Dalberg

East Africa Lime Sector Analysis: Ethiopia

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EXECUTIVE SUMMARY

Soil acidity has critical adverse impacts that impacts Ethiopia's food security, agribusiness potential, and industrialization agenda. Soil acidity reduces yields of major crops such as cereals, including wheat, barley, maize; and of pulses by more than 50%[1]. Indirectly, soil acidity results in yield loss through inefficient input absorption, with an estimated 44% of fertilizers applied to acidic soils lost due to reduced uptake efficiency in crops.[2]

Currently, ~40%[3] of Ethiopia's cultivated land is affected by soil acidity with 28% (3.5 million hectares) identified as highly acidic (less than pH 5.5)[4]. At a regional level, the Amhara (35%), Oromia (60%), and SNNP (72%) regions are severely affected, while the Benishangul-Gumuz, Gambella, and Tigray regions are moderately affected.

Solutions to treat soil acidity remain out of reach for most smallholder farmers. While several solutions to addressing soil acidity exist globally, including Fertilizing Residual Materials (FRMs), oyster shells, acid-tolerant seeds and crop rotation, and wood ashes, differing availability and effectiveness of these solutions in the local context, climate impact, as well as cost factors, limit farmer uptake.

With sufficient reserves, lime is a viable option to address soil acidity in Ethiopia. The Ministry of Mines and Petroleum estimates Ethiopia has more than 900 million metric tons of limestone reserves, spread across various regions. To put in perspective, the 3.5 million hectares of cultivated land identified as highly acidity, would need an average of 7.7 million tons of lime[5] per planting season. Considering the level of acidity and the associated differences in the number of years required for continuous application of lime, the country has sufficient reserves to address soil acidity challenges.[6] While the quality of lime is deemed to be adequate for agriculture, [7] more research is needed to identify the types of available lime (calcitic, dolomite, or blend) to understand the most effective sources.

However, lack of demand is a critical binding constraint to the effective supply of lime. For the past ten years, Ethiopia's government and development partners, specifically GIZ, have been providing lime for free for demonstration purposes in selected regions of the country. This initiative intended to increase awareness and enable farmers to understand and recognize the full benefits of lime, eventually driving up demand and increasing farmers' willingness to pay. Nevertheless, the initiative fell short of its goal- lime awareness is limited to demonstration areas, and as a result, demand for lime remains sub-optimal.

Over and above the lack of demand, several challenges across the value chain affect the quality and availability of lime. At the mining stage of the supply chain, the lack of mechanized excavation and dependency on human labor lowers mining efficiency. At the processing stage, lime crushing is often inefficient due to unreliable electricity resulting in machine downtime, inflating operating expenses. At the distribution stage of the supply chain, transportation costs due to poor road infrastructure account for around 64% of the total cost of lime, making it too expensive for farmers to pay for last-mile delivery[8]. Overall, insufficient evidence of demand means that there is little incentive to address the inefficiencies in the supply chain nor attract private sector participation or investment in the lime sector.

In addition, limited access to finance and policy gaps currently restricted the growth of the lime sector. Financing limitations are prevalent on both the supply and demand sides. On the demand side, the

[1] ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015
[2] MoA, A Policy Document on Acidic Soil Management: Productivity and Economic Benefits of Using Agricultural Lime, 2020
[3] ICRISAT-GIZ, Managing Acid Soils for Reclaiming Livelihoods in Ethiopia, 2019
[4] Ibid
[5] Calculated by multiplying the 3.5 million ha with the average recommended application of ~2.2 tons per ha
[6] Dalberg Analysis of interview insights, 2021
[7] Dalberg Analysis of Interview insights, 2021
[8] According to a 2018 assessment of a GIZ pilot project in these three regions, participating farmers have mentioned they are only willing to pay a price of 80 ETB per 100kgs, which does not include the cost of transportation to plots (last mile). This 80 ETB, according to the study, is a GIZ subsidized price and it is approximately only 40% of the full cost delivered price.

