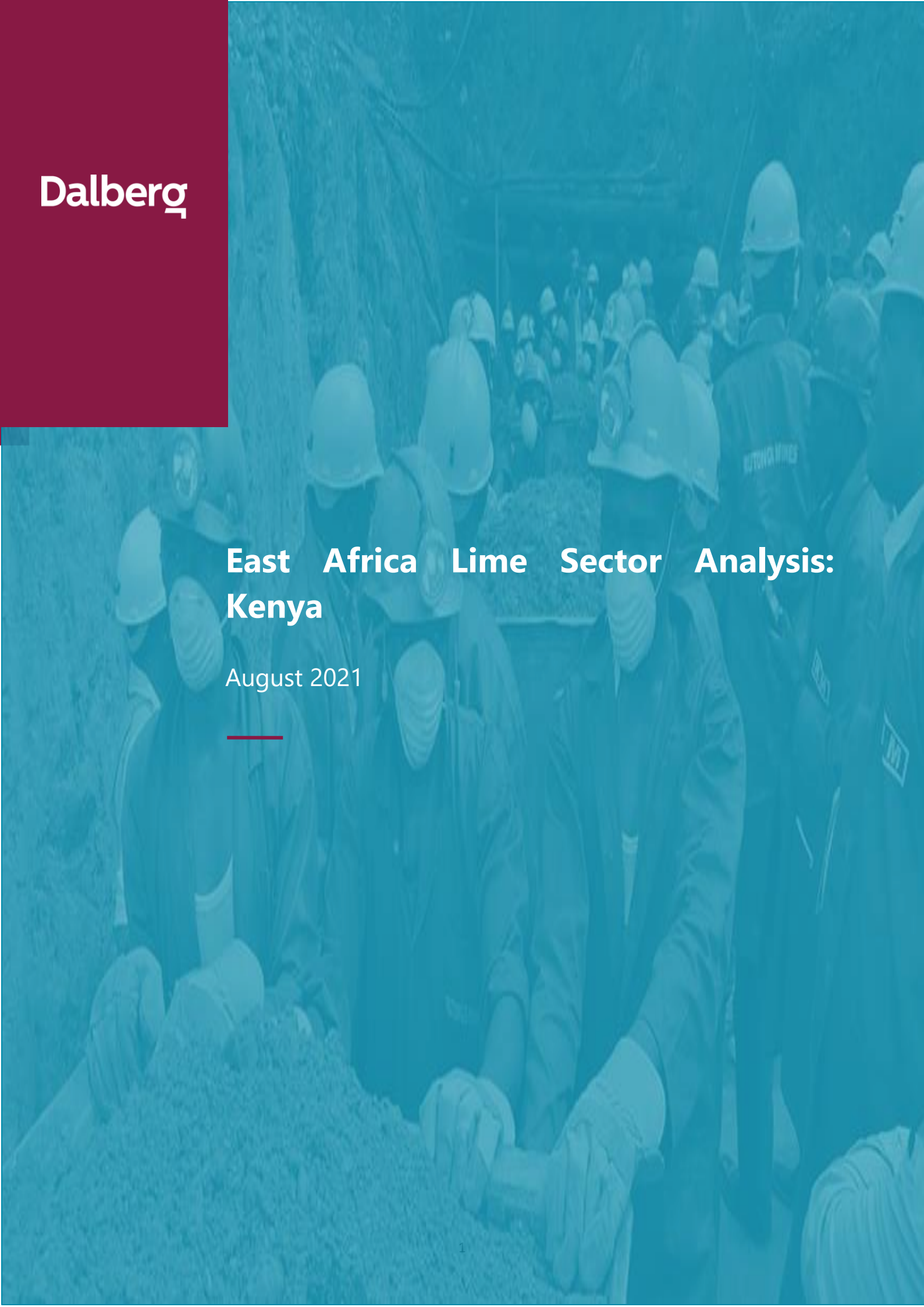
Dalberg



East Africa Lime Sector Analysis: Kenya

August 2021

EXECUTIVE SUMMARY

Soil acidity has critical adverse impacts that threaten Kenya's food security and agribusiness potential. In Kenya, the agricultural sector accounts for 33% of gross domestic product (GDP) and provides a livelihood to 40% percent of the country's population and 70% of the rural population[1] who depend on subsistence growing for their food security. However, agricultural productivity for smallholder farmers has stagnated in recent years- (i) food crop yield per acre, particularly for staples that guarantee food security such as maize, beans, millet, potatoes, and wheat are on the decline[2]; and (ii) earnings from cash crop are under pressure with three of the leading export earners for Kenya in coffee, flowers, and vegetables facing decreasing yield and reducing agribusiness income. Acidic soils hamper crop production and hence, are a major cause of crop yield reduction and, consequently, reduced agricultural incomes.

Currently, 13% (7.5 M hectares) of Kenya's cropland is acidic, and solutions to treat soil acidity remain out of reach for most farmers.[3] Soil acidity is concentrated in the Central, Western, Lake Basin, and Rift Valley regions, the main food baskets for Kenya. Central Kenya is the main region to produce coffee, tea, beans, and wheat; sugarcane and maize are primarily produced in the Western region; maize, tea, and wheat are grown in Rift Valley regions; and the Lake Basin is the main region for sugarcane and millet.[4] The level of soil acidity is likely to worsen due to increasing fertilizer use and soil leaching. As a result, crop yields are expected to continue to decline.[5]

Lime presents the most viable solution to address acid soils due to its availability, effectiveness, and cost. There are three main solutions to address soil acidity: fertilizing residual materials, acid-tolerant seeds, and lime. Among these, lime proves to be the most effective approach to achieve efficient agricultural output, due to its ample local availability, effectiveness (lime in Kenya has a high concentration of calcium carbonate), soil impact, and, as the lime industry grows, is the most affordable option at scale.

However, limited demand is a critical binding constraint to the effective supply of lime, with only 20%[6] of farmers reported to have used lime. A host of interlinked issues drive limited demand. The high cost of lime due to expensive transport costs makes lime purchase prohibitive to farmers. While the raw material cost of lime at between ~USD 40 to USD 60 per ton is relatively affordable to farmers, transport increases the cost of lime by USD 0.12 per ton for every Km transported, resulting in farm gate prices of between ~USD 100 – USD 120 (depending on location). This is unaffordable for smallholder farmers, who have a median monthly income of USD 124.[7][8] Demand is further constrained by limited awareness of quantity, timing, application methods, and yield response to lime. This leads to mismatched expectations on the expected return on investment (ROI) for lime; farmers tend to use lime and then abandon it as they cannot determine the benefits of using lime on their crop yield.[9] Furthermore, the reaction time of lime is

[1] USAID – Agriculture Fact Sheet, Kenya
[2] Soil Sustainability Evaluation of Maize production in Kenya. Pg. 7
[3] Enhancing market access and use of agricultural lime amongst small holder farmers in Western Kenya: Early Impact Assessment Report
[4] Local and regional variations in conditions for agriculture and food security in Kenya, pg. 7
[5] Soil Sustainability Evaluation of Maize production in 20% Kenya. Pg. 7
[6] Economics of granulated lime – pg. 49
[7] Expert interviews
[8] Comparative analysis of smallholder farmers in Kenyan, Zambia and Tanzania, pg. 19
[9] Expert interview

directly linked to the quality (i.e., fine lime reacts with the soil quicker) and appropriate lime application. Inconsistent quality of lime makes it hard to evaluate the ROI from lime as farmers do not understand the differing calcium carbonate content, mesh size and trace element composition of the lime available.

Over and above the lack of demand, several challenges across the supply chain affect the quality and availability of lime. First, while there is a clear need to improve the quality of lime, lime manufacturing is inefficient due to limited capacity and seasonality of demand, and manufacturers are unwilling to invest in improving quality due to low demand. Agricultural lime is therefore primarily collected as a by-product from cement manufacturers, with limited quality checks in place[10]. Second, last-mile delivery costs are prohibitive to both smallholder farmers and suppliers due to diseconomies of scale and poor infrastructure. This is evidenced by only 29.3% of farmers reporting accessibility of lime[11]. High last-mile distribution costs and low demand further disincentivize distributors from ensuring lime is locally accessible, thereby limiting the overall economic viability of the supply chain.

In addition, limited access to suitable finance and policy gaps currently hinders the growth of the lime sector. For manufacturing, traditional financing options, particularly for CAPEX investments in lime, come with high interest rates and long lead times for due diligence that discourage investments. For demand, the lack of access to either subsidies or cheaper credit facilities inhibits the purchasing of lime by smallholder farmers, who are often cash-constrained and prefer to acquire agricultural inputs on credit. With regards to policy, there are no tax policy incentives that reduce the cost of lime. In comparison, fertilizer, as an agricultural input, is exempt from tax. Granulated lime, a premium product used by large and specialty farmers, is mainly sourced from importers despite the potential viability of local production to meet the niche demand. The inconsistent quality of lime is exacerbated due to the lack of quality standards for lime, with no labeling of component percentage, on lime bags. Lack of policy has also led to unharmonized and confusing information on (i) soil health- farmers often receive different soil results from different providers; and (ii) liming best practices leading to low usage of lime.

