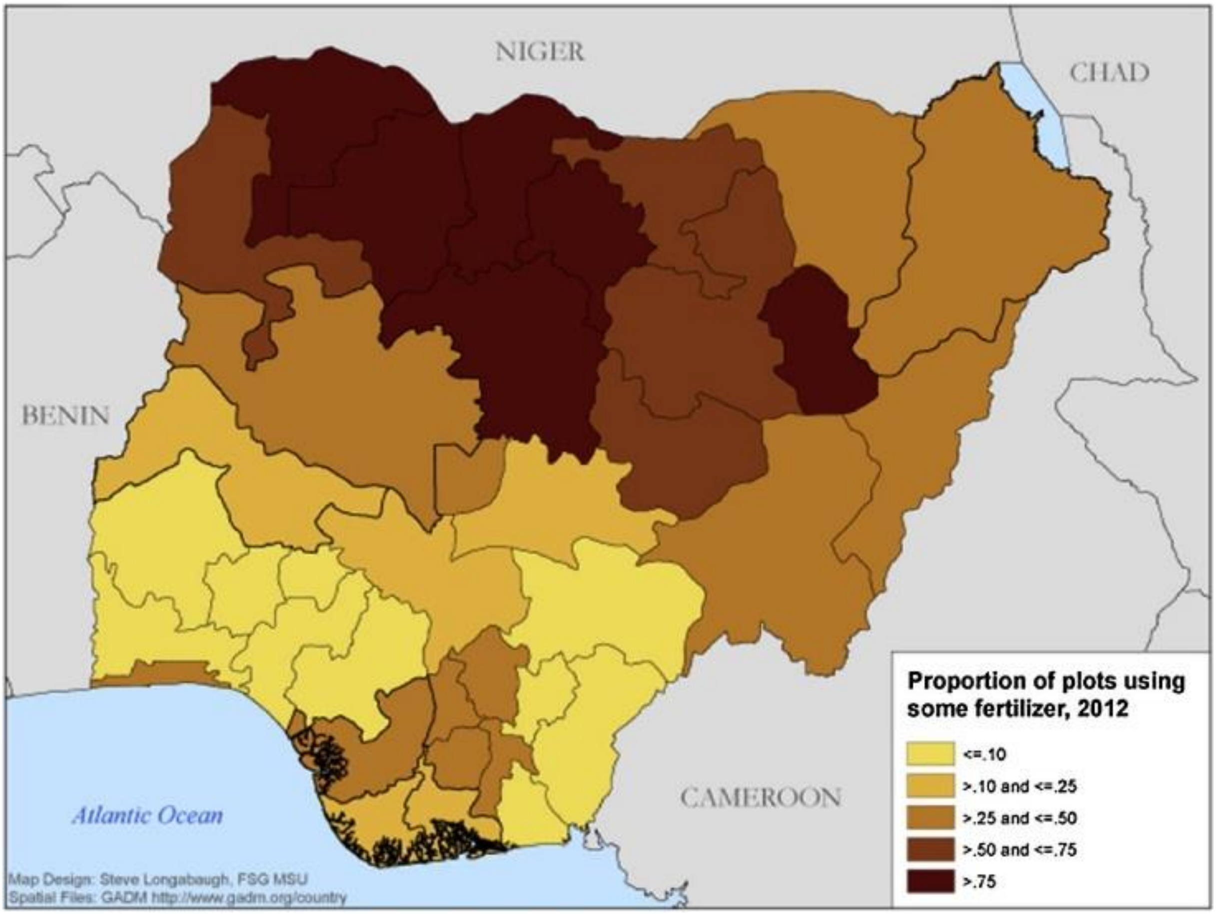
Figure 8: Fertilizer nutrients (kg/ha) consumed in Nigeria (2002-2016).

However, in a recent study, it was found that fertilizer use rates may not be as low as previously reported by many authors (Adediran, et al., 2005; Banful, et al., 2009; Banful, et al., 2010; Bosede, 2010; Liverpool-Tasie, et al., 2017; Liverpool-Tasie & Takeshima, 2013; Manyong, et al., 2001; Olasantan, 1994). Liverpool-Tasie, et al., (2017) noted that despite many factors that had been cited as being responsible for the low use of inorganic fertilizer in Nigeria, these authors found that the rate of fertilizer use across Nigeria is diverse in terms of farming systems and cropping patterns. In addition, they found that fertilizer use and needs still vary across agro-ecological zones (AEZ), market conditions, government policies, cropping patterns and fertilizer responsiveness. It was observed from their study that fertilizer use in the northern part of Nigeria was higher than what obtained in the southern states (Figures 9A and 9B). The higher application rates in the northern part of Nigeria was attributed to lower soil fertility (Smith et al., 1997), larger cultivated area, and the cultivation of high value crops (i.e. vegetables and cereals) (Eboh et al., 2006). In addition, it has been reported that since the colonial era, more fertilizer subsidies have been provided for the northern states of Nigeria at the expense of the southern states (Mustapha, 2003). Also, there is increasing soil nutrient depletion along with increased desertification in the north (Liverpool-Tasie et al., 2017a).



(Source: Liverpool-Tasie, et al., (2017)

Figure 9A: Inorganic fertilizer application in Nigeria on plot basis in 2010



(Source: Liverpool-Tasie, et al., (2017)

Figure 9: Inorganic fertilizer application in Nigeria on plot basis in 2010

Also, contrary to the widely believed notion in literature, Liverpool-Tasie et al., (2017) found in a recent study that many Nigerian smallholder farmers apply more than 100kg/ha of fertilizer and this occurs in over 70% of cultivated areas (Figures 10A & 10B). This was also in agreement with what was reported earlier that unconditional and conditional fertilizer rates were found to be between 130kg/ha and 310 kg/ha (Sheahan & Barrett, 2017).

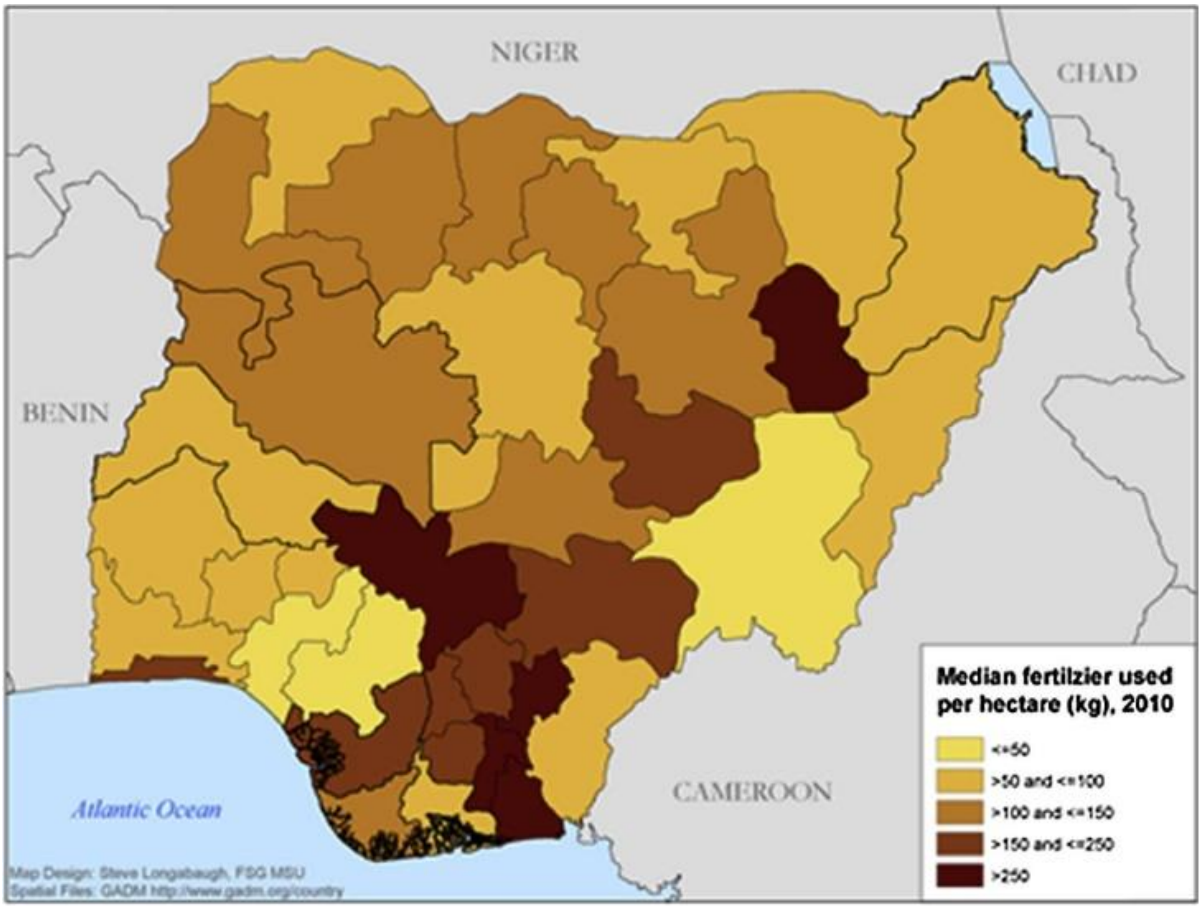
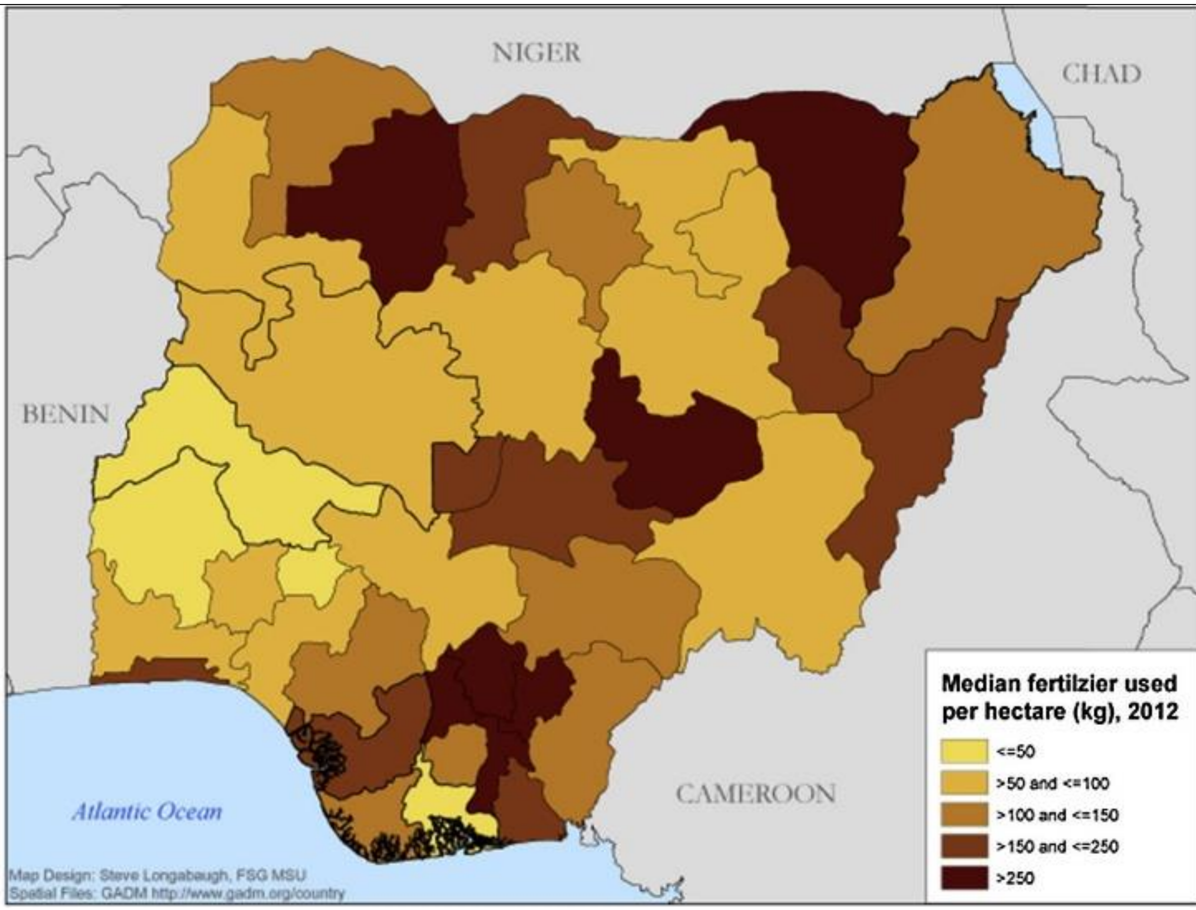


Figure 10A: Median quantity of fertilizer applied per hectare of land in Nigeria, 2010. Source: (Liverpool-Tasie et al., 2017a)



Source: (Liverpool-Tasie et al., 2017a)

Figure 10: Median quantity of fertilizer applied per hectare of land in Nigeria, 2010

Uganda Uganda fertilizer consumption has been fluctuating substantially between 2002 and 2016 ending at 1.9 kilograms per hectare in 2016 (Figure 11). This is reported as the lowest rate in the whole of SSA. This low consumption rate may be as a result of unfavorable government policies on fertilizer in the country. In addition, it is reported that Uganda has one of the most fertile soils in SSA (i.e. high total N, P, K, cation exchange capacity, and soil organic matter (Chenery, 1960; Foster, 1971; Minai, 2015).

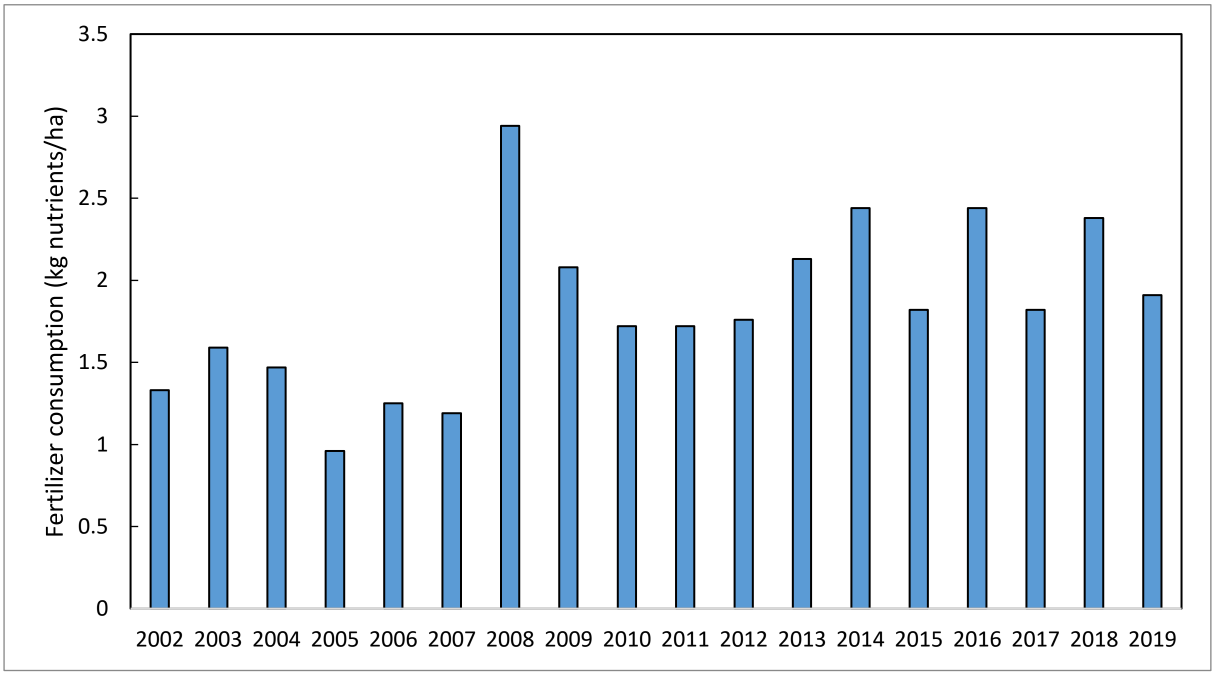


Figure 11: Fertilizer consumption in kg of nutrients /ha, Uganda

In Uganda, the fertilizer industry is private sector-led and liberalized as the country does not currently produce inorganic fertilizers, though there used to be production of phosphate in the past years. The country currently is in partnership with a company from China, called Guangzhou Dongsong Energy Group to re-activate this plant in the Tororo district as at 2016[23]. The Sukulu Phosphate Comprehensive Industrial Project has been commissioned, and it is being implemented by the Guangzhou Dongsong Energy Group (Uganda Limited) in Sukulu village in Eastern Uganda's Tororo District[1]. The cost is about US$620 million and it is planned to also commence the production of organic fertilizers of about 50,000 tonnes. This is expected to increase to 100,000 tonnes as the demand grows even beyond borders across the region. It is reported that there is currently no primary production of fertilizers in Uganda and there are no blending plants in the country and most of the fertilizers used are imported[2]. The amount of fertilizer imported to Uganda has been increasing over the years. Between 2015 and 2016, an increase of between 5 and 36% was reported[13] (Table 8).

Details on the types of fertilizer imported and the quantity showed that NPK and urea were dominant across the years (Table 8) and these originated from Saudi Arabia, Russia, Kenya,

[1] https://www.newvision.co.ug/new_vision/news/1488309/president-commissions-tororo-sukulu-phosphate-project [accessed 10/12/2019]

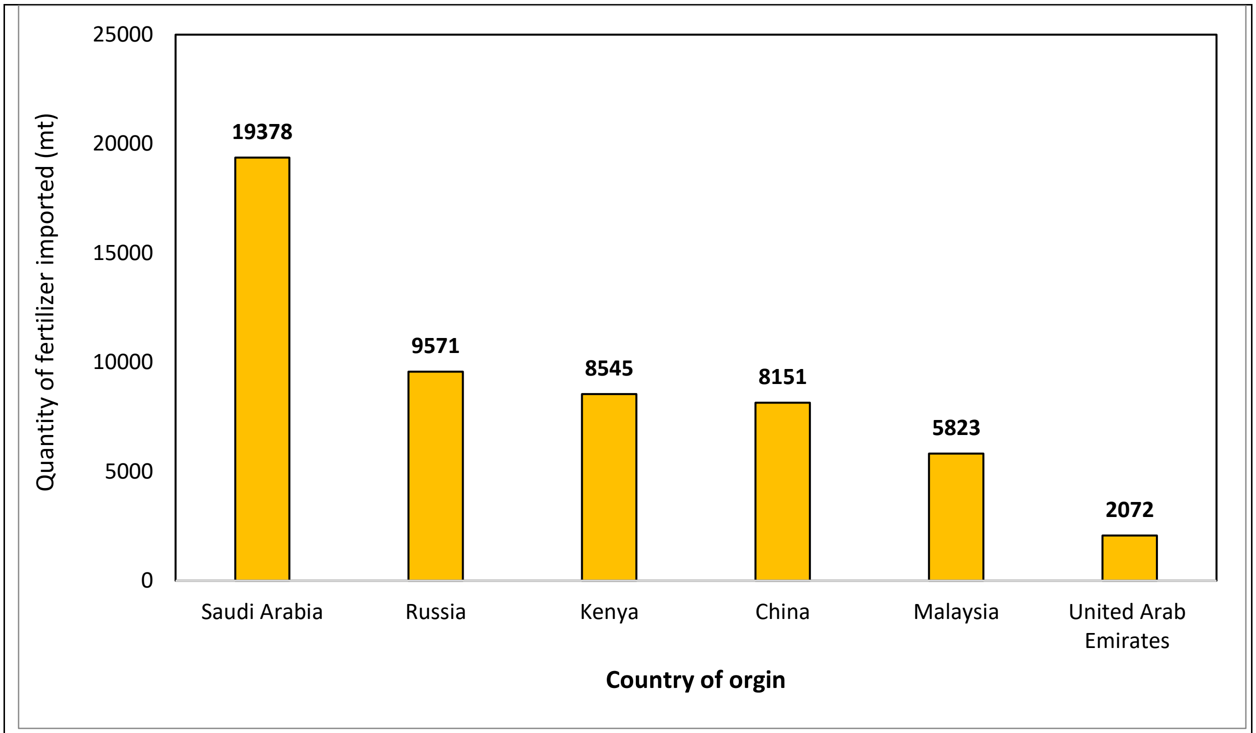
[2] www.africafertilizer.org

Malaysia and other countries. The largest sources of fertilizer supply are Saudi Arabia and Russia (Figure 12) which were 19,378 and 9,572 tonnes, respectively (Table 9). This clearly demonstrates that NPK, urea, and DAP were sourced from Saudi Arabia. An examination of monthly fertilizer imports across the four quarters (i.e. Q1, Q2, Q3 & Q4) showed that most fertilizer imported into Uganda reached the country in the first quarter, with the month of March recording 13,471 tonnes across all the years (i.e. 2013 -2017) (Figure. 13).

Table 8: Fertilizer imported into Uganda, 2013-2017

Fertilizer Name	**2013**	**2014**	**2015**	**2016**	**2017**
			(Tonnes)		
NPK	31,315	28,774	26,569	24,507	44,394
Urea	11,902	5,723	6,955	9,271	11,225
DAP	2,098	1,822	1,837	3,458	3,148
MoP	1,744	346	1,385	2,280	1,607
Calcium Nitrate	678	1,724	619	1,094	1,263
Others	3,895	3,593	9,334	8,403	5,060
Total	**51,633**	**41,982**	**46,700**	**49,013**	**66,697**

DAP= Diammonium phosphate; MoP= Muriate of potash; Source: Africafertilizer.org



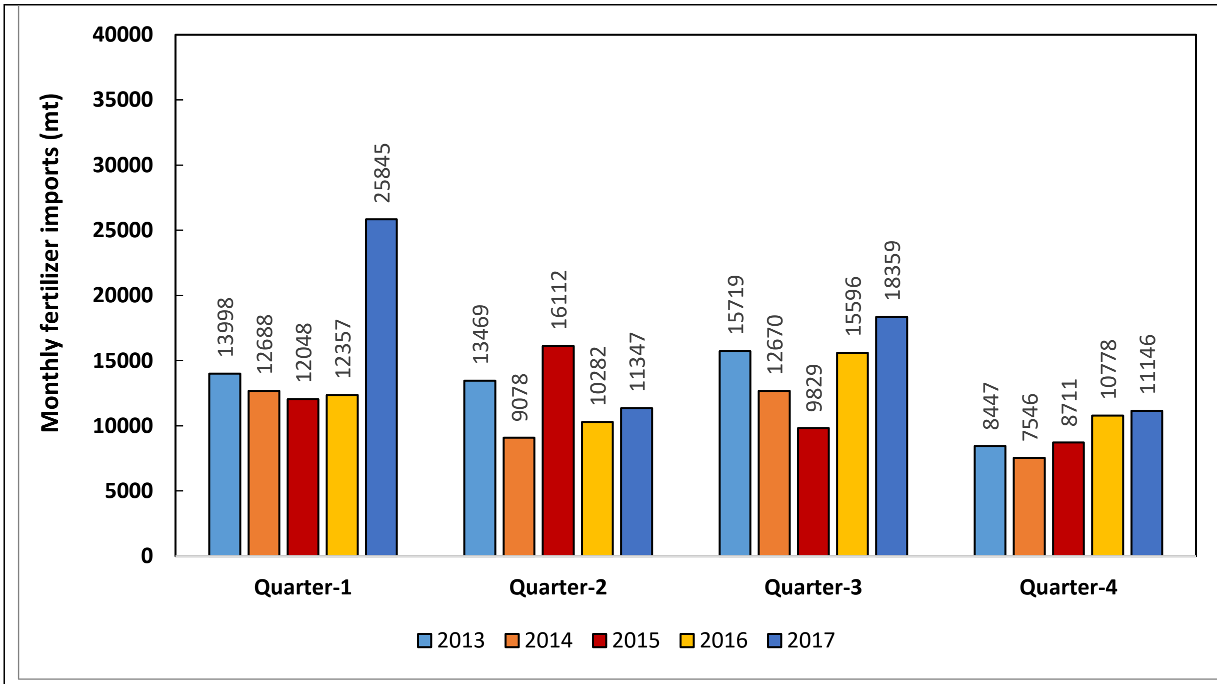
(Source: Africafertilizer.org)

Figure 12: Sources of fertilizer imported into Uganda, 2017

Table 9: Relative percentages of fertilizer sourced from different countries by Uganda, 2017

Fertilizer Types	Countries where fertilizer originates					
	Saudi Arabia	Russia	Kenya	China	Malaysia	Others
	%					
NPK	26	21	14	12	13	14
Urea	57	0	9	9	0	24
DAP	33	0	7	0.31	0	29
Calcium Nitrate	0	0	0	35	0	0
Others	4	0.02	16	7	0	71

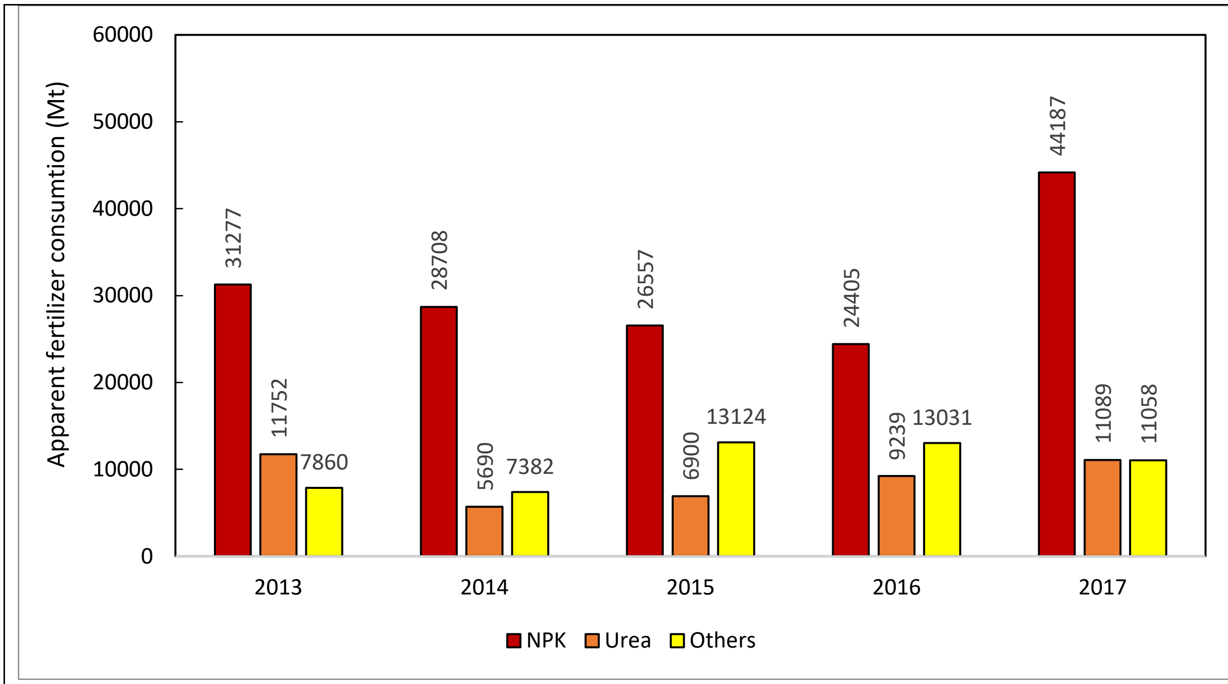
DAP= Diammonium phosphate; MoP= Muriate of potash; Source: Africafertilizer.org



(Source: Africafertilizer.org)

Figure 13: Monthly fertilizer imports into Uganda, 2017

In 2017, the apparent fertilizer consumption in Uganda was reported to have increased by 42% (Figure 14), which was as a result of increase in the fertilizer used by smallholder farmers. It was reported that there has been increase in the use of fertilizers by extension agents and the heightened activities of the non-governmental organizations (NGOs) that have opened up approximately about 30,000 ha of new commercial plantations. It was reported that in Uganda, eligible farmers experienced significant increases in agricultural production, savings and wage income, which led to improved food security as a result of increase in the adoption of inorganic fertilizer (Pan et al., 2018).



