

## Ensuring Quality Fertilizer for Farmers in Sierra Leone

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**Abstract:** Problems with poor quality of fertilizers are common in West Africa and represent a major barrier to agriculture growth in the region. Underweight bags and nutrient deficiency of fertilizer samples subjected to laboratory tests have been confirmed across several countries in West Africa. There is a critical need in Sierra Leone to ensure that proper usage and quality control of fertilizers are enhanced with a view to improving fertilizer use efficiency, boosting crop productivity and household food security in Sierra Leone. Importers and distributors must ensure that the authenticity and quality of fertilizer products traded and utilized in Sierra Leone are ascertained before distribution. This report serves to remind our agriculture policymakers that while promoting greater fertilizer use, it is equally important to effectively control its quality. This would ensure that farmers and other end users get what they are paying for.

**Keywords:** Quality Fertilizer, adulterated fertilizers, Misbranding, Fertilizer Regulatory Agency

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### I. Introduction

Sierra Leone is a relatively small country of 71,740 square kilometers on the west coast of Africa between latitude 6° 55'N and 10° 00'N and longitude 10° 16'W and 13° 18'W (GoSL, 2013). The country covers a total area of 7.2 million hectares, of which 5.4 million hectares (75%) are arable (MAFFS, 2015; WFP, 2015). The national temperatures generally range from an average of 24.1°C to 28.3°C. Agriculture employs about 60 % of the population (Mahmood, 2016). The soils are generally poor, acidic, rich in iron oxide and prone to heavy leaching (Rhodes, 1988; Amara Denis et al., 2013). Agriculture, forestry and fisheries are the mainstay of the economy in terms of employment, engaging about 65 percent of the labour force, mostly working in subsistence agriculture (ILO, 2015). The staple food crop is rice, which is usually grown in mixed stands with other crops such as cassava, maize, sorghum, sweet potatoes, millet, sesame, ground nuts and maize (Jalloh, 2017). Rice occupies half of all cultivated land, yet due to very low yields (Mahmood, 2016), the country is still a net importer of rice. In 2018 alone, Sierra Leone imported 400,000 MT of rice. Together with other food import, this costs \$700 million in food import, according to government sources (Tillen, 2019).

The vast majority of farmers in Sierra Leone are strongly dependent on the native soil fertility, thereby degrading the soil to a stage where cropping becomes unprofitable (GoSL, 2009). In recognition of this, and in line with the Abuja Declaration on Fertilizer for an African Green Revolution (AU, 2006), the government of Sierra Leone, through the Ministry of Agriculture and Forestry (MAF), had been embarking on a massive drive to ensure that fertilizer becomes available to Sierra Leonean farmers at a reasonable cost as an agricultural intensification strategy to facilitate the adoption of other yield-increasing technologies. Huge quantities of fertilizers have been imported into Sierra Leone, traded in Sierra Leone, distributed to farmers, and utilized without ascertaining their authenticity and quality.

Farmers and a majority of those involved in fertilizer procurement (Importers, wholesalers, retailers, and agro-dealers) are not well trained on fertilizer specifications, labeling requirements, nutrient deficiency, adulteration, misbranding, etc. Most fertilizer suppliers and dealers in Sierra Leone are poorly informed about what they sell, so cannot advise farmers appropriately. Thus, they cannot make informed decisions when purchasing their fertilizer stock. Similarly, personnel involved in distribution, handling, and storage of fertilizers are not trained in good housekeeping practices like ventilation, stacking, etc. This indicates a serious need for a fertilizer regulatory system that not only properly regulates the type and quality of fertilizer that is sold in markets but ensures that all participants in the fertilizer supply chain can make informed decisions in the importation, storage, and distribution of the product.

The consequences of using fake, substandard, low quality or adulterated fertilizers are grave. They hold the potential of seriously damaging the agricultural sector and hence the economy, along with the environment (NACGLOBALBLOG, 2017). Poor quality of the fertilizers not only erodes the trust of farmers in fertilizers, it discourages them from using it at all. It also curbs the efforts of the private and government organizations to follow food security, reducing poverty and promoting national economic growth.