Without addressing demand challenges first, suppliers are likely to have limited appetite to optimize the manufacturing and distribution chain and a limited effect on solving finance and policy gaps. To help increase demand, a targeted awareness drive focused on areas with the highest soil acidity should be prioritized. Awareness should focus on teaching two main areas: the best practices of liming and the benefits of liming beyond just improving soil acidity, such as improving water use efficiency due to better root development, increasing soil microbial activity, and lowering toxicity levels of aluminum and manganese. Additionally, the provision of subsidies or cheaper credit facilities would make lime more affordable to farmers and help increase uptake. Different private sector interventions to increase awareness, and increase uptake, have been undertaken; for example, a pilot project for the provision of credit facilities to purchase lime, by the One Acre Fund[12] and different producers such as Homa Lime and ARM have conducted demonstration plots to build capacity and raise awareness across different regions[13]. Achieving

[10] Expert interviews
[11] Economics of granulated lime pg. 48
[12] Managing soil aciditiy with lime – 2015 Trial report
[13] Expert interview

sustainability and attracting investment to scale the lime sector requires specific interventions to address the demand and supply side challenges, along with supportive policies and incentives.

ACRONYMS

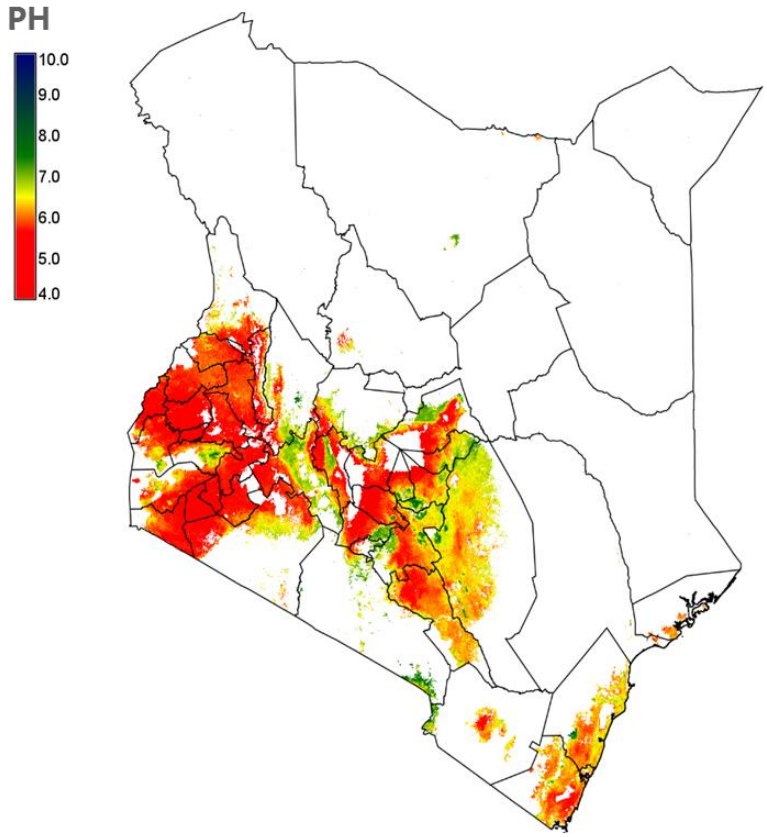
ARM	Athi River Mining Ltd
Ag-lime	Agricultural Lime
DAP	Di- Ammonium Phosphate
FBO	Farmer Based Organizations
FRMs	Fertilizing Residual Materials
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
IFDC	International Fertilizer Development Center
KALRO	Kenya Agriculture and Livestock Research Organization
KEBS	Kenya Bureau of Standards
KES	Kenya Shilling
KMT	Kenya Markets Trust
MoA	Ministry of Agriculture
NGOs	Non-Governmental Organizations
ROI	Return On Investment
SHFs	Smallholder Farmers
USD	US Dollar

Contents

I. INTRODUCTION

Kenya faces significant and growing challenges with soil acidity. Currently, 13% (7.5 M hectares) of Kenya's cropland is acidic, and solutions to treat soil acidity remain out of reach for most farmers[14]. Soil acidity is concentrated in the Central, Western, Lake Basin, and Rift Valley regions, the main food baskets for Kenya. Central Kenya is the main region to produce coffee, tea, beans, and wheat; sugarcane and maize are primarily produced in the Western region; maize, tea, and wheat are grown in Rift Valley regions; and the Lake Basin is the main region for sugarcane and millet.[15]

Figure 1: Soil Acidity map – Kenya



Worsening soil acidity has critical adverse impacts that challenge Kenya's food security and agribusiness potential. Despite most areas being acidic due to the composition of parent rock material[16], the acidity situation has worsened due to increased fertilizer use and soil leaching. The agricultural sector accounts for 33% of gross domestic product (GDP) and provides a livelihood to 40% of the country's population and 70% of the rural population,[17] who also depend on subsistence growing for their food security. However, agricultural productivity for smallholder farmers has stagnated in recent years due to climate change and soil acidity, showing the critical need to address soil acidity. Food crop yields per acre for staples that guarantee food security,

[14] Enhancing market access and use of agricultural lime amongst small holder farmers in Western Kenya; Early Impact Assessment Report

[15] Local and regional variations in conditions for agriculture and food security in Kenya, pg. 7

[16] Expert interviews

[17] USAID – Agriculture Fact Sheet, Kenya

such as maize, beans, millet, potatoes, and wheat, are on the decline[18]. Earnings from cash crops are also under pressure, with three of the leading export earners for Kenya in coffee, flowers, and vegetables facing decreasing yield and reducing agribusiness income.

Among solutions for managing soil acidity, lime is the most effective and accessible approach to achieving efficient agricultural output. Solutions to address soil acidity include

- **Fertilizing Residual Materials (FRMs)** which combine fertilizing and liming components. Though this industry is nascent, emerging fertilizer manufacturers such as MEA Fertilizer and Baraka Fertilizer, etc., blend their products with lime.[19] FRMs have the competitive advantage of leveraging fertilizer purchase and distribution channels to ease the distribution of lime to farmers. FRMs also typically provide smaller and easy-to-carry packaging for farmers applying fertilizer and lime jointly.
- **Oyster shells** are composed of calcium carbonate, and when crushed and composted, can reduce soil acidity. However, similar to FRMs, oyster shells are scarce in African countries - Senegal is the only African country that commercially produces oysters. Hence, supply is likely to be insufficient to fulfill Kenya's and the region's liming needs.[20]
- **Acid-tolerant seeds and crop rotation** involves planting relatively acid-tolerant crops such as tea (or using genetically modified acid-tolerant seeds), followed by more acid-tolerant and lower-yield crops such as wild oats or triticale and eucalyptus. While this approach provides a temporary solution to growing crops on acidic soil, it does not address the root cause of diminishing yields due to soil acidity.
- **Wood ashes** are relatively easy to obtain in Kenya. While wood ash is more soluble and reactive (it changes the soil pH more quickly) than ground limestone, the quantity of wood ash required is two to four times the quantity of limestone required.
- **Limestone** requires large volumes but is relatively easy to obtain. Given the abundance of limestone deposits in-country and its effectiveness, lime presents the most viable solution for acidic soil management in Kenya.

Table 1: Analysis of solution for managing soil acidity[21]

Factor	Fertilizing residual materials (FRMs)	Oyster shells	Acid tolerant seeds	Lime	Wood ash
Soil impact	Neutralizes soil acidity over time	Neutralizes soil acidity over time	No impact on soil acidity	Neutralizes soil acidity over time	Neutralizes soil acidity quicker than lime
Availability	Not produced locally or regionally, therefore limited access in-country, and imports are expensive	Scarce in African countries - Senegal is the only African country that currently produces oysters commercially. Hence, there is a high likelihood of insufficient supply	Kenya produces and imports some acid-tolerant seeds	There are sufficient lime deposits in the country, however, lime is not sold by agro-dealers and easily accessible by farmers, particularly SHFs	Any burnt wood can be used as wood ash, but due to the large amounts needed it may not be readily available

[18] Soil Sustainability Evaluation of Maize production in Kenya. Pg. 7
[19] Nutriliming agents | FRM and alternatives to agricultural lime (agro-100.ca); The Guardian, "Oyster shells will give your soil a balanced boost", 2021; "Solutions to Soil Problems: Soil Acidity", 2019; UNH Cooperative Extension, "Guide to Using Wood Ash as an Agricultural Soil Amendment",2018
[20] The Guardian, "Oyster shells will give your soil a balanced boost", 2021
[21] Factors listed here based on farmer use are soil impact, use, availability and cost and climate impact is listed to ensure environmental perspectives are considered

Cost	High cost due to need for imports	High cost due to 1. Global supply 2. Need for imports	Relatively inexpensive if produced in-country, high cost if imported	Lime is relatively inexpensive (cost of distribution results in high end-user prices)	Wood ash is relatively inexpensive unless it is commercially sold
Ability/Ease of use	Easier to use as it is in granulated form	Relatively easy to use compared to alternatives; can be harvested any time of the year	Easy to use compared to soil acidity management methods	Lime in powder form is difficult to apply to farms and handle; requires safety precautions	Wood ash is in powder form and is difficult to apply to farms and handle, requires safety precautions
Climate impact	Relatively ecologically sustainable	Can be sustainably farmed. Oysters purify the water, and act as carbon capturers, sequestering nitrogen and carbon dioxide	May contribute to increasing acidity of the soil	Releases carbon dioxide in processing and also in its reactions with the soil once applied on the farm	Releases carbon dioxide in processing and also in its reactions with the soil once applied on the farm

Indicates high difficulty/barriers, indicates medium, and indicates little or no difficulty/barriers to implementation

Powdered lime is the most preferred option by most farmers in Kenya, providing a unique entry point in an emerging industry. ~97% of farmers that have used lime use powdered lime, with most of them being smallholder farmers. As shown in Figure 1, most powdered lime is produced locally by two manufacturers - Homa Lime and ARM. Granulated lime is primarily imported[22] and locally blended[23]as granules or as part of blended fertilizer and is used by ~2% of farmers, largely mid to large size commercial farmers. Only < 0.5% of Kenyan farmers use imported liquid lime[24], restricted to specialty growers such as flowers or vegetable growers who use irrigation methods.