(Source: africafertilizer.org)

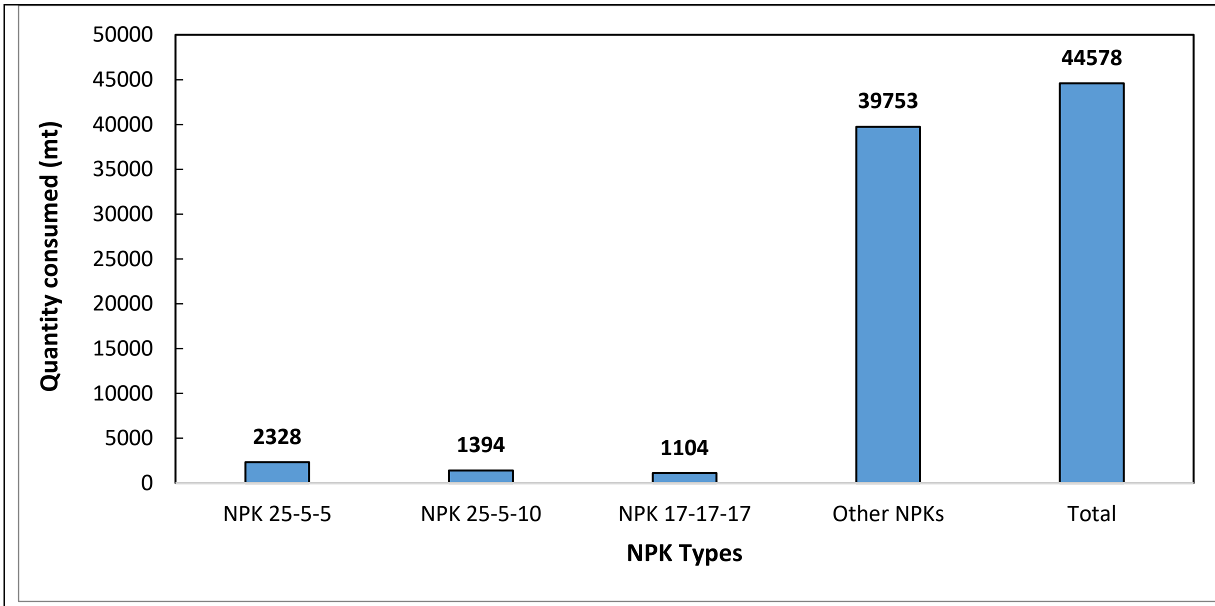
Figure 14: Apparent fertilizer consumption in Uganda in 2017

In Uganda, it is evident that the most apparently consumed fertilizers types are urea and NPK (Figure 15). The analysis of different fertilizers (i.e. total NPK, total NP, total NK, and total NK) consumed in Uganda between 2013 and 2017 showed that total NPK is the most consumed (Table 10). There are different types of NPK and the main one used/consumed is NPK 17-17-17 (Figure 15) and it is mainly used on plantation crops – sugarcane, coffee and banana.

Table 10: Analysis of NPK fertilizer consumed in Uganda (2013-2017)

Fertilizer name	2013	2014	2015	2016	2017
Total NPK	31315	28774	26569	24507	44394
Total NP	10	198	173	5	30
Total NK	37	-	-	-	-
Total PK	-	243	54	-	154
Total (mt)	31,363	29,214	26,796	24,512	44,578

Source: Africafertilizer.org



(Source: Africafertilizer.org)

Figure 15: Different types of NPK fertilizer consumed in Uganda, 2017

In the 2008/2009 season, the Uganda Census of Agriculture (UCA) conducted a household survey across the main regions – East, West, Central and North, and reported that most fertilizers are applied in the Eastern and Western parts of the country with about 32% of smallholder farmers applying this input. The least region to apply fertilizer was the north, with just only 9% of the farmers[3] (Ssewanyana & Okidi, 2007). A breakdown of the fertilizer application across these regions (Figure 16) and considerable quantity of organic is applied in the Western part of the

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country by 40% of the smallholder farmers while about 37% in the Eastern part of the country uses inorganic fertilizers.

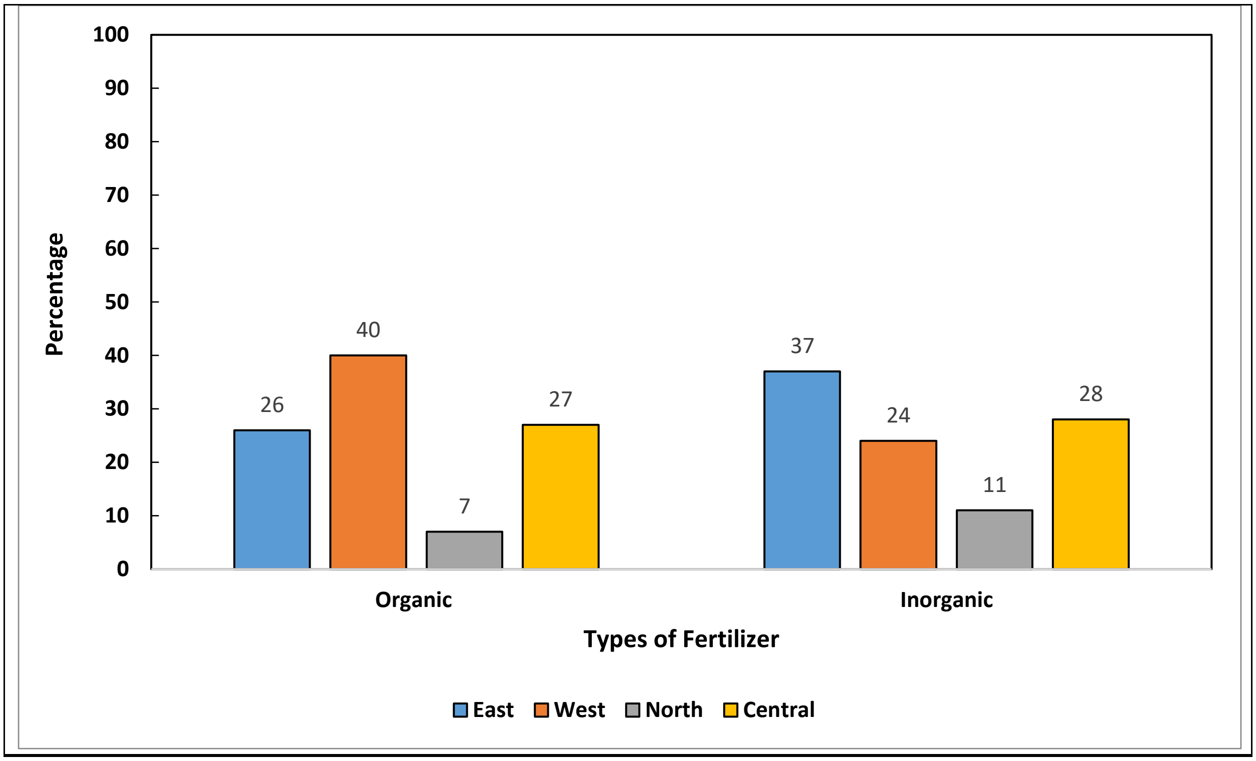


Figure 16: Proportions of farmers using organic and inorganic fertilizers in different regions of Uganda, 2008/2009 cropping seasons

(ii) Fertilizer Supply Chains

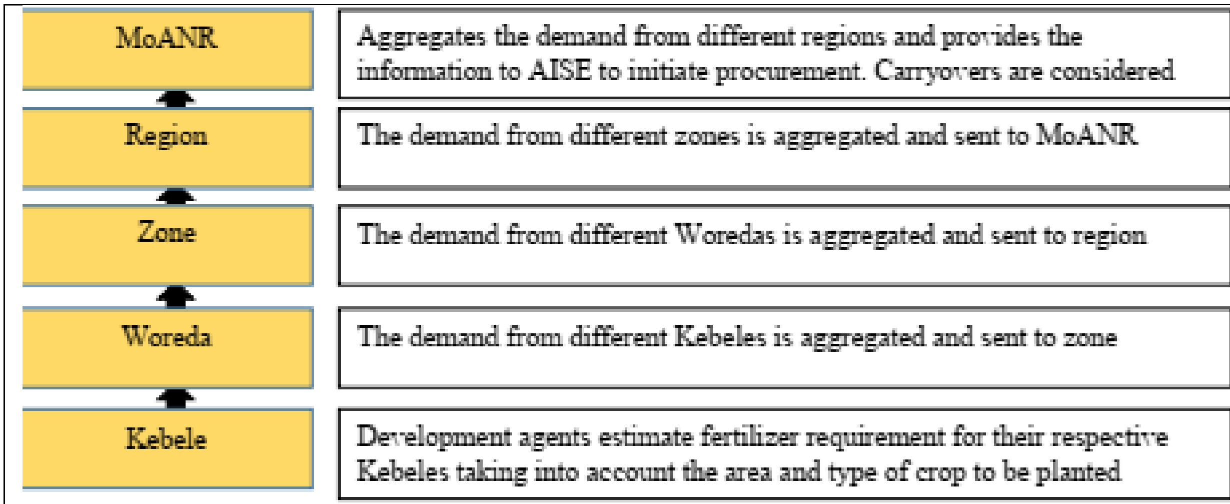
Ethiopia: In Ethiopia, the total quantity of fertilizer required for consumption is imported and distributed annually by the Agricultural Inputs Supply Enterprise (AISE) to farmers via primary farmers' cooperatives and cooperative unions (FC/FCU). Importation comes through the Djibouti port , and cargoes are discharged directly at the port, and the fertilizers are delivered to the warehouses of the FC/FCU which store these in 33 warehouses located in different parts of the country, and then later transfer to the cooperatives. The quantity of fertilizers to each *woreda* is pre-determined based on a plan aggregated at the Federal level. The FC/FCU and farmers take delivery from AISE warehouses. The purchases by the FC/FCU and farmers involve no advance purchase, storage and working capital investments (IFDC, 2015). In Ethiopia, as at 2014, there were over 50,000 cooperatives involving both genders (Table 11) (Mojo et al., 2017) .These cooperatives play a very important role in facilitating re-distribution of fertilizers from AISE to famer members. Farmers wishing to purchase fertilizer by cash or on credit often go to the closest cooperative and purchase the quantity of fertilizers needed (IFDC, 2015). Ethiopia has moved from partial liberalization since the 1990s, subsequently, AISE has become the sole importer of fertilizer into the country. The main sources of fertilizers are North Africa, East Europe and Russia as these offer short voyage time and distribute lots of fertilizers ranging between 12,500-60,000 tonnes. The major constraint is the unavailability of trucks that will facilitate the movement of fertilizers from the ports to the central warehouse (IFDC, 2015; AISE, 2014).

Table 11: Status of cooperatives societies by region and gender in Ethiopia, 2014

			Number of Members		
S/N	**Regional States**	**Number of coops**	**Male**	**Female**	**Total**
1	Dire Dawa	201	5,994	7,877	13,871
2	Harari	178	6,335	4,705	11,040
3	Benshangul Gumuz	349	11,977	10,217	22,194
4	Gambela	516	6,888	4,785	11,673
5	Afar	777	18,223	9,470	27,693
6	Somale	1,821	28,136	18,532	46,668
7	Tigray	4,539	583,002	232,253	815,255
8	Amhara	7,412	2,161,646	678,724	2,840,370
9	SNNP	11,702	1,126,649	297,844	1,242,493
10	Addis Ababa	12,130	462,276	478,715	940,991
11	Oromia	16,419	2,538,463	472,556	3,011,019
Total		**56,044**	**6,949,589**	**2,215,678**	**8,755,576,011**

Source: Mojo, Degefa, & Fischer, (2017)

However, this constraint is being alleviated by the construction of Ethio-Djibouti railway, which will shorten transportation by trucks of between 4-5 days to about 10 hours (IFDC, 2015). The demand decision of fertilizer is made by the AISE, that makes annual forecasts to meet the anticipated demand of farmers. The estimates of fertilizer to be consumed start at the *kebele* level by the development agents (DAs) and are then aggregated to *woredas*, the zonal regional and national levels and coordinated entirely by the Input Supply and Marketing Directorate of the Ministry of Agriculture and Natural Resources (Figure 17) and often do not consider any changes during the cropping seasons, hence it is rigid.



(Source: IFDC, 2015); MoANR

Figure 17: Estimation of fertilizer demands in Ethiopia

There are many actors involved in the fertilizer value/supply chains in Ethiopia, which include: (i) import planning, (ii) import execution, and (iii) marketing and distribution (Figure 18). The planning of import starts as shown in Figure 18, and followed by aggregation at the *woreda* level and the estimates are sent to the Bureau of Agriculture and Rural Development Board (BoARD). The final aggregation is conducted by the MoARD/MoANR which comes up with the national demand estimates. Finally, the net fertilizer to be imported is determined by deductions from the leftover stocks of the previous year as well as from the current year's demand.

Actors	Demand Assessment	Procurement	Import and Transportation	Marketing and Distribution
Governmental	Kebele, Woreda, Zone, RBoAs & MoANR	MoANR, MoFED & National Bank of Ethiopia		Regional Governments
Parastatals		AISE *(Supplier)*	Ethiopian Shipping & Logistics Services Enterprise	
Financial Institutions		Commercial Bank of Ethiopia *(Financier)*		
Cooperatives				FCUs and primary coops (Last mile distributors)

. (Source: IFDC, 2015; MoANR/MoARD)

Figure 18: Different actors, roles in fertilizer value/supply chain demand assessment & distribution in Ethiopia

In order to execute imports, the MoANR prepares tender documents and invites the consortium of public institutions – Ministry of Finance and Economic Development (MoFED), National Bank of Ethiopia (NBE), Commercial Bank of Ethiopia (CBE) as well as the Quality & Standard Control Office- to review and approve projected demand. Then, it arranges the necessary foreign exchange and opens an international procurement tender. Since 2008, this process has been facilitated by the AISE that takes advantage of the economies of scale- as importing large volume of fertilizer will reduce transaction cost, thereby making the value chain more efficient (Rashid et al., 2013). Once the imported fertilizer arrives at Djibouti ports, it is stored in the warehouse of AISE and it then informs regional cooperatives unions and the consignment is moved to warehouses from where various cooperatives/unions have the fertilizer delivered into their various warehouses. However, in some regions where there are no cooperatives/unions, AISE acts as the wholesaler and takes responsibilities for the delivery of shipments to the primary cooperatives (Mojo et al., 2017; Rashid et al., 2013). The Regional BoARDs are also important actors in the marketing and distribution of fertilizers, and they play important roles in facilitating input credit guarantees to the CBE by providing transportation facilities and also ensuring the timely delivery of fertilizers. The AISE determines the weighted average price of fertilizer at the central warehouse and the BoARD, adds profit margins (i.e. for both union/federation and primary cooperatives), loading and unloading costs, warehouse rent, bank interest rates and administrative costs (Rashid et al., 2013, IFDC, 2015).

Rashid et al., (2013) also highlighted that to determine the prices of fertilizers in each region, consultations are made with the unions. For example, since there are two seasons (*Meher*- main cropping season and *Belg* – minor season) in Tigray and SNNP, prices are determined twice a year. In the *Meher* season, prices are made up of storage and administrative costs, while in the *Belg* season, prices are determined by using the *Meher* season's price along with bank interest rates and administrative costs (Rashid et al., 2013). The product and cash flows with all actors involved in the value/supply chain is shown in Figure 19. The chart showed that to import fertilizer, the cooperatives/unions would have to go through the AISE and fertilizer importation are processed in two installments – (i) during the opening of the letter of credit and (ii) upon arrival at the Djibouti port (Rasid et al., 2013). The primary cooperatives receive fertilizers on credit from the unions and disburse to smallholder farmers when they pay cash. In some regions – Amhara and SNNP, where there are some food insecure households, the farmers are reported to receive fertilizers with a 50% down payment and the outstanding balance is paid at harvest based on agreement. Rashid et al., (2013) however noted that the long chain of money transactions has some problems, which concerns accountability.

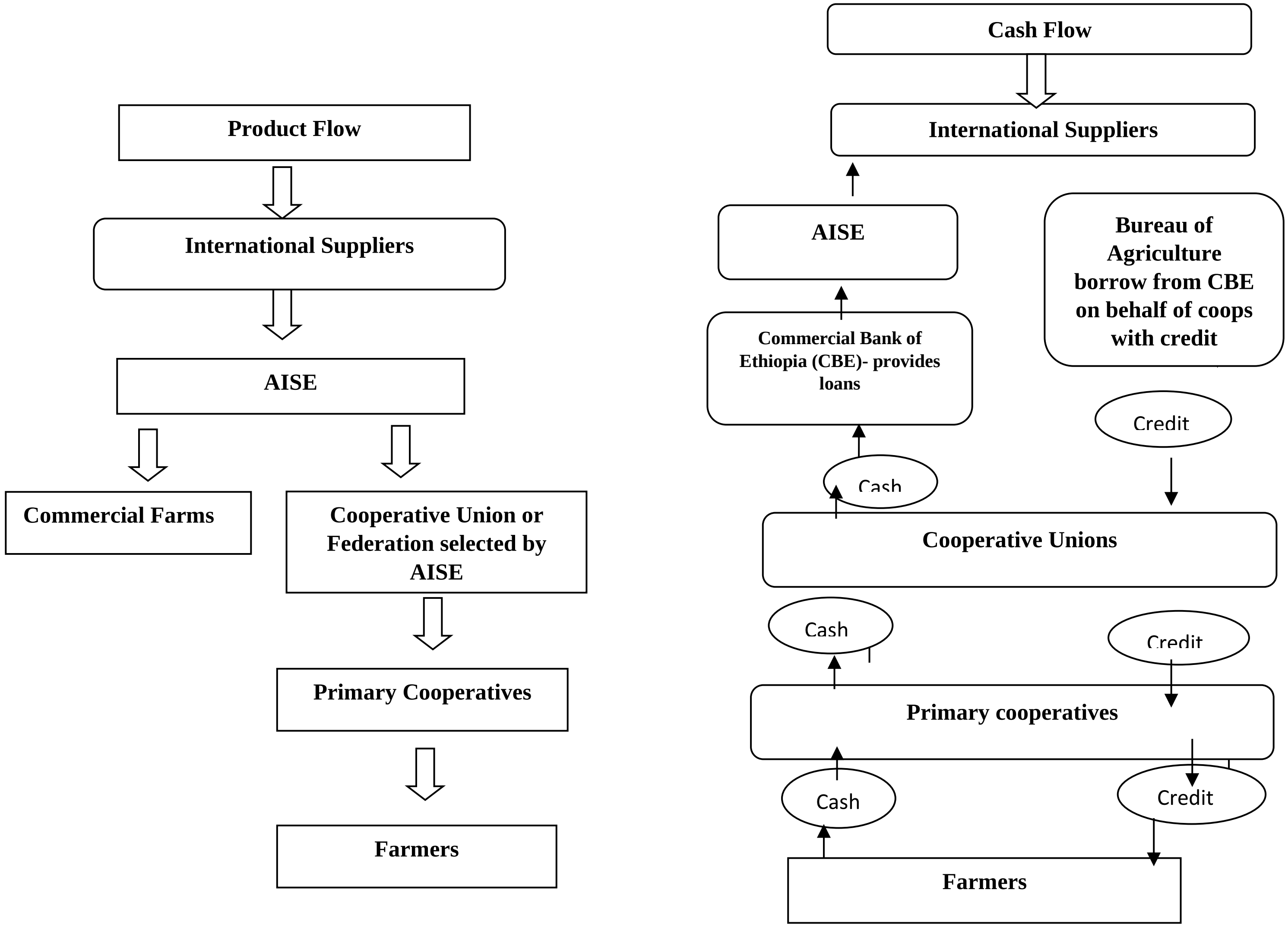
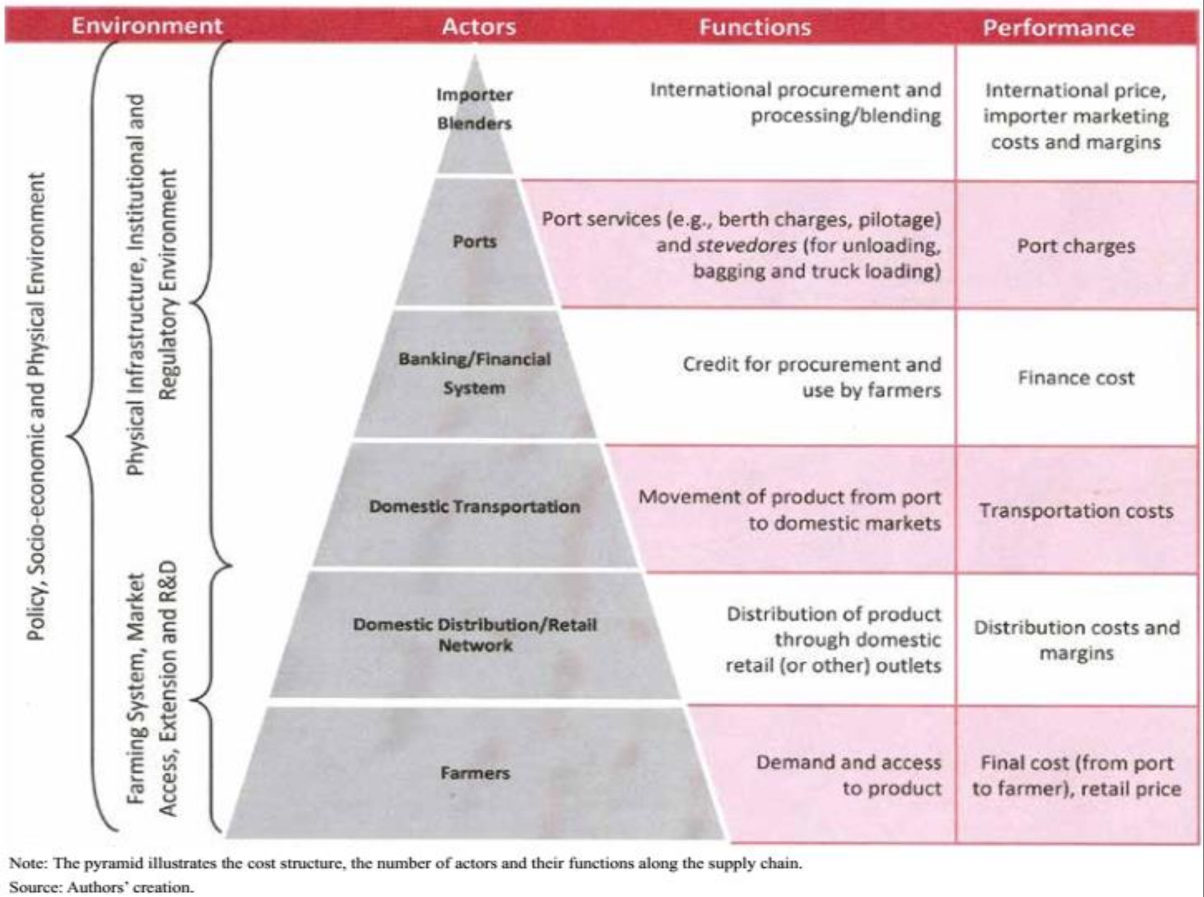


Figure 19: Movement of inorganic fertilizer products and cash in Ethiopian fertilizer value chain

The BoARD provides credit guarantee; therefore, banks have no risks by lending money, but when it comes to credit collection, it is reported that the responsibilities rest with the cooperatives and here, the BoARD has no authority (Rasid et al., 2013).

Nigeria: The general illustration of the fertilizer supply chain, cost structure, and various actors involved in the domestic supply chain is shown in Figure 21. Each stage illustrated in the supply chain can impact the overall fertilizer cost that will accrue to smallholder farmers at the end of the chain. These include: (i) poor infrastructure and market coordination inefficiencies related to inadequate ports and road conditions (i.e. rural roads), (ii) weak and underdeveloped marketing and retail networks, (iii) weak institutional and regulatory environment, and (iv) lack of knowledge and technical assistance. All these factors have been pointed-out to have policy implications, while improvement in these factors will have positive effects on the functioning of the fertilizer supply chain in Nigeria and reduce transaction costs, while improving efficiency. Consequently, the need for fertilizer subsidies would be drastically reduced (Fuentes, Bumb, & Johnson, 2012).

Since independence, three fertilizer distribution networks have been identified in Nigeria, and these are: (i) primary distribution points (PDPs), (ii) the public distribution channels and (iii) the private distribution channels. The PDPs were established in different parts of the country and were operated by the Fertilizer Procurement and Distribution Divisions (FPDD). The FPDD hired trucks from the private sectors to distribute products to all states of the federation – from Lagos ports and are deposited at the Agricultural Development Projects (ADPs) of the Farm Service Centres (FSCs), where the fertilizers are then sold to smallholder farmers. Under this arrangement, the Federal Government of Nigeria (FGN) provided the subsidies for the transportation of these products. As from 1997, this arrangements stopped, and from that point, the FGN engaged the National Fertilizer Company (NAFCON) as the sole distributor of both domestic and imported fertilizers to different parts of the country. Following the intervention of the FGN in the fertilizer distribution, there now existed other two distribution channels as stated previously – the public and private distribution channels.



(Source: Fuentes, et al., 2012)

Figure 21: General fertilizer supply cost structure and players' functions in the domestic supply chain

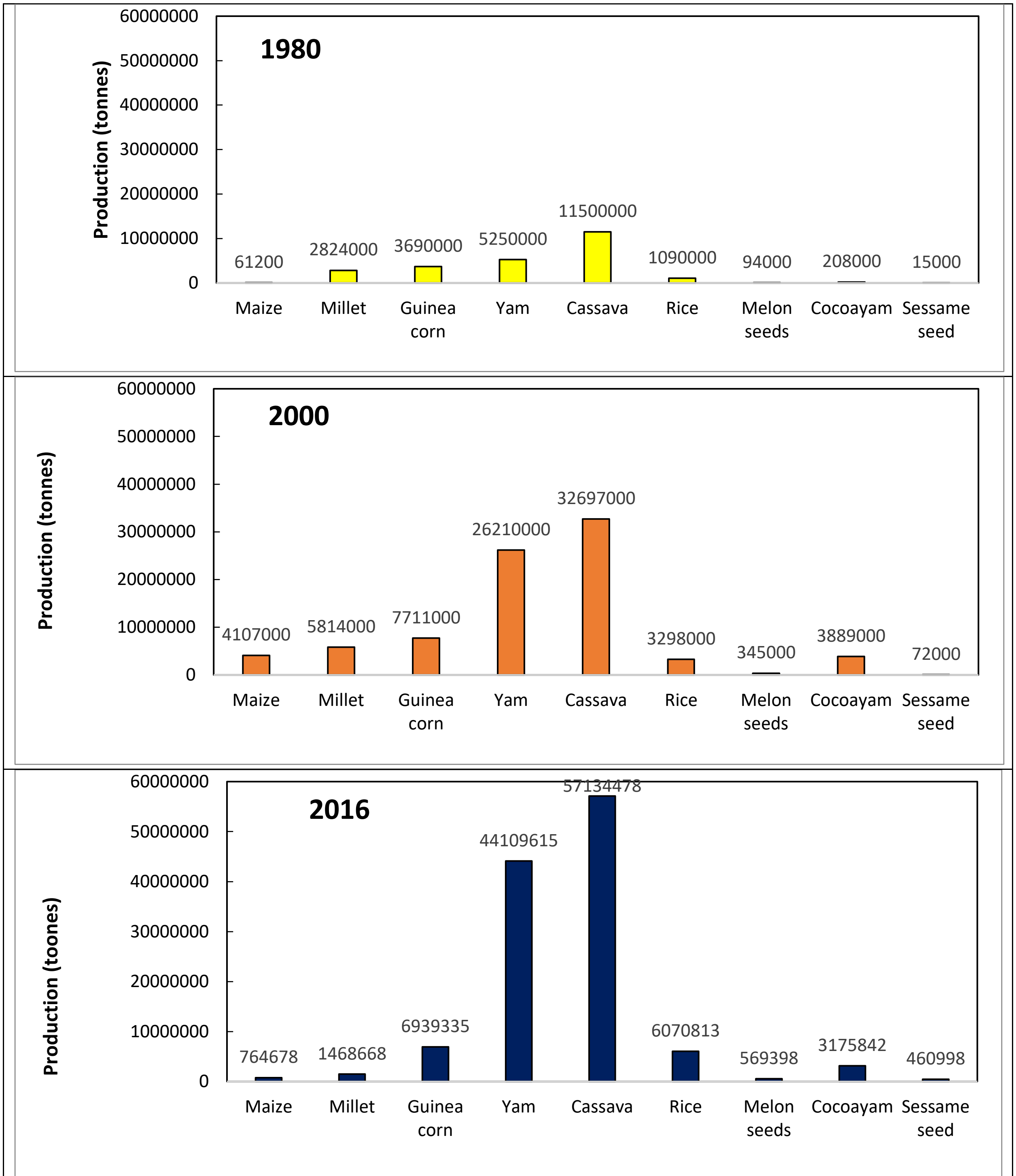
The public distribution channels involve the private sector in the acquisition of fertilizers from international markets (imports) through a tender process (Fuentes et al., 2012). These private importers/suppliers were known to incorporate distribution costs into their bids and these products are then delivered to designated state warehouses. The products are distributed through public channels without the involvement of the private sector distribution network. Some of the products may also be distributed through the small-scale agro-input dealers which are situated in local markets and semi-urban areas. The public distribution system of subsidized fertilizer is highly inefficient, grossly mismanaged, fraudulent and very corrupt (Fuentes et al., 2012) and this scenario operates at both the state and federal levels in the subsidized fertilizer procurement and distribution. There is also international procurement of subsidized fertilizers through the private sectors for each of the states in the country. However, this has not been effective due to limited incentives, limited opportunities for the private sectors to develop alternative distribution channels and difficulty in making reasonable profits (Fuentes et al., 2012).