The purpose of this article therefore is to narrate efforts made the government of Sierra Leone so far to address the issue of fertilizer quality and propose next steps in the way forward. This report will also serve as a reminder to our agricultural policymakers that while promoting greater fertilizer use, it is equally important to effectively control its quality. This would ensure that farmers and other end users get what they are paying for.

## **II. The Current Fertilizer Situation In Sierra Leone**

The Ministry of Agriculture, Forestry and Food Security (MAFFS) developed and adopted its first ever national fertilizer policy in 2017, which shifted from the government-led fertilizer strategy to private-sector-led strategy and set a goal of a fertilizer application rate at 50 kg/ha by 2029 (Tillen, 2019). To ensure continuity, this strategy has been incorporated into the five-year plan (National Agricultural Transformation Programme 2023) of the current government's New Direction Agenda. The policy was harmonized with the ECOWAS Regulation on fertilizer quality control C/REG.13/12/12. To implement the policy, Sierra Leone's Parliament passed the National Fertilizer Regulatory Agency Act 2017. The National Fertilizer Regulatory Agency (NaFRA) is now a new government agency in charge of regulating the fertilizer sub-sector, but is yet to be operational. When fully operational, the NaFRA will be responsible for:

- Regulating and supervising the packaging and labeling of fertilizer
- Inspecting and analyzing fertilizers distributed in the country (quality control)
- Regulating the importation and exportation of fertilizers
- Maintaining a National Fertilizer Registry
- Issuing licenses to importers, exporters, and manufacturers of fertilizers

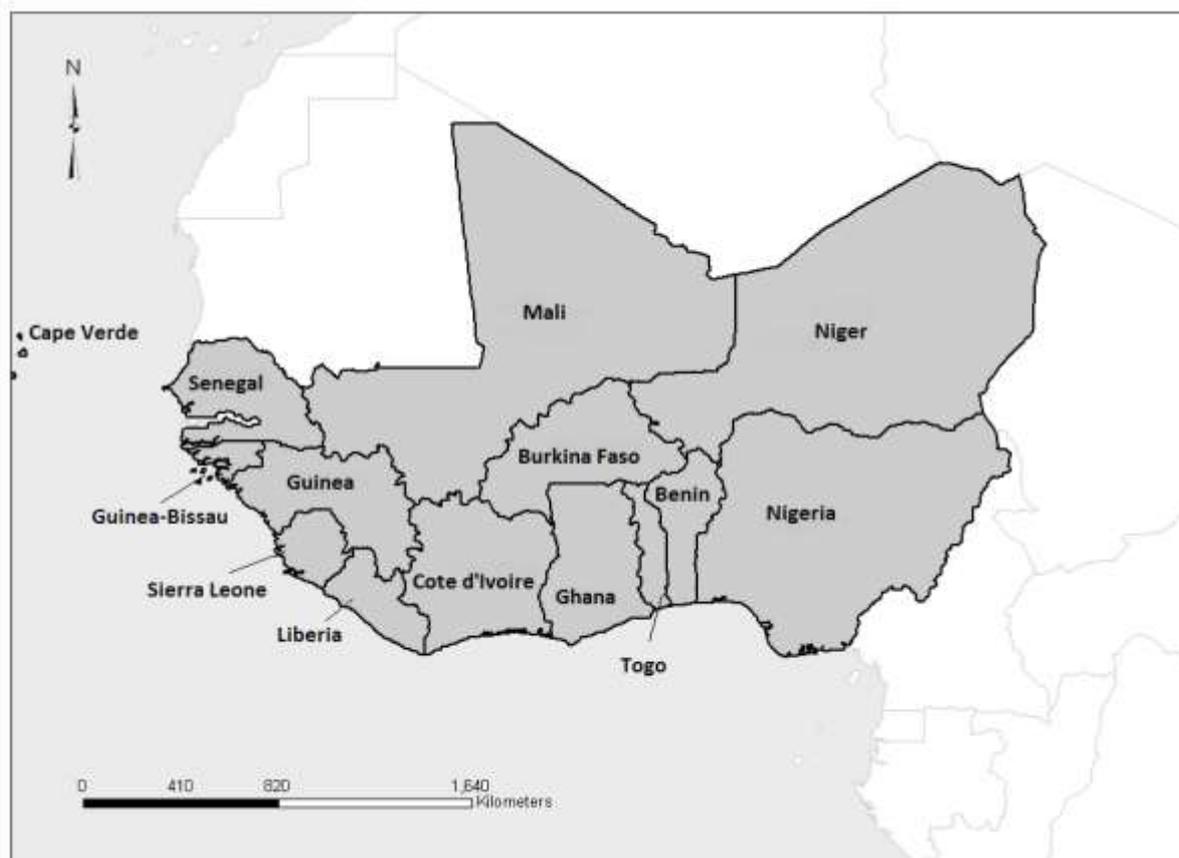
At the moment, government provides little to no quality control of fertilizers on the open market. Corporate farms sometimes pay service providers such as Sierra Leone Agricultural Research Institute (SLARI) and Njala University to test their imported fertilizers. However, the labs at SLARI and Njala University are not properly equipped for fertilizer analysis. Labeling is also not regulated; agro-dealers and retailers can re-package fertilizers in smaller sizes without appropriate labeling or fear of inspection. Farmers cannot be certain whether these new and smaller packages contain the appropriate ingredients at the weights advertised. Quality control issues like these decrease trust between agro-dealers and farmers further undermining fertilizers adoption among farmers (Tillen, 2019).