Figure 1: Lime types in Kenya

Type of Lime	Main producers	Market Share	Demand amount 2020 (MT)	Main Users
Powdered Lime	Locally sources from: • Homa Lime • Athi River Mining Ltd	~ 97%	~180,000	• Small holder farmers • Medium to large scale farmers
Granulated lime - can be blended with fertilizer	Imported by: • Omya ltd • Lachlan • Yara • Syngenta Local blending done by: • MEA Fertilizers • ARM - Mavuno • Toyota Tsusho • Elgon Kenya	~ 2%	~4,000	• Medium to large scale farmers
Liquid Lime	• Cosmocell • Nutrien • Dudu Tech	~ <0.5%	~900	• Specialty growers who use irrigation e.g flower and vegetables

[22] Importers of granulated lime in Kenya include Omya, Yara, Lachlan and Syngenta
[23] Granulated lime is blended by local organizations including locally blended by MEA Fertilizers, ARM, Toyota Tsusho (Barak Fertilizer) and Elgon Kenya
[24] Importers of liquid lime include Cosmocell, Nutrien and Dudu Tech

The GAIA Project is seeking to enhance its contribution to healthier soils and land management towards smallholder enterprises development. This study is one of the numerous work packages that focus on the supply chain of lime. It sets out to identify the key challenges in the supply side and identifies opportunities to address the challenges. The approach to evaluating the supply side considered challenges in the value chain and challenges in the enabling ecosystem, including policy, access to finance, etc. In brief, this study aimed to answer the following questions:

- What are the needs and ambitions of different supply chain actors?
- What are the key binding constraints to the effective supply of lime?
- What can be done to improve the supply of lime in Kenya?
- What is an implementation plan for the recommendations proposed?

For this study, we implemented a mixed-methods approach. Our approach comprised a market scan that included reviews of relevant policy documents, industry reports, and desk research. This was followed by discussions with 12 experts across the value chain from government officials, private sector actors, NGO's and research organizations. The Dalberg team then synthesized the collated data and research to generate insights and make recommendations.

This document aims to generate an understanding of the supply chain that will feed into the subsequent phase of developing investment plans. Over the course of six weeks, we aimed to develop a clear understanding of the agricultural lime industry with a specific focus on the supply side. The next phase, focused on supporting the development of national investment plans for the Kenyan government, will draw from the insights from this work and the outputs from other work packages focused on evaluating demand and the policy environment.

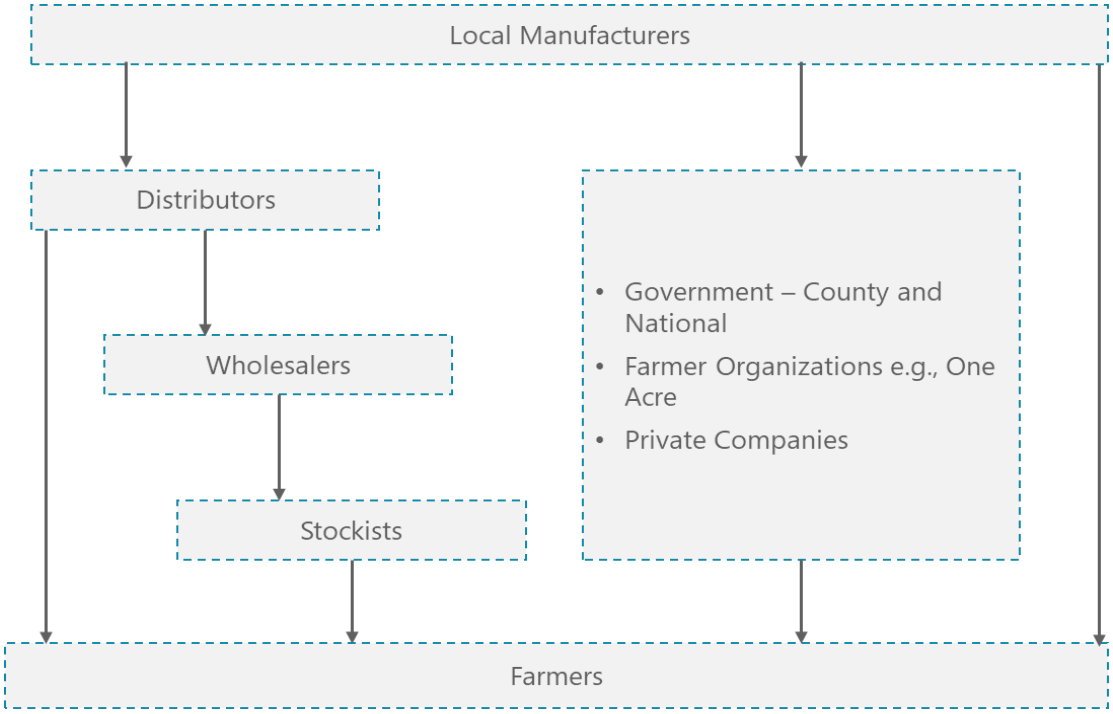
While agricultural liming is a critical element of improving productivity and food security, it is important to place liming solutions within broader efforts to develop the sector. The reality is that soil acidity remains one of several other factors in the agriculture sector. As such, liming would not be the silver bullet to addressing agriculture productivity issues. For example, climate change issues such as reduced rainfall and flooding[25], postproduction problems such as poor post-harvest handling mechanisms that lead to high yield loss, limited distribution and cold chain facilities, and lack of market linkages are other issues facing agriculture in the country. This assessment, however, is limited to only focusing on enhancing soil health and yield through the lens of soil acidity and particularly liming.

[25] Soil Sustainability Evaluation of Maize production in Kenya. Pg. 7

II. Defining And Understanding The Challenges in the Supply Chain

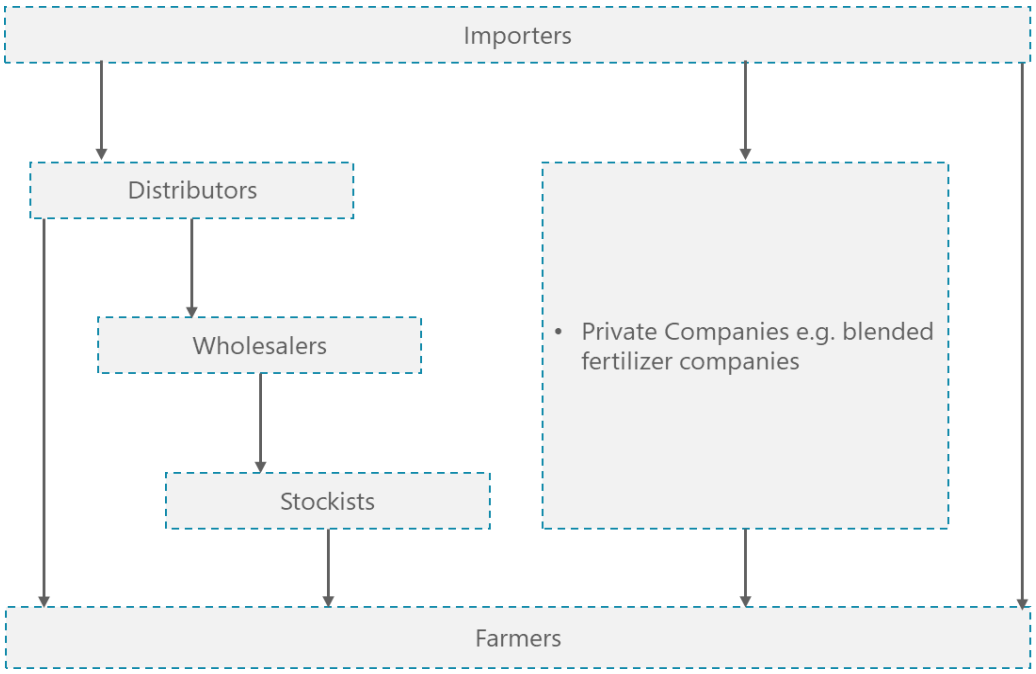
Prior to delving into the challenges in the supply chain of lime, it is helpful to describe the key components and actors of the supply chain. Kenya's lime sector is emerging with a well-established and highly competitive supply chain. As shown in Figure 2 and 3 [26] below, lime moves from importers and local manufacturers to final consumption by farmers with different players in between who help disaggregate the product into more affordable sizes for farmers and bring the product to closer proximity to farmers for easier purchase as detailed below;

Figure 2: Diagram/flow chart to show distribution of local lime produced in Kenya (mainly powdered lime)



[26] Economics of granulated lime report

Figure 3: Diagram showing flow chart for distribution of imported lime (mostly granulated and a bit of liquid lime)



- **Local manufacturers** mainly produce powdered lime for local consumption and directly sell to select large farmers. There has been a growth of several more producers beyond just ARM and Homa Lime, such as Maisha, Minjinku, and Unique Mining Ltd, who have increased the local production of lime. However, as shown in Figure 4, ARM and Homa Lime remain the most dominant players with a ~74% market share.