The overall effect of this is that products may not eventually reach smallholder farmers, and even if they do, only 30% of subsidized fertilizers reach the farmers and are often very expensive and unaffordable to smallholder farmers. Thus, the involvement of the public sectors in fertilizer distribution has resulted in the following (Fuentes et al., 2012):

i. The number of importers are few, and the limited number participates in the tenders of the FGN and state government , and constitute the "same importers that supply the private sectors"
ii. Fewer number of importers negatively impact the targeted beneficiaries as a limited quantity of the products is delivered, which often does not meet the demands of smallholder farmers. This is as a result of late payment to the suppliers by the state and federal governments.
iii. Fertilizer prices are set on annual basis and do not reflect the short-term movements in fertilizer and freight prices. This is a drawback for importers that have to estimate future prices (at the time of delivery) and transaction costs at the time of contract negotiations. Often, this results in over estimation of price margins to be higher than normal as a mechanism to protect businesses against the risk of "wrong prices, transaction costs, and unexpected financial burdens"
iv. There is disruption in the deliveries of subsides for smallholder farmers
v. The distribution channels of the private sector suppliers is limited or restricted.
vi. The amount of product available on the market is limited

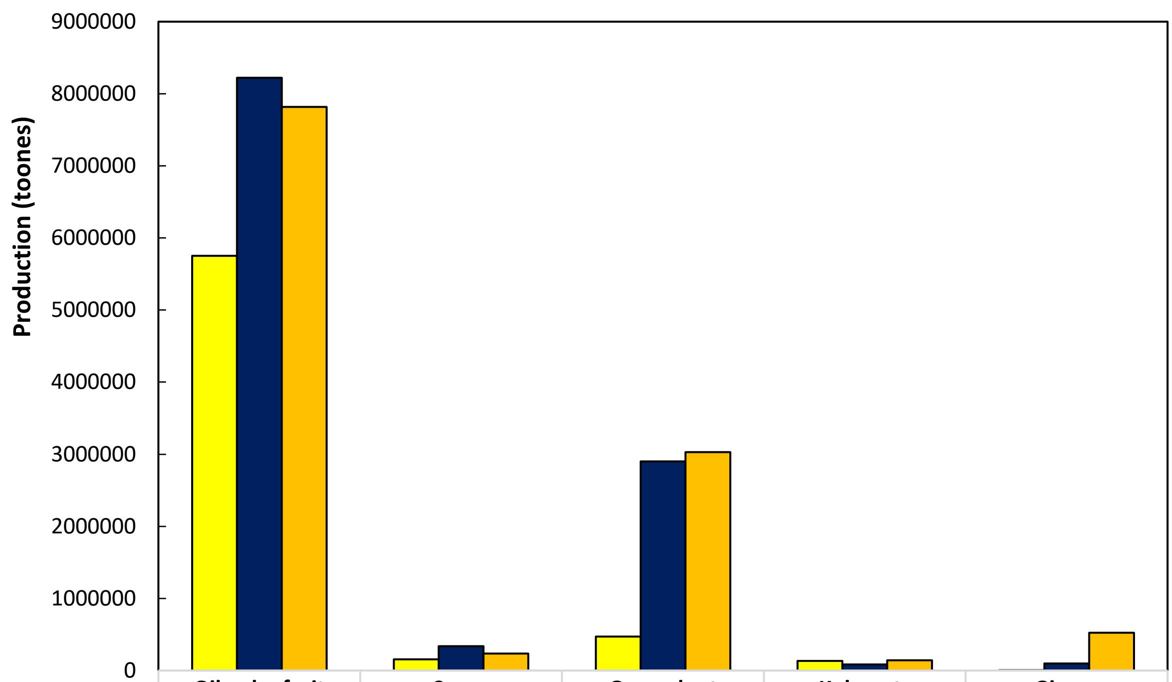
The third set of distributors is the private channels, which include market wholesalers and the importers that supply the private distribution networks (i.e. agro-dealer shops and other retail outlets in the country). These importers/wholesalers have been found to be the main source of supply of the fertilizer that has been subsidized and these are fed into the "public distribution channels". Most of the private agro-dealers have been found to be more in the urban and semi-urban areas and have relatively well-developed market infrastructures compared to the poorly served rural areas. Fuentes, et al., (2012) noted that about 5% of the 8000 to 12,000 existing agro-dealers have no? formal training in input and business management hence, they have limited knowledge and most of them cannot provide additional sources of information that the smallholders might need which otherwise would have been provided by qualified agricultural extension workers.

The main fertilizer products that Nigeria consumes are urea, DAP, MOP and NPK and other speciality fertilizers. Major staple crops and cash crops grown in Nigeria are shown in Figures 22 and 23. Other crops include arrays of vegetables and fruits.



(Source: FAOSTAT, 2018)

Figure 22: Outputs of major staple crops in Nigeria (1980, 2000 and 2016)



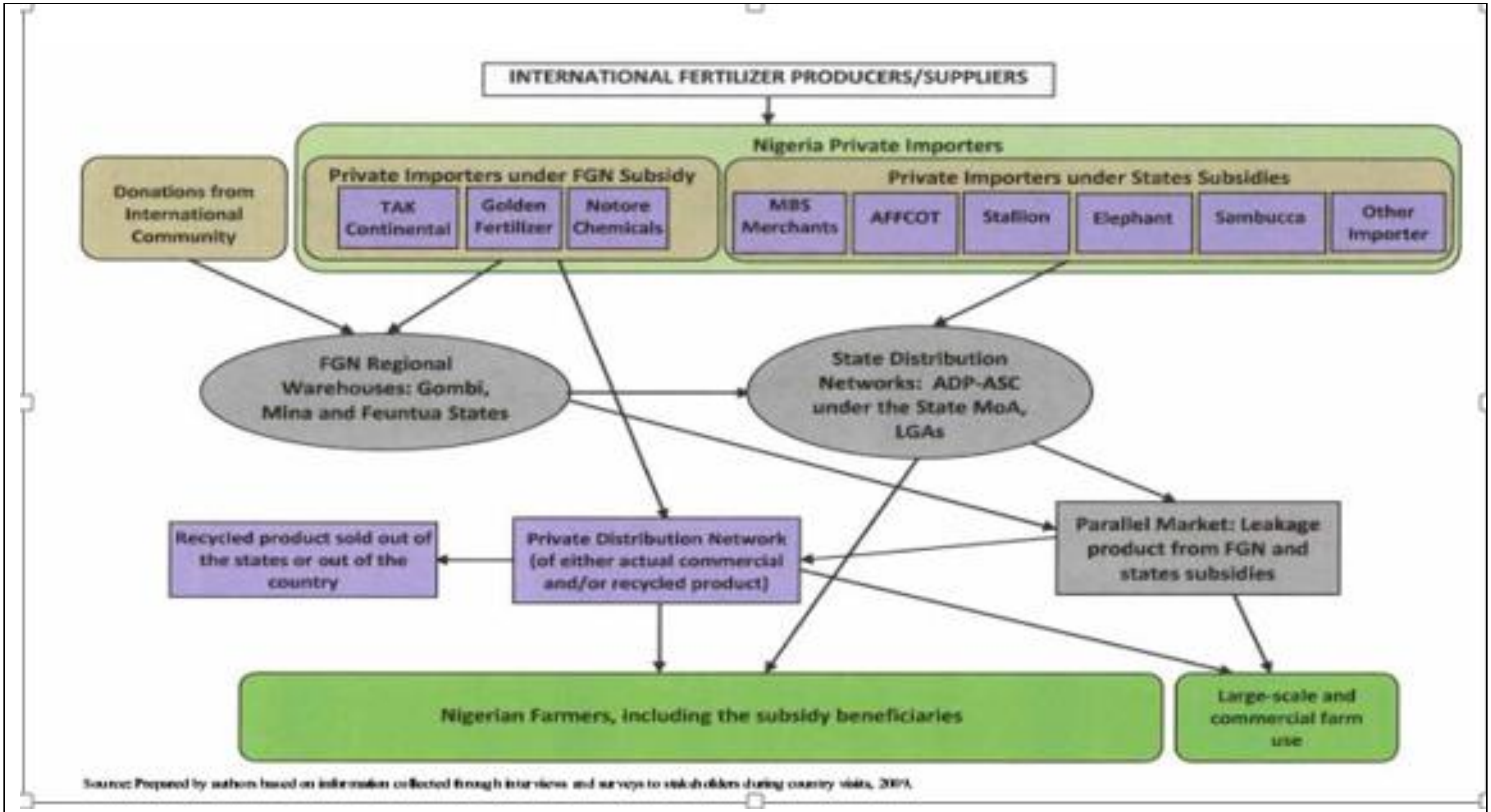
	Oil palm fruit	Cocoa	Groundnut	Kola nuts	Ginger
1980	5750000	153000	471000	135000	200
2000	8220000	338000	2901000	82000	98000
2016	7817207	236521	3028571	143829	522964

(Source: FAOSTAT, 2018[11])

Figure 23: Output of major cash crops in Nigeria (1980, 2000 and 2016)

Key players in the supply chain: In the early 1990s, the full monopoly of fertilizer importation and distribution was under the auspices of the Fertilizer Procurement and Distribution Division (FPDD) and in 1997, the fertilizer market was liberalized and subsidies were removed. Currently, all fertilizer products are imported by the private sector and the main importers are Golden Fertilizers, Tak Continental, and Notore (the owner of NAFCON fertilizer plant, in Port Harcourt, Nigeria).

Bumb et al., (2011) reported that though fertilizer marketing and distribution was mainly by private sectors in Nigeria, the FGN implements subsidy programmes which guide large share of the market, but this subsidy has created many distortions in the fertilizer markets (Figure 24). Several studies conducted over the years by the IFDC and other researchers have shown that the fertilizer subsidy does not help smallholder farmers, but it is rather creating distortions in the market (Eboh et al., 2006; Thomas S. Jayne et al., 2018; Liverpool-Tasie & Takeshima, 2013). One major problem with the fertilizer supply chain in Nigeria is the operation of two types of supply chains (Bumb et al., (2011): (i) standard private-sector based chain, where fertilizer importers import fertilizer and supply it to wholesalers and retailers who in turn sell to the farmers. Also, importers and wholesalers can supply fertilizer products to blending plants in the country. The authors estimated that the number of retailers and wholesalers were between 40,000 and, 30 respectively across the country. (ii) the second supply chain is that of the FGN that is distributed through its subsidy program. Under this scheme, the FGN targeted 600,000 tonnes of products under the "so-called" subsidy programs, but only distributed about 464000 in 2008 (Bumb et al., 2011). Nigeria procures products from domestic markets through tendering, and in 2007, more than 100 companies were awarded tenders for distributing fertilizers. Bumb et al., (2011) opined that such large numbers of suppliers created logistic and coordination problems, thus in 2008, the FGN streamlined the number to only three – Golden, Tak Continental, and Notore. However, due to delays in payment by the FGN, Tak Continental ran into cash flow problems and could not fulfill the allocated supply quota. Consequently, the FGN decided to award more tenders to other suppliers in 2009, but due to delays in budget approval, though not uncommon, introduced more uncertainty in fertilizer supply to smallholder farmers.



Fertilizer distribution channel/structure, Nigeria (Source: IFDC, 2012; Bumb, et al., 2011)

Figure 24: Fertilizer distribution channel/structure, Nigeria

Other key players in the fertilizer supply chain are the 36 state governments which are located within each of the six geo-political zones. Within each of these states are the 774 Local Government Authorities (LGAs) (Table 16). Each state has Farmer Service Centres (FSCs) which are domicile within the state Agricultural Development Programmes (ADPs). Theoretically, the FSCs are located within 15-km radius from farmers, but the FSCs are largely non-functional, thus fertilizer supply bypass farmers. Currently, the FGN is planning to establish 774 service centres for farmers across the country, according to the Minister of Agriculture and Rural Development. Through this, it is hoped that farmers would have access to improved seeds and other farm inputs from the centres. Other retail outlets are the LGAs, which also conduct annual sales at specified locations, but most of the fertilizers supplied through the LGA channels are rather politicized. Therefore, fertilizers and other inputs may not reach smallholder farmers. Also, most of the private fertilizer suppliers –which are agro-input dealers- are located within the urban centres, often times these do not have stock of fertilizer throughout the year, and even if they have, it is always in larger quantities (i.e. 50kg) which is often beyond what smallholder farmers can afford. Most of these farmers often purchase fertilizers of about 4kg (called a *mudu*, which is a local measure).

Uganda: Prior to the 1990s, fertilizer purchased and brought into Uganda was primarily for cash crop production and most of it was used for the production of tea and sugars and was largely imported via tenders (Benson et al., 2012). Also, there were few smallholder farmers producing tobacco under contract farming systems, these farmers also used some quantities of inorganic fertilizers. However, in recent times, there are large-scale oil palm plantations with corresponding out grower schemes, which have been increasing the demand for inorganic fertilizers in the country. Benson et al., (2012) also observed that in addition to the previously stated volume of fertilizers imported into the country, there has been increase in the use of fertilizer by smallholder farmers since 2000. It was observed that since 1994, no private traders imported fertilizer for sale to smallholder farmers and that this sector has been private-sector-managed systems and that the government's role is limited to only regulations and advisory services to a limited degree. In addition, government has not subsidized fertilizer supply to smallholder farmers since the 1990s (Tukacungurwa, 1994). Despite all these, application of inorganic fertilizer has gained momentum as regards the following crops – maize, coffee and vegetables.

Though, the growth in importation of fertilizer into Uganda is encouraging, the country still has one of the lowest rates of fertilizer consumption (i.e. nutrients in kg/ha) in SSA. This ranged between 1.33kg nutrients/ha (2002) and 1.91 kg nutrients/ha (2017) (Christiaensen and Demery, 2017). Though, this may look very minute, it may be as a result of the high soil fertility in the country coupled with poor government policies on fertilizer importation and consumption. Until the 1990s, Uganda had no national fertilizer subsidy program in comparison with most of her neighbors (i.e. Kenya and Ethiopia). Fertilizer importation has been largely donor-driven and importation and distribution was largely under the control of the NGOs. And subsequently, distribution is made to smallholder farmers. Most of the farmers used these products on high-valued crops grown for commercial and export purposes. When the scenario in Uganda is compared to one of her neighbors (i.e. Kenya), the amount of fertilizer that was imported in 2010 was estimated at 480,000 tonnes and that of Uganda in the same time period was about 40,000 tonnes (Ariga and Jayne, 2011). The UBOS (2007) in 2005/2006 noted that the household survey estimated that only one per cent of smallholder farmers applied inorganic fertilizer to any of their crops.

Uganda is a landlocked country; consequently, fertilizers are imported into the country from international suppliers and the port from where these are imported is about 1000km from the main ports with no subsidies from the government. There are two pathways to importing fertilizer into Uganda: (a) by direct acquisition from international sources or (b), through key importers based in Kenya and Tanzania (Figure 25). However, commercial plantations or estate farms that grow tea, sugarcane and tobacco import directly from wholesalers, cooperatives and retailers/stockists (Figure 26).

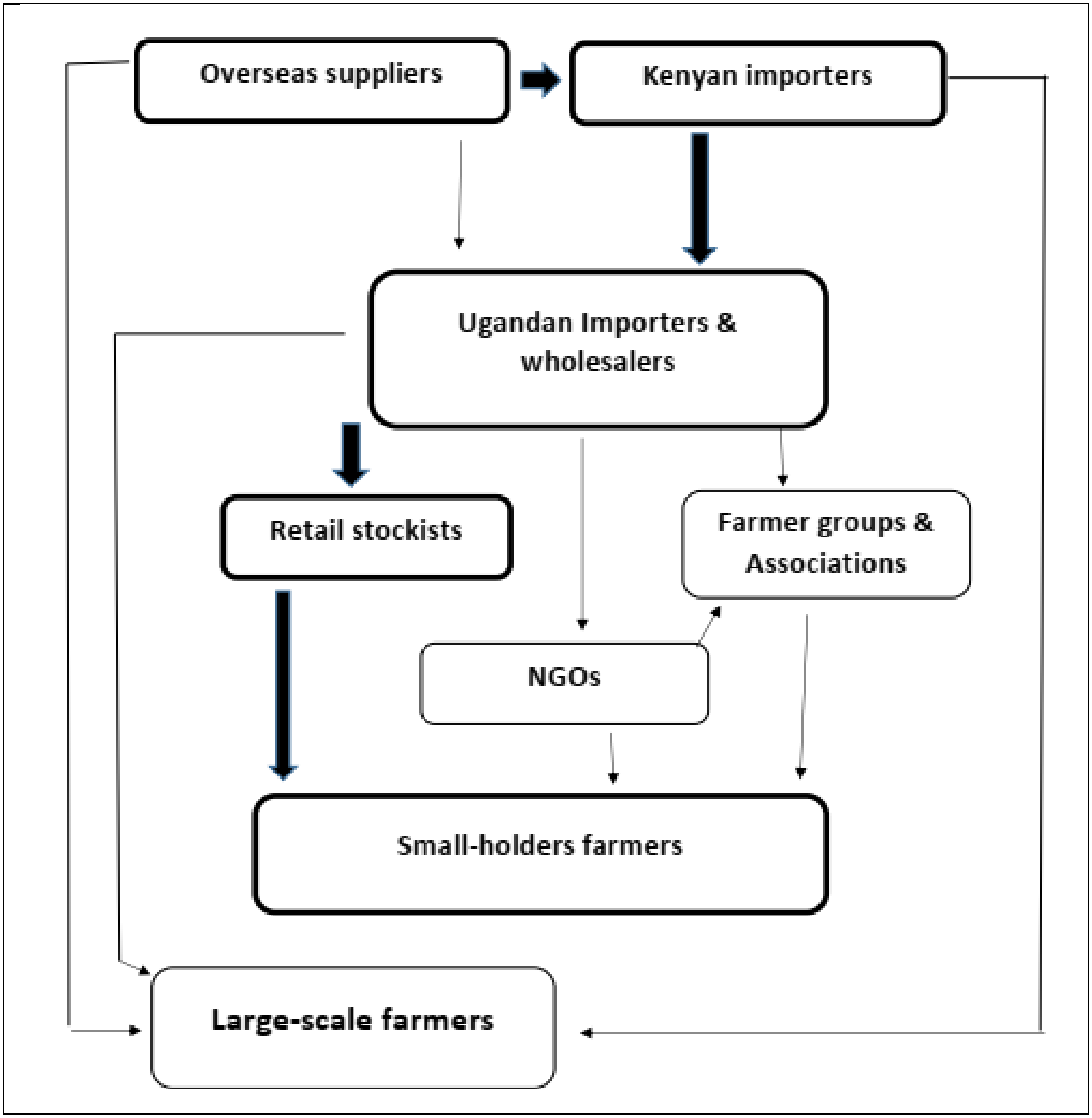
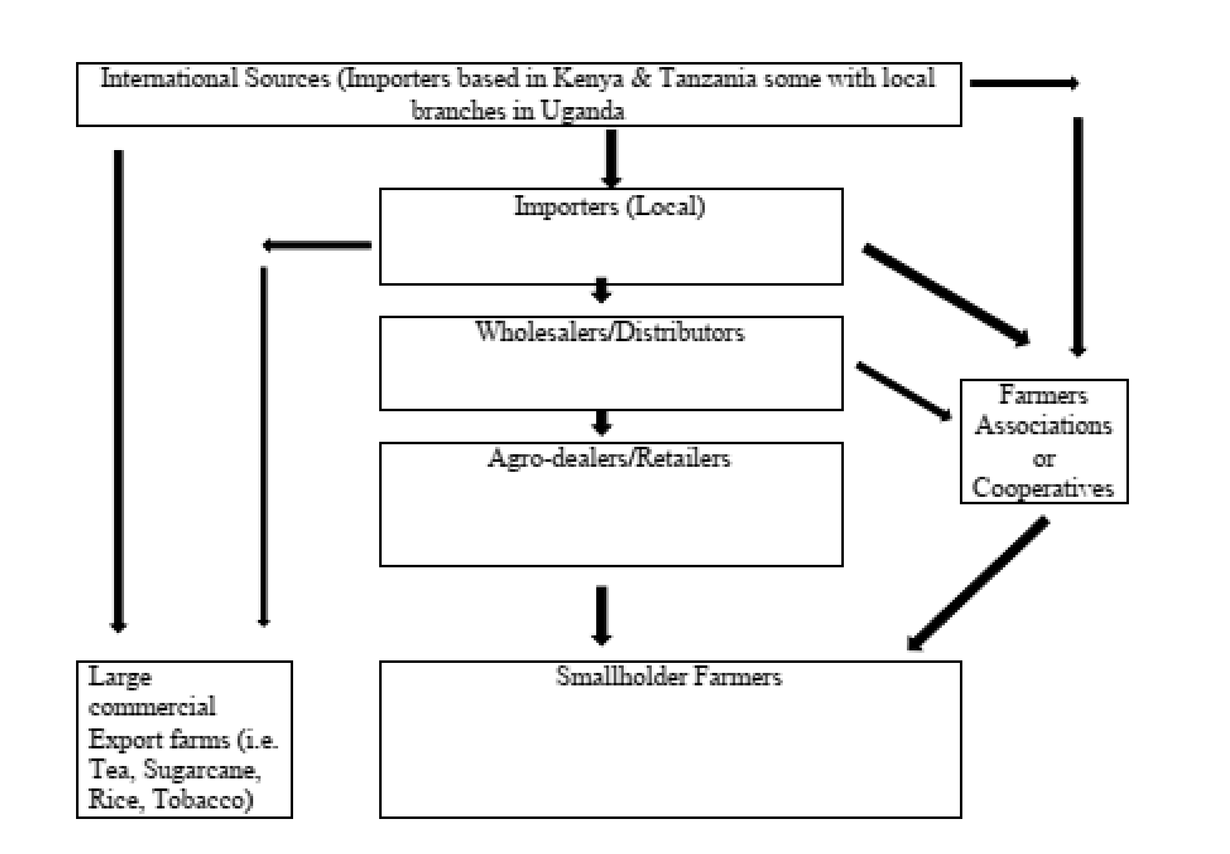


Figure 25: The Principal procurement and distribution channels for fertilizer in Uganda (Source: Omamo, 2003). NB: Principal procurement & distribution channels are shown in bold.



The Actors and Fertilizer Supply Chains in Uganda (Source: IFDC/AFAB, 2014)

Figure 26: The Actors and fertilizer supply chains in Uganda

(iii) Cost structure

Ethiopia: Fertilizers are more expensive in Africa compared to other regions of the world (i.e. Asia and South America) (World Bank, 2006). The current prices across selected African countries compared to the world fertilizer prices is shown in Figure 27. It was reported that ocean freight costs are lower in Asia due to economies of scale compared to African countries. This was attributed to higher freight and domestic transport costs coupled with weak infrastructure and policy environment (World Bank, 2006; Rashid et al., 2013). Within each of the countries in Africa, there is little that each government can do to influence ocean freights fees, but they can influence directly domestic transaction costs by improving existing infrastructure, institutions, and policy environments within their respective countries. Rashid et al., (2013) reported that in Ethiopia, though the ATA?? transformation has performed exceptionally well in reducing domestic marketing costs, at the macro-level. The domestic marketing costs of fertilizer was estimated as the difference between weighted retail price and the landed cost at the port (Rashid et al., 2013). It was also reported by these authors that Ethiopia has made significant progress in improving rural infrastructure (i.e. road construction, telecommunications), which has led to drastic reduction in the domestic retail prices of di-ammonium phosphate (DAP) between 1980s and 2010 (i.e. a decline from $229 tonnes to $174/ tonne in the 1990s to $150/ tonne in 2010) (Rashid and Negassa, 2013).

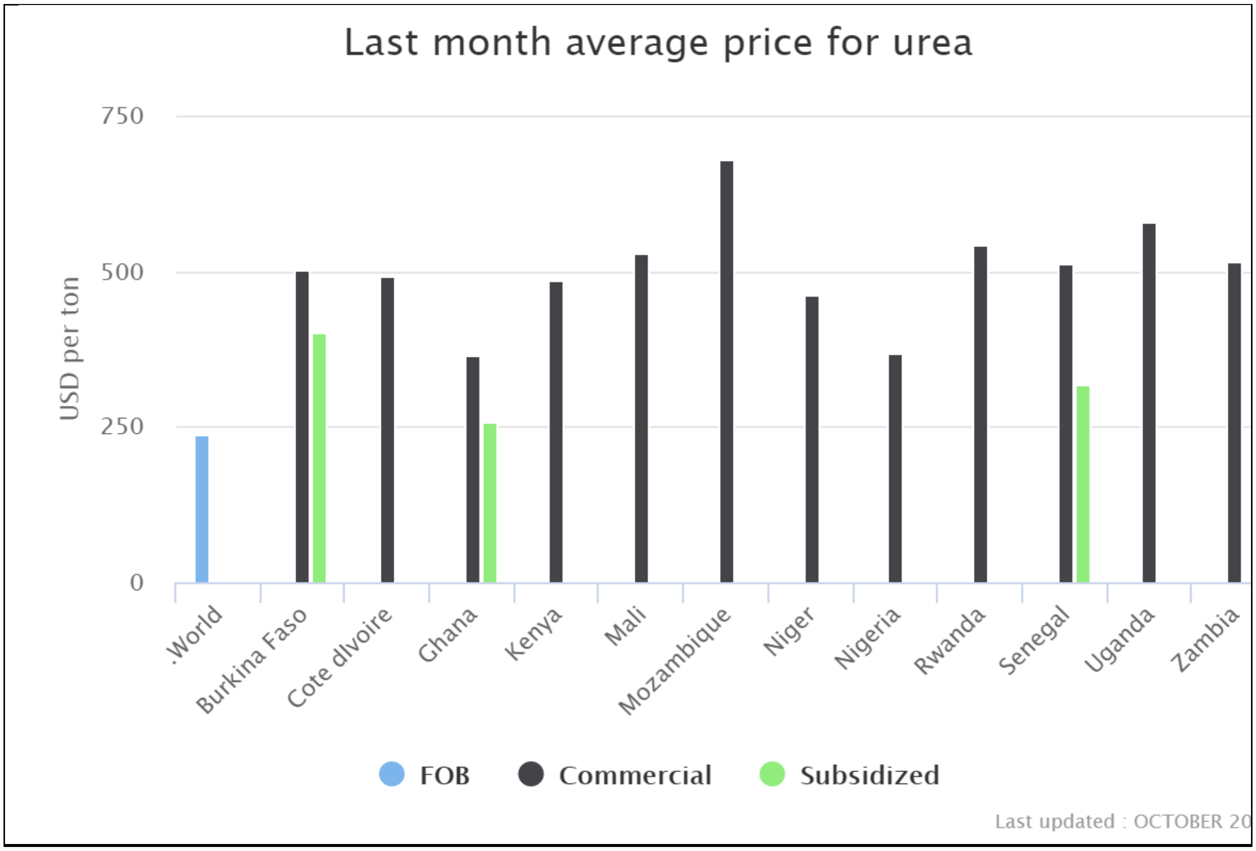
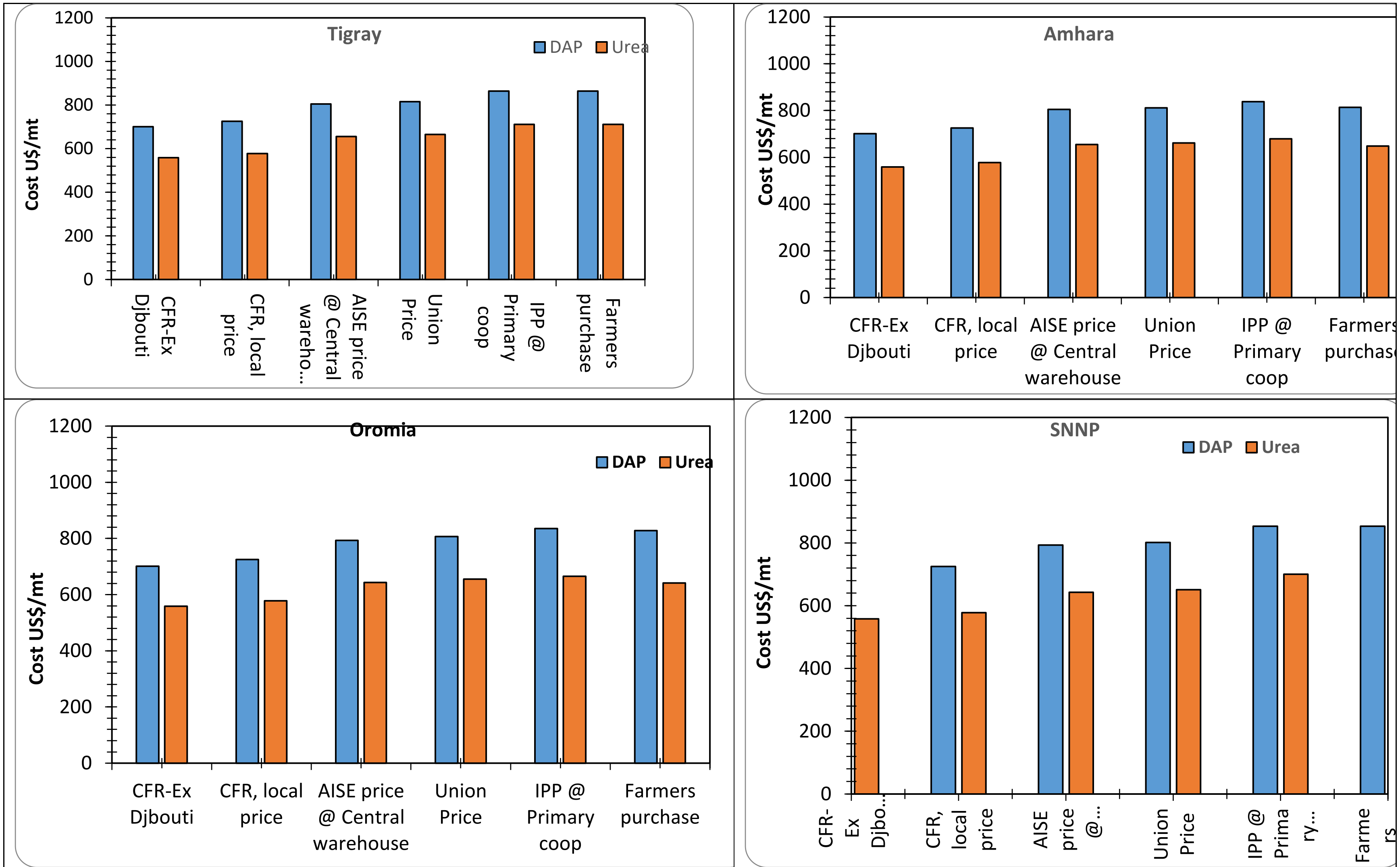


Figure 27: Prices of urea, in other parts of the world compared to African counties

The build-up costs of fertilizers imported across four regions in Ethiopia – Tigray, Amhara, Oromia and SNNPR showed that there were little variations in the prices (i.e. US$/ tonne) (Figure 28). The difference between farm-gate price and landed cost is between US$110 (Oromia) for urea to about $US138 (Tigray) and for DAP, it is between US$87 (Oromia) to US$134 tonne (Tigray) (Figure 29). The difference between transport costs as a percentage of farm-gate price is between US$65 for urea (i.e. Oromia) and 70% (Amhara) and for DAP, it is between 69% (Tigray) and 80% in Oromia (Figure 30). The AISE supplies from the ports to each central warehouse in different parts of the country.