There is anecdotal evidence suggesting high levels of non-compliance of nutrient content and bag weight in Sierra Leone. Some bad actors open sacs of fertilizer, replace portions of the contents with fillers, and still sell the sacs for full price. A joint report published by ECOWAS, UEMOA (West African Economic and Monetary Union), and IFDC (International Fertilizer Development Centre) in March 2013 puts into context the potential extent of this non-compliance in Sierra Leone:

“.....there is a 41 percent chance that the bag weight does not comply with the ECOWAS tolerance limit in Nigeria, a 28 percent chance for this to occur in Côte d'Ivoire, 13 percent in Senegal, 12 percent in Ghana and 7 percent in Togo. The lowest probability of fertilizer bags out of compliance in Togo may be explained by the country's simpler distribution chain.....”(Sanabria et al., 2013). Given these high rates of bag weight non-compliance in countries where fertilizer quality is already enforced, rates of non-compliance may be as high or higher in Sierra Leone.

Unfortunately, the primary black market seems to be the illegal re-sale of fertilizer distributed by the government. During a fertilizer market survey conducted by the Tillen Group (Tillen, 2019), respondents reported that significant amounts of fertilizer distributed by the government is re-sold on the open market below market value. For example, farmers, agro-dealers, and government officials all reported high quantities of re-sale to marijuana farmers in some parts of the country. As a consequence of this illegal re-sale of government fertilizer, not only do these government programs fail in their missions to increase crop production among target farmers, they also distort the price of fertilizer on the open market.

In their fertilizer market survey in Sierra Leone, Tillen Group (Tillen, 2019) found that the majority of fertilizer imported in 2018 was Urea and various NPK blends. Urea comprised 41% of all types of fertilizer while NPK 4-5-50 and NPK 10-10-30, both of which are used for Oil Palm production, comprised 25% each. Eight different NPK blends were imported by port in 2018. “Other NPK” include 15-15-15 and 17-17-17 commonly used for rice and vegetables as well as specialized blends like 18-8-15, 20-0-20, and 11-29-15. It was surprising that little NPK 15-15-15 was imported through the port in 2018. Available literature on fertilizer use in West Africa, as well as several expert interviews conducted by the Tillen Group (Tillen, 2019) during their fertilizer market survey, suggest that NPK 15-15-15 is one of the most common fertilizer brands on the market in the region. However, only one import of 35 MT, less than 0.36%, was made in Sierra Leone in 2018. The study found that the majority of NPK 15-15-15 on the open market was imported from neighboring Guinea (Figure 1).



**Figure 1:**Map of West Africa showing ECOWAS member states. Source: Bumb et al. 2011.

Most Corporate and Open Market imports come from Europe, primarily Belgium, and Morocco while Government imports include more sourcing from Iran and China. Nearly 85% of all Urea imported in 2018, for example, was purchased by the government from Iran, which is offering Urea at heavily discounted prices due to pressure from international sanctions. Most fertilizer is imported directly by corporate farms that transport the fertilizer to their own warehouses and apply it directly on their own farms. Government imports are transported to District level warehouses, mostly in the capital cities of each district, and then transported to smaller warehouses at Agricultural Business Centers (ABCs) owned by Farmer Based Organizations (FBOs).