one-year loan repayment period is too short for smallholder farmers in the Amhara region. Unlike fertilizers, much lime is required to rehabilitate acidic soils, and yield improvement outcomes are realized over a two-to-four-year timeframe. On the supply side, fees incurred at each value chain stage, including quarry right-to-use, royalty fees, and value-added taxes, hinder new entrants into the sector. Persistent supply-side challenges limit efficiency gains, ultimately failing to reduce end-user cost. In the enabling environment, the absence of national farmland management policy and regulatory frameworks contribute to convoluted and bureaucratic processes governing rural land administration. The lack of clear and supporting policies affects farmers' demand and willingness to pay for lime. Moreover, the lack of national strategies and governing frameworks prevent the institutionalization of good land management practices. In addition, there is a lack of policies surrounding the coordinated allocation of dedicated power stations, which affects electricity availability for lime processors and stifles the sector's growth. Achieving 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.

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ABBREVIATIONS AND ACRONYMS

ATA	Agricultural Transformation Agency
CIMMYT	International Maize and Wheat Improvement Center
CSR	Corporate Social Responsibility
DA	Development Agents
EIAR	Ethiopian Institute of Agricultural Research
ETB	Ethiopian Birr
EthioSIS	Ethiopian Soil Information System
FRM	Fertilizing Residual Materials
GAIA	Guiding Acid Soil Management Investments in Africa
GIZ	German Agency for International Cooperation
IFPRI	International Food Policy Research Institute
KPIs	Key Performance Indicators
LSS	Lime Supply System
MFIs	Microfinance Institutions
MoA	Ministry of Agriculture
MoFED	Ministry of Finance and Economic Development
PPPs	Public-Private Partnerships
RBoA	Regional Bureau of Agriculture
SNNP	Southern Nations, Nationalities, and Peoples' Region
USD	United States Dollar
VAT	Value Added Tax

I. INTRODUCTION

Ethiopia faces significant and growing challenges with soil acidity, with 43%[9] of agricultural land affected by soil acidity, out of which, 28% is identified as highly acidic with less than pH 5.5. As shown in Table 1, soil acidity is spread across various regions, with ~98%[10] of soil acidity concentrated in Amhara (35% of land area in the region), Oromia (60%), and SNNP (72%). These three regions collectively contribute to an estimated 90%[11] of all grain and cereal production.

Table 1: Magnitude of acidic soils per region

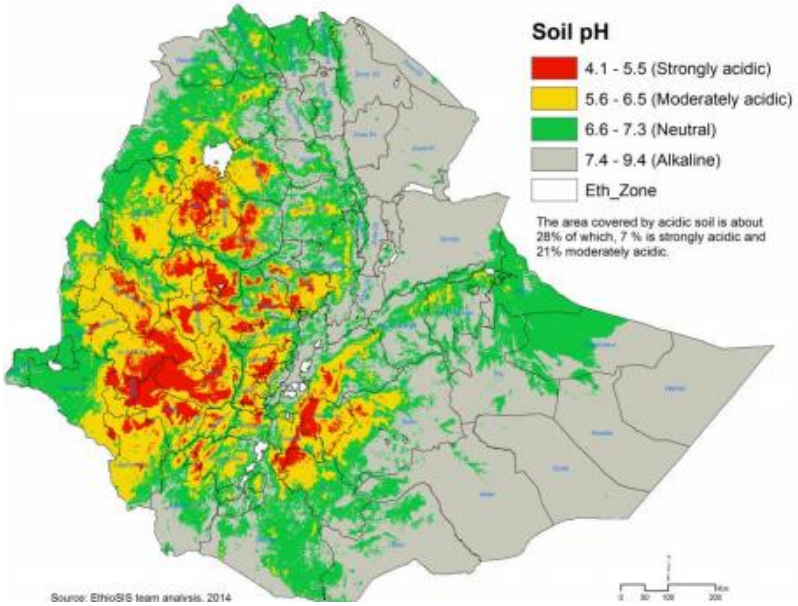
Regional state	Land area affected (ha)	Land area affected (%)	Number of Woredas affected*	Major types of staple crops grown in top 25 woredas[12] (non-exhaustive)
Amhara	1,026,200	35%	55	Wheat, barley, maize, sorghum, teff, chickpea, and sesame
SNNP	1,426,408	72%	103	Coffee and maize
Oromia	3,730,800	60%	179	Coffee, wheat, teff, maize, sorghum, barley, chickpea, and sesame
Tigray	20,000	Na	1	Maize, teff, sorghum, and sesame[3]
Gambella	57,200	Na	5	N/A
Benishangul-Gumuz	82,300	Na	10	N/A
Total	**6,342,908**	-	**355**	