(Source: Rashid et al., (2013)

Figure 28: Fertilizer build-up cost by regions in Ethiopia, 2012

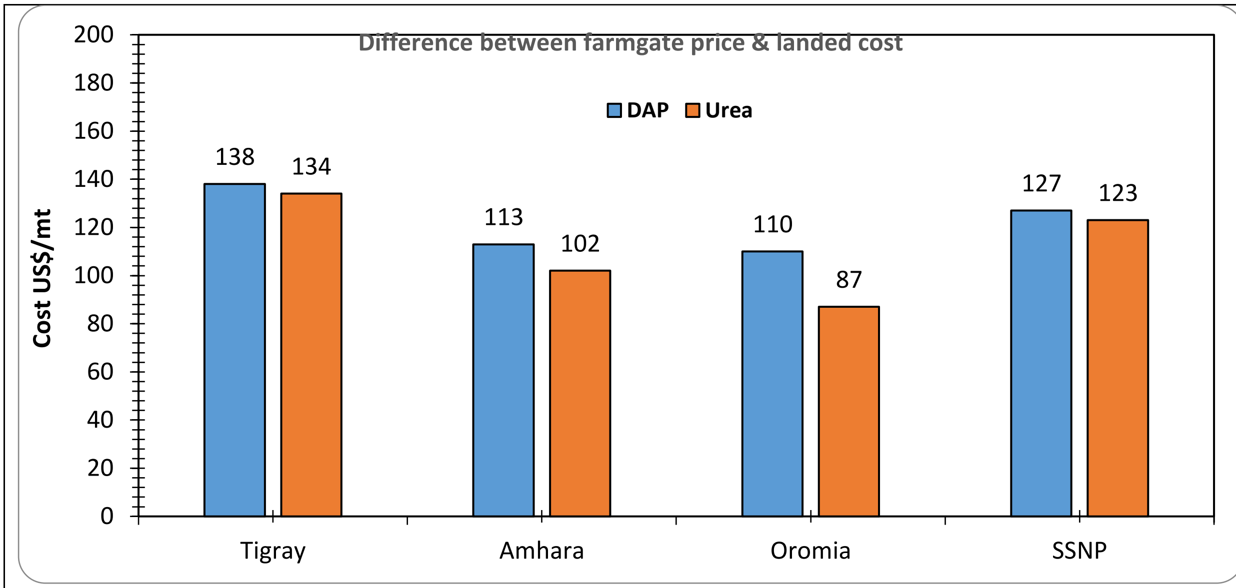


Figure 29: Difference between farm-gate price and landed cost of fertilizer, Ethiopia, 2012
Source: Rashid et al., (2013)

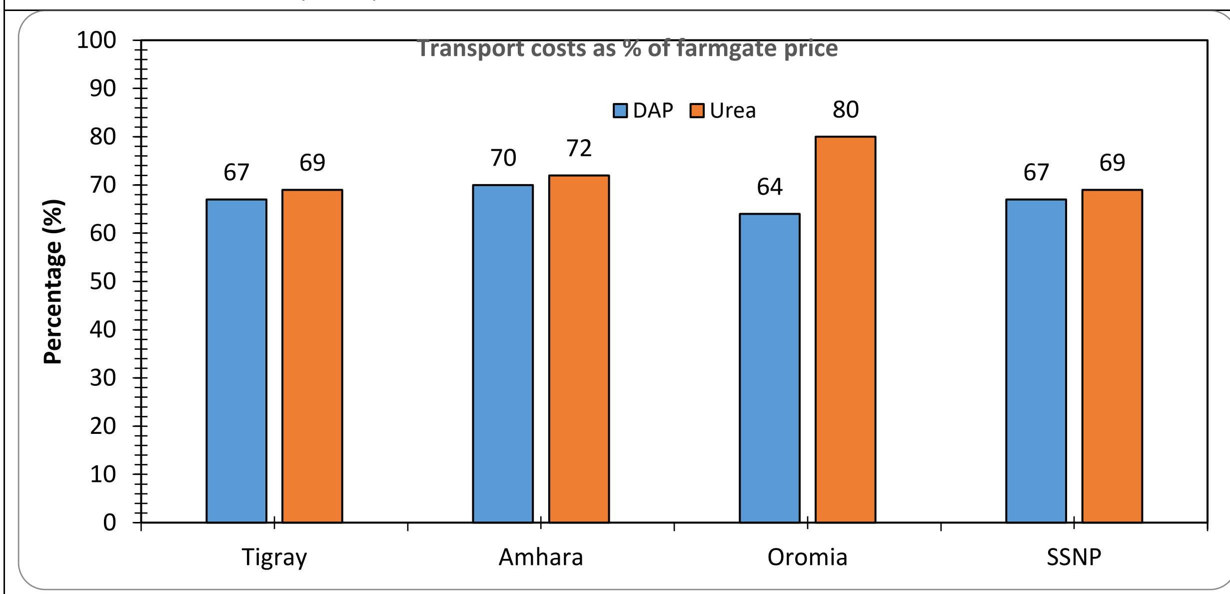


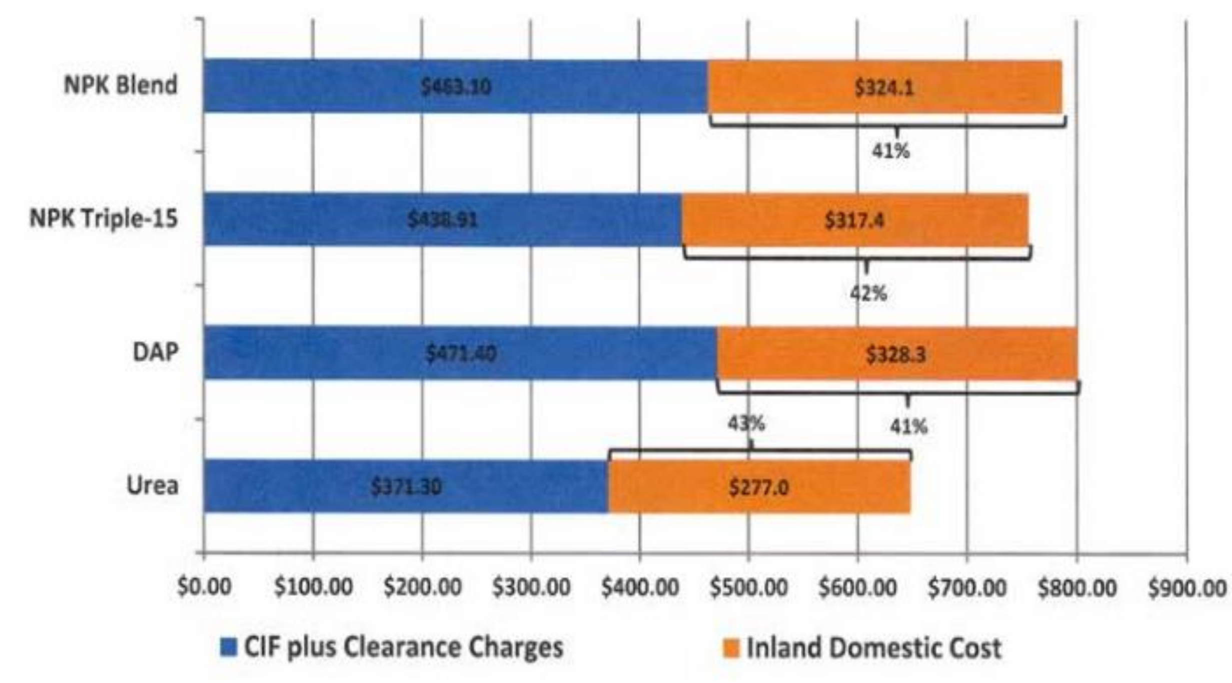
Figure 30: Transport costs as a percentage (%) of farm-gate price of fertilizer, Ethiopia, 2012
(Source: Rashid et al., (2013)

According to Rashid et al. (2013), the cost build-up is based on the location of a warehouse and the volume of import received. The authors noted that the hand-over prices is determined by the AISE as the sum of weighted average cost of insurance and freight (CIF) prices at the Djibouti ports along with the transportation costs. These costs are adjusted based on the following factors (Rashid et al., 2013): (i) distance from the port, (ii) cost of insurance, (iii) clearing and transit, (iii) bank commissions, (iv) inspection, (v) bagging and re-bagging, (vi) unloading costs at the central warehouse and overhead cost. Despite the long chain, these cost differentials are little which was due to a healthy competition in fertilizer prices. Additional costs, according to these authors at the regional bureaus were: (i) transportation costs, (ii) profit margins and administrative costs for cooperatives, (iii) bank interests, (iv) warehouse rent, and (v) loading and unloading costs at the cooperative stores.

Nigeria: Along the fertilizer supply chain, the cost structures can be divided into two: (i) international and (ii) domestic cost. Domestic cost is made up of inland costs, that is incurred from port to the point of final sale and this includes port charges, vessels unloading, bagging, government charges, finance costs, domestic transportation costs along with marketing and distribution margins. The prices of fertilizer in the Nigerian domestic market are based on a tender-bid process where the FGN negotiates the price with importers to supply all the 36 states of the federation. The final price paid to the smallholder farmer is set on a pan-territorial basis, and this is supposed to be same across all the 36 states, but differs according to the type of fertilizer and formulation. The final price paid to producers reflects, the prices negotiated by the FGN with the input providers. On the demand price, the state governments negotiate the tender process on behalf of the farmers and their organizations, hence, smallholders do not have any influence on price determination; they are the expected recipients of the final product and final beneficiary of the subsidy programof the government.

The general cost structure of main types of fertilizers imported into Nigeria (i.e. NPK-blend, triple super phosphate (TSP), di-ammonium phosphate (DAP) and urea is shown in Figure 31. The mean CIF plus clearance charges is about US$436.18 for all types of fertilizers, and this cost increases by an average of 42% (i.e. mean of US$ 311.7/ tonne) which ranges between 41 and 43% of total cost, from importation to distribution to smallholder farmers, who are the final consumers (Fuentes et al., 2012). Most of the fertilizers imported into Nigeria are in bulk and are then bagged at the port into 50kg each before being delivered to inland storage and distribution centres. Subsequently these are transported by importers to the regional warehouses of the government, then to the FSCs under the auspices of various ADPs, cooperatives, and retailers participating in the distribution of subsidised fertilizer. The movement of these fertilizers from the wholesalers and/or retailers is the sole responsibility of smallholder farmers. In 2009, the sub-components of the domestic cost of fertilizer in Nigeria showed that the cost of transportation is the highest compared to other costs (i.e. distribution along the supply chain, finance cost, port charges) (Fuentes, Bumb, & Johnson, 2012). The lowest of these costs is that imposed by the FGN (i.e. in form of taxes and levies) (Figure 32).

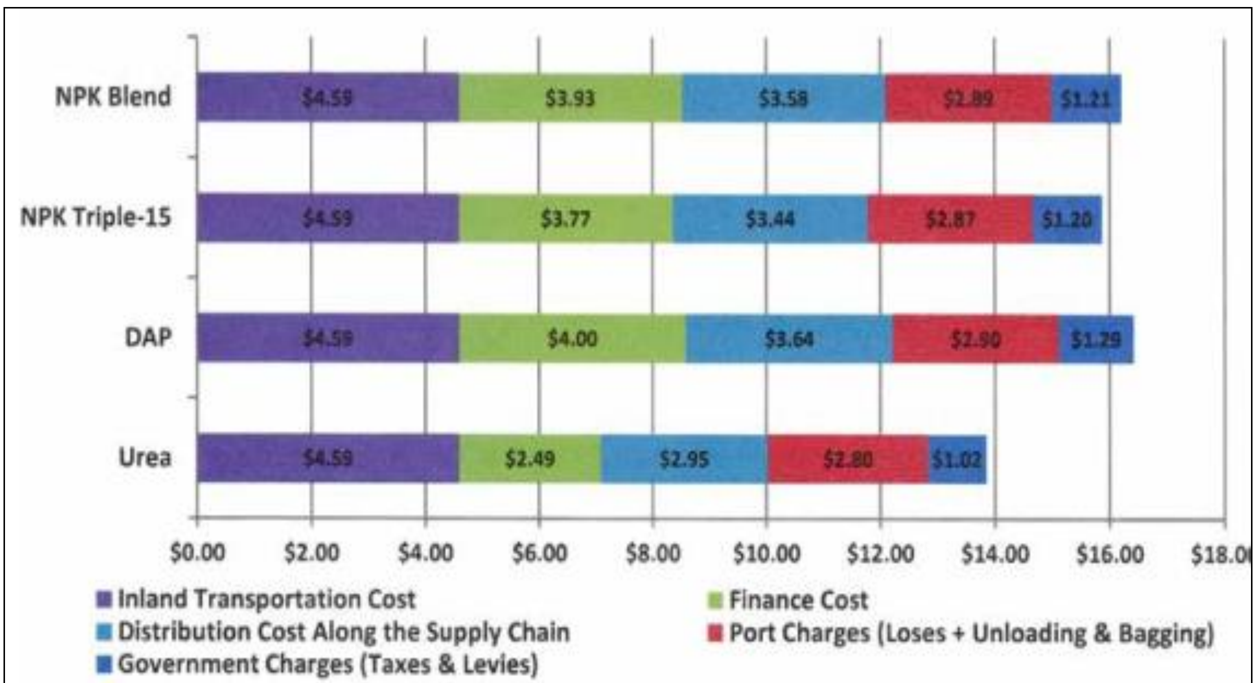
Domestic cost: Fuentes et al., (2012) shed further light on the components of this domestic transportation costs in the supply chain and it was found to account for an average of 29.6% with a range of between 28 and 33.1% depending on the fertilizer type that would be distributed. These authors reported that in monetary terms, this will translate to an average of US$ 4.59 per 50k-kg of fertilizer that is being distributed.



(Source: Fuentes et al. 2012)

Figure 31: Cost structure of fertilizer components in Nigeria (US$/ tonne) in 2009

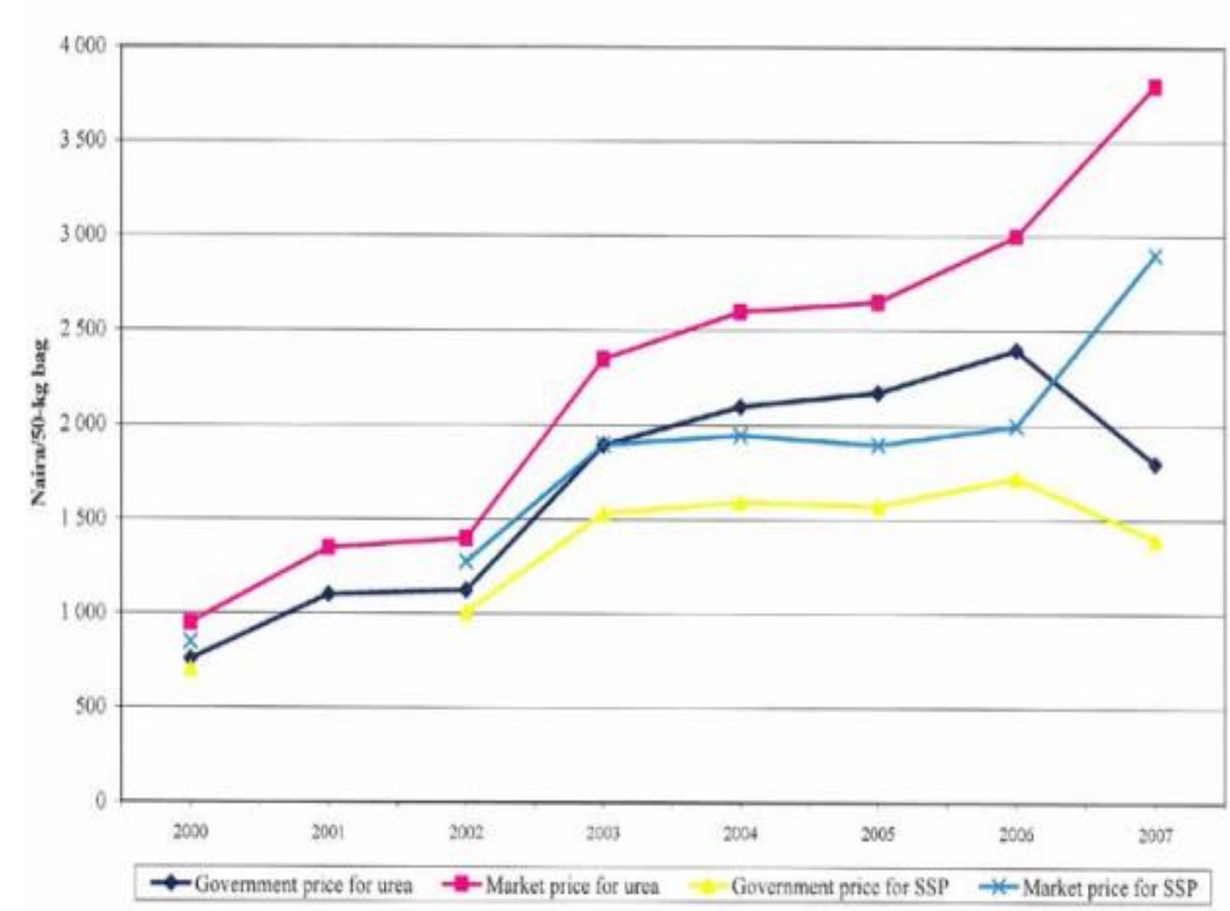
Generally, in Nigeria, the main mode of transporting these products is by trucks and most of the roads from the Lagos ports to other parts of Nigeria are in deplorable conditions and need improvements.



(Source Fuentes et al., 2012)

Figure 32: Domestic cost of fertilizer per 50kg-bag in Nigeria in US$/bag in 2009

It was estimated that average inland transportation cost from Lagos to the regional warehouses of the FGN was at US$0.05/ tonne /km (or US$ 0.08mt/mile) as at 2009. Therefore,, with a full truck load (up to 30 tonne /truck) and longer distances above 1000km, the cost of transportation between Lagos ports and warehouses was found to be much higher, but this is rarely taken into account since the products are bagged and loaded into trucks and then delivered to regional warehouses. When compared to other West African countries, the cost of transportation within Nigeria was found to be the lowest in the ECOWAS region (Fuentes et al., 2012). Other significant costs are those of finance that translates to a range between US$2.49 and US$4.00 of the domestic cost per 50-kg bag; the marketing costs/distribution channels range between US$2.95 and US$4.64 per 50-kg bag and the port charges range between US$2.87 and US$2.90 per 50-kg bag. All these costs depend on the fertilizer type/product. The fertilizer imports in Nigeria are exempted from taxes under the fertilizer subsidy program of the FGN. This cost is between US$ 1.02 and US$1.29 per 50-kg bag. The evolution of prices of SSP and urea in Nigeria showed a wide variation in fertilizer prices when the market prices are compared with the government prices for both fertilizer types (Figure 33). The presence of subsidized fertilizer (government price) creates a parallel market whereby the private sector may not be able to compete. Also, the subsidized fertilizers are generally not available for smallholder farmers. Currently, between January, 2019 and November, 2019, there were a wide variation between global (or world) prices of urea fertilizer compared to that of other selected countries (Figure 34A). When compared with the mean global price, most countries in the SSA have higher costs of urea which vary between US$378 /tonne (Ghana and US$639/ton (Uganda) (Figure 34B). The factors that may be responsible for the fluctuations can be linked to global economic factors, which include commodity prices, cost of raw materials, worldwide natural resources, energy and transportation costs, the US$ exchange rate, global economic development and population growth (Haile et al., 2014; Kenkel, 2009; Lahmiri, 2017). The performance and flow chain in Nigeria is depicted in Figure 35, and it showed that at the farm-gate, the prices of fertilizer has increased by as much as 42% (Feuntes et al., 212).



(Source Fuentes et al., 2012)

Figure 33: The urea and SSP prices in Nigeria between 2000 and 2007

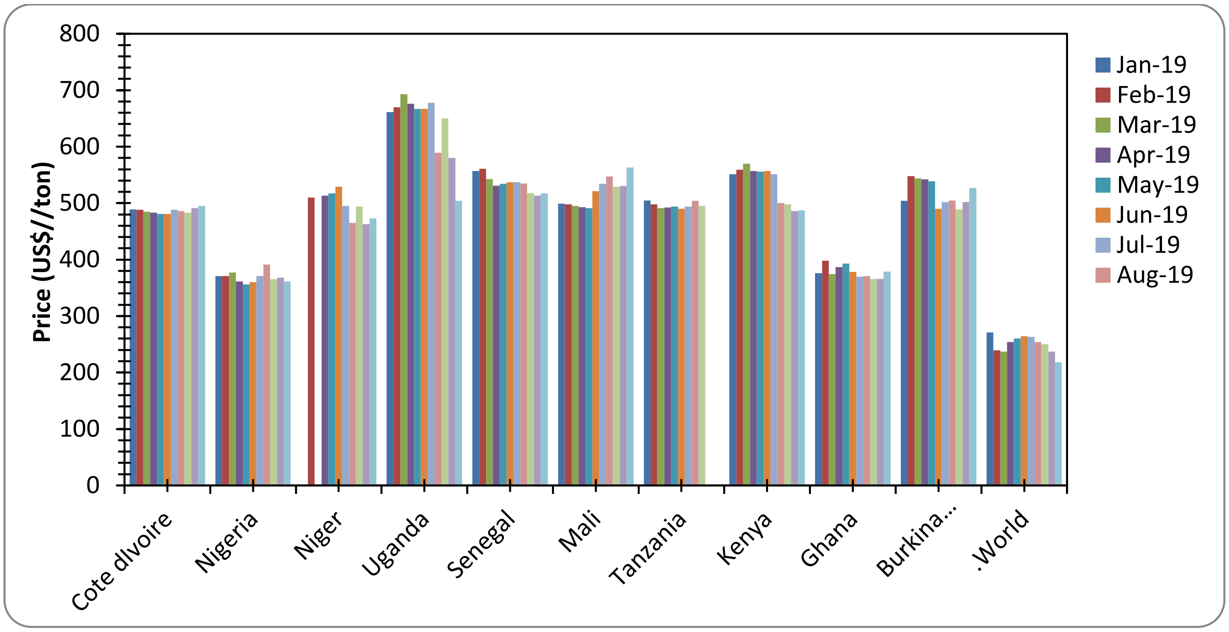
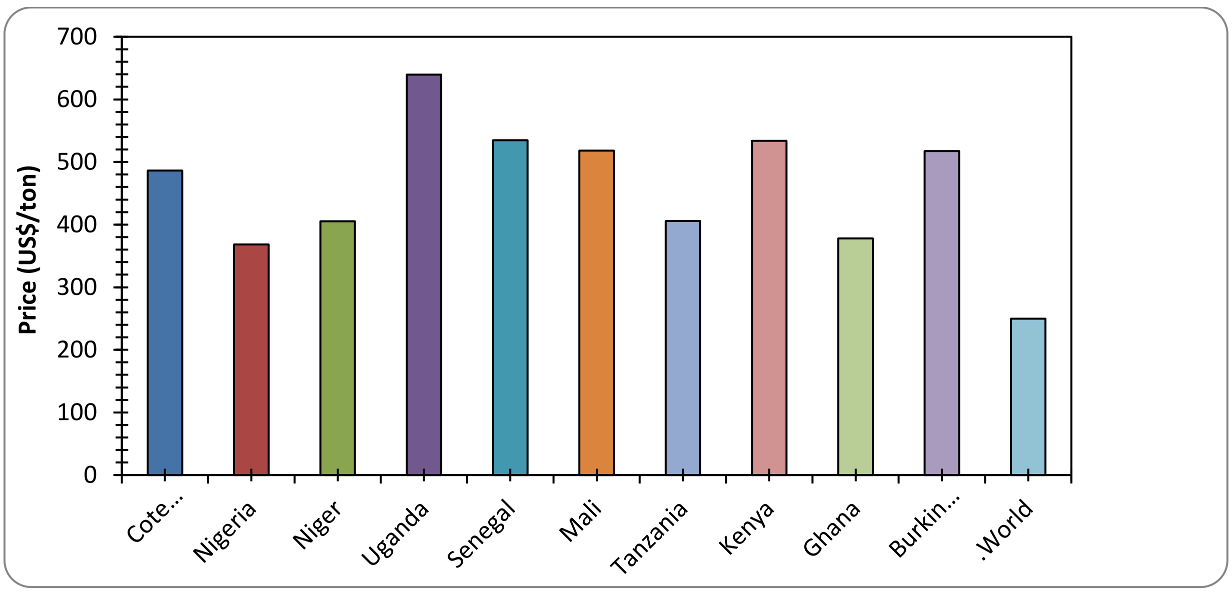


Figure 34A: Urea fertilizer prices across months in selected countries (Source: Africafertilizer.org)



(Source: Africafertilizer.org)

Figure 34: Fertilizer prices across in selected countries compared to the global mean

Uganda: In order to raise fertilizer consumption in Uganda, it is imperative to analyze the cost as well as fertilizer distribution, which will provide information that can guide both local and international bodies that may be willing to improve fertilizer consumption in Uganda and mitigate costs so that farm gate prices can be reduced. An observation of the location of Uganda showed that it is a landlocked country that is sandwiched between South Sudan, Democratic Republic of Congo (DRC), Kenya, Rwanda and Tanzania. Thus, its location determines the supply chain of fertilizer, which also directly has impacts on the prices of inorganic fertilizer. These costs can be divided into international costs (i.e. outside and within Kenya before reaching the Ugandan border at *Malaba* and the domestic costs of transportation within Uganda, before the products get to the smallholder farmers. It was reported that the government of Uganda (GoU) is only interested in the domestic costs, which is also impacted by the international costs (IFDC/AFAP, 2014). It was also reported that the countries with the East African Community (EAC) has already started to work together to implement policies that may have effect on the international costs (i.e. to reduce the costs as well as the lead time that products (i.e. fertilizers) take from the port to destinations by reducing the number of weighbridges as well as police inspection stops in Kenya. In addition, the EAC countries have started working on a new railway line in order that the government of Uganda (GoU) may be able to reduce the international costs of fertilizers through regional cooperation. The East African Community (EAC) member states, Tanzania, Kenya, Burundi, Rwanda and Uganda have been planning to implement joint infrastructure projects to further boost regional trade and growth. The project will involve constructing a 2561km of standard gauge railway to connect Dar Salaam to landlocked neighbours of Rwanda, Burundi, Uganda, Zambia and eastern Democratic Republic of Congo at a cost of almost US$7.6bn.

The fertilizer supply for Ugandan farmers mirrors that of Kenyan smallholders; however, the farmers in Uganda pay higher costs for fertilizer when compared to that of Kenya, which is due to higher transportation. There are four major cost items in Uganda and they are: (i) port handling, (ii) transport costs, (iii) transaction costs and (iv) trade margins (IFDC/AFAB, 2014). When all these costs are considered, the ones that generated most interest are the port and transaction costs. There was a great problem while attempting to estimate business margins and transaction costs as those involved did not want to divulge such information (i.e. as it was considered as confidential). The cost estimate of margins was from the interviews that were conducted with the importers as a percentage of costs (IFDC/AFAB, 2014). Thus, one determinant of fertilizer prices in Uganda is the transportation costs. For example in 2014, in the study conducted by the IFDC/AFPAP, it was found that to transport DAP from Mombasa in Kenya to Kampala, Uganda (i.e. 1,200km), the cost of transport was very high (i.e. 40%) compared to other costs – port/bagging/warehousing, finance and other marginal costs (Figures 35A and 35B).