### III. The ECOWAS Fertilizer Regulation

On 2 December 2012, the Economic Community of West African States (ECOWAS) adopted Regulation C/REG.13/12/12 relating to fertilizer quality control in the ECOWAS region at its Sixty-Ninth Ordinary Session held in Abidjan, Côte d'Ivoire. According to Article 18 of the ECOWAS Regulation C/REG.13/12/12 relating to fertilizer quality control in the ECOWAS region, fertilizer labelling requires the net weight, brand and/or grade, guaranteed analysis, and the name and address of the manufacturer or re-packing agent (ECOWAS Commission, 2012). The purpose of Regulation C/REG.13/12/12 is to harmonize the rules governing quality control of fertilizers in the ECOWAS Member States, to safeguard the interests of farmers against nutrient deficiencies, adulteration, misleading claims and short weight as well as to contribute to the creation of an enabling environment for private sector investment in the fertilizer industry. Sierra Leone has adopted these regulations and already enacted a fertilizer regulatory mechanism along the ECOWAS regulations, but implementation has not commenced.

In the process of developing the regional legal framework for controlling the quality of fertilizer traded in West Africa (Sanabria et al., 2013), the ECOWAS Commission and the West African Economic and Monetary Union (UEMOA) initiated a study to assess the quality of fertilizer traded in West Africa as well as factors influencing fertilizer quality. The study was carried out by trained inspectors from the national fertilizer regulatory services in five West African countries – Côte d'Ivoire, Ghana, Nigeria, Senegal and Togo, the largest consumers of fertilizer in the ECOWAS region. Fertilizer sampling and collection were conducted following an agreed-upon protocol. A total of 2,037 fertilizer samples were collected from 827 wholesalers, government depots and retailers of various sizes in the five countries.

The chemical analyses carried out show that NPK fertilizers manufactured through blending present the most frequent cases of poor quality compared with compound products. More specifically, 51 percent of the 106 samples of the 15:15:15 blend were out of compliance with the newly adopted ECOWAS tolerance limits for nutrient content deviations. Incidentally, the bulk of NPK imported into Sierra Leone are blended fertilizers.

Of the 10 samples of single superphosphate (SSP) collected from several locations in Nigeria, seven of them were found to contain no phosphorus ( $P_2O_5$ ) but contained mainly quartz ( $SiO_2$ ). Trained inspectors reported evidence of adulteration in 31 of 134 (23 percent) samples collected in Côte d'Ivoire. An analysis of the weight of 1,055 fertilizer bags collected from all five countries indicates that there is a 41 percent chance that the bag weight does not comply with the ECOWAS tolerance limit in Nigeria, a 28 percent chance in Côte d'Ivoire, 13 percent in Senegal, 12 percent in Ghana and 7 percent in Togo.

Statistical analysis performed on 106 samples of the NPK 15:15:15 blend and agro-dealer characteristics reveal that agro-dealers with "good knowledge about fertilizers" are more likely to sell a higher percentage of "Good" quality products than others. Similarly, analyses carried out with the 624 samples of NPK 15:15:15 blend, 15:15:15 compound and 16:16:16 compound show that the agro-dealers with a license for selling fertilizer are more likely to sell a higher percentage of "Good" quality fertilizers than non-licensed agro-dealers.

The study results clearly suggest that effectively implementing the adopted ECOWAS fertilizer regulatory system is likely to ensure that products supplied to the market meet high quality standards. The system calls for licensing of agro-dealers as well as inspection, sampling and analysis of fertilizers at importation points and along the distribution chain.

This has created a serious need to provide information that will assist the Government of Sierra Leone improve the quality, cost-effectiveness and ecological sustainability of fertilizer use in Sierra Leone. In order to achieve this, analytical capabilities for fertilizers in the Sierra Leone must be enhanced. Enhancement of analytical capabilities will provide information that will enhance proper usage and quality control of chemical fertilizers in Sierra Leone with a view to improving fertilizer use efficiency, crop productivity and household food security in Sierra Leone.