Figure 4: Kenya lime market share[27]

Supplier	Amount of Reserves	Type of lime produced	Main Target Regions and crops	Estimated market share
Athi River Mining Ltd	• Unspecified	• Powdered • Blended – Through partnerships with Mavuno Fertilizers	• Central – With a primary focus on coffee farmers • Rift Valley – Focus on coffee and maize	• 35% - 42%
Homa Lime Ltd	• 65M surveyed and; • 20M unsurvey	• Powdered	• Lake Region – Focus on sugarcane and maize • Western – Focus on maize • Rift Valley – Focus on coffee and maize	• 27% - 32%
Others	• Unspecified	• Powdered • Granulated • Blended • Liquid	• National market	• 26% - 38%

- **Importers** mainly focus on bringing in granulated and liquid lime that is directly issued to exclusive distributors, blended fertilizer manufacturers, or large specialty farmers. Granulated lime is mainly imported by players such as Omya, Yara, Lachlan, Syngenta, etc.

[27] Expert interviews

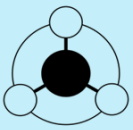
They either sell it in prill form or offer it as a raw material to blended fertilizer manufacturers. On the other hand, imported liquid lime is brought in by players such as Cosmocell, Nutrien, and Dudu Tech.

- **Governments and Farmer Based Organizations (FBOs)** are key buyers of powdered lime from local manufacturers. Their main value proposition is that they purchase lime in bulk on behalf of smallholder farmers and offer it at subsidized prices or on credit, which helps increase lime uptake.
- **Distributors** typically have exclusive rights to distribute and promote ag-lime brands from importers or local manufacturers with an agreement to serve a specific region**.** There are currently estimated to be ~ 250 to ~350 distributors across the country which is a significant increase from the ~20 distributors in the early 2000's Additional competition has only marginally driven down costs, likely due to the bulkiness and quality f lime required. .
- **Wholesalers** procure lime from distributors and oversee smaller regions. Typically have warehouse services that break the commodity into smaller quantities for purchase and bring them closer to stockists for further purchase.
- **Stockists** are the smallest point of sale for lime. They procure from wholesalers and are the closest to farmers as they break down lime to affordable farmer quantities. There is an estimated ~ 2,000 to ~4,000 stockists across the country with significant variation mainly because they open up stores seasonally across different regions based on demand.

Varying degrees of challenges in demand, supply, and the enabling environment are constraints for the growth of the lime industry. Our assessment focused on the supply chain while also understanding the interconnectedness between demand and supply of lime cannot be overstated. Addressing demand challenges will therefore be a prerequisite to unlocking growth with the supply chain of lime. The supply chain has processors facing sub-optimal and seasonal production challenges; distributors incur significantly high distribution costs and lack of adequate and efficient storage facilities due to bulkiness and dustiness of lime. Lastly, there is no strong policy initiative from the government for lime as compared to fertilizer, with most initiatives driving up lime uptake done by NGOs and the private sector. Financing is also a significant barrier, with high interest rates and long-term due diligence processes impeding fundraising.

Figure 5 below shows a summary of the constraints in the three-tier framework

Figure 5: Summary constraints for Kenya

Binding constraints	Rationale
Demand 	• **Limited demand is the key binding constraint** to the supply of lime in Kenya. This limited demand is driven by two main key factors: – Prohibitive costs of lime due to high logistics cost of distribution and storage – Lack of awareness of timing, quantity, application method and yield response of lime
Supply 	• **Manufacturing is complex** due to unutilized capacity and surges in demand mainly due to: – Seasonality of demand as most of the lime is purchased during the rainy season at point of planting – Lack of adequate demand from farmers despite having adequate machinery for production • **There is inconsistency in the availability, price and quality of lime** across different distributors mains due to: – No price regulation across an extremely margin sensitive distribution chain – No quality regulation for the standard of lime produced – Lack of availability in some areas due to bulkiness of lime needing too much space and dustiness in the storage spaces
Enabling environment 	• **Unregulated standards for lime production, distribution and sales** has led to the proliferation of inconsistent quality in the market • **Incoherent tax policy** that drives up cost of machinery for lime and cost of imported granulated lime • **Investments from traditional lenders are not suitable** for the lime sector due to: – Most financial institutions having high interest rates at >14% – Slow to release capital for lime capex due to long due diligence processes • **Inappropriate use of lime due to unharmonized, multiple and conflicting sources of information** on soil acidity and the appropriate benefits and use of lime

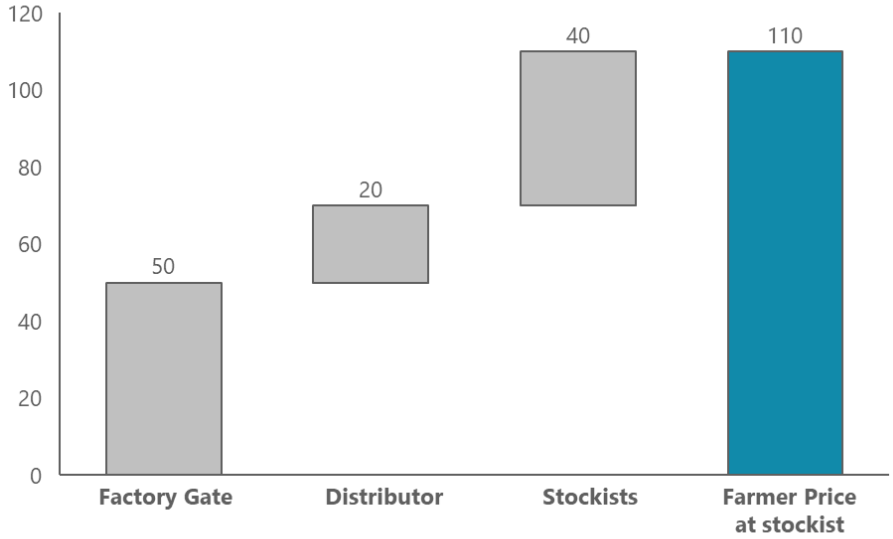
Demand side challenges

The low uptake of lime is primarily driven by the high cost of lime caused by high markups in the distribution chain and high transport costs.[28] As shown in Figure *6* [29] [30], despite the factory gate price of lime being USD 40 to USD 60 per tonne, the final cost of lime is ~USD 100 to USD 120 per ton at farm gate. This is unaffordable for smallholder farmers, who have a median monthly income of USD 124.[31] [32]

[28] Improving financial inclusion through data for smallholder farmers in Kenya pg. 9
[29] Lime valued provided here are based on expert interviews that triangulate average prices. Costs for distribution and stockists greatly vary based on the distance that the lime is transported with high distances leading to higher final costs
[30] Transport costs averaged based on actual factory gate versus final costs for Homa Lime - powdered lime
[31] Expert interviews
[32] Comparative analysis of smallholder farmers in Kenyan, Zambia and Tanzania, pg. 19

Figure 6: Cost breakdown of lime from production to end consumer

Price of local powdered lime (USD per tonne)[12]



Price range	USD 40 – 60	USD 50 - 80	USD 100 – 120
Main sales	Large and medium Farmers	Large and medium farmer	Small holder farmers

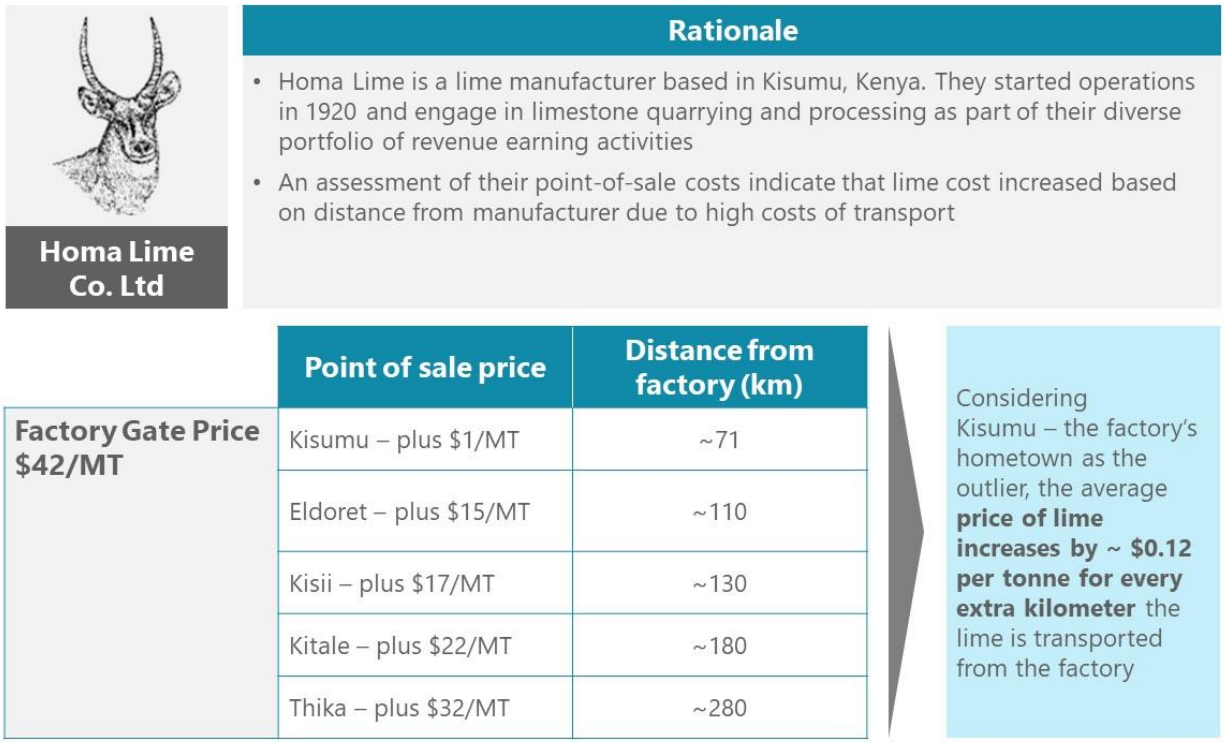
The final cost of lime is driven by:

- **Markups across different points in the distribution chain which unpredictably drive up the price of lime**. At each level of the distribution chain, players will add the logistics cost of transport and storage to their purchase price and markup of approximately between 10% to 12%. Storage costs can be quite significant especially for distributors or Governments or Farmer based organizations who buy in bulk but often, due to lower than predicted demand, have to store unutilized lime supply for the following season.[33] In addition, though markups added are not excessive, they are not regulated and vary greatly across different players who allocate prices based on their own preferences, leading to unpredictability in the pricing of lime

- **The transport costs of lime increase by USD 0.12 per ton for every extra Km[34].** As shown in Figure 7, transport costs often vary depending on the state of road infrastructure across different locations. The additional transport costs incurred by distributors are passed on to farmers driving up the final price of lime.