The item tagged margins are “gross” (i.e. the internal costs incurred by the business that is related to fertilizer activities. This includes labor, capital, and overhead (IFDC/AFAB, 2014). It is evident that these costs constituted a challenge to improving the movement of fertilizers to smallholder farmers at affordable prices. Thus, in order to improve the amount of fertilizer used along with the consumption, efforts should be made to reduce transportation cost by improving transport efficiency.

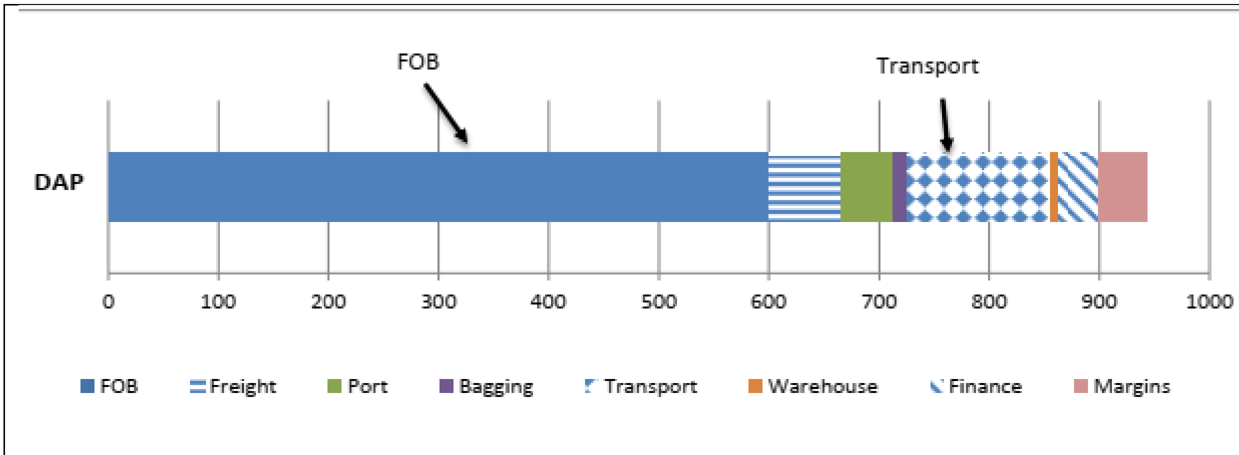


Figure 35A: Total cost (US$) buildup for Importing DAP from Mombasa port to Kampala, 2013

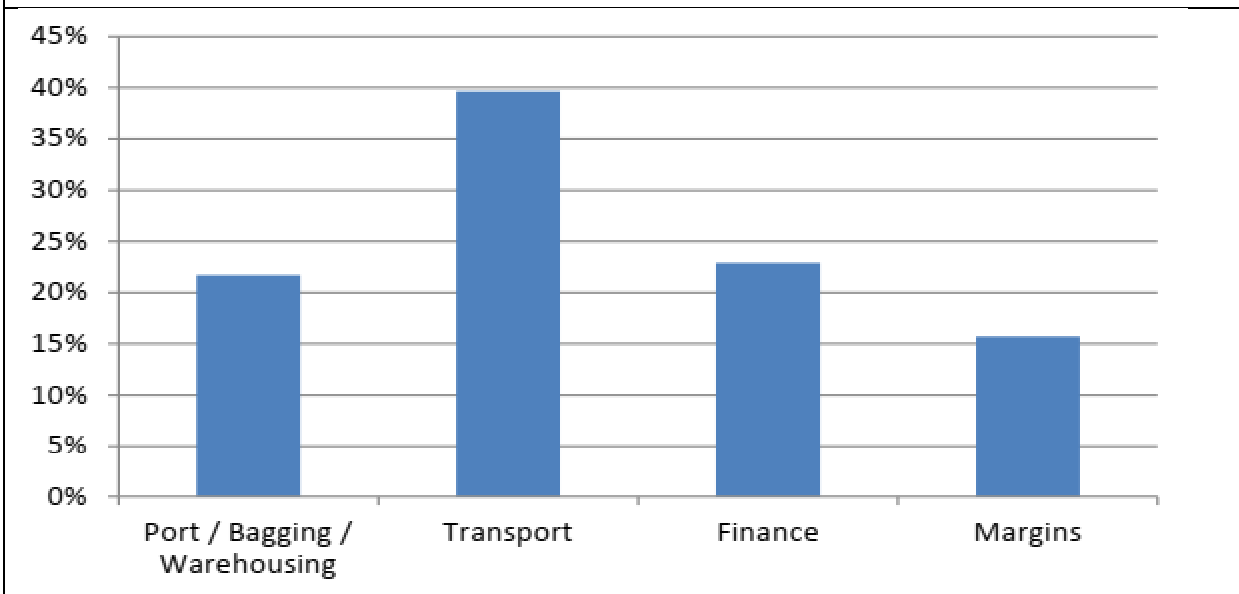
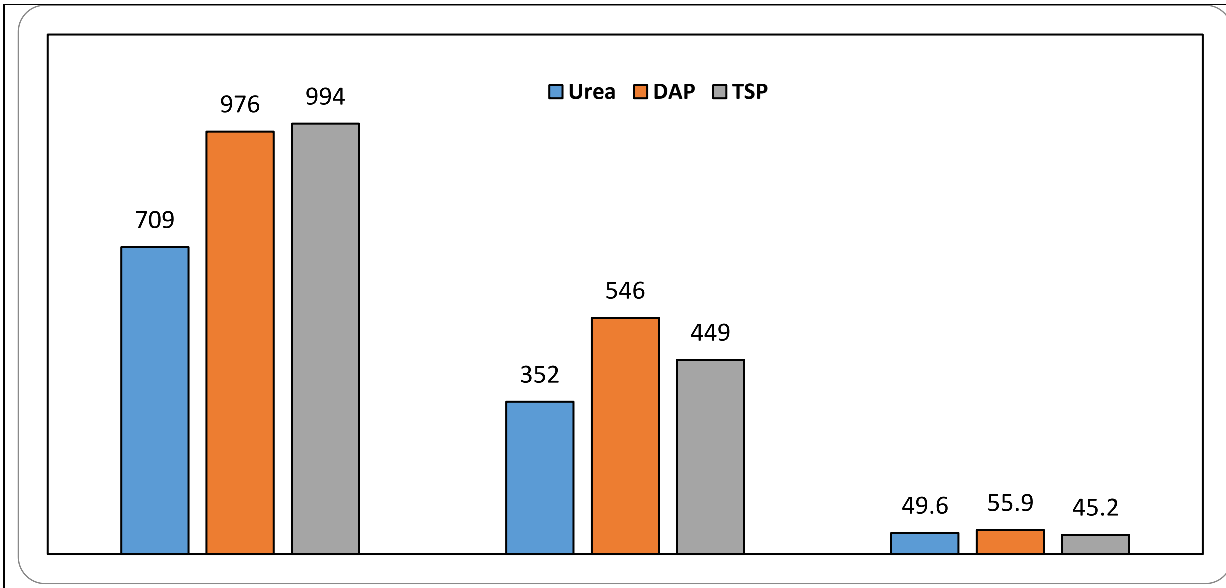


Fig. 35B. Percentage of individual items in the total domestic costs of fertilizer, to Uganda, 2013

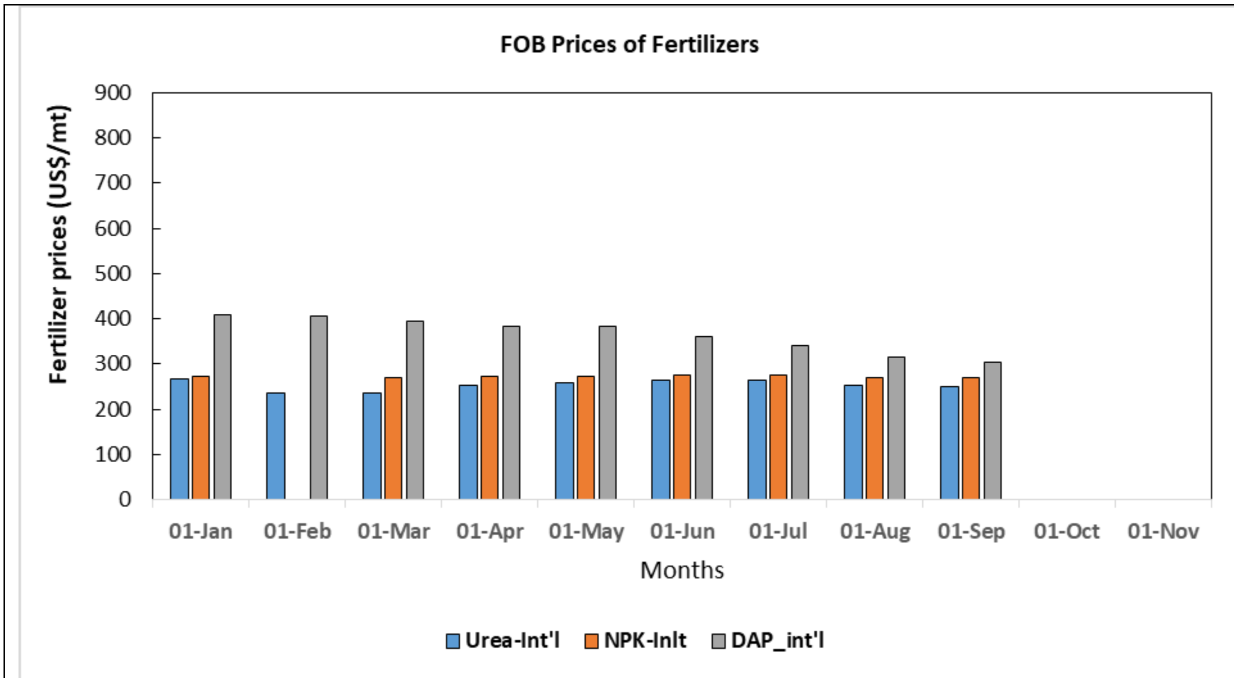
Figure 35: Cost structure of fertilizer in Uganda Source: IFDC/AFAB, (2014).

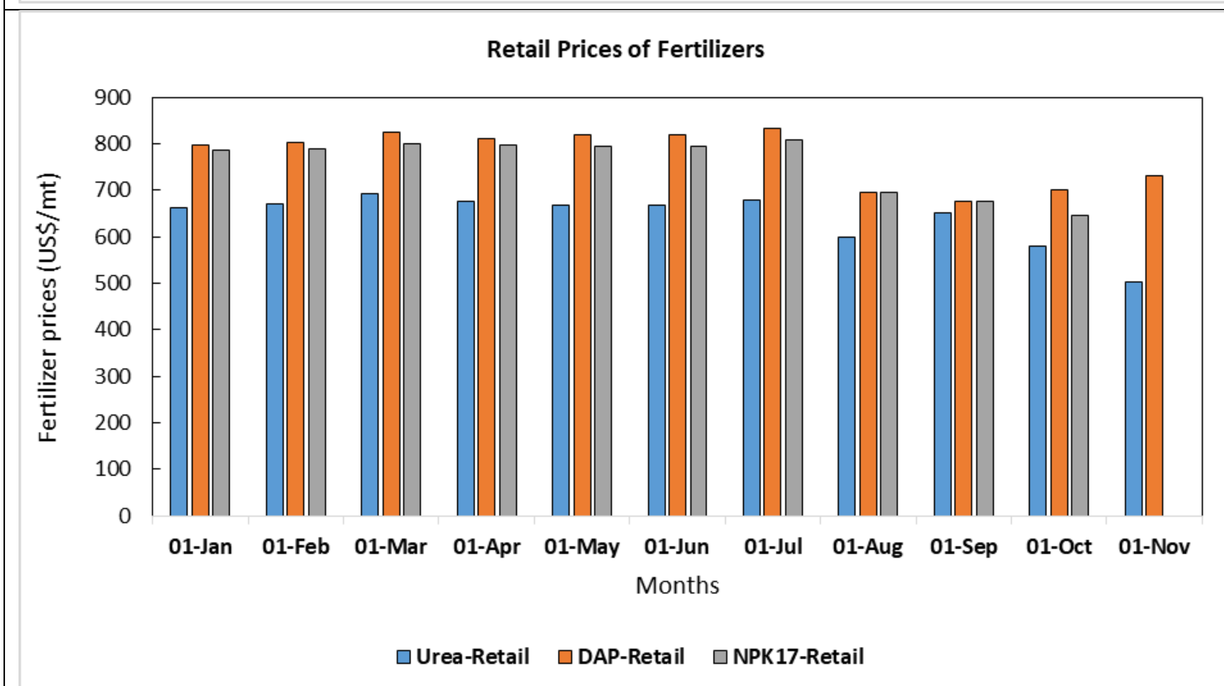
Between August, 2010 and January, 2011, Benson et al. (2012), compared fertilizer retail price within the country with that of the free-on-board price from international suppliers (i.e. US$/tonne) and results showed that the prices of local retail prices for urea, diammonium phosphate (DAP) and triple super phosphate (TSP) were between 45.2% and 55.9% higher (Figure 36). Destination sources of urea, DAP and TSP were Arab Gulf, Baltic and North Africa, respectively (Figure 37).



Mean comparison of retail prices of fertilizer against FOB from Int'l suppliers, 2010-2011 (Sources: www.amitsa.org; Benson et al., (2012).

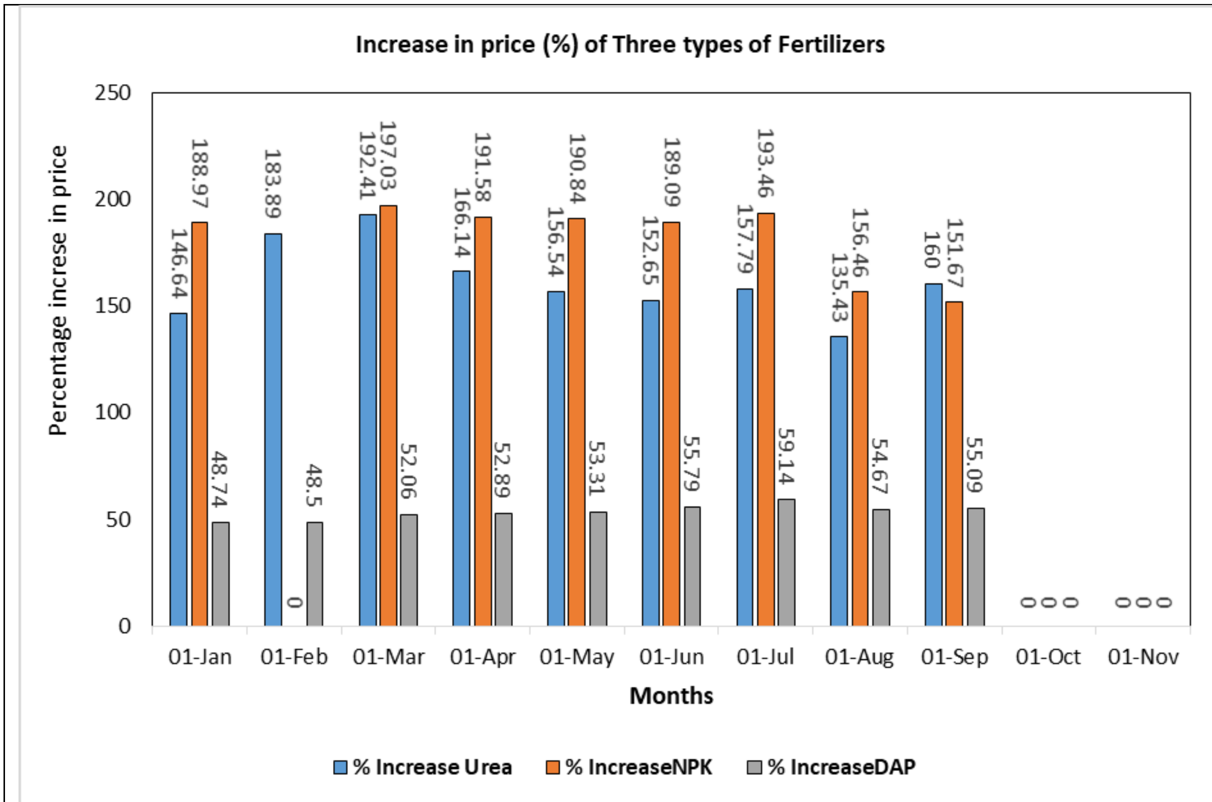
Figure 36: Mean comparison of retail prices of fertilizer against FOB from International suppliers, 2010-2011





Comparison of prices of three types of fertilizers – FOB vs Retail prices (Jan -19 –Sep-19). (Source: Africafertilizer.org)

Figure 37: Comparison of prices of three types of fertilizers – FOB vs retail prices



Percentage increase in prices of three types of fertilizer in Uganda (Jan 19-Sep-19) (Source: Africafertilizer.org)

Figure 38: Percentage increase in prices of three types of fertilizer in Uganda

A similar trend can be observed between the retail prices of fertilizers locally within Uganda between January, 2019 and September, 2019 compared with the FOB (or international prices) of three types of fertilizers – DAP, urea and NPK 17-17-17 (Figure 38). The percentage increase in prices is between 146-192% (urea fertilizer), 151-197% (NPK 17-17-17) and 48.5-59.14% (DAP), respectively (Figure 38). From these analyses, it is evident that "gains can be achieved by improving access to finance by importers, reducing the overhead charges that dealers incur, and removing any taxes and fees levied on fertilizer importers and dealers that work against the objectives of improving agricultural productivity and the profitability of farming for Ugandan smallholder" (Benson et al., 2012).

(iv) Transportation:

Ethiopia: The study by Rashid et al., (2013) compared average fertilizer prices between Ethiopia and other neighbouring countries (Kenya, Rwanda and Tanzania), and the study showed lower prices in Ethiopia compared to the other countries (Figures 39A and 39B). The percentage difference in prices are higher in these countries than in Ethiopia (Figure 39C). The percentage difference in prices between Ethiopia and these countries ranged between 84% (Tanzania) and 95% (Rwanda) for DAP and urea. It ranged from 75% higher (Tanzania) to 94% in Rwanda. The reasons alluded to this were (Rashid et al., 2013): (i) lower interests rates on fertilizer levied by the bank compared to national lending rate, (ii) there is no allowance for storage and spoilage costs, and (iii), the profit margins in the cooperatives are set to lower than the market rates. However, in a similar study, Minten et al. (2013), estimated that the farther a farmer lives from the cooperative warehouses, the higher the cost of fertilizers that would be paid by such a farmer. For example, these authors stated that a farmer who lives 10km away from the cooperative centres would incur transaction costs of almost the same as that of brining fertilizer from the Djibouti port to a cooperative which is almost 1000km away.

There are other costs associated with the procurement of fertilizers, and these are called total implicit and carryover costs and they are displayed in Tables 12 and 13.

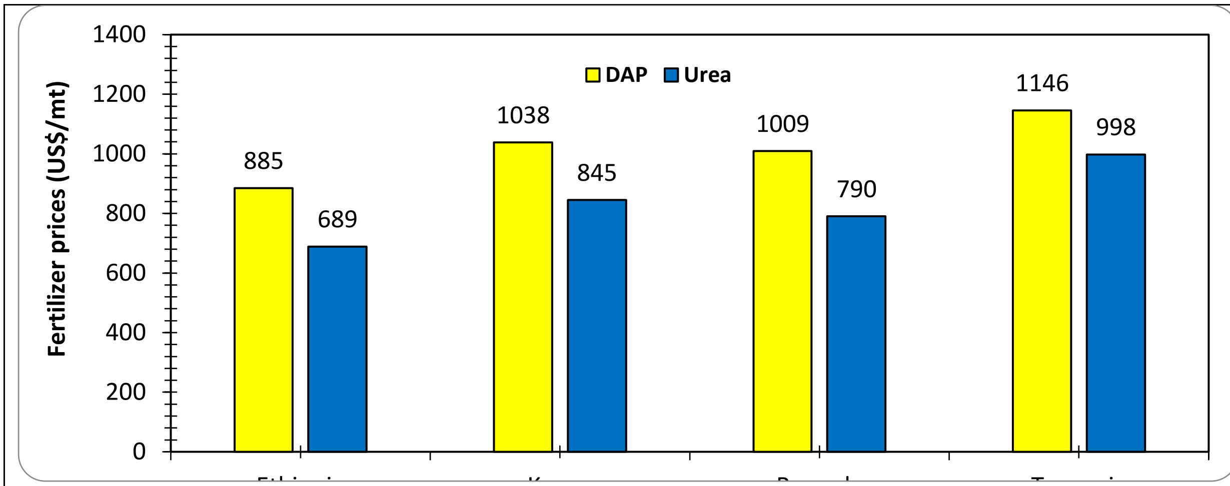


Figure 39A: Comparison of fertilizer prices between Ethiopia and neighbouring countries

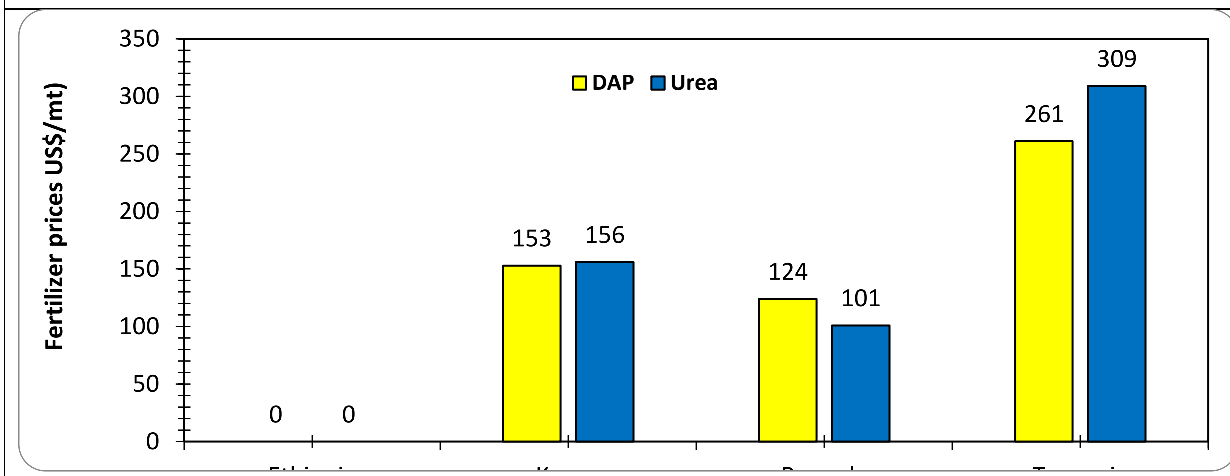


Figure 39B : Differences in prices of fertilizer in Ethiopia compared to neighbouring countries

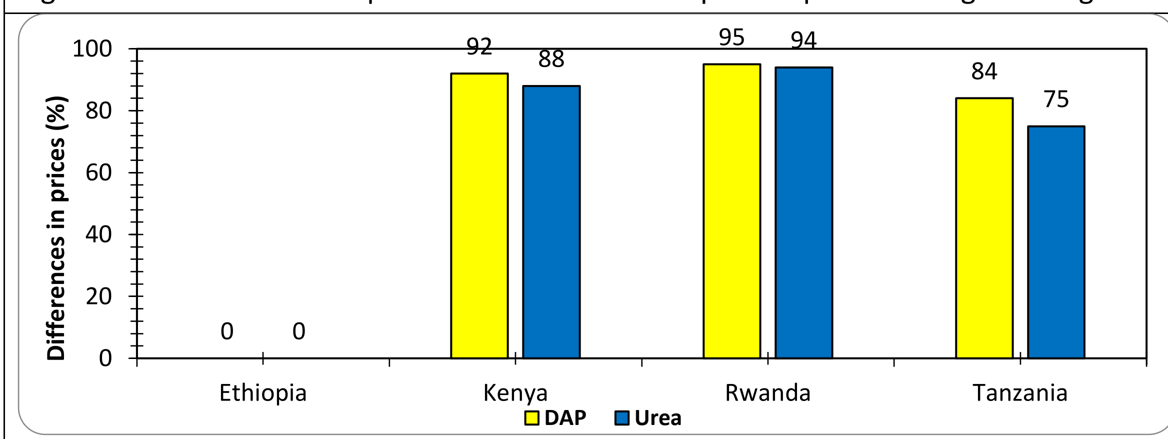


Figure 39C: Percentage difference between fertilizer prices in Ethiopia compared to neighbouring countries (Sources: Rashid et al., 2013)

Figure 39: Difference between fertilizer prices in Ethiopia compared to neighbouring countries

Table 12: Estimated implicit costs of current fertilizer policies (2008-2012)

Sources of implicit Costs	Year				
	2008	2009	2010	2011	2012
Low interest rates (8% less than lending rates) (in US$ millions)					
DAP	9.39	9.87	5.95	9.35	12.31
Urea	3.75	1.53	3.08	4.13	5.80
Subtotal	13.4	11.40	9.03	13.48	18.11
Spoilage & weight loss (1%)					
DAP	2.35	2.47	1.49	2.34	3.08
Urea	1.32	0.53	0.85	1.34	1.79
Subtotal	3.67	3.00	2.34	3.68	4.87
Coop opportunity costs (for six months)‡					
DAP	12.91	13.57	8.18	12.86	16.93
Urea	5.15	2.10	4.23	5.68	7.97
Subtotal	18.06	15.67	12.41	18.54	24.90
Storage costs (for six months)δ					
(DAP+ Urea)	4.42	5.61	5.54	5.51	6.33
Grand Total	39.29	35.67	29.32	41.20	54.21

Source: AISE data; Rashid et al., (2013); ‡ Coops receive $6.90, which is roughly 1% of gross return and this is assumed to be 11% since lending rate is 12%; δ Storage is estimated at ETB 26 (≈US$1.55 ton per month @ the exchange rate of 2013). DAP= Di-ammonium phosphate

The implicit cost is as shown before, except these are expressed in total costs per tonne of fertilizers imported, and it is evident that DAP across years accounted for more than 50-70% of the total cost (Rashid et al., 2013). The other cost is that associated with the carry-over stocks. The components of these costs are: (i) interest costs (opportunity cost of the money tied in stocks), (ii) spoilage and weight loss, (iii) primary cooperatives costs and (iv) an adjustment cost for storage.

Table 13: Benefit-cost analysis of carryover stocks of DAP and urea in Ethiopia (2002-2011)

Types	Year	Quantity ('000mt)	Retail price ($/mt)	Administrative cost A	Interest, market rates (12%) B	Potential physical losses (2%) C	Direct total costs of carry over D=(A+B+C)	Gain (loss) due to price change E	Net benefit (costs) of carryover F=(E-D)
				In $ millions					
DAP	2002	130.7	295	0.92	4.63	0.77	6.32	(0.15)	(6.47)
	2003	2.4	294	0.02	0.08	0.01	0.12	0.14	0.02
	2004	25.1	355	0.18	1.07	0.18	1.43	2.07	0.64
	2006	54.1	438	0.38	2.84	0.47	3.70	1.47	(2.23)
	2007	19.1	465	0.14	1.06	0.18	1.38	7.51	6.13
	2008	37.0	859	0.24	3.82	0.64	4.70	(9.57)	(14.27)
	2009	203.7	600	1.07	14.68	2.45	18.19	(34.90)	(53.09)
	2010	148.2	429	0.63	7.63	1.27	9.53	36.00	26.47
	2011	135.0	672	0.49	10.89	1.81	13.19	(24.62)	(37.81)
Average		**83.9**	**490**	**0.45**	**5.19**	**0.86**	**6.51**	**(2.45)**	**(8.96)**
Urea	2002	94.6	229	0.67	2.60	0.43	3.70	0.42	(3.28)
	2003	4.6	233	0.04	0.13	0.02	0.19	0.37	0.18
	2004	32.6	314	0.23	1.23	0.20	1.67	2.18	0.52
	2006	91.2	381	0.64	4.17	0.70	5.51	4.02	(1.49)
	2007	26.1	425	0.19	1.33	0.22	1.74	4.76	3.02
	2008	45.8	608	0.30	3.34	0.56	4.19	(8.00)	(12.20)
	2009	97.8	433	0.52	5.08	0.85	6.44	(4.37)	(10.81)
	2010	104.0	388	0.44	4.85	0.81	6.10	13.58	7.48
	2011	132.5	519	0.48	8.24	1.37	10.10	(16.74)	(12.84)
Average		**69.9**	**392**	**0.39**	**3.44**	**0.57**	**4.40**	**(0.42)**	**(4.82)**

Source: Rashid et al., (2013); DAP= Di-ammonium phosphate; mt= metric tons

Nigeria

Roads, though expensive, enables the "creation of, and the participation in markets" and these makes developments possible. Africa has the lowest road density in the world which was estimated at about 204km of roads per 1,000 Km^2 (Ali et al., 2015). Roads are built to connect major economic activities by linking cities, markets, rural areas where agricultural products are produced. It is reported that Nigeria has an extensive road network of more than 85,000km Gwilliam, 2011) and if the country is to meet its economic and social targets for transportation infrastructure, then about US$1.2 billion should be invested annually for the next 10 years (Alli et al., 2015). The distribution of fertilizer products in Nigeria has been a problem and small-scale farmers have suffered for a long time as a result of poorly funded and inefficiently executed distribution of this product as at when needed. One of these problems is the poor state of infrastructure in Nigeria. The state of poor road networks, lack of investment along with ethnic unrest (i.e. the surge in the activities of Boko Haram) has made fertilizer distribution very difficult in several parts of the country, thus, making fertilizer distribution very difficult and the product cannot be delivered to the beneficiaries as at when needed at a reasonable cost. For example, it was reported that Nigeria loses about 2% its gross domestic product (GDP) every single years due to poor infrastructure, which translates to about Naira 2.03 trillion, considering the GDP of 2016 which was Naira 101.59 trillion.