#### **IV. Quality Of A Fertilizer**

Fertilizer quality is usually determined in terms of its physical and chemical characteristics. The physical parameters include moisture content, particle size, particle hardness, and caking. The chemical parameters refer to the amount and form of nutrients, and to various impurities that may be toxic to plants above a critical limit, e.g. biuret in urea. Both its physical quality and its plant nutrient content determine the quality of a fertilizer.

Problems with poor quality of fertilizers are common in West Africa and represent a major barrier to agriculture growth in the region (Liverpool-Tasie et al., 2010). Quality problems can arise anywhere along the supply chain. During a case study on fertilizer quality issues carried out in selected countries in West Africa, numerous complaints were recorded in each country visited of problems with underweight bags and grossly adulterated products, even to the point of ash and pure sand sometimes being sold as fertilizer (Ayoola, 2014; Eilittä, 2014). Other fertilizer quality issues including poor quality bags and storage facilities (Figure 1), inadequate warehouse ventilation, poor product handling and misbranding, fake, misleading or absent labels, and specifications claiming nutrient content different from reality have also been reported across West Africa.

A recent study conducted jointly by the International Fertilizer Development Center (IFDC) and the Economic Community of West African States (ECOWAS) to analyze the quality of fertilizer in five West African countries tells a compelling story (IFDC, 2013). Extensive fertilizer market research and product testing found the existence of severe nutrient deficiencies in bulk blends due mainly to inappropriate blending technology, frequent bag weight shortages, low quality in some fertilizer imports, and degradation of fertilizer physical attributes due to manual handling and inadequate storage.

A major factor limiting use of quality fertilizers for enhanced agricultural productivity is the unavailability of properly packaged and labeled fertilizers in quantities small-scale farmers can afford (IFDC, 2016). Most often, fertilizers available on the market are packaged in 50 kg bags and sold at prices not usually affordable to many small-scale farmers, effectively preventing them from applying fertilizers on their farms. In an effort to alleviate this problem, many middle level fertilizer distributors, retailers and agro-dealers in West African markets repackage fertilizers into smaller quantities that fit into small-scale farmers' meager budgets. This solution, however, has caused problems and raised several questions: are proper packaging and labeling standards as stipulated by regional and national laws being met by these dealers? And, essentially, are small-scale farmers getting what they pay for?

As researchers are finding out, if the fertilizer available is mostly low-quality, it may not be worth it. A recent study in Uganda (Toro, 2015) suggests that good quality fertilizer is more important than agricultural education or micro credit for improving food security. The study tested samples of urea fertilizer for sale to

farmers in Uganda and found that shoddy, low quality fertilizer was pervasive in the Ugandan market. “On average,” the report says, “retail fertilizer contained 31% less nutrient than authentic fertilizer.” And virtually every one of the 369 samples the team tested was significantly understrength, with less than 1% being more than 90% pure (Toro, 2015).

According to a study by the Soil Research Development Institute in Bangladesh, the percentage of questionable fertilizer in the country ranged from almost zero for urea to 87 % for the nitrogen-phosphorus-potassium (NPK) composite fertilizer (Zahur, 2010). A country-wide inspection in Vietnam, in which 850 fertilizer samples were collected from 17 cities and provinces, shows that almost half of the tested samples do not meet the quality standards (Viet Nam News, 2010). Similar problems on fertilizer quality have also been found in Cambodia (Hamaguchi, 2011) and Nigeria (Liverpool-Tasie et al., 2010).

In Tanzania, the Ministry for Agriculture, Food Security and Cooperatives found fertilizer samples that have been mixed with cement and salt (Mwakalebela, 2012). Farmers report suspicions about fertilizer sold past its expiration date, along with concerns about purchasing urea fertilizer that has been mixed with table salt, or Di Ammonium Phosphate (DAP) diluted with powdered concrete. Poor quality fertilizer has direct effects on yields. Mather et al. (2016) calculate a linear maize-nitrogen response rate for Tanzania of 7.6 kilograms of maize per kilogram of nitrogen applied; 10% nitrogen missing from the fertilizer means a 10% loss in production.