[33] Expert interview
[34] Homa Lime ltd price distance and price comparison

Figure 7: Homa Lime Case Study in transport price case study



Source: Dalberg Analysis, Stakeholder interviews

Smallholder farmers may also have to incur additional transport costs of lime for last-mile delivery, over and above the price of lime paid to stockists. 30% of farmers surveyed indicated that the additional costs of last-mile delivery are a key barrier to adoption.[35] Stockists prefer to only stock a limited amount of lime based on guaranteed orders they can fulfill due to the lack of adequate storage space and the dusty nature of lime that blows onto other products in storage. Considering the final end cost of powdered lime is between ~USD 100 to ~USD 120, due to the added markup and transport and storage costs, lime would have to lead an increase maize yield by an extra 7-8Kg per acre and increase in coffee by an extra ~1Kg per acre to break even as shown in Table 2 below.

Table 2: Breakeven additional yield needed for lime using farmers[36]

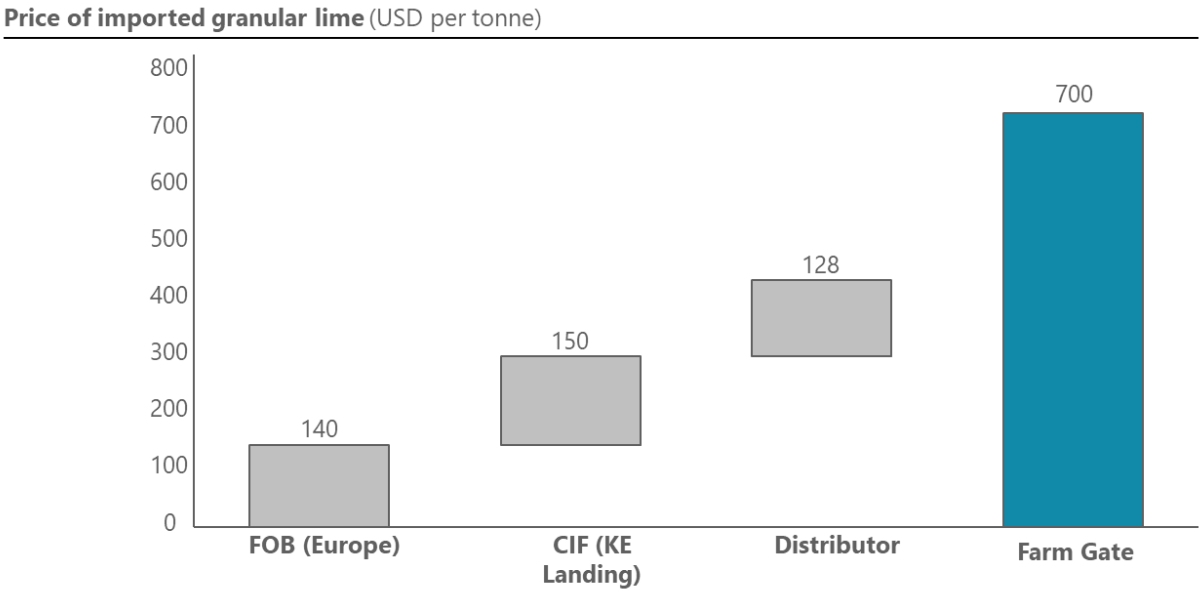
	Lime needed per acre (Tonnes)	Cost of lime needed (Assume 3T per acre)	Average price of per Kg	Breakeven additional quantity per acre
Maize	2 - 4	KES 300	KES 90	~ 8.0 Kg
Coffee	2 - 4	KES 300	KES 240	~1.0 Kg

Despite the prohibitive cost of powdered lime, it remains cheaper than imported granulated lime, as shown in

[35] Economics of granulated lime report – pg. 48
[36] Coffee Farmer eye higher earnings as yield doubles, Business Daily, 2021; Maize Prices Rise after tightening of Import conditions, Business Daily, 2021

Figure 8[37]. The final gate price of imported granulated lime is between USD 680 – USD 720 per tonne compared to locally produced powdered lime, which is between USD 100 to USD 120 per tonne. However, it is worth noting that a lower quantity of granulated lime is required per acre as it is more effective than powdered lime. The decrease in quantity required does drives down the cost of granulated lime needed per acre, though it remains more expensive than powdered lime.

Figure 8: Price of imported granulated lime



	FOB (Europe)	CIF (KE Landing)	Distributor	Farm Gate
Price range	USD 110 – 170	USD 270 - 310	USD 400 – 435	USD 680 – 720
Main sales	Large and medium farmers	Large and medium farmer	Large and medium farmer	Large and medium farmer

Due to granulated lime being more expensive, it is primarily used by medium and large-scale commercial farmers; demand for granulated lime is currently estimated at only 4,000[38] metric tons per annum. In addition to being sold as prills, Granulated lime is also sold as a raw material for fertilizer blends. This method enables the use of the more established fertilizer value chain to target increased liming uptake amongst commercial farmers.

Lack of awareness on the quantity required, application time and method, and yield response for lime further limit demand. According to the Kenya Market Trust (KMT) survey that interviewed more than 50,000 farmers across four counties in 2020, only 59% of surveyed farmers were aware of lime[39]. Lack of awareness has led to slow uptake and poor liming practices resulting in insufficient improvement in crop yield, further discouraging farmers from purchasing lime in subsequent years. Prevalent poor liming practices compared to best practices are further detailed in Figure 9.

[37] Data based on interviews with importer of granulated lime
[38] Economics of granulated lime report – pg. 58
[39] Economics of granulated lime report – pg. 47

Figure 9: Summary of current practices vs. recommended practice on liming in Kenya

	Current practices	Best Case Practice
Timing	• Predominantly applied by farmers at date of planting which leads to high demand for lime during rainy season	• Preferred application at least one to two months before planting
Quantity	• Depends on the crop variety selected, soil test results and composition of CaCO3 in the lime being used. • However. farmers do not typically pay for soil tests or have specific data on the composition of their lime	• Soil test done by farmer to understand their soil health and PH levels • Understand the composition of the lime being used with a focus on the % of CaCO3
Application method	• Lime is applied at the specific point of planting	• Lime should be spread across the whole farm
Yield Response	• No recording or monitoring is done to understand the difference in yield from lime application	• Active record keeping of lime amounts applied and the subsequent effect on yield

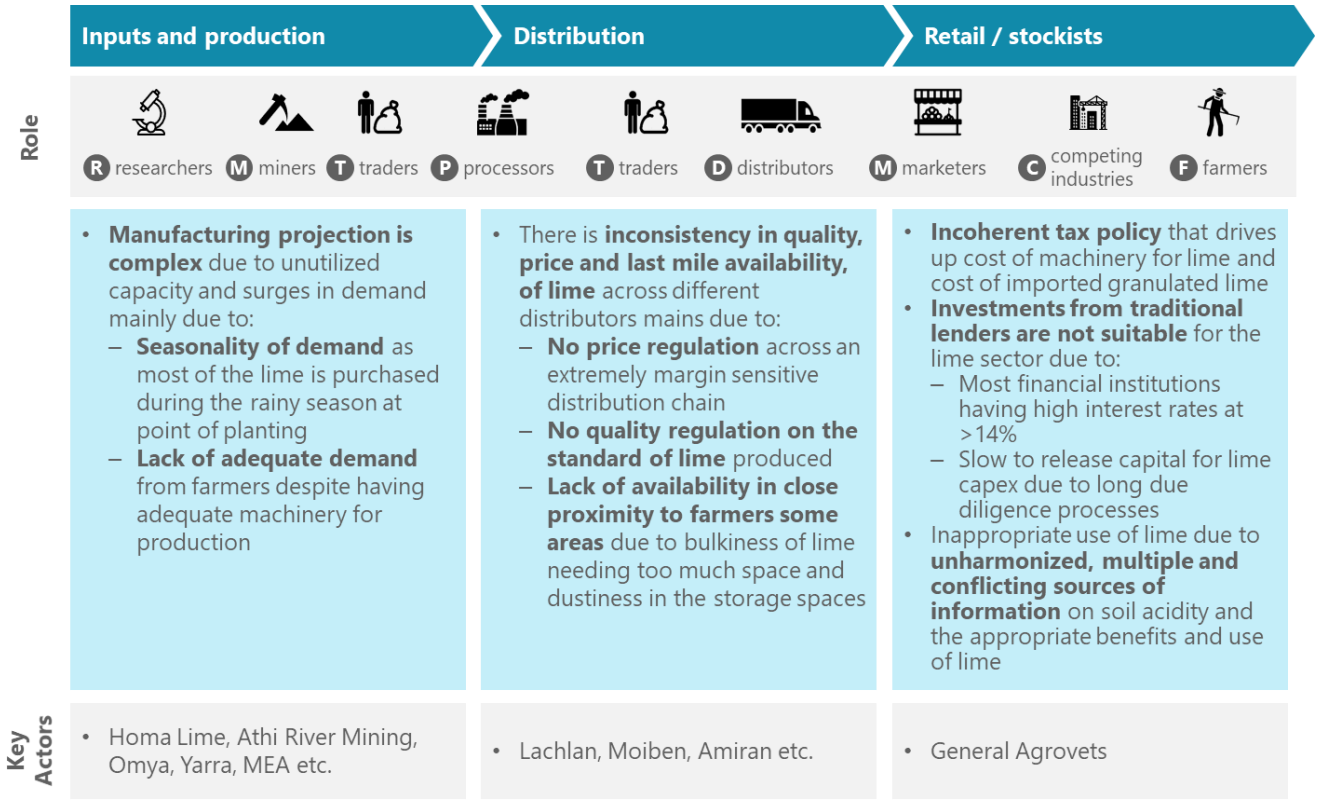
- Most farmers predominantly apply lime during planting. This is contrary to best practice, which recommends applying lime at least one to two months before planting.
- Determining the right quantity of lime to apply depends on soil test results and the type of crop selected for planting. Soil test results can indicate soil texture, the soil's pH level, and soil components that determine both the quantity and type of lime most suitable for the farm. Different crops' optimal pH levels for growth also determine the appropriate quantity of lime to be applied to help soil reach the best pH. However, smallholder farmers typically do not conduct soil testing due to price constraints- a single sample costs between USD 25 – USD 50[40].
- How and where lime is applied is critical to its optimal use. Currently, most farmers apply lime only at the point of planting through micro-dosing. Best practice, however, recommends that lime is spread across the entire farm for longer-term reduction in soil acidity.
- There is no consistent tracking and monitoring to help farmers understand the resulting increase in yield from best practice liming practices. Records on the mesh of lime used, the calcium carbonate content of the lime, the amount applied, and the number of lime applications are needed to understand the effect of lime on crop yield. Farmers lack the capacity to maintain records over two to four years resulting in a limited understanding of ROI, resulting in lower uptake of lime.