Source: Ministry of Agriculture and Natural Resources, Policy Brief: Unlocking the Potential for Transformational Agriculture Development of Acid Soils in Ethiopia, 2017

Alternating drought and high rainfall have contributed to soil acidity in the highlands through topsoil erosion and organic matter depletion. To better adapt to the increased soil acidity, some farmers in the Oromia region have shifted from higher-value crops to planting acid-tolerant crops such as potato, triticale, wild oats, and eucalyptus.[13] However, farmer yields have remained low even with acid-tolerant crops since creating biomass in acidic conditions is challenging.[14] Farmers' inability to grow higher-value crops on acidic soils, and their lower yields despite their transition to acid-tolerant crops, have negatively affected their sustainability and incomes.

[9] ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015
[10] MoA, Unlocking the Potential for Transformational Agriculture Development of Acid Soils in Ethiopia, 2017
[11] Central Statistical Agency, Agricultural Sample Survey (2014/16): Area and Production of Major Crops, 2015
[12] Research for Ethiopia's Agriculture Policy, Woreda-level Crop Production Rankings in Ethiopia: A Pooled Data Approach, 2015
[13] AgriProFocus Ethiopia, Reflection on Acid Tolerant Crops, 2019
[14] Ibid

Figure 1: Map of acidic soils in Ethiopia[15]



Soil acidity inhibits root growth and nutrient absorption, decreasing crop yield. Soil acidity leads to more than a 50% reduction in crop productivity.[16] For major cereal crops, such as Maize, Teff, and Barley, acidic soils result in a yield per hectare reduction of an estimated 13%, 60%, and 83%.[17]

Among viable solutions available for managing soil acidity, lime is the most effective approach. Alternatives to address soil acidity include Fertilizing Residual Materials (FRMs), vermicompost, acid-tolerant seeds, lime, and wood ash. While all solutions except for acid-tolerant seeds can treat acidic soils with varying neutralizing values, accessibility remains a challenge for most smallholder farmers. Lime is a viable solution compared to alternatives due to its impact on acid soils over a relatively short period of time, in-country availability, and low cost (as a raw material). '

[15] ATA, EthioSIS team analysis, 2014
[16] ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015
[17] Ibid

Table 2: Analysis of solutions for managing soil acidity

Factor	Fertilizing residual materials (FRMs)[18]	Vermicompost[19]	Acid tolerant seeds[20]	Lime[21]	Wood ash[22]
Soil impact	Neutralizes soil acidity over time	Neutralizes soil acidity faster than conventional compost and chemical fertilizers	No neutralizing impact as soil continues to acidify without treatment	Neutralizes soil acidity over time	Neutralizes soil acidity quicker than lime
Availability	Not produced locally or regionally therefore limited access in country	Could be produced at large scale locally - Guder Lime Factor in the Oromia region already has a vermicompost production center – however, on average, amount needed is 5X lime/ha	While some are readily available, such as, potato and wild oats, the type of tritikale prevalent is an imported hybrid cross between wheat and oats	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 and detrimental climate risks associated, it may not be readily available
Cost	High cost due to need for imports	Increased cost due to the need to mix with fertilizer	Relatively inexpensive if produced in-country	Lime is relatively inexpensive (cost of distribution results in high end user prices)	Wood ash is relatively inexpensive
Ability/Ease of use	Easier to use as it is in granulated form	Easy to use as it only requires following the furrow plowed with a line of application	Easy to use compared to soil acidity management methods	Lime in its powder form is difficult to apply to farms as it is easily blown away by wind and requires safety precautions	Wood ash is in powder form, making it difficult to apply to farms as it is easily blown away by wind and requires safety precautions
Climate impact	Relatively ecologically sustainable	Ecologically sustainable	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