Ashour et al. (2015) surveyed 2400 Ugandan farmers and found that nearly 20% believed that the quality of mineral fertilizer is lowered due to adulteration or counterfeiting and that 70% reported that they did not buy fertilizer in the last two agricultural seasons due to quality concerns. They found that mineral fertilizer in those markets show nutrient deficiencies: on average, about 10% or 2.3 kilograms of nitrogen are missing from a 50 kg bag of Urea. Moreover, almost 25% of the samples exhibited some degradation in physical quality characteristics.

In Nigeria, fertilizer quality issues remain a challenge. Fake, adulterated, and misbranded fertilizers exist alongside underweight fertilizer bags in the Nigerian market (Liverpool-Tasie et al., 2010). Quality issues have been identified as a major supply constraint to fertilizer use in Nigeria and farmers have indicated interest in fertilizer despite the cost, if they were assured of improved quality (Nagy and Edun 2002; Chude 2006). Adulteration, which usually involves fertilizer being mixed with products like sand and crop or weed seeds, changes the appearance and potency of the product. This could be damaging to plants if extraneous substances mixed in are chemicals and in sufficient quantity to affect crop growth and development (Viskeret al.1996).

Underweight bags, used to increase profit margins, occur during multiple levels of re-bagging that takes place in several West African countries, often in the absence of proper scales. Other fertilizer quality issues include poor quality bags and storage facilities, inadequate warehouse ventilation, poor product handling and misbranding, fake, misleading or absent labels, and specifications claiming nutrient content different from reality (Ayoola et al. 2002).

Fertilizers can be short of their guaranteed nutrient content for numerous reasons including adulteration, poor storage and handling, or production problems. Of these, adulteration perhaps receives the most attention from policy makers, farmers, researchers, and the press (Liverpool-Tasie et al., 2010).

Overall, farmer suspicions about quality may partially explain the slow uptake of the use of fertilizer in Sierra Leone. In the long-term, uncertainty regarding fertilizer quality could have widespread consequences for the functioning and growth of fertilizer demand. Such problems could hamper efforts to increase adoption of fertilizer as a means of raising regional agricultural productivity and improving household and national food security. In the long-term, uncertainty regarding fertilizer quality could have widespread consequences for the functioning and growth of fertilizer demand. Such problems could hamper efforts to increase adoption of fertilizer as a means of raising regional agricultural productivity and improving household and national food security. As a result, it is critical for policy makers to understand not merely the determinants of quality and quality degradation but also how farmers are assessing fertilizer quality, what attributes they care about, and how they decide whether a fertilizer has those attributes.

## **V. Physical Quality Of A Fertilizer**

The physical quality of a fertilizer is an important factor affecting the ease, speed and uniformity of application. The most frequently encountered problems resulting from deficiencies in physical properties are caking (agglomeration or lump formation), dustiness, poor flowability, excessive hygroscopicity (moisture absorption characteristics), and segregation (non-uniformity of composition throughout a fertilizer lot). (FIFA, 2006).

The acceptability of a fertilizer in the marketplace depends not only on its nutrient content but also on its physical quality. In a fertilizer distribution system, it is important that fertilizers remain free-flowing (non-

caking), that they be relatively non-dusty, and that they withstand a reasonable amount of exposure to normal atmospheric humidity (UNIDO/IFDC, 1998).

Particle size is very important for fertilizer blends. A mismatch in size range between different blend components will result in a product that is susceptible to segregation through vibration during transport, when stored in piles, or when propelled through the air. The crushing strength or hardness of a particle is important in determining the storage properties of a product. For example a granule which can be crushed between the thumb and forefinger is classified as 'soft'. If it can be crushed with the forefinger on a hard surface, it is regarded as being of 'medium hardness'. If it remains intact when subjected to pressure by the forefinger against a hard surface, it is classified as hard (FIFA, 2006).