Supply side challenges

The lime sector also faces different challenges across the supply chain in input, production, and distribution, as summarized in Figure 9.

[40] Expert interview

Figure 9: Summary of supply side challenges



Input and Production Challenges

Limited storage capacity affects the manufacturer's ability to produce lime on demand and achieve effective capacity utilization. Lime manufacturers are not willing to invest in additional storage capacity due to a lack of demand. In addition, the seasonality of demand leads to underutilized capacity of plants during low demand season and surge capacity during high demand season. Idle production capacity results in reduced income and potential loss of profit, thereby limiting the appetite to further invest in production for improved quality or reduce costs.

Manufacturers and distributors are not willing to invest in storage solutions due to lack of demand. Increased storage could facilitate demand and supply. However, the bulky and dusty nature of lime requires large storage facilities. Distributors and stockists have limited appetite to invest in increased storage capacity until they are convinced of an increase in demand and hence, guaranteed offtake of the stored lime.

Manufacturing, distribution & retail challenges

The inconsistent quality of lime makes it difficult to ensure the efficacy of lime. Manufacturers and distributors are not required to list the components within each lime bag by the Kenya Bureau of Standards (KEBS) or as per any policy from the Ministry of Agriculture (MoA). This results in an inconsistent quality of lime, with different amounts of calcium carbonate and trace elements. This lack of consistency makes it difficult to ensure the quality of lime and thereby measure its effect on reducing soil acidity across different soils. There is also the risk that additional cost incurred by manufacturers in labelling and ensuring quality standards will be passed on to farmers, further increasing the price of lime.

Last-mile availability of lime also varies across different parts of the country, limiting broader access to lime. 30% of farmers reference lack of access to lime as a key barrier to adoption.[41] Despite having an extensive distribution of network for lime across the most soil acidic regions, last-mile proximity to smallholder farmers remains a challenge. As noted earlier, distributors and stockists are unwilling to invest in additional facilities (for example, storage) closer to farmers due to poor rural/last mile road infrastructure resulting in increased transportation costs and limited and fluctuating demand.

Markups are unregulated, and hence, the price of lime remains variable across the distribution chain. Typically, there is an expected markup across the distribution chain of 10% - 12%, in addition to the logistics cost of transport and storage. However, different actors in the value chain often add variable markups, making it difficult for farmers to budget accurately or afford the end cost of lime.

[41] Economics of granulated lime – pg. 48

III. CHALLENGES IN THE ENABLING ECOSYSTEM

While low demand remains the biggest constraint to the supply of lime, the current regulatory and macro-economic environment poses additional specific challenges that limit growth of the sector.

Currently, the Government does not offer tax exemptions for lime products, unlike fertilizer which has specific tax codes that reduce its price, thereby increasing uptake. Powdered lime produced locally is subject to VAT duty, and local lime producers and distributors are subject to standard corporate taxation. Imported granulated lime has a 10% import duty, and an additional 16% VAT levied on the final price, significantly increasing the overall cost of the lime. In contrast, imported fertilizer has tax exemptions.

There is, however, tax exemption on the import of machinery used in the manufacture of local agricultural inputs. This includes lime equipment required for the expansion of local production of both granulated and powdered lime.

Multiple and often conflicting sources of information on soil test results lead to confusion on soil health. For example, the different actors who conduct soil tests, such as CropNuts, KALRO, AgoCares, and SoilCares[42], each base their analysis on different soil maps and testing methods as shown in the case study in Figure 10. As a result, farmers get different soil health reports, depending on which soil test provider they use, leading to a lack of clarity on the correct remedy to address soil acidity.

Figure 10: Case Study of AgroCares Soil testing[43]

Lack of authoritative information leads to poor liming practices by farmers that limit the effectiveness of lime. Lime application practices are unharmonized with no authoritative source on the best practice application methods nor the benefits of lime. Developing a definitive guide on liming is further complicated by inconsistencies in the quality of lime. As a result, it is difficult to

[42] Expert interview
[43] ICT Update Issue 89, Data4Ag: New Opportunities for Organized Smallholder Farmers, 2018

define or predict the impact of lime on crop yield. Government-backed research institutions such as KALRO, NGOs such as One Acre Fund, and private sector actors such as Cropnuts are working to bridge this gap and have published articles that outline best practice lime application methods, but no uniform guides on liming have yet been developed.

High interest rates and long due diligence limit access to patient capital required to ensure uniform lime quality and grow supply and demand. Limited access to suitable capital across the supply and demand chain has hindered the growth of the lime sector:

- **For manufacturing:** capital required for setting up greenfield or brownfield lime production facilities close to demand areas attracts more than 14% interest rate from traditional banking institutions. These rates are prohibitive to both local and international entrepreneurs looking to use local debt to improve the quality of lime and reduce the cost of production through scaling.
- **For stockists and distributors:** additional capital needs to grow storage capacity has been identified. However, there is hesitancy to invest in this as it needs to match up with growing demand. Current sources of capital with high interest rates and immediate interest payments with no grace periods are not patient enough to allow them to recoup returns and make interest payments sustainably
- **For farmers:** there is a preference to purchase inputs on credit due to cashflow constraints faces particularly by a majority of small holder farmers. The One Acre Fund has driven pilot programs offering credit facilities to farmers with up to 9 month repayment periods but high interest rate payments over the long term still make lime unaffordable to smallholder farmers[44]

[44] Expert interviews

IV. RECOMMENDATIONS TO ADDRESS THE GAPS AND ADVANCE THE SUPPLY OF LIME

An in-depth understanding of the demand, supply side, and enabling environment challenges in the lime sectors forms a sound basis for recommendations to grow the industry. The interventions must be specific for each phase of the supply chain and detail the required stakeholders across both the public and private sector to be consulted and to implement the proposed interventions.

Figure 11 Synthesis of opportunities addressing lime supply in Kenya

Binding constraints	Challenges	Opportunities
Demand 	• **Demand remains minimal** due to **prohibitive cost and lack of awareness**	• **Provision of subsidies** to increase demand for lime • Targeted **education prioritizing farmers in the soil acidic regions** on benefits and best practice of lime to increase demand
Supply 	• **Unutilized capacity and fluctuating manufacturing capacity** due to seasonal and low demand • **Inconsistency in the availability, price and quality of lime**	• Investment in local production of granulated lime as a premium product • Use of digitization to have more direct distribution from importers/manufacturers and farmers to Reduce cost and Increase data • **Increase in blended fertilizer sales** to leverage existing fertilizer value chains for uptake of lime • Installation of **modular storage containers with stockists to increase shelf space and accessibility** for bulky and dusty lime
Enabling environment 	• **Incoherent tax policy** that drives up cost of machinery for lime and cost of imported granulated lime • Investments from traditional lenders are not suitable for the lime sector due to **high interest and long lead times** • **Inappropriate use of lime** due to unharmonized, multiple and conflicting sources of information	• **Co-development of regulation on quality, price and use of lime** with all industry stakeholders • **Mezzanine financing options for the lime sector** with concessional debt options • **Revision of tax policy** to have exemptions for local producers and distributors to reduce lime cost and encourage local production of granulated lime for premium use

Demand side opportunities

Our research revealed that **lack of demand for lime is driven by a core set of interconnected factors,** including prohibitive lime prices caused by high transportation cost and lack of awareness on the timing, quantity, application method, and yield response times of lime. Some proposed key interventions to address these challenges can help unlock demand for lime and, in turn, solve for the supply side challenges

1. **Targeted awareness drives in highly soil acidic regions are required to increase demand**
   Prioritizing farmer education programs in highly soil acidic regions to raise awareness on the benefits of lime. Education programs could be funded by either Government, NGOs, and private sector CSR initiatives through extension officers trusted by farmers and farmer-based organizations. It can be focused on raising awareness on:
   - **Best practice on liming** focused on- the timing of lime application to be at least one to two months before planting; quantity of application based on soil test and

crop to be planted; application method based on lime spreading and mechanization; and measuring yield response to lime over time to accurately predict and raise awareness of the ROI of lime.