Uganda: Auditing of principal importers of fertilizer in Uganda has been conducted over the past 20 years and they also act as retailers. There were about 5000 to 6000 importers in the 1990s who imported fertilizers as indicated by Tukacungurwa (1994). Over 60% of this number included the Uganda Tea Growers Corporation, British-America Tobacco, Kakira Sugar, Toro Mityana Tea Company, Sugar Cooperation of Uganda, the Ministry of Agriculture and others that were responsible for distributing fertilizers for various developmental projects. During this period, there was no involvement of private importers and fertilizer stocks were delivered through the Mombasa port, Kenya. Between the year 2000 and 2010, the amount of fertilizers imported into the country increased from about 20,000 tonne /annum to over 40,000 tonne/annum, and this increased the number of importers, who mainly procured their consignments from Kenya and many of these have their base in Kampala, Uganda as the headquarters (Omiat and Diiro, 2005). However, a few others were also located in Mbale and Masaka, west of Kampala. Most of the fertilizers also came in 50- kg bags and some importers were found to sell small quantities to smallholders, though these bags were poorly labelled, thus going against the regulations under which agricultural chemicals can be sold (Benson, et al., 2012).

Transportation of fertilizer import shipments: In Uganda, transport costs of a 28-tonne truck load of fertilizer is between US$2,000 and 2,200 from Nairobi to Kampala and that from Mombasa to Kampala is between US$3000 and 3, 3000 (Benson et al., 2012). These costs include – roadblock fees and Uganda toll tax and transport fees. There has been a railway from Kampala to Mombasa, which is run by Rift Valley Railways consortium which can handle close to 23 tones of fertilizers and the cost is US$2,200 from Mombasa to Kampala. Though it is considerably cheaper than road transportation. Most shippers are not willing to use it as there are import delays, hence there would be a cost build-up especially for storage and financing (Benson et al., 2012). Compared to other selected countries, the road low density (km paved roads/million capita is about 493 compared with that of Zimbabwe and the USA (Figure 40). Furthermore, when the scenario in Uganda is compared with that of her two neighbors (i.e. Kenya and Ethiopia), the low utilization of inorganic fertilizer in Uganda is striking. One of the reasons for this is the lack of credit facilities in Uganda. Benson et al., (2012), reported that in the past years, no household in the Ugandan sampled households received credit from any sources to buy inorganic fertilizer. The authors reported that "there is no large-scale government fertilizer program" unlike that which operates in Ethiopia that has been known over the years to provide subsidized fertilizer to farmers. In Kenya, there is an active private fertilizer sector that supplies fertilizer to smallholder farmers at competitive prices. However, Uganda is a landlocked country and the transportation system connecting these countries and ports is poorly developed; consequently, access to inorganic fertilizer market is not favorable. Strong infrastructure growth in most African countries (Yamano, & Arai, 2011). This is not a complete sentence. The continent has seen tremendous economic growth in the past years; however, there are still serious infrastructure shortcomings in most landlocked countries (i.e. Uganda), and this has been hampering business growth, service delivery, trade, and investment. This has in a way contributed to the higher cost of inorganic is very important for productivity and fertilizer in Uganda This sentence is not complete

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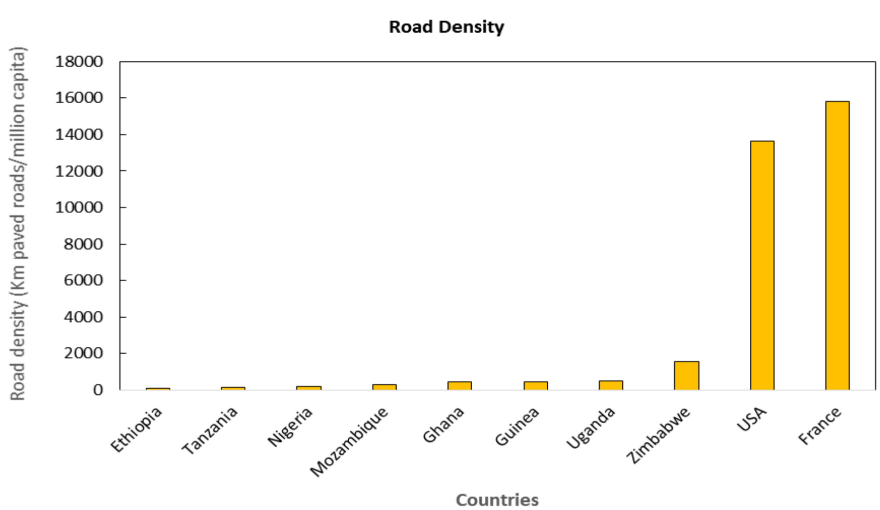
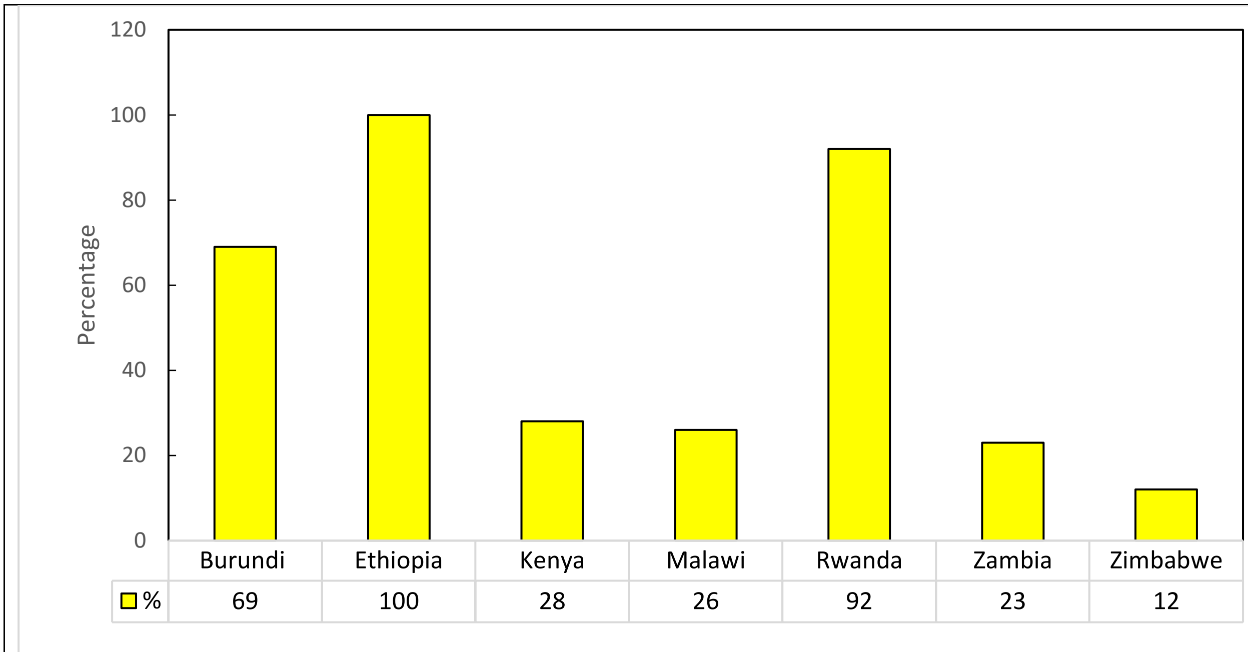


Figure 40: Road density in in selected countries (kilometer paved roads/million capita) (Source: Roy, 2016)

Subsidies

Ethiopia

Fertilizers are very expensive, and in order for smallholder farmers in SSA to have access to fertilizers, the cost of fertilizers must be subsidized. Consequently, over the years, most African governments have implemented input subsidy programs (ISP). However, large proportions of budget allocated to agriculture are used to finance it (AGRA, 2014). It was reported that since the year 2000, ten African countries have spent about US$ 1billion on ISPs which accounted for about 28.60% of public expenditures on agriculture (Jayne & Rashid, 2013). Some countries in SSA (i.e. Ghana, Malawi and Zambia) spent between 14 and 26% of the total agricultural budgets on fertilizer subsidies, thereby leaving very small percentages for research and extension (Kotschi, 2013). In 2016, data across selected SSA countries showed that the percentage of subsidy ranged from 12% (Zimbabwe) to 100% (Ethiopia) (Figure 41). There has been several reports stating that these ISPs may have increased fertilizer use; however, no conclusive information exists on whether ISPs led to increased fertilizer purchase/utilization or not (AGRA, 2014). In most SSA countries, it was reported that subsidized fertilizers are often diverted into secondary markets and are delivered very late to smallholder farmers (Ariga, 2017). Generally, Bumb and Gregory (2006), noted that wherever subsidies have been used, the results have been generally unimpressive due to: (i) high cost of ISPs, and (ii) low benefits accruing to farmers from the incremental fertilizer use. Bumb and Gregory (2006) noted that fertilizer subsidies can crowd-in commercial fertilizer sector by making farmers to be aware of the benefits of fertilizer, thereby increasing its demand and helping this sector to increase their profitability through economies of scale so as to handle large volumes of fertilizers. In addition, increased demand will increase importation and domestic transportation of fertilizer in bulk quantity thereby reducing the unit cost (World Bank, 2007, p150-151). Through this, smallholder farmers can increase savings from reduced production costs or increase sales from increased fertilizer use. However, if the conditions mentioned earlier do not hold, fertilizer subsidies can crowd-out the commercial fertilizer sector (Xu et al., 2009; Ricker-Gilbert et al., 2011).



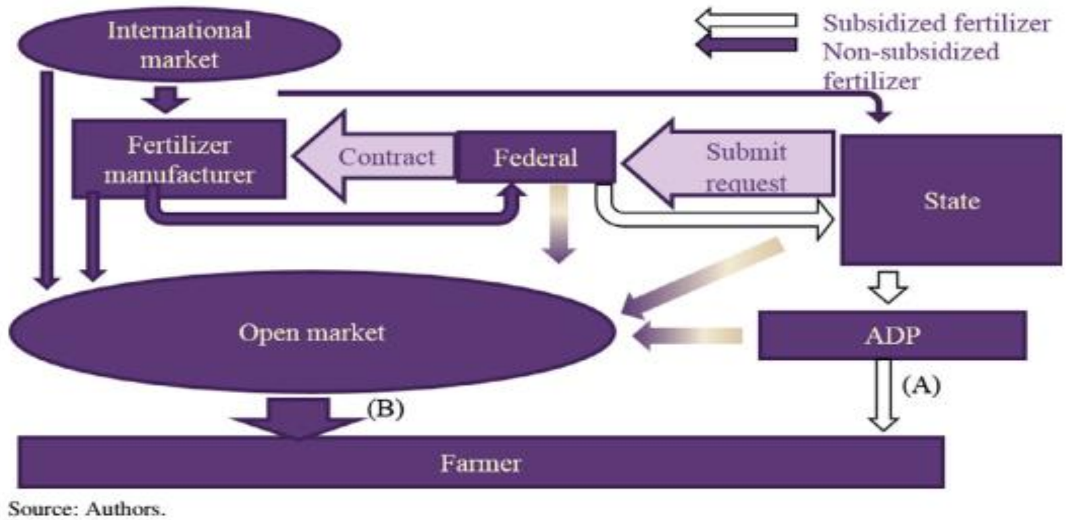
(Source: IFAP and IFDC, 2017)

Figure 41: Percentage share of subsidy volume in selected countries in SSA

Despite these disappointing feedbacks, the ISPs have started to attract attention in most SSA countries as the program can be implemented for political popularity (Bumb and Gregory, 2006). The authors expressed that apart from the political appeal of the ISPs, they can be used to increase agricultural productivity, improve food security, reduce poverty and hunger and simultaneously be used as a "convenient instrument for channeling income support" towards smallholder farmers who may need public assistance in the rural areas. Despite the appeal ISPs are supposed to be used with extreme caution in some SSA countries. Empirically, as several authors have stated, ISPs have been inefficient, costly and fiscally unsustainable (Houssou et al., 2017; Jayne & Rashid, 2013; Jayne et al., 2018; Michael et al., 2018).

Nigeria

Fertilizer subsidies account for about 30% of the budget on agriculture (Takeshima and Nkonya, 2014); though, in the past, the FGN had allocated less than 3% of its budget to agriculture (Liverpool-Tasie & Takeshima, 2013) (Mogues et al., 2012). The Fertilizer Market Stabilization Program (FMSP) was implemented in Nigeria between 1999 and 2011 (Liverpool-Tasie & Takeshima, 2013). Under the FMSP, subsidized fertilizer was distributed through the channels as shown in Figure 42. In the FMSP, each state government submits their requests to the FGN to procure some volumes of fertilizer based on the demand projections from each state government based on the farm area along with recommended fertilizer rates (Afua Branoah Banful & Olayide, 2010; Liverpool-Tasie et al., 2017b). It is the FGN that determines fertilizer procurement based on the budget allocation along with tender for private fertilizer manufactures.



(Source: *Takeshima and Nkonya, 2014)*

Figure 42: Fertilizer subsidy program scheme in Nigeria

After procuring fertilizer, the FGN distributes it to the warehouses in each of the 36 states in Nigeria, then fertilizer is distributed to the Agricultural Development Projects (ADP) and subsidy is from zero to 50% (Takeshima and Nkonya, 2014). The other route (i.e. Channel B) is not subsidized as fertilizers are obtained from the open market (i.e. directly from the international market).

Uganda In the eastern and south-western parts of Uganda, there exist extensive soils called Andisols (volcanic soils) that are young, fertile, and with considerable amounts of soil nutrients (Ssali, 2003; Palm et al., 2007). In a study conducted by Foster (1971), it was shown that most soils in this part of Uganda have mean values for pH (6.10), SOM (3.48 %) and total N (0.21%), relative to the critical thresholds provided by Foster (1971). This shows that generally, most Ugandan soils are suitable for most crops with minor limitations. This agrees with Chenery's (1960) findings. This author compared soils of Uganda with those of other tropical African soils with that of Uganda and concluded that the soils of Uganda are, "on the whole, very fertile"? . The relatively high fertility of most soils in Uganda may have accounted for the low use of inorganic fertilizers (Bayite-Kasule, 2009), hence, fertilizer use may not have been profitable at the household level (Nkonya et al., 2005), but Yanggen et al., (1998) were of the notion that despite this school of thought, there are compelling reasons to evaluate the extent to which application of fertilizers may be economically or socially profitable. In a conventional economic theory where there is a divergence between private and public interests, funding through government subsidies may be needed. In order to improve inorganic fertilizer market performance in Uganda, the country has to approach the issue holistically, and this should be aimed at strengthening both the private and public sectors. In addition, the GoU should increase expenditure on infrastructural development, agricultural research, quality control, agricultural extension services and improve the promotion of regional trade (Bayite-Kasule, 2009).

Results

This section addresses the research questions in the ToR and the results of the field work.

Efficiency of fertilizer supply chains in SSA, especially in remote areas

As the study has clearly demonstrated along with the detailed review of literature/desk study, in most SSA countries and especially in Ethiopia, Nigeria and Uganda, fertilizer supply chains are not efficient. Most of these countries (i.e. Ethiopia, and Uganda inclusive) and largely Nigeria rely on imported fertilizers for domestic supply. In the three countries studied, the cost in the supply chain include the following: (i) international procurement, (ii) shipping and transportation, (iii) port operations, (iv) bagging and warehousing, (v) inland transportation and (vi) wholesale and retail operations. In addition, in all the countries studied by Chemonics International, (2007), it was found that there was between 1.5 and 2.5%? increase in fertilizer costs from the FOB international price to the farmer retail levels. Details of these can be observed in as well in Ethiopia, Nigeria and Uganda in the chapters that follow. Procurement by governments (i.e. Government of Ethiopia (GoE), Federal Government of Nigeria (FGN) and Government of Uganda (GoU), and/or parastatals in these countries can be marred by corruption (e.g. Nigeria) and Uganda, which can add close to about 20% increase to the farm-gate prices of fertilizers. In Ethiopia, this is not the case as the GoE is completely in direct control of fertilizer importation till date. It was also observed in this study along with the studied literature that fertilizer-shipping costs to African countries are higher when compared to other parts of the world (i.e. Asian countries) on a cost-per-day basis due to small cargo sizes. The Chemonics International (2007) reported that *shipping costs* represent 10-15% of the retail price (or between $50-75/metric tonne). There are several available options for shipment of fertilizer and these include (i.e. bulk, bagged, bulk with bags etc), by shipping contract (i.e. charter party, linear terms, and container shipments) in shipping vessels of between 15,000 and 35,000 tonnes . However, for most SSA countries, smaller bulk quantities of between 5,000 and 25,000 tonnes are shipped in vessels with capacities ranging from 5,000 to 10,000 tonnes for bagged NPK products. Freight rates quoted for fertilizer shipments to most of the ports in SSA countries were found to be between $4 and $7 per tonne higher for most African countries in 2007 compared to other ports (i.e. Thailand) with the same distance. For example, port costs in SSA countries is between $8 and $10/ tonne , compared Asian countries (i.e. Thai ports) which is between $1.00 to $1.25/tonne . Another cost that seemed to be high is *warehousing costs* and this has been shown to vary greatly/tonee /month and based on the distance from the ports. This was estimated to be between $2 –and $6.00/ tonne for transportation, and added to this is $1.50 to2.50/ tonne for unloading, stacking and loading. Added to these costs is the rental charges which range between $1.50 and $2.50/tonne /month. Another major cost that increased retail fertilizer prices is taxation and in Asian countries (i.e. Thailand), it was found to be $0.2/tonne . However, in the Economic Community of West African States (ECOWAS), it ranged between 4 and 7%, while in the Common Market for Eastern and Southern African countries (COMESA) countries, it is about 12% (Chemonics, Int., 2007). In the literature, another high cost that eventually affects the farm-gate prices of fertilizer is the Inland transportation costs in most SSA countries which account for between 20 and 40% of the retail cost of fertilizers, and was reported as being the largest cost element after the FOB cost. The cost of road and rail transportation varies across countries; however, it has been observed that the rail systems, if functioning well in these countries, can drastically lower transportation costs. On the contrary, in Kenya, Mozambique, Uganda, Ethiopia, Nigeria and Ghana, rail transportation is inefficient, unreliable, under-capitalized and virtually not in use (Chemonics, Int., 2007).

Informal cross- border trade and local fertilizer markets

To which extent do the informal fertilizer trade and informal cross-border trade distort local fertilizer markets?

Cross-border trade in fertilizer is very negligible in Ethiopia, Nigeria and Uganda; the only effect that these may have on the farm-gate price of fertilizers is the position of a given country – whether landlocked or coastal. Studies have shown that there is little or no cross-border trader or smuggling of fertilizers across countries, such as, between Uganda and her neighbours (Benson et al., 2012). When the overall cost of fertilizers is compared between the landlocked and coastal countries, there seemed to be little variation (Figures 43A and 43B). It is evident from the two figures that transportation costs have a greater impact on the farm-gate prices of fertilizers among landlocked when compared to the coastal countries. The taxes and levies, financial costs and overheads in these countries (i.e. landlocked and coastal countries) stand between US$5.00 and US$30. This is though small, but considerable. A closer observation of the data across these countries showed that the grand total costs of fertilizers is between US$386 (Ghana- a coastal country in West Africa) and US$ 540 (i.e. Uganda- a landlocked country in East Africa).

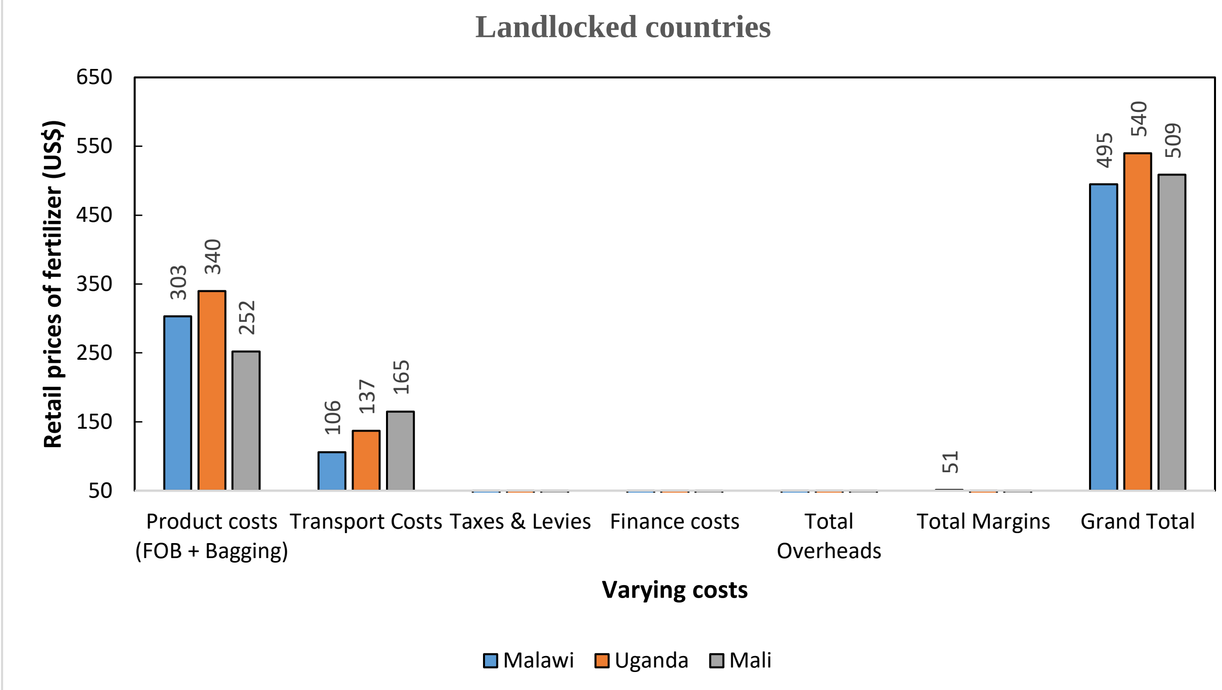


Figure 43A: Comparison of fertilizer costs in landlocked in SSA
(Source: Chemonics Int., 2007)

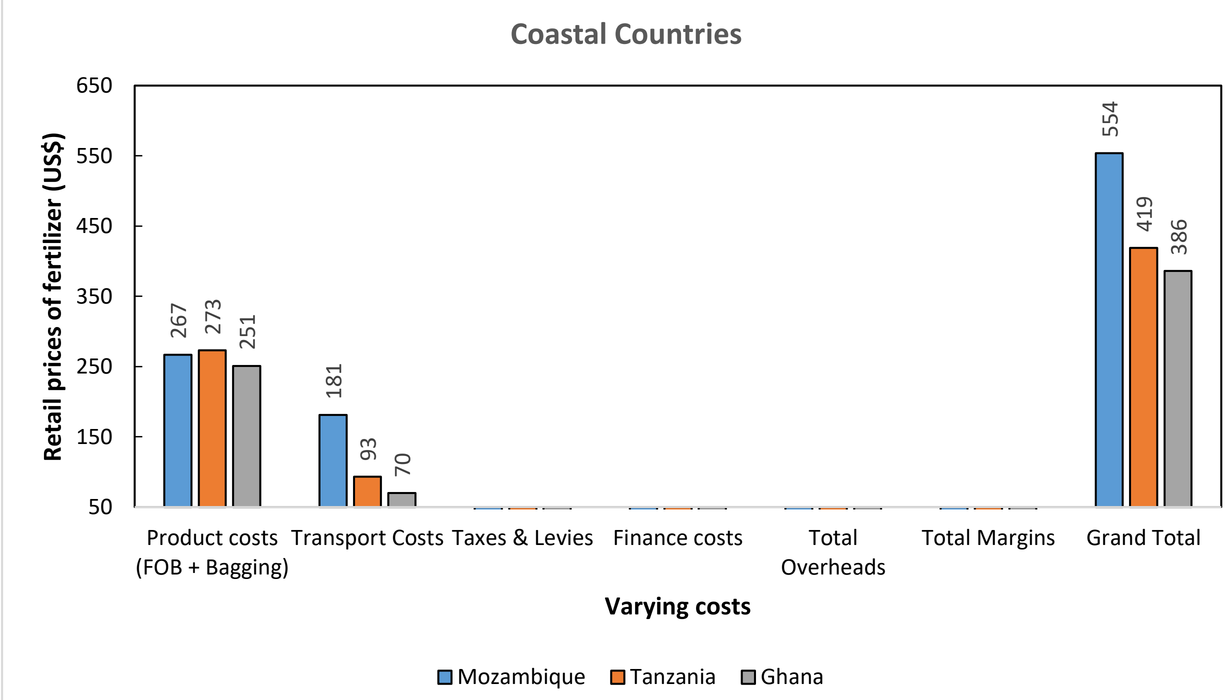


Figure 43B: Comparison of fertilizer costs in coastal countries in SSA
(Source: Chemonics Int., 2007)

Figure 43: Comparison of fertilizer costs in landlocked and coastal countries in SSA

Policies to reducing transaction costs for fertilizer dealers and increase fertilizer use in SSA

The policy responses that can be used to reduce the cost of purchasing fertilizer in these countries (i.e. Nigeria and Uganda) may be by reducing the price of fertilizer through the use of fertilizer subsidies as well as reducing the transportation costs for smallholder farmers. Many authors have shown that fertilizer subsidy programs in some situations may result in increased fertilizer purchased by smallholder farmers (Xu et al. 2009; Liverpool-Tasie, 2014). However, it was stated that attention must be on how to reduce "potential inefficiencies and prevent distortionary effects of such programs on private sector activity and demand" (Ricker-gilbert et al; 2011; Mason and Jayne, 2013; Takeshima and Nkonya, 2014).

Policies to mobilize private-sector investment in fertilizer production and distribution in SSA

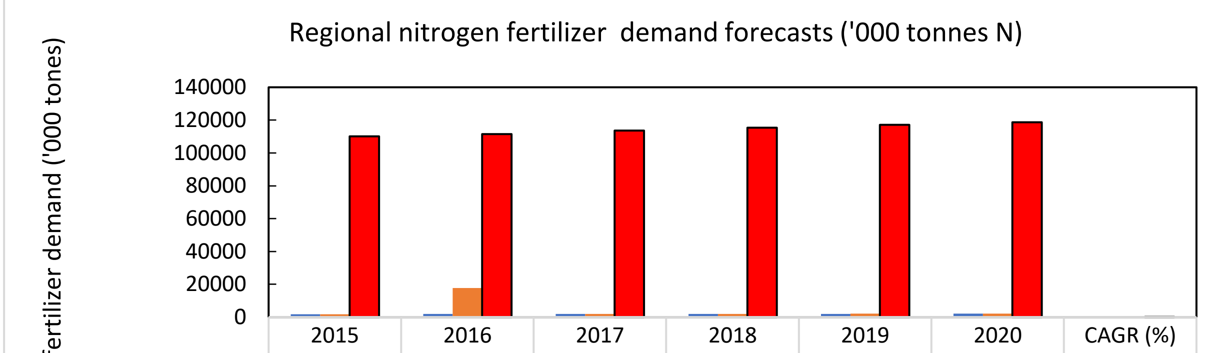
Increase in agricultural productivity is possible with the use of improved technologies – irrigation, improved seeds, use of herbicides and pesticides and inorganic fertilizers; however, these improved technologies are lagging behind when agriculture in SSA is x-rayed. In terms of the use of inorganic fertilizers, the SSA is lagging behind when compared to other regions of the world (i.e. East Asia, Latin America and South Asia) between 2000 and 2018 period (IFA Statistics, 2018). As observed earlier by other researchers (Heffer & Prud'homme, 2016), the average application rate of fertilizer is still the lowest in SSA; however this has been observed to have increased from 6kg/ha of nutrients (2000) to about 15kg/ha (2018). Nevertheless, it is projected to increase to reach about 19kg/ha by 2021, but this is still far below the Abuja declaration (Heffer & Prud'homme, 2018) and paints a gloomy picture for smallholder farmers when compared to their counterparts in North Africa and South Africa where the average rate of application is 103kg/ha and 55kg/ha, respectively (Badiane et al., 2013; Heffer & Prud'homme, 2016; Wanjiku et al., 2016). Analysis of fertilizer consumption across different sub-regions of Africa (Table 44; Figure 11) showed that the region with the highest fertilizer consumption was North Africa across the two years (i.e. 2015 and 2016), respectively and Central Africa being the lowest (i.e. 2% of 5.5 tonnes in 2015 and 2% of 6.0 tonnes in 2016) (IFA, 2018). Also, within each sub-region, fertilizer consumption (i.e. kg/ha of nutrients) was also reported to vary tremendously.