Fertilizers are generally hygroscopic in nature, meaning that they can absorb moisture from the atmosphere and dissolve in that water. Excessive moisture may damage the granular structure of fertilizers, affect their quality and influence their nutrient content by increasing the weight of fertilizers in a given container. Therefore, the longevity of inorganic fertilizers can be extended if they are stored in very dry environment; this is a critical rule for fertilizer storage (Rutland and Polo, 2005). This rule was apparently not observed during a visit made to the government fertilizer store in November 2017. On entrance into the fertilizer store, pools of putrid and colored water were observed throughout the store. This water was seeping directly from the bags of stored fertilizer as is illustrated in the accompanying figures below (Figure 2).



**Figure 2:** This pool of colored water can be traced right underneath the heaps of fertilizer bags in the background.

Fertilizer that contains powdered or dust particles can be difficult to apply and hazardous to work with. Storage and transport of mineral fertilizer with broken and powdered prills can cause farmers problems as the dust is susceptible to trickling out of the manufacturer bag (Rutland & Polo 2005) and the powder is highly hygroscopic and likely to quickly absorb water in humid conditions (Figure 3).



**Figure 3:** Sample of NPK fertilizer showing the moist condition of the fertilizer during storage

Note that just as fertilizer with compromised nutrient content impacts farmer profits, physical quality problems also can have associated costs for farmers independent of inferred implications about nutrient content or agronomic efficacy. For example, caked fertilizer must be broken up by the farmer before application. Powdered fertilizer is difficult to apply and can result in losses during handling or storage (UNIDO/IFDC, 1998). Fine powders, dusty fertilizers, and small crystals are particularly susceptible to caking or setting because their larger surface area results in greater uptake of moisture and reaction with adjacent particles. Dusty materials may pose a health risk through irritation to eyes and soft tissues. Dusty and fine materials are susceptible to drift when broadcast applied (FIFA, 2006).

Fertilizer clumping can occur when the fertilizer is exposed to water or high humidity — during initial packaging and handling of manufacturer bags as well as subsequent transportation and storage (Sanabria et al 2013). Several factors increase the likelihood of caking; the moisture content of the fertilizer after manufacturing and whether the fertilizer is conditioned with an anti-caking agent. Storage conditions are also important as caking is especially sensitive to temperature and humidity, pressure in piles and stacks, and storage time (Rutland & Polo 2005).

Fertilizers preferably should be free from particles so small that they generate air-borne dust during handling and application, not only to ensure farmer acceptance but also to prevent unhealthy working conditions and environmental damage around fertilizer plants and bulk-handling operations. Mismatched particle sizes in raw materials used for blending can result in segregation of particles during transport and storage. Granular fertilizers should have sufficient mechanical strength to withstand normal handling and storage without significant fracturing of granules and creation of excessive dust (UNIDO/IFDC, 1998).

Impact resistance is the resistance of granules to breakage upon impact against a hard surface. It is of interest when fertilizer spreaders are used, when a material is discharged from an overhead point such as loading into a ship hold, and when bags of material are dropped during handling.

Hygroscopicity is the moisture absorption properties of a fertilizer under specified conditions of humidity and temperature. Most fertilizer products are hygroscopic to some extent because of their normally high water solubility. The more hygroscopic a fertilizer is, the more problems one can expect during storage and handling.

Because of the large quantities of fertilizer products and raw materials handled in bulk, their dustiness is of particular concern and can cause significant problems (UNIDO/IFDC, 1998). First, significant quantities of material can be lost during processing, handling, and application resulting in lost revenues. Second, environmental pollution and exposure of employees to hazardous levels of dust are not indicative of a responsible organization.

## **VI. Nutrient Content And Quality**

The nutrient content and the form in which that nutrient is present largely determine the performance of any fertilizer. Fertilizer products must have a label printed, stenciled, or securely affixed to the package. In the case of bulk fertilizer, a label or advice note containing the label information must accompany each load. Many countries have standardized the labeling of fertilizers to indicate their contents of major nutrients. The most common labeling convention, the NPK or N-P-K label, shows the amounts of the chemical elements nitrogen, phosphorus, and potassium.

The label must state the form and concentration of the elements N, P, K, and S, Mg, etc., when present in the fertilizer. The label or advice note will usually state or contain the distinguishing name of the product; the quantity of fertilizer within the package or bulk delivery; the name and full business address of the supplier; an analysis of the ingredients of the fertilizer; and any applicable warning statements that are prescribed under regulation.