From the farmer's perspective, indicates high difficulty/barriers, indicates medium, and little or no difficulty/barriers to implementation

With more than 900[23] million metric tons of limestone reserves spread across various regions, lime has the potential to address Ethiopia's soil acidity challenges. Locations of limestone reserves include Mekele, Abay (Nile) gorge, Butajira, Ogaden, Denakil, Diredawa and Harar areas. Limestone in the country is currently largely utilized by the cement industry and usage remains very nascent in the agricultural sector.

[18] Agro 100, Nutriliming Agents: Agro-100's Nutriliming Agents made from FRMs, 2019; Dalberg analysis of interview insights, 2021

[19] Interview with OCP Ethiopia, 2021; Vermicompost, and Chemical P Fertilizer on Selected Properties of Acidic Soils of Ebantu District, Western Highlands of Ethiopia, 2017; AgriProFocus Ethiopia, Acid Soils Management Training and Visit to Guder Lime Factory, 2019 ; AgriProFocus Ethiopia, Acid Soils Management Field Day in Jeldu, West Shewa Zone, Oromia Region, 2019; Dalberg analysis of interview insights, 2021

[20] AgriProFocus Ethiopia, Reflection on Acid Tolerant Crops, 2019; Dalberg analysis of interview insights, 2021

[21] Dalberg analysis of interview insights, 2021; IFPRI, EIAR, Soil Acidity Problems in Ethiopia: Magnitude, Current Awareness and Practices, and Policy Actions, 2016; IFPRI, EIAR, CIMMYT, A Pilot Program to Rehabilitate and Enhance the Productivity of Acid Soils in Ethiopia, 2018; ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015

[22] UNH Cooperative Extension Programs: Guide to Using Wood Ash as an Agricultural Soil Amendment, 2018; Hindawi, Effects of Lime; Dalberg analysis of interview insights, 2021

[23] Ministry of Mines and Petroleum, Ethiopia Mining Cadastre eGov Portal, 2021

Figure 2: Map of limestone deposits in Ethiopia[24]

The Guiding Acid Soil Management Investment in Africa (GAIA) project is seeking to enhance its contribution to healthier soils and land management towards smallholder enterprises development by developing a clear understanding of the lime sector from all relevant stakeholders while considering the interlinkages of demand, supply, and enabling environments. GAIA, with targeted work packages, plans to address supply and demand side challenges and opportunities that could, in the longer term, inform Ethiopia's national investment plan, thereby playing a critical contributing role in enhancing food security and agricultural economic gains in the country.

This study set out to identify the key challenges on the supply side and identify 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. This study aimed to answer the following questions:

- What are the key binding constraints to the effective supply of lime?
- What are the needs and ambitions of supply chain actors?
- What can be done to improve the supply of lime in Ethiopia?
- What are the relevant best practices that could be contextualized for Ethiopia?

For this study, we implemented a mixed-methods approach. We leveraged interviews with experts and businesses in Ethiopia and reviewed publicly available data. Stakeholder engagement focused on understanding the constraints and opportunities for ag-lime in Ethiopia through 13 stakeholder discussions with Government, private sector NGOs/donor interviews, and sector experts. Secondly, we reviewed relevant policy documents, industry reports, and research documents on acidic soil management, as well as proclamations and regulations that govern the agricultural lime value chain, sectoral diagnostics reports, and market potential analyses. The Dalberg team then synthesized the collated data and research to generate insights and make recommendations.