- **The benefits of lime beyond just emphasis on increasing soil PH[45].** For example, including details on the additionality of lime- lowers toxic levels of aluminum and manganese, increases soil microbial activity through decomposition, overcomes the potential for calcium deficiency, increases symbiotic nitrogen fixation in legumes, increases the availability of phosphorus and molybdenum, and improves water retention in the soil.

2. **Provision of subsidies to reduce the price of lime and drive demand**
   Subsides from either government or NGO's can help to reduce the end cost of lime and thereby increase uptake. The effectiveness of subsidies in driving up demand is dependent on where the subsidy is issued as detailed below and in Table 1;
   - **Manufacturing** - to manufacturers who can then sell the lime at a lower cost from the factory grate. This is expected to lead to lower trickle-down prices for farmers. The subsidies can also be based on the results of their lime use, e.g., payments based on how much was the soil PH changed. However, there is a risk that subsidies issued to manufacturers do not trickle down to the farmer as other players in the distribution chain add higher markups.
   - **Distributors, retailers, and stockists -** Issuing of subsidies to lower last-mile distribution costs. However, distributors, retailers, and stockists may not tax registered and therefore are ineligible for subsidies
   - **Farmers -** Provision of direct subsidies to farmers or concessional credit terms from government or Farmer Based organizations. However, lower prices can lead to a sudden increase in demand that the supply chain may find hard to meet. This can lead to an increase in the price of lime. In addition, farmers may get used to subsidized rates and be unwilling to pay for lime once subsidies are rolled back

Table 3: Subsidy considerations across the supply and demand chain

Subsidy point	Description	Risks	Risk Mitigation
Manufacturing	• Issuing of subsidies to manufacturers who can then sell the lime at lower costs from the factory gate • This is **expected to lead to a lower trickle-down price that gets lime to farmers cheaply** • Alternatively, manufacturers can also be **issued with a subsidy based on the results of their lime use,** e.g., how much was the soil PH changed based on the lime	• The **subsidy issued to manufacturers does not trickle down to the farmer** as other players in the distribution chain add higher mark-ups	• Add a **price ceiling to factory gate prices,** ensuring that they do not exceed a certain amount • Add a **distribution clause for manufacturers** and **targets for smallholder farmer reach**

[45] Importance of Calcium by Homa Lime Ltd

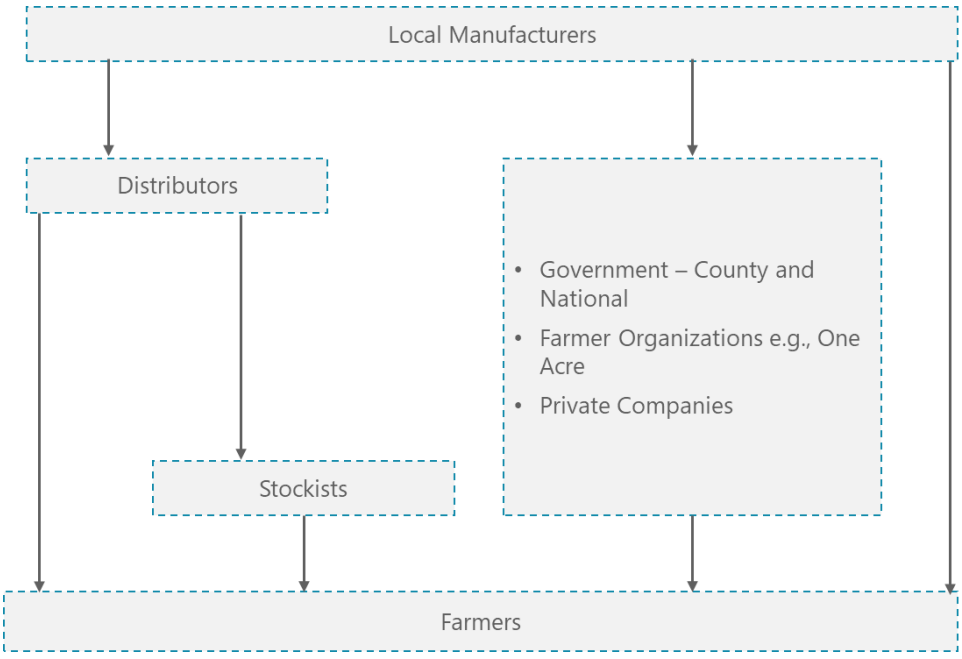
Distribution, Retailer, and stockists	• Issuing of subsidies to distributors, agro-dealers, and village-based associations, particularly those who are closest to farmers or provide last-mile distribution services	• **Several distributors, retailers, and stockists are not tax registered** and therefore cannot be eligible for rolling out government or NGO subsidies	• Encourage registration and formalization of agricultural input distributors and stockists, such as by **offering tax exemptions for new registrants before offering the subsidy**
Farmer	• Provision of **direct subsidies to farmers through voucher systems dependent on soil pH or purchase at lower than market prices** from government or Farmer Based organizations	• Once accustomed to the subsidy, **farmers are not able to transition to higher regular market prices and** therefore **do not purchase lime once subsidies stop**	• **Careful design of the subsidy** including farmer contribution from the beginning, develop widespread and suitable credit schemes for when the subsidy is stopped

Supply side opportunities

In parallel, supply side actors can explore options for improving the commercial viability of supplying lime through partnerships and optimization at the level of quality and cost. Given the identified supply side opportunities, interventions should be focused on optimizing an already competitive distribution channel, leveraging partnerships with existent manufacturers for value-added products and additional distribution channels

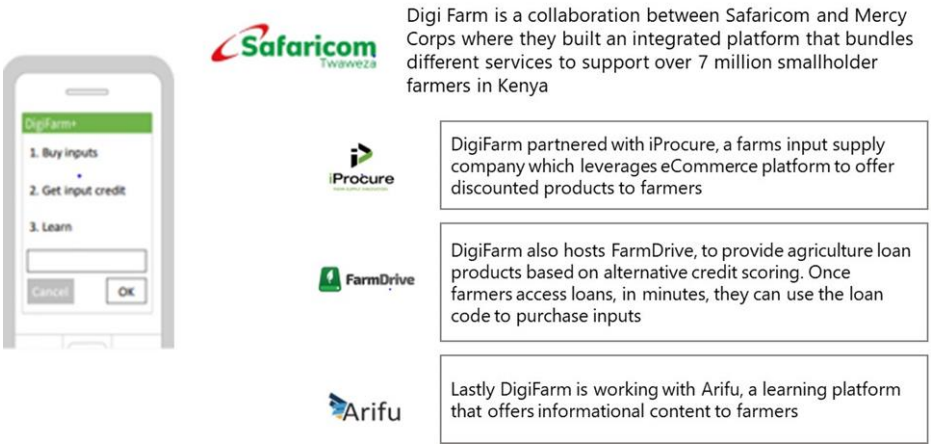
1. **Introduction of digital services that integrate the distribution chain to reduce the cost of lime and acquire more data to drive up demand**
   Downward vertical integration can lead to lower prices and more data-centric decision-making. As shown by Figure 12 below, new importers and local manufactures are working to integrate further downwards and sell directly to farmers using mobile phone technology.

Figure 12: Lime distribution chain



Manufacturers, importers, and distributors directly sell to farmers and collect key data points such as name, location, amount of lime purchased that can be used to project demand in the upcoming year directly. Stockists are used as final points of sale for pick-up of items and paid a commission for sales, with no marketing expected. This trend is expected to grow as distributors, importers, and local manufacturers look to cut out middlemen and offer cheaper lime while also considering the margin sensitivity of lime. An example case study of such a product has been Digifarm which has ben used to directly offers bundled products to farmers that include inputs directly from suppliers as shown by Figure 10.

Figure 11: Digifarm case study for digitized direct distribution channels[46]



2. **Investment in the installation of lower-cost storage refurbished shipping containers to add space and manage dustiness for wholesalers and stockists.** Less expensive, refurbished containers can be installed next to stockists, wholesalers, and distributors to increase their storage space, manage the dustiness for lime and protect it from rain or wind elements for longer-term storage without interfering with other items in stock

3. **Leverage established fertilizer distribution chain through the sale of blended fertilizer.** Current blended fertilizer manufactures have the capacity to produce for additional demand: they have production capacity of 150,000 MT per year and are only producing 50,000MT per year. Blended fertilizer has the key advantage of being sold as a single product with both fertilizer and lime components. This allows for lime to piggyback on established fertilizer demand and distribution chains. It is important to note that the use of fertilizer blends may not reverse the soil pH for acidic points but only maintain the pH level.