For products sold by weight, the concentration of each ingredient in a fertilizer must be expressed on the label or advice note as the percentage weight in weight (w/w) and as the percentage weight in volume (w/v) for all products sold by volume.

There are many reasons for this. Fertilizer use is an ongoing farming practice, with a major influence on yields and earning. Smallholder farmers are rarely in a position to examine the quality of a fertilizer, so that they have to trust the information supplied by the producer. Given that serious damage can arise from the use of adulterated or incorrect fertilizers, the quality of which cannot in any case be checked after they have been incorporated to the soil, certain means of preventive quality control become necessary.

The ultimate purpose of the fertilizer is that it shall be applied to the appropriate soil, under the appropriate climatic conditions and supply the necessary nutrient elements to the appropriate kind of plant. This will only be achieved if the purchaser clearly knows what he/she is paying for. In other words, the exact type of the fertilizer contained in the package and also the quantities that can be used for a certain kind of crop in a given area under given climatic conditions; and that the product will not have lost its specific qualities as a result of bad storage conditions, tampering with, unsuitable containers, etc. by the time it comes to be used.

The need to inform the purchaser of the quality and the possible uses of the fertilizer he buys can be met by marking the container itself in a manner ensuring that the purchaser will have no problem in identifying the type of fertilizer for the purpose he has in mind; or by the seller supplying the purchaser with a written statement on the name, composition, qualities and possible uses of the fertilizer; or both these methods combined.

Provisions regarding the labeling of the fertilizer container are found in most countries or regions of the world. Details of some of these can be found in Association of American Plant Food Control Officials (AAPFCO, 2019), National Code of Practice for Fertilizer Description and Labeling (Fertilizer Australia, 2018), The International Code of Conduct for the Sustainable Use and Management of Fertilizers (FAO, 2019), and FAO Fertilizer Legislation (FAO, 1973).

Specifications of fertilizers sold in the ECOWAS Member States shall be printed on the fertilizer container in clearly legible and conspicuous form. According to Article 20 of ECOWAS Regulation C/Reg.13/12/12, a major purpose of fertilizer quality assessment is to ensure that fertilizers traded in the ECOWAS region have labels that are truthful. A fertilizer shall be deemed to be misbranded if its label is false or misleading in any manner; if it is distributed under the name of another fertilizer product; if it is not labeled as required in the present Regulation. An illustration of an acceptable fertilizer label is shown in Figure 4.

## **VII. Conclusion**

There is a critical need in Sierra Leone to ensure that proper usage and quality control of fertilizers are enhanced with a view to improving fertilizer use efficiency, boosting crop productivity and household food security in Sierra Leone. Baseline data on current status of fertilizer quality in Sierra Leone are urgently needed as a starting point.

Importers and distributors must ensure that the authenticity and quality of fertilizer products are ascertained before distribution. As a national policy, fertilizer types and formulations to be imported by prospective importers must conform to fertility status of the soil and crop nutrient requirements for different crops in the agro-ecological zones of the country.

There is a need to train input dealers and distributors on the appropriate storage and handling of fertilizer products as well as their physical and chemical properties. Doing so will contribute to reducing the effect of physical attributes of fertilizer on product quality. These quality problems will increase if the market should continue growing without effective control; significant environmental hazards may also occur. In addition, only quality products can enable farmers to maximize the returns from their investments and encourage them to continue using fertilizers.

There is also a need to ensure that the ECOWAS regulation on fertilizer quality control in the ECOWAS region is widely popularized among stakeholders.

When procuring fertilizers, there should be an indication of the origin of the fertilizer. There must be a mention of either date of manufacture or expiry date, so that it becomes quite clear as to how long this fertilizer has been standing with the supplier before it was shipped to Sierra Leone.



**Figure 4:** Acceptable Label, as stipulated in the ECOWAS Fertilizer Regulation C/Reg.13/12/12

Enforcement of the whole regulatory system is the way to change the fertilizer quality situation in Sierra Leone. The government of Sierra Leone must create or improve their regulatory capacities by having appropriate personnel that can inspect blending plants, ports and markets, and establish functional laboratories or collaborate with private laboratories to perform proper chemical analyses of fertilizers.

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