The purpose of this document is to develop a clear understanding of the agricultural lime industry, with a particular focus on the supply side. 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. This involved (i)

[24] Ministry of Mines and Petroleum, Ethiopia Mining Cadastre eGov Portal, 2021

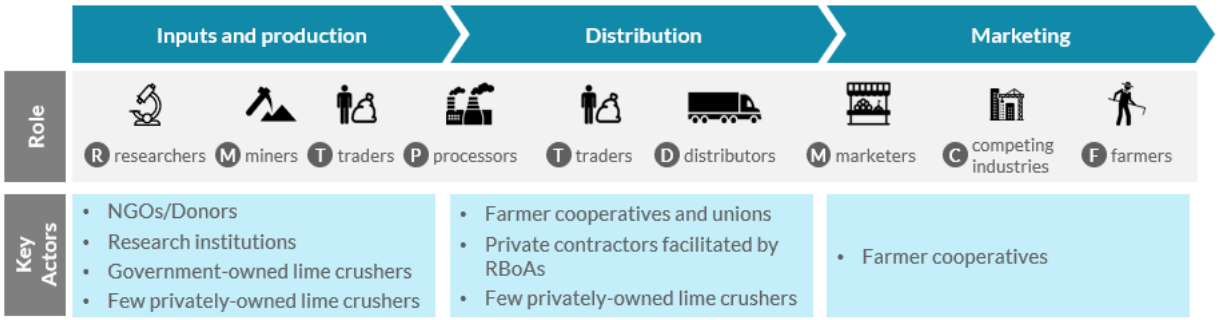
defining and understanding the challenges in the supply chain, (ii) identifying challenges in the enabling ecosystem, (iii) developing recommendations to address the gaps and advance the supply of lime, and (iv) identifying next steps. The next phase, focused on developing national investment plans for the Ethiopian government, will draw from the insights from this work and the outputs from other work packages focused on evaluating the demand and the policy environment in Ethiopia.

II. Defining And Understanding The Challenges in the Supply Chain

Overview of the Lime Supply Chain

The lime supply chain is nascent, with very few players in the market at each stage of the value chain, as shown below in Figure 3. The inputs and production segment of the value chain is largely publicly driven. The distribution stage is based on Regional Board of Agriculture (RBoA) tenders with few participating private sector actors, and the marketing stage is driven predominantly by farmer cooperatives.

Figure 3: The agricultural lime supply chain



The **inputs and production** segment of the supply chain involves various local and international actors. Donors, such as GIZ, as well as local and global research institutions, such as the Ethiopian Institute of Agricultural Research (EIAR), the International Food Policy Research Institute (IFPRI), and CIMMYT, have been spearheading research in this sector. Three government-owned lime processing plants – Dejen in the Amhara region, Guder in the Oromia region, and Butajira in the SNNP region - make up the lion's share of production and processing, with few private sector players, such as Dashen and Muger, recently joining the market. Apart from the Oromia region, in the Amhara and SNNP regional lime processing plants, excavation is done through manual labor[25], which has low productivity[26]. Although this need for manual labor is creating job opportunities for the community[27], the health hazards associated with inhaling and handling powered lime without protective equipment[28] as well as the low productivity of laborers with highly tedious tasks,[29] is likely to offset any potential gains through the creation of job opportunities.

The **distribution** segment of the supply chain is based on tenders that involve a multi-stage planning process (see Annex 1). Consequently, winners of the regional public tenders handle the distribution of lime. The initial assessment of demand is carried out by extension agents at the district (Kebele) level and is then escalated to the district level for aggregation.[30] The region then examines district estimates and comes up with final official estimates. Public tenders are then issued to procure the estimated quantity of lime inclusive of transportation/distribution costs[31] by district and at a predetermined price. Usually, the farmer cooperatives and unions win these tenders, and lime is transported from the farmer cooperatives to primary cooperatives then to farmers to collect.[32] Despite this, cooperatives raise concerns over the small supply of lime, which creates inefficient transportation assignment of time and resources.[33] Farmer cooperatives dominate the **marketing** segment of the supply chain. There are currently only a few cooperatives involved