For example, it was reported to be highest within the SADC region which is about 20kg/ha (AGRA, 2016). Within the SSA, the countries with the major users of fertilizers are Ethiopia, Kenya, Nigeria and South Africa (IFA, 2018).

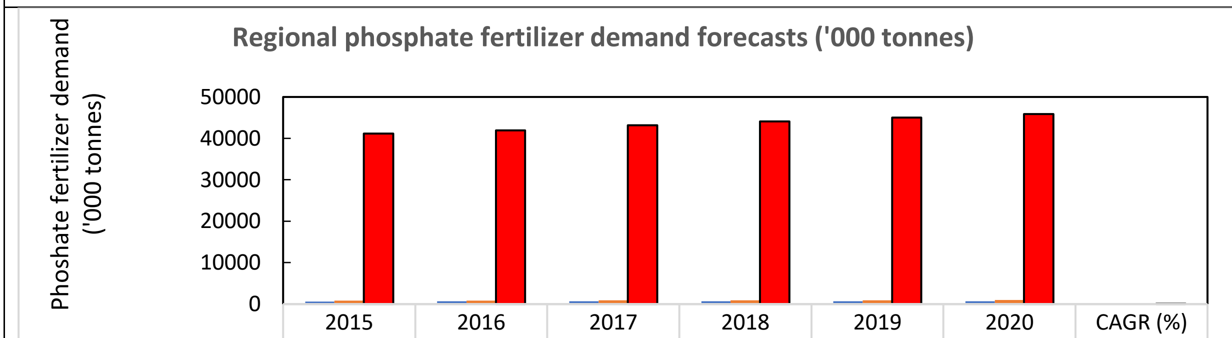
Table 14: Fertilizer consumption across regions of Africa

Region	2016 (5.5 tonnes)	2016 (6.0 tonnes)
	%	
North Africa	40	38
South Africa	23	21
East Africa	19	19
West Africa	16	20
Central Africa	2	2

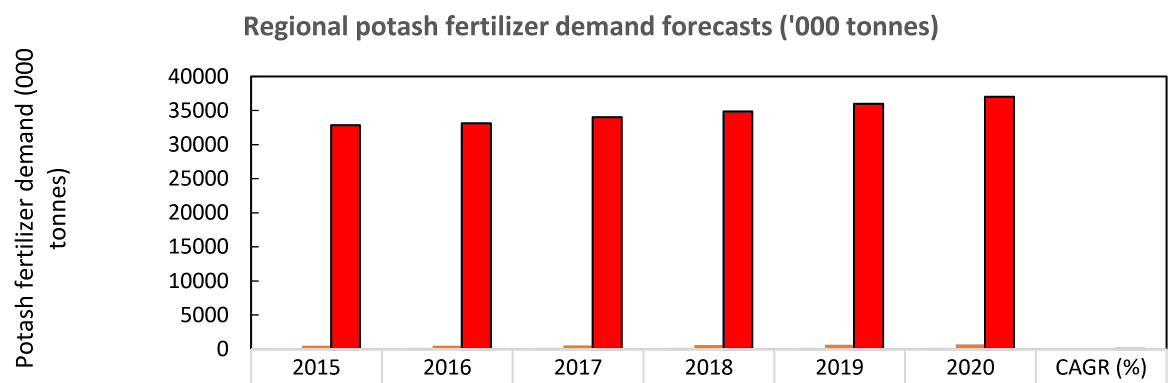
Source: IFA (2018)



	2015	2016	2017	2018	2019	2020	CAGR (%)
North Africa	1835	1870	1929	1984	2042	2102	2.75
Sub-Saharan Africa	1738	17732	1860	1980	2084	2201	4.83
World	110027	111575	113607	115376	117116	118763	1.54



	2015	2016	2017	2018	2019	2020	CAGR (%)
North Africa	633	642	653	664	675	686	1.6
Sub-Saharan Africa	815	847	876	907	939	973	3.6
World	41151	41945	43195	44120	45013	45858	2.19



	2015	2016	2017	2018	2019	2020	CAGR (%)
North Africa	151	157	166	175	187	198	5.56
Sub-Saharan Africa	495	505	542	590	650	698	7.11
World	32838	33149	34048	34894	35978	37042	2.44

(Source: FAO, 2017)

Figure 44: World, Africa (North Africa & sub-Saharan Africa) fertilizer demand forecasts and compound annual growth rate (CAGR), 2015-2020

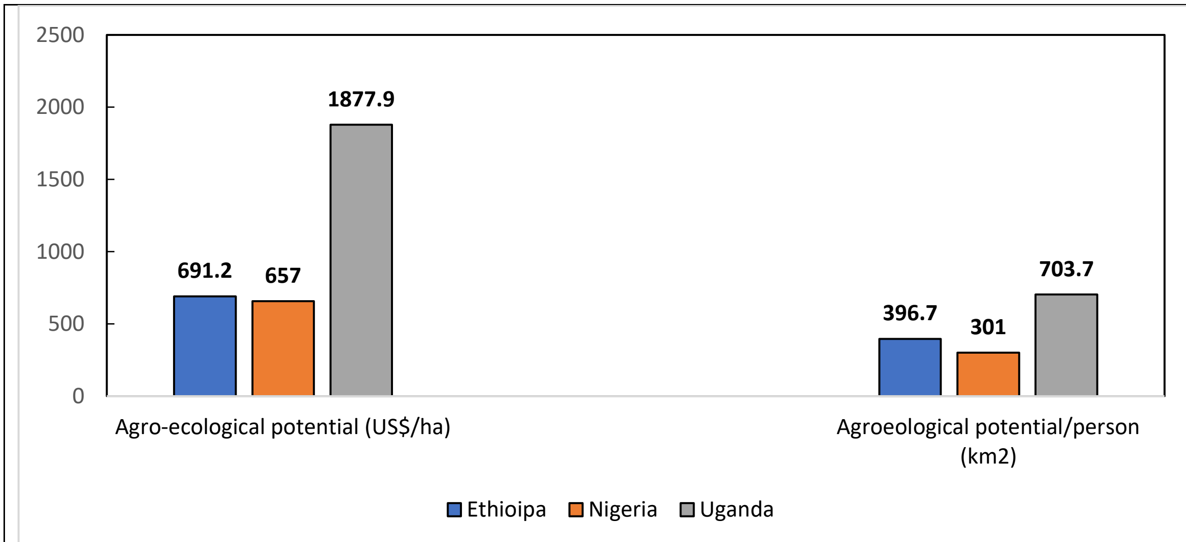
NB: Compound annual growth rate (CAGR) = $\frac{Endvalue}{Startvalue}^{\frac{(1)}{numberofyeas}} - 1$

Status of agricultural intensification in selected African countries

Since the independence in the 1960s, there has been rapid population growth in many of these sub-Saharan African countries (i.e. Ethiopia, Nigeria, and Uganda). Over the years, these countries have faced rapid urbanization and economic growth and consequently, there has been increased demand for agricultural inputs (i.e. seeds, herbicides and fertilizers) (Binswanger-Mkhize & Savastano, 2014b; Headey et al., 2014; Krautkraemer, 1994). Therefore, the livelihoods of farmers in these countries would depend on farming on reduced land area, and this would require rapid intensification and increased use of agricultural inputs to increase agricultural productivity growth. The increasing demand for agricultural commodities may be beneficial to them, in terms of better access to market and then obtaining higher prices for traded products.

In the of Boserup and Ruthenberg (BR) model of Boserup and Ruthenberg (Boserup, 1965; Ruthenberg, MacArthur, Zandstra, & Collinson, 1980), agricultural intensification is a function of market access and population density. Applying the BR to selected countries in the SSA (i.e. Ethiopia, Nigeria, and Uganda), Binswanger-Mkhize et al., (2014) observed that the bush fallow system is no longer practised, hence, the amount of organic carbon (organic matter) in the soils are very low. It was also noted that smallholder farmers apply little or no organic and inorganic fertilizers to maintain soil fertility. Binswanger-Mkhize et al. (2014), estimated the agro-ecological potential (AEP) per hectare from the data available at the Global Agro-Ecological Zones (GAEZ) after the methods of (Fischer et al., 2012)? ? . The results showed that AEP (US$/ha) and

AEP (person/km^2) is of the order Uganda > Ethiopia > Nigeria (Figure 45). The highest AEP (US$/ha) in Uganda and AEP (person/km^2) meant that the climate in Uganda is good for cropping and the country has the lowest population density (Binswanger-Mkhize & Savastano, 2014a). In SSA and in some of the countries studied above, the sources of revenue are limited and budget deficit is increasing. As a result, it is critical to create favourable business environments that would allow private sectors to flourish. One of the critical areas is the availability of fertilizer in the right amount and at the right time and its accessibility and affordability to rural famers.



Source: Binswanger-Mkhize et al., (2014).

Figure 45: Agro-ecological potential (US$/ha) and agro-ecological potential/person (km2) in Ethiopia, Nigeria and Uganda

Regional cooperation between SSA countries help achieve economies of scale, self-sufficiency in fertilizer production and sub-regional policies and frameworks to ensure effective production, distribution and marketing of fertilizer

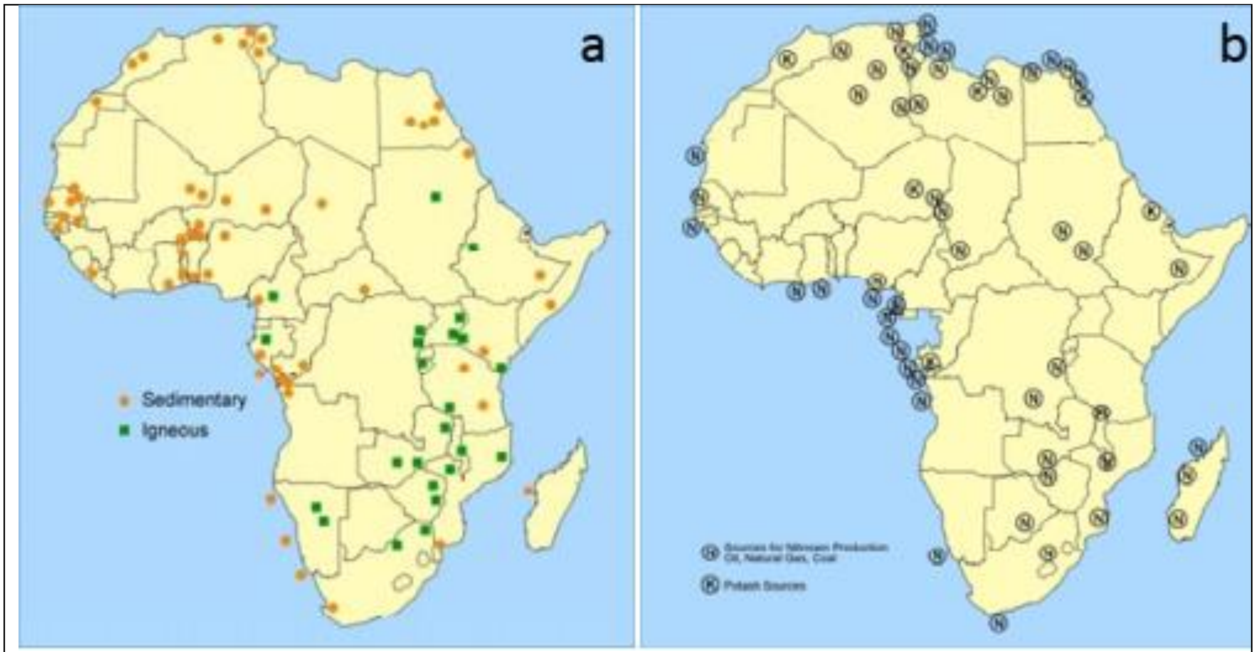
The Regional Economic Communities (RECs) in Africa work together with individual countries in sub-regions for the purposes of achieving greater economic integration. Currently, there are eight RECs recognised by the African Union (AU). These are: (i) Arab Maghreb Union (UMA), (ii) common Market for Eastern and Southern Africa (COMESA), (iii) community of Sahel-Saharan States (CEN-SAD), (iv) East African Community (EAC), (v) Economic Community of Central African States (ECCAS), (vi) Economic Community of West African States (ECOWAS), (vii) Intergovernmental Authority on Development (IGAD) and (viii) Southern African Development

Community (SADC). The sub-Saharan Africa (SSA) consumption of the three main fertilizer nutrients, nitrogen (N), phosphorous expressed as phosphate (P_2O_5) and potassium, expressed as potash (K_2O) is estimated to reach 4302 tonnes , 1659 tonnes , and 897 tonnes by the year 2020 (Table 15) at an annual growth rate (AGR) of 4.83%, 3.60% and 7.11%, respectively (Figure 46). One of the challenges faced by most of these countries in the SSA is the dependence on imported fertilizers for agricultural production as a result of lack of low-cost raw materials for fertilizer production, low domestic capacity utilization, and high capital investments in production facilities (Heffer & Prud'homme, 2014, 2015, ACB, 2014; FAO, 2017). Africa has abundant natural resources for fertilizer production (Van Kauwenbergh, 2006; Van Kauwenbergh, Stewart, & Mikkelsen, 2013). These resources include the phosphate rocks (Figure 13a???), accumulations of deposits of natural gas, and deposits of coals that can be used for the production of nitrogen fertilizers and potash deposits.

Table 15: Fertilizer supply, demand and balance in Africa (2015-2021) ('000 tonnes N)

Parameters	2015	2016	2017	2018	2019	2020
			Fertilizer N supply and demand			
NH_3 capacity	8310	9545	10739	10700	10700	11000
NH_3 supply capability	6201	7724	8741	9000	9100	9200
N available for fertilizers	5663	7168	8174	8424	8424	8606
N fertilizer demand	3573	3641	3788	3964	3964	4302
N other uses	538	556	567	576	586	594
Potential N balance	2089	3526	4386	4460	4388	4304
			Fertilizer P_2O_5 supply and demand			
H_3PO_4 capacity	9138	10038	10488	10548	11394	12939
H_3PO_4 supply capability	7141	7220	7993	8567	8955	9402
H_3PO_4 available for fertilizer	6640	6678	7369	7981	8368	8814
P fertilizer demand	1406	1489	1485	1571	1614	1610
Non- H_3PO_4 fertilizer demand	42	43	45	46	47	48
Potential H_3PO_4 balance	5324	5233	5884	6456	6802	7204
			Fertilizer K_2O supply and demand			
K_2O capacity	-	-	-	-	-	-
K_2O supply capability	-	-	-	-	-	-
K_2O available for fertilizer	-100	-100	-100	-100	-85	-100
K_2O fertilizer demand	647	662	708	765	838	897
Non- K_2O fertilizer demand	100	100	100	100	100	100
Potential K_2O balance	-747	-762	-808	-865	-923	-997

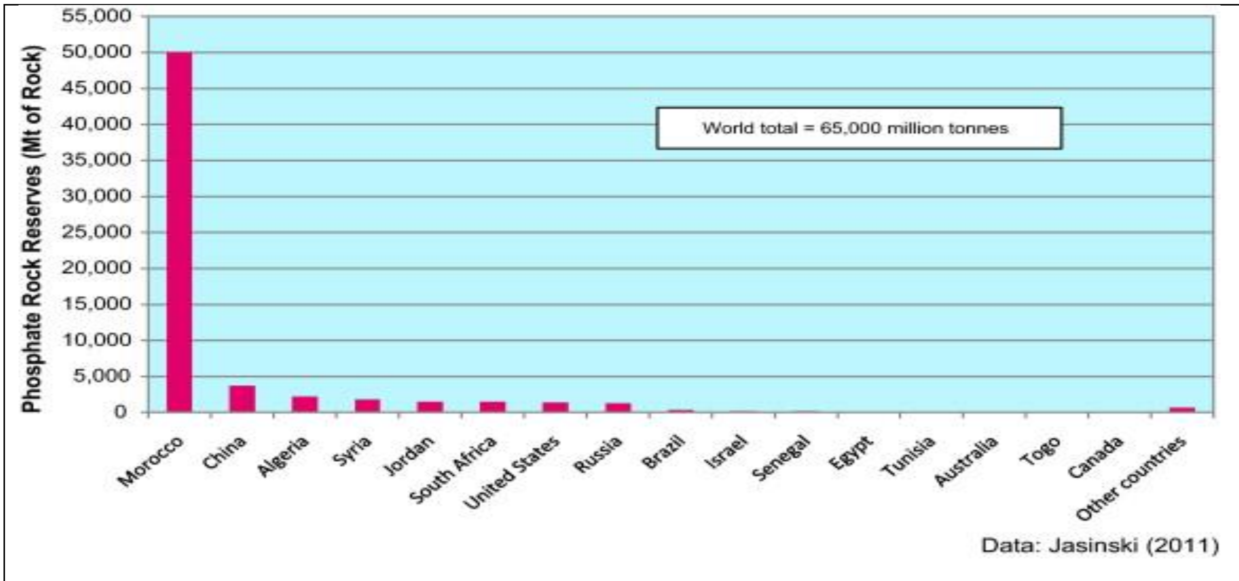
Source: FAO, (2017). NB: Potential balance, is the difference between supply and total demand (i.e. fertilizer demand + non-fertilizer demand



Phosphate rock deposits (a) and nitrogen and potash resources (b) in Africa.
Source: van Kauwenbergh, (2006)

Figure 46: Phosphate rock deposits (a) and nitrogen and potash resources (b) in Africa

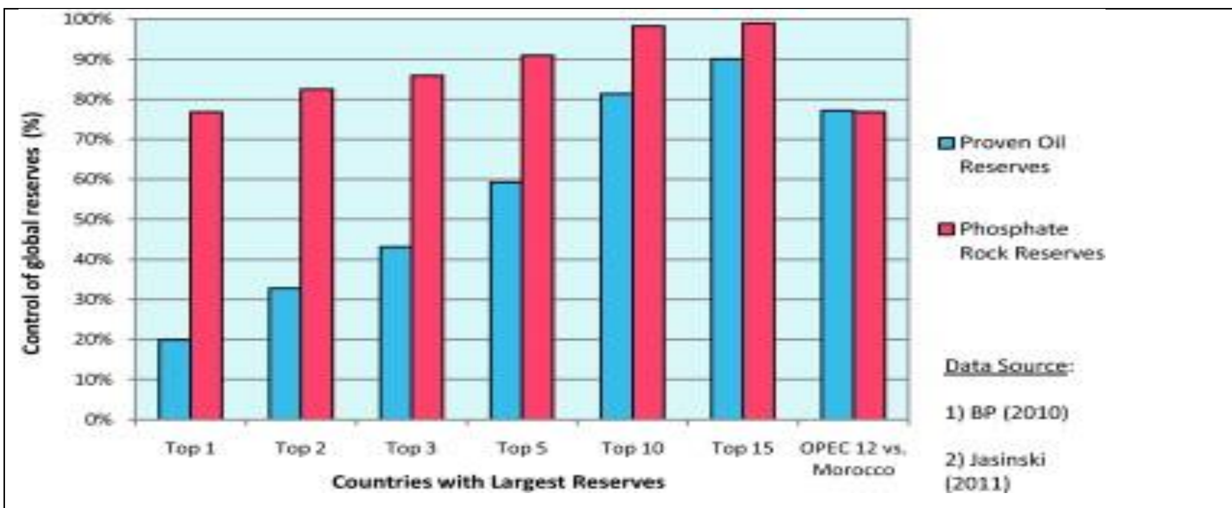
The distribution of the global phosphate rocks reserves is shown in Figure 47, and the final category (i.e. other countries) has other countries together. The northern part of Africa (i.e. Morocco, Tunisia, Algeria and Egypt) has considerable deposits of phosphate rocks and natural gas (Figure 47). These countries except Algeria has ≈ 88% of the deposits for fertilizer production which is exported (William et al., 2005; Van Kauwenbergh et al., 2013). Currently, South Africa is the fourth-largest producer with significant phosphate rock deposits and produces 90% of its fertilizer requirements. Other countries with some deposits of phosphate rocks are Tanzania, Togo, and Senegal, Mozambique and Namibia (Wanzala & Groot, 2013). In terms of the urea capacity, this has been expanding massively in Africa since 2015. The largest capacity increments have been observed in Algeria, Egypt and Nigeria (FAO, 2017). Currently, the production of fertilizer is concentrated in these countries – Algeria, Egypt, Morocco, Nigeria, South Africa and Tunisia. Despite this bright scenario, most African countries still import fertilizers for agricultural production due to lack of low-cost materials for fertilizer production, low domestic demand, low capacity utilization, and high capital investment in production facilities (FAO, 2017). It was reported that most of the fertilizer plants in SSA still operate between 20-40% of their installed capacity (AfricaFertilizer.org, 2018).



(Source: Jasinski, (2011)

Figure 47: Global distribution of phosphate reserves

The concentrations of phosphate rocks geographically may be compared to that of oil reserves (Figure 48) (Cooper, 2011). Morocco has the largest deposit of phosphorous. As reported by the United States Geological Services (USGS), the proportions of the deposits is about 77% which is equivalent to the oil reserves held by all the 12 member states of the Organisation of Petroleum Exporting Countries (OPEC) (BP., 2011).

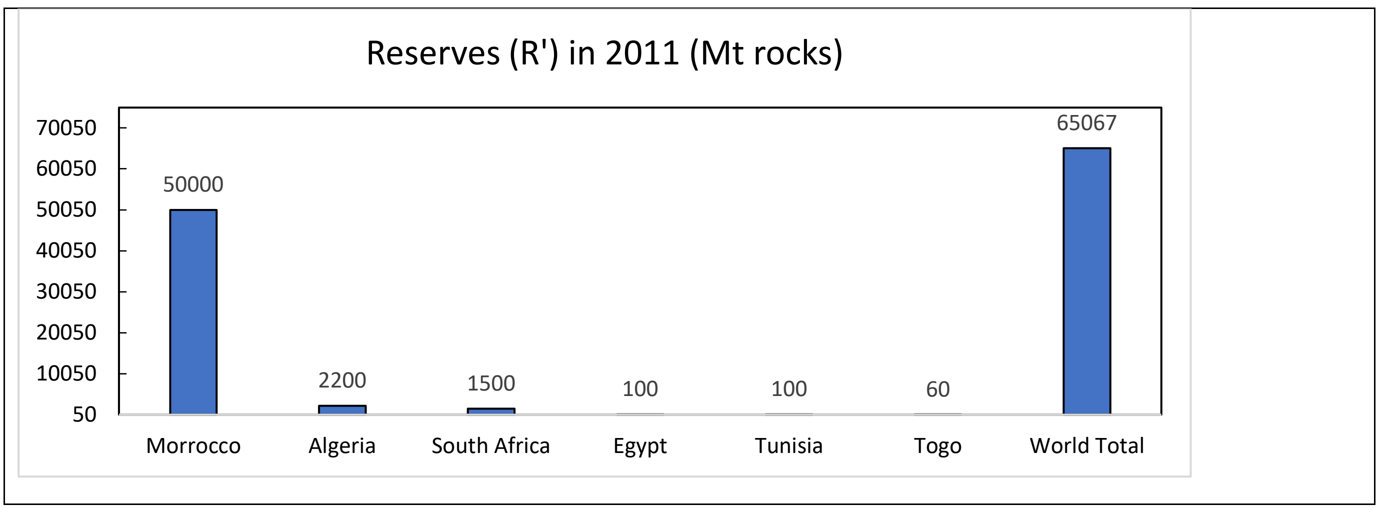


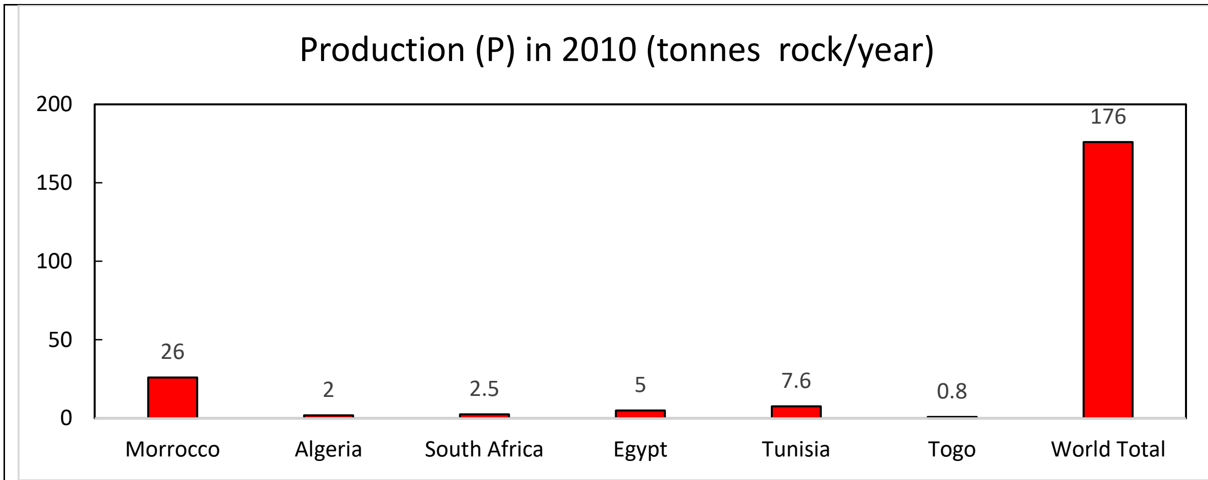
(Source: BP, 2011)

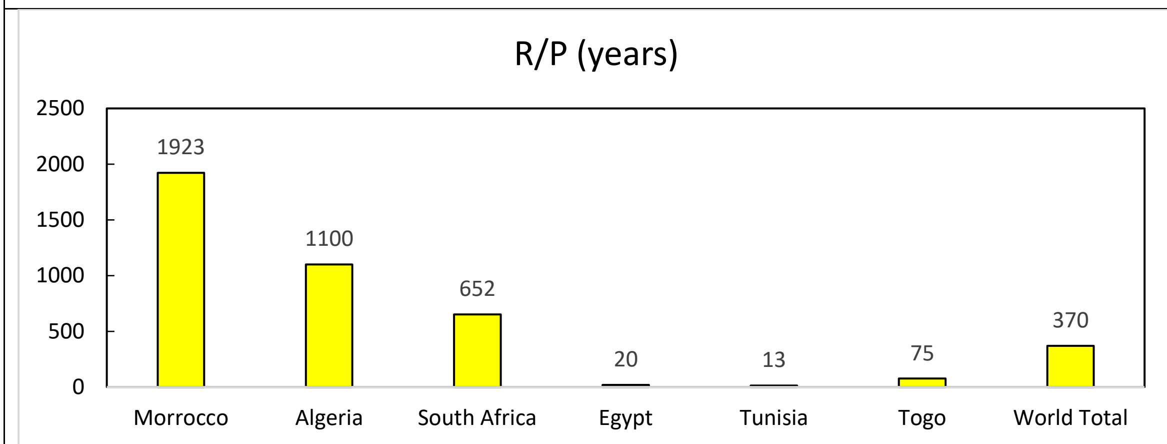
Figure 48: The distribution of phosphate rock and oil reserves compared

Most of the phosphorous derived from phosphate rocks is used in agriculture; therefore, its future demand is closely linked to crop and food production (Brunner, 2010) and it is projected that food demand will increase as a result of increasing population and changing diets (Cooper et al., 2011), hence the total demand for food is projected to increase by 40% by 2030 and 70% by 2050 (Beddington,, 2011). This increase has been projected by the Food and Agriculture Organisation (FAO) of the United Nations that fertilizer demand would increase by around 1-1.5% per year till 2030 (FAO, 2000; 2002). Jasinski, (2011) estimated that a reserve-to-production (R/P) ratio gives an indication of the lifetime of the reserves at current production rate. The author estimated this using the USGS ?? figures that the current R/P ratio for global phosphate rock reserves is around 370 years (Cooper et al., 2011; Van Kauwenbergh et al., 2013) and this ratio varies among producing countries, and the relationship between reserves and production varies with countries (Figure 49). Compared to other countries, Morocco has the largest reserves and the R/P ratio of about 1923 years.

The production of fertilizer (i.e. urea and phosphorous) in Africa is concentrated in Algeria, Egypt, South Africa, Tunisia, Morocco and Nigeria, which have developed fertilizer industries and also high levels of fertilizer use. Estimated reserves in the countries of Africa by region is shown in Table 16 (Heffer & Prud'homme, 2014, 2016) for urea and phosphorous; however, for potash, some projects are being developed in the Republic of Congo, Ethiopia and Eritrea. Production within these countries is carried-out by a handful of firms in the SSA (Table 16).