4. **As the lime sector continues to grow there is a mid to long term opportunity for local manufacturing of granulated lime for premium use amongst medium to large scale farmers.**

[46] Mercy Corps, AgriFin Digital Agriculture Platforms BluePrint, 2020

- Demand for imported granulated lime is estimated at 4,000 MT[47] annually, and this is estimated to grow as overall lime demand increases in the country, even though it will only account for a small percentage of overall sales
- Demand for granulated lime will however be restricted to specialized farmers who are typically medium to large size farmers. It will not act as a substitute to powdered lime amongst small holder farmers as granulated lime, even if produced locally and less quantity per acre is needed, would still be unaffordable compared to powdered lime which retails at USD 100 – 120 per tonne farm gate price
- Compared to powdered lime, granulated lime has the following key benefits[48]- (i) ease of handling and use as granules are often dry and compact, odorless thus less offensive during application; (ii) convenient transportation and storage as granulated fertilizer is less bulky and industry, easier to package and store due to reduced moisture absorption; (iii) less harmful to soils as heating often kills pathogens and foreign matter so that the resultant granules are cleaner; (iv) enables compounding to create a multi-nutrient fertilizer (compound fertilizers); (v) easier to mechanize application
- Overall demand for lime in the three most soil acidic regions is currently estimated at ~ 187,000 MT and is expected to grow to 532,000MT in the next ten years[49]. Local powdered lime manufacturers can tap into this growing demand by offering powdered lime to most price-sensitive farmers and providing granulated lime as a value-added product for commercial farmers. Local production would also reduce the cost of granulated lime, potentially making it affordable to a broader base of mostly large and medium sized farmers.
- Local production of granulated lime, as a substitute to imports, would however be a mid to long term opportunity dependent on pace of growth and maturity of the lime sector in the next 5 to 10 years.

It is important to note that there is likely to be a limited desire to invest in solving supply-side challenges without increased demand. For example, the ability to integrate downwards, invest in additional storage space, or investing in value-added products such as blended fertilizer or granulated lime is only viable if there is sufficient demand for lime.

Enabling environment opportunities

Identifying appropriate pathways towards commercial viability requires addressing the gaps in access to finance and policy. Complementary interventions to improve access to finance and the policy environment and demand and supply side interventions are key to growing the lime sector. Some initiatives to be considered are:

1. **Co-creation of regulation on quality standards, best practice and tax policy with all industry stakeholders**
    - **Quality standardization**- Agreement between the government and private sector actors on the quality standards required for lime manufacturing, distribution, and

[47] Economics of granulated lime pg. 11
[48] Economics of granulated lime pg. 23
[49] Economics of granulated lime pg. 55

sales. This should include clear labeling standards that detail the components of calcium carbonate and trace elements across each lime bag

- **Best practice -** Creation of a uniform source of information that provided accurate and consistent quality soil tests across different service providers and establishing liming best practice on the timing, quantity, application method, and yield response times.
- **Tax policy revision -** Consideration of tax incentives for new and existing lime producers and distributors to reduce the final cost of lime and encourage local production of granulated lime.

2. **Access to patient capital and mezzanine financing that matches impact and financial return incentives across the supply chain and demand.**
    - **For manufacturers, stockists and distributors:** Partnerships between traditional banking institutions, NGO's and private investors to provide either guaranteed loans or mezzanine financing at cheaper rates would encourage more investment into storage facilities. Lower interest rates and grace periods would allows for demand uptake to increase slowly without considerable strain to settle interest obligations in the immediate term for storage or machinery investments. Further investment by NGO's or Government agencies into publicly available investment reports that project the profitability of lime would also encourage faster release of funds from banking instructions or foreign investors**.**
    - **For farmers:** Provide additional access to more patient capital that allows for long credit terms that match the effectivity period of lime and also have low interest rates for farmer payback is manageable over longer periods. This can be done through partnerships with the government financials agencies such as the Agricultural Finance Cooperation and the One Acre Fund. Their cooperation with farmer-based organizations can help increase community awareness as well as leverage social group networks to ensure high rates of repayment on any credit.

A coordinated government effort that prioritizes soil acidity as a critical issue and private sector engagement is key to creating a robust enabling environment for lime. Beyond the challenges laid out, governments need to work with other stakeholders to put in place the appropriate investments, fiscal incentives such as feed and tax breaks, as well as quality standardizations, demonstrate. Brazil is an inspirational example of how they were able to address soil acidity and turn the country's most infertile land into its breadbasket[50].

[50] Source: Infrastructure and Conservation Policy in Brazil; Land-use trends and environmental governance policies in Brazil; The Economist: Miracle of the Cerrado; Ethiopian Agricultural Transformation Agency (ATA), 2016

Figures 13: Case study on Cerrado Region (Brazil)

The private sector can also work to implement select initiatives alongside government efforts to strengthen the lime supply chain and increase demand. We envision the private sector filling this role in five main ways: as a convener, policy supporter, knowledge developer, innovators, market grower.

Figure 14: Five roles the private sector can play to strengthen the lime sector

- **Convenor:** The private sector can act as a key player in bringing together all players across the supply and demand chain who work in the lime sector. This co-operation is needed to ensure assets, knowledge and resources are efficiently exchanged between both the public

and private sector. For example, the sharing of storage facilities between different players could offer a chance for mutual collaboration that brings inputs to closer proximity to farmers and required less investment through shared obligation.

- **Policy Supporter:** The private sector can help to set up relevant policies to govern the lime sector as there are currently no regulations on lime in Kenya. Such co-operation on policy will lead to standardization of the quality of lime and collaboration in spreading any relevant information from the government to all lime players.
- **Knowledge developer:** Different private sector actors have information on soil acidity mapping and liming best practices on quantity timing and yield response for lime that can help grow the lime industry further. More independent research should be funded to develop this knowledge and publicly share any information that is not intellectual property.
- **The deal maker and innovator:** The private sector should work to spear head collaboration with different financing partners to drive innovation across the lime sector. For example, funding of lime spreader machinery innovation accessible to small holder farmers, digital innovation that help track farmer data on liming use and refurbished storage units to increase space for stockists and distributors are key points the private sector is innovations already in the pipeline.
- **Market Growers:** Alongside other government awareness initiatives, the private sector should continue funding awareness campaigns. This can be done through set up of demonstration farms and privately sponsored campaigns to target farmer-based organizations with best practice information on liming.

The GAIA Project is well placed to guide and manage the lime ecosystem and generate the knowledge required. Alongside several other work packages the project can play a central role as a technical expert on soil acidity, undertaking several studies around acidity improving liming practices` across East Africa. Further, the project through its various wok packages has forged strong relationships with in-country public or private implementing partners. This positions the institution as the potential liaison between the external ecosystem and the in-country lime stakeholders who can facilitate the exchange of information, technical expertise, and financial support.

V. NEXT STEPS

This study focused on identifying the critical challenges in the supply side and identifying opportunities to address the challenges. Our analysis revealed that the lack of awareness and the high cost of lime are the core factors determining the low demand for lime. Lack of demand is the key binding constraint to the supply of lime, but there are however interlinked supply and enabling environment policy and financial challenges that cause further limits on uptake of lime.

As a first step, we recommend that stakeholders discuss and align on the outputs of all work packages. Besides our work package, GAIA has commissioned different work packages focuses on i) alternative investments in soil acidity, ii) incentives to adopt soil management, iii) knowledge gaps on the impact of lime, iv) policies to support investment, v) multistakeholder collaboration, vi) access and use of data, etc. Consolidating output from these work packages will be the aim of the national investment plan, with a draft to be delivered in the first quarter of 2022 and by engaging with different work packages, the involved teams will ensure an adequate understanding of the core challenges and interlinkages between demand, supply, and policy. This will enable stakeholders to align and collaborate and develop tailored solutions. This is the first step to understanding the building blocks of a national investment plan.

There is a need to build commitment to increase resource allocation to the sector- to improve demand and supply (capacity-building, etc.) to enable liming to deliver clear results, outcomes at a grassroots level. The Ministry of Agriculture will need to be included as a primary driver for stakeholder conversations with all industry actors to drive alignment and commitment.

As noted in this report, this requires supportive policies, informed by a diagnosis of the current situation and relevant financing mechanisms to enable private sector investment to achieve sustainability and growth in the sector. Based on our findings on the supply side, the specific technical areas required to achieve growth of liming include:

- **Targeted education drives in the most soil acidic regions**. This can be driven by extension services funded by both count and national government actors and private sector actors such as One Acre Fund
- **Government and private sector coordination of soil map databases and best practice guides on the use of lime.** Creating a uniform source of information on soil maps and liming best practices by research institutions such as KALRO and private sector actors such as One Acre Fund and Cropnuts would help streamline information in the sector. This will provide accurate and matching quality soil tests across different players and establish liming best practices on the timing, quantity, application method, and yield response
- **Supportive policy and regulatory environment** to encourage investment in lime through:
    - Standardizing the quality of lime to ensure consistency in the product across the country
    - Tax revisions that reduce the cost of production and distribution of lime and encourage promote local production of lime products
- **Provision of subsidies to reduce the price of lime and drive-up demand.** Subsidies offer an excellent opportunity to make lime more affordable to several farmers. Further research is needed to understand what point of the supply or demand chain best provides maximum ROI on subsidies

- **Providing suitable finance to promote the growth of the lime industry, including patient capital and mezzanine finance that matches impact and return incentives.** This finance can be used to provide subsidies or cheaper credit facilities, improve uptake of lime amongst smallholder farmers and fund manufacturers to grow their capacity to match increasing demand.

VI. ANNEX

Stakeholders consulted

Homa Lime Ltd

One Acre Fund

Kenya Markets Trust

Kenya Agriculture and Livestock Research Organization (KALRO)

Hello Tractor

Lachlan

Minjingu Fertilizer

Omya East Africa Ltd

Unique Mining Limited

OCP Kenya

IFDC

Baraka (Toyota Tsusho)

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