[25] Dalberg Analysis of Interview insights, 2021
[26] IFPRI, EIAR, CIMMYT, A Pilot Program to Rehabilitate and Enhance the Productivity of Acid Soils in Ethiopia, 2018
[27] Interview with Dejen Lime Factory, July 2021; The Dejen Lime Factory currently employs 68 daily laborers with 7 contract workers. Out of the daily laborers, 33 are female and 35 are male
[28] Ibid
[29] IFPRI, EIAR, CIMMYT, A Pilot Program to Rehabilitate and Enhance the Productivity of Acid Soils in Ethiopia, 2018
[30] IFPRI, EIAR, Soil Acidity Problems in Ethiopia: Magnitude, Current Awareness and Practices, and Policy Actions, 2016
[31] Dalberg Analysis of Interview insights, 2021
[32] Ibid
[33] IFPRI, EIAR, CIMMYT, A Pilot Program to Rehabilitate and Enhance the Productivity of Acid Soils in Ethiopia, 2018

in lime's marketing, and they lack technical, financial, and managerial capacity.[34] Despite their heavy involvement in the production/processing part of the value chain, publicly owned plants have no active role in the marketing (and distribution) of lime.[35]

Varying degrees of interlinked challenges in demand, supply, and the enabling environment constrain the growth of the lime industry. Demand is minimal and addressing limiting factors for demand will be a prerequisite to unlocking growth within the supply chain of lime in Ethiopia. The supply chain has numerous challenges across the value chain, affecting the commercial viability and accessibility of lime. Lastly, there are a set of requirements that further impede the involvement of small-scale and private processors as well as financing gaps that span across the value chain.

Figure 4: Summary of binding constraints across the demand, supply, and enabling environment framework

Binding constraints	Rationale
Demand 	• Free handing of lime by Government and development partners has led to the increased use of lime • However, demand is limited to areas with Government or development partners demonstration projects • As a result, demand remains sub-optimal as compared to the depth of the issue
Supply 	• Public-sector dominated investments have crowded out the private sector investments • Consequently, systemic (delays in public procurement) and infrastructural (predominantly human labor-driven) inefficiencies in the publicly owned lime processing has resulted in diseconomies of scale • As a result, the publicly owned lime crushers never realized their full production potential • Poor road infrastructure and remote location of farmers, coupled with the large amount of agricultural lime needed (average 2.2 tons/ha) to treat acidic soils, varying based on the extent of acidity, makes distribution and transportation expensive, accounting for ~64% of the cost of lime • Absence of financial and non-financial incentives have failed to make the sector attractive for private investment
Enabling environment 	• Absence of a national farmland management policy and regulatory framework prevents the institutionalization and hence enforcement of good land management practices • Convoluted processes governing rural land administration as well as quarry right-to-use (same as land tax), royalty, land compensation, and VAT fees hinder private sector investment • The lack of dedicated power-substations and the constant power disruptions, increases the downtime of lime crushing factories, lagging production • Absence of concerted coordination between farmers cooperatives and unions, MFIs, regional Bureau of Agriculture (BoAs) and Ministry of Agriculture, with regards of implementing the Lime Supply system impedes acidic soil rehabilitation efforts

Demand side challenges

In the past decade, the free-handling of lime by the government and GIZ has had mixed effects on demand. According to a recent assessment[36] on lime awareness and use among smallholder farmers conducted in selected districts with high soil acidity in the Amhara, Oromia and SNNP regions, about 65% of farm households were aware of soil acidity, and about 58% of households reported that they had soil acidity issues on their farms. However, only 24% of households report having used lime on their farms. Free provision of lime has increased the use of lime, but the overall demand for lime seems to be limited to areas where these demonstration projects have taken place.[37] As a result, overall demand remains sub-optimal.

Limited awareness of agricultural lime, attributed to the lack of a dedicated extension service system, also reduces ag lime demand.[38] There are currently no systems in place to carry out lime awareness efforts. Due to weak extension service systems, most farmers, even in Woredas, where demonstrations take place,

[34] IFPRI, EIAR