Africa (Source: Jasinski, 2011)

Figure 49: Phosphate rocks reserve –to-production (R/P) ratios for selected countries in Africa

Table 16: Estimated reserves of fertilizer raw materials in Africa

Country	Natural gas estimates (trillion cubic meters)	Phosphorous ('000 tonnes)	Potash deposits
AMU Region			
Algeria	4505	2,200,000	None
Libya	1505	None	None
Mauritania	28.32	100,000	None
Morocco	1.5	50,000,000	None
Tunisia	65	100,000	None
ECOWAS Region			
Benin	1.133	none	None
Burkina Faso	None	60,000	None
Cote d' Ivoire	28.32	none	None
Ghana	165	none	None
Mali	None	12,000	None
Nigeria	5246	None	None
Togo	None	30,000	None
EAC Region			
Kenya	5	None	None
Uganda	None	230,000	None
Rwanda	56.63	None	None
Tanzania	1614	375,1000	None
SADC Region			
Botswana	None	None	2,100
Mozambique	2832	274,000	None
South Africa	400	1,500,000	None
Zimbabwe	None	124,000	None
ECCAS region			
Angola	271.8	None	None
Congo-DR	0.99	None	None
Cameroon	135.1	None	None
Equatorial Guinea	36.81	None	None
Rep. of Congo	90.6	None	None
IGAD region			
Egypt	2180	1,300,000	None
Ethiopia	28.32	None	4.2 billion tons
Eritrea	None	None	1.1 billions
Sudan	85	None	None

Sources (Hernandez & Torero, 2018; Manning, 2018; Prakash & Verma, 2016; USGS, 2018; IFDC 2015)

Effective partnership arrangements

What partnership arrangements will be most effective for fertilizer manufacture and use in Africa?

There are a total of 14 manufacturing and 80 processing plants and 16 fertilizer manufacturing plants in SSA producing nitrogen-based and phosphate based fertilizers. Details of the locations, addresses and production capacities of these plants are detailed in Appendix I. Some of these plants operate at 100% and the remaining 14 plants operate between 20 and 40% of their installed nominal capacities and these processing plants will start functioning within the next five years.

Fertilizer demand and supply environment in Ethiopia, Nigeria and Uganda

It is always difficult to separate the demand and supply factors when evaluating farmers' decisions to adopt fertilizers along with the decisions about application rates (Hernandez & Torero, 2018; Liverpool-Tasie & Takeshima, 2013). Some of the factors that are known to determine the demand of fertilizers include fertilizer availability as well as prices and quality of fertilizers ((Heisey & Mwangi, 1996; Lahmiri, 2017). From the data collected on the field, results showed that the following factors will affect the supply of fertilizer. In Ethiopia, (i) the level of education and farming experience (Table 17); in Nigeria: (i) size of farms (ha), (ii) access to extension agents/services and (iii) sources of family income (Table 17) and in Uganda (i) gender, (ii) age of farmers (which is related to farming experience), (iii) educational qualification, (iv) sources of income, (v) time of fertilizer delivery, (vi) access/frequency of extension visits, and (vii) yield of crops (i.e. maize) (Table 17). These were in agreement with the findings of (Byerlee, 1994; Heisey & Mwangi, 1996; Vlek, 1990) that reported some of these factors as affecting the demand of fertilizer by smallholder farmers in SSA. Some of these factors can also be grouped into non-price factors- such as cash constraints or availability of credit facility (Berkouwer & Dean, 2019; Binswanger & Sillers, 1983; Gebeyehu, 2019; Liverpool-Tasie et al., 2017b).

Table 17: Multivariate logistic analysis of farmer and farm-level determinants of fertilizer use, Ethiopia, Nigeria and Uganda

Parameter	Odds Ratio Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Ethiopia				
High education status	0.739	0.1401	4.6757	0.0306*
Farming experience (years)	5.685	0.6121	8.0615	0.0045**
Nigeria				
Size of farm	2.009	0.2423	8.2833	0.0040**
Access to extension service	2.635	0.4420	4.8045	0.0284*
Source of family income	0.315	0.4404	6.8726	0.0088**
Uganda				
Gender	14.78	5.07	8.48	0.0036**
Age (Years)	0.37	0.12	8.77	0.0031**
Highest educational qualification	9.87	4.75	4.30	0.0379*
Sources of income	21.12	9.39	5.05	0.0245*
Frequency of extension visits	12.69	5.66	5.02	0.0250*
Maize yield (kg)	0.004	0.002	4.26	0.0388*
Fertilizer delivery Time	-14.56	6.38	5.19	0.0226*

***Significant at 5%; **Significant at 1%.;** Source: Field Survey, (2019)

Fertilizer input supply in sub-Saharan Africa: Ethiopia, Nigeria and Uganda

In most countries where fertilizer markets are functioning, there is an integrated chain of suppliers at all levels (i.e. import, wholesale, and retail) that sell to farmers (Bumb and Gregory, 2006). These authors stated as shown in (Figure 50) below that in a competitive organisation, there should be the differentiation of the main functions “extensive retail market of networks” and this is complemented by the direct access of famers to such inputs (i.e. inorganic fertilizers). However, in most African countries, the fertilizer supply chains that operate in Ethiopia, Nigeria and Uganda are typified by the flows in Figures 19, 24, 25 and 26 respectively.

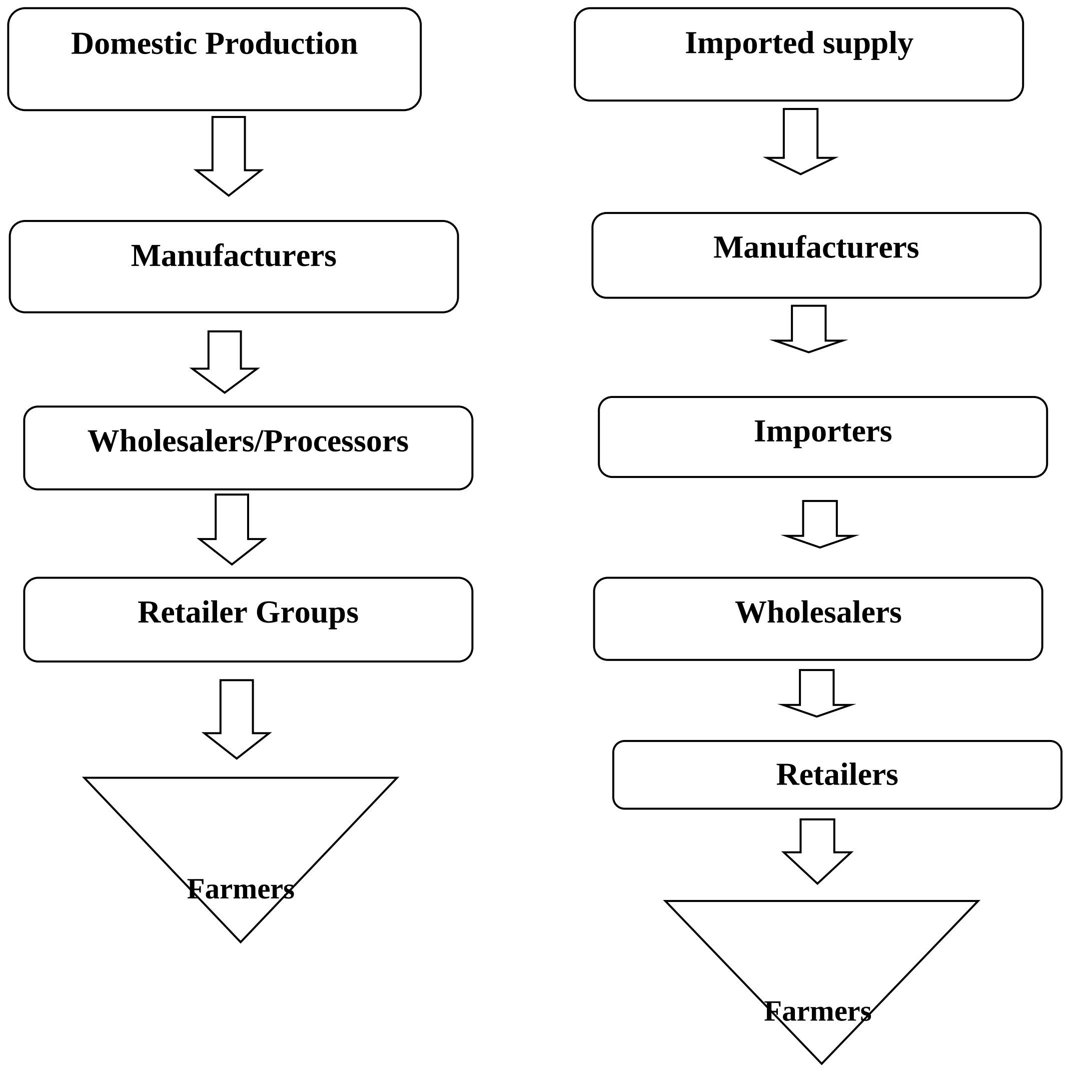


Figure 50: A well – functioning fertilizer supply systems

The typical fertilizer supply chain in most SSA countries along with support services received by the government along with some of the problems faced along the channels was documented by (Hernandez et al., 2018) (Figure 51).

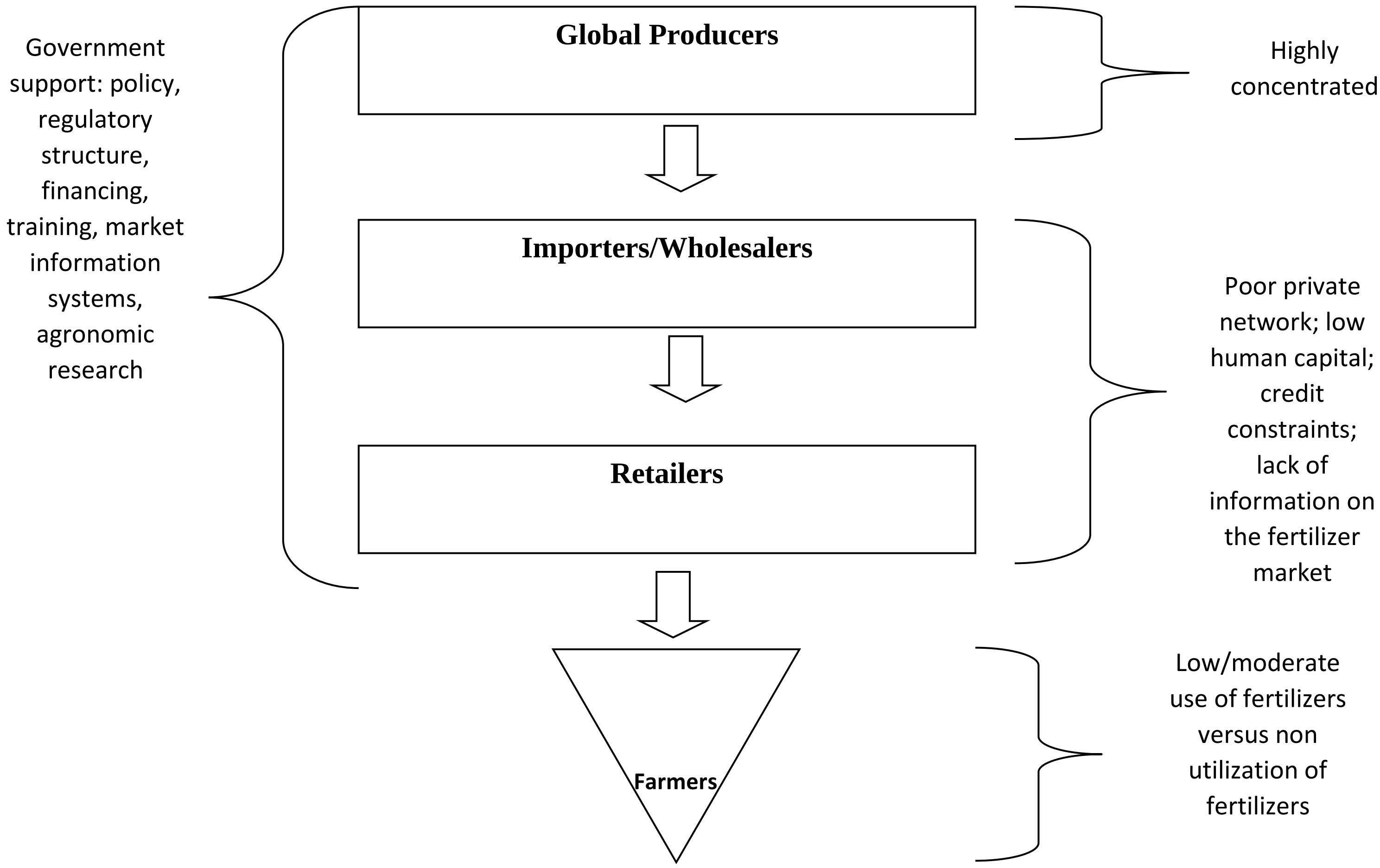


Figure 51: A typical fertilizer supply chain in sub-Saharan Africa (Source: Hernandez et al., 2018).

Factors that were found to be significantly related to fertilizer supply chains in selected countries are access to credit, fertilizer subsidy, fertilizer sources, average bag of fertilizer purchased/month, sources of income and level of education in Ethiopia (Table 18). However, in Nigeria, the determinants of fertilizer supply were found to be the average bag of fertilizer purchased/month (Table xx?????), while in Uganda, these factors were found to be fertilizer sources, subsidy, access to credit and membership of a cooperative society (Table 18).

Constraints affecting the supply of fertilizer supply in SSA can be grouped into three (Fuentes et al., 2012), which are: (i) market development, (ii) technical constraints and (iii) infrastructural constraints. According to Bumb and Gregory, (2006), a well-functioning market for adequate and timely supply of fertilizer is stated to have the following in order to function effectively: (i) an enabling policy environment, (ii) adequate human capital, (iii) ease of access to finance and (iv) market information coupled with effective regulatory systems. In most countries in SSA (inclusive of Ethiopia, Nigeria and Uganda), as a result of liberalization, price and marketing controls have been removed, hence, most private sectors have been able to gain access to fertilizer markets. However, over the years, it has been found that in most countries, the private sectors have not been capable of supply inputs (i.e. inorganic fertilizers) in cost-effective ways. Therefore, the government of most countries in SSA have had to intervene directly in the market place. In Nigeria and Zambia in 1999 and 2003, respectively, it was found that the respective governments of these countries imported fertilizers up to about 120,000 tonnes and about half of this was subsidized and then distributed to small-scale farmers (Bumb and Gregory, 2006). However, it was reported that payment for such deliveries were not made promptly by these respective governments to the private sectors.

Table 18: Results of the multiple stepwise discriminant analysis of factors affecting fertilizer supplies in Ethiopia, Nigeria and Uganda

Step	Variables	Partial R^2	F Value	Pr>F	Wilks' Lambda	Pr<Lambda	Average Squared Canonical Correlation (ASCC)	Pr>ASCC
				Ethiopia				
1	Access to credit	0.8846	31.61	<0.0001	0.1157	<0.0001	0.0304	<0.0001
2	Fertilizer subsidy	0.5395	31.61	<0.0001	0.0533	<0.0001	0.0486	<0.0001
3	Fertilizer sources	0.5094	4.81	<0.0001	0.0261	<0.0001	0.0660	<0.0001
4	Average bag of fertilizer purchased/ month	0.4534	4.22	<0.0001	0.0142	<0.0001	0.0811	<0.0001
5	Source of income	0.4000	3.35	0.0001	0.0085	<0.0001	0.0942	<0.0001
6	Higher education status	0.3057	2.67	0.0024	0.0055	<0.0001	0.1043	<0.0001
				Nigeria				
1	Average bag of fertilizer pchased/month	0.0961	4.30	0.0167	0.9039	0.0167	0.0480	0.0167

				Uganda				
1	Average bag of fertilizer purchased/ month	0.4154	5.12	<0.0001	0.5846	<0.0001	0.0415	<0.0001
2	Access to credit	0.3930	4.60	<0.0001	0.3548	<0.0001	0.00785	<0.0001
3	Membership of cooperative	0.2577	2.43	0.0151	0.2634	<0.0001	0.1028	<0.0001
4	Fertilizer subsidy	0.2508	2.31	0.0209	0.1973	<0.0001	0.1250	<0.0001
5	Fertilizer sources	0.1853	1.55	0.1423	0.1607	<0.0001	0.1416	<0.0001

However, as a result of this late payment, the private sectors in these countries were found to reduce fertilizer importation for the next cropping season. Many analysts reported that once smallholder farmers become aware that inputs (i.e. inorganic fertilizers) have been subsidized, often times they refuse to purchase fertilizer from private sectors at full price, hence these private sector suppliers incur losses in carry-over stocks for a year since fertilizer use is seasonal ((Houssou et al., 2017; Jayne et al., 2018; Lunduka et al., 2013; Michael et al., 2018; Bumb and Gregory, 2006).

Another marketing constraint is the quantity and quality of human capital involved in the fertilizer business as well as access to finance. In Ethiopia and Uganda, results showed that access to credit (Table 18) is one of the major factors that may hinder/limit the ability of private sectors to purchase fertilizer. Bumb and Gergory (2006) refer to quantity as the number of input dealers that are available in each country – especially in the rural areas, while quality is the marketing and technical skills of the input dealers in each rural area in Ethiopia, Nigeria and Uganda. In Nigeria, currently, there are about 21 inorganic fertilizer suppliers under a trade name called Fertilizer Producers and Suppliers Association of Nigeria (FEPSAN). This is a National Trade Association set up to represent the needs and interests of fertilizer manufacturers. Recently, the Africa Fertilizer Financing Mechanism (AFFM) launched a US$2.2 million project to provide fertilizer suppliers in Nigeria with financial support to improve supply for 200,000 smallholder farmer. It was gathered during the focus group discussion (FGD) that most of the fertilizer suppliers stated that most Banks in Ethiopia, Nigeria and Uganda have little or no presence in the rural areas. It was reported that in some SSA countries most commercial banks had lost large sums of money in the past, hence their unwillingness to finance agricultural inputs (Bumb and Gregory, 2006).

However, as a result of late payments, the private sectors in these countries were found to reduce the fertilizer importation for the next cropping seasons. Many analysts reported that once smallholder farmers become aware that inputs (i.e. inorganic fertilizers) have been subsidized often times they will often refuse to purchase fertilizers from private sectors at full price, hence these private sectors suppliers incur losses in carry-over stocks for a year since fertilizer use is seasonal (Houssou et al., 2017; Jayne et al., 2018; Lunduka et al., 2013; Michael et al., 2018; Bumb and Gregory, 2006).

Traders/wholesalers/suppliers of fertilizers in these Ethiopia, Nigeria and Uganda have limited access to financing. During the FGD, it was gathered that one of the constraints limiting importation of these products is limited accessibility to financing. It has been reported that the fertilizer industry is capital intensive. Bumb et al., (2011) reported that to import 20,000 tonnes of urea, an importer might need between US$6-$8 million to buy the product as at 2010 global market price. Data below showed price (US$/tonne) as at September, 2019 for DAP (US$300/ton), MoP (US$280/tonne) urea (US$200/tonne) (Figure 52). For a local importer in either ECOWAS or COMESA region, to raise such money from a bank, they would need to pay interests rates of between 20-30% to the bank and require about 150% as collateral (Bumb et al., 2011). Hence, the reason why most of these local importers have resorted to importing small lots of between 1,000 and 5000 tonnes thereby restricting the growth of fertilizer markets and rural-based agro-dealers.

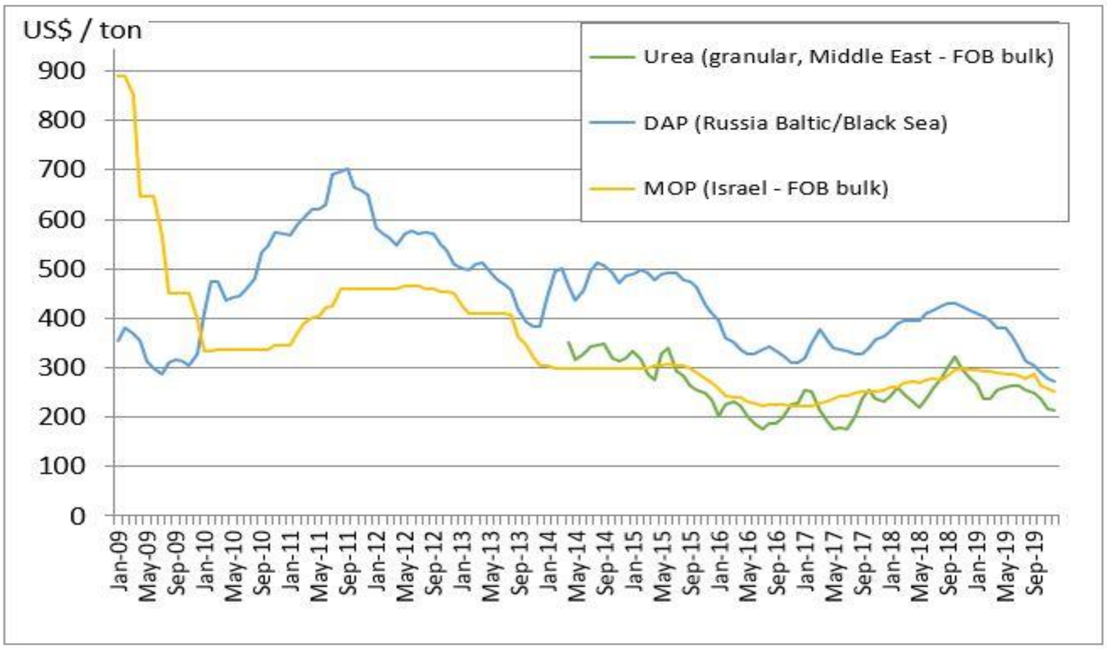


Figure 52: Global fertilizer prices for urea, DAP and MOP (2009 - 2019)

Another constraint to fertilizer supply chain in these countries is the lack of adequate and timely market information which provides market transparency and information flow, that enables planning and reducing transaction costs. It was noted that inadequate information on inorganic fertilizers makes it difficult for government and private sectors to plan ahead so as to address shortfalls or carryover stocks especially in the following cropping seasons. From the field survey during the FGD, one of the factors that was mentioned as affecting fertilizer supply to both the input suppliers and smallholder farmer is lack of information and poor linkages between the suppliers/wholesalers, traders and smallholder farmers. Considerable attention has been placed on information in terms of market information for agricultural commodities (i.e. West African Market Information Network (WAMIN), information on agricultural input flow is still very rudimentary. ARGUS Fertilizers was developed in collaboration with IFDC for use in SSA and this service gives in-depth analysis of rapidly growing input market. ARGUS provides detailed country-by-country outlook. But the draw-back in most of these MIS???? is that most smallholder farmers may not have access to this as most have very low level of education. In Ethiopia, Nigeria, Uganda, majority of the smallholder farmers have at least primary school certificates. The information on these sites should be distilled in such a way that despite their low level of education, they should be able to navigate the developed application systems and obtain information as at when needed.

Another constraint was categorized by Bumb and Gregory (2006) as technical constraints (i.e. level of education). This factor was found to be significantly related to fertilizer input supply in Ethiopia (See Table 18), but was found not to be significantly related to input supplies in Nigeria and Uganda. In Ethiopia, inputs (i.e. fertilizers) is largely controlled by the Government of Ethiopia (GoE). An observation of the frequency distribution of this factor in Nigeria and Uganda showed that most input suppliers in Nigeria have primary school certificates, while in Uganda, majority has secondary level of education (Fig 53). This was in agreement with what some other researchers have observed about

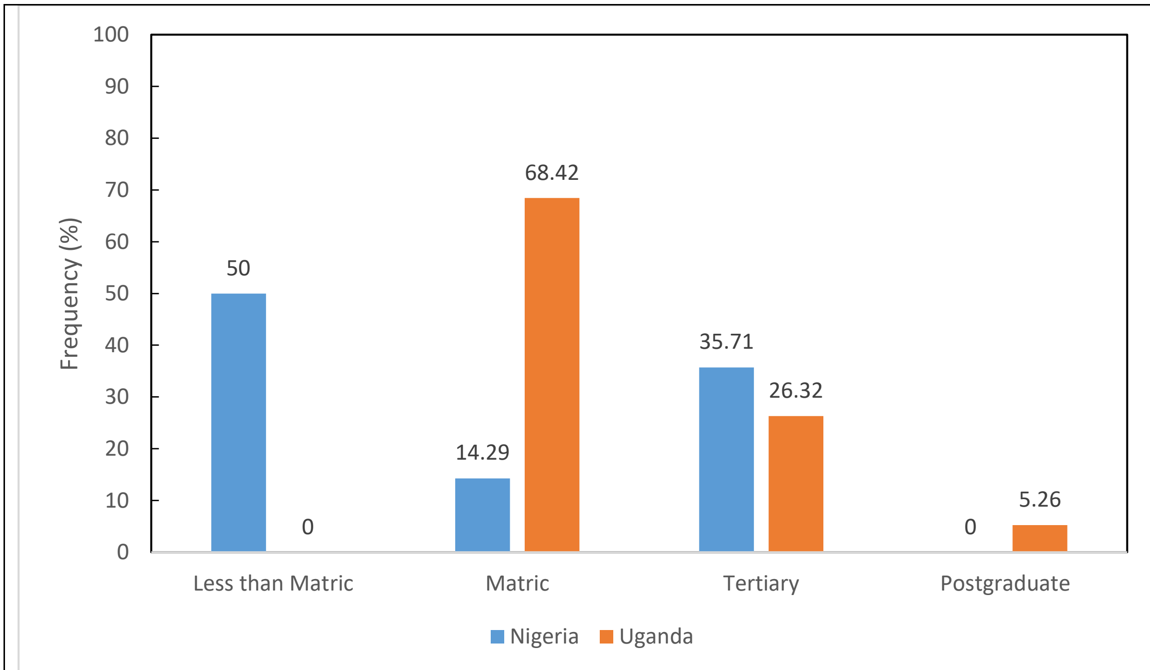


Figure 53: Level of education of input suppliers in Nigeria and Uganda

input suppliers in most SSA countries (Liverpool-Tasie & Takeshima, 2013; Michael et al., 2018). With this level of education, these lacks adequate knowledge about how to disseminate knowledge of the use of inputs (i.e. rate, quantity and time of application). In order to circumvent the low level of education by both famers and input suppliers, an app called a fertilizer optimizer has been developed by CABI. According to CABI, this app will assist smallholder farmer in using fertilizer more efficiently to optimize their fertilizer investments. This has been tested in over 30 countries in the SSA and has proven to be successful in Uganda. The app will ask farmers information on crops grown, area planted, expected crop sale prices, fertilizers costs and the budget they have to invest in fertilizer products. "Based on robust crop response functions, it will calculate the most profitable combination of fertilizers to purchase and advise you on crop and site specific application rates". It is reported that the app can also take into account any integrated soil fertility management (ISFM) practices to tailor the fertilizer recommendation to specific farm.

Transportation problems: After the costs, insurance, and freight (CIF), the second high cost of fertilizer prices is the high cost of transportation especially for landlocked countries (e.g. Uganda). These high costs have many components- (i) road blocks-(i.e. inspection and clearance, (ii) escort systems for cross-border movement, (iii) quota systems for truckers, (iv) taxes and levies, and (v) poor road networks/conditions. The policy responses that can be used to reduce cost of purchasing fertilizer in these countries may be by reducing the price of fertilizer through the use of fertilizer subsidies and reduction of transportation costs for smallholder farmers. Though, some authors reported that fertilizer subsidy programs resulted in price increase of fertilizer for smallholder farmers (Xu et al. 2009; Liverpunldool-Tasie, 2014). However, it was stated that attention must be on reducing "potential inefficiencies and prevent distortionary effects of such programs on private sector activity and demand" (Ricker-gilbert et al; 2011; Mason and Jayne, 2013; Takeshima and Nkonya, 2014).

Conclusions

Data collected from past studies and field work showed that:

1. Introduction of subsidies in Nigeria, in recent years has contributed to the high costs which have added to fiscal burdens.
2. Uganda, recently came-up with the national fertilizer policy, hence the fertilizer supply chain is still riddled with several bottle-necks.
3. In the three countries, the fertilizer policy environment seems not to be conducive for the development of competitive fertilizer markets at the local, national and regional levels.
4. In the ECOWAS, COMESA and SADC countries, there exists value added tax (VAT) of about 18% and other levies, which eventually add-up and increase the farm-gate prices of inorganic fertilizers for smallholder farmers.
5. In Uganda, results showed that there was poor quality control, hence, inorganic fertilizers are not properly labelled and are often adulterated.
6. Other factors that were observed across the three countries were lack of information and poor linkages between suppliers/wholesalers, traders and smallholder farmers.
7. In Uganda and Nigeria, after the cost, insurance, and freight (CIF), the second highest cost of fertilizer prices is the high cost of transportation which is especially burgeoning for a landlocked country like Uganda.
8. Increasing attention to supply-side factors in the use of inorganic fertilizer is an important element that the three countries must continue to pay attention to in order to help smallholder farmers gain access to inorganic fertilizers at the lowest cost, at the right time, and in the right quantity so as to increase crop production, productivity and reduce poverty.

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Apparent fertilizer consumption = [(production + imports) – (exports –Exports-non-fertilizer use)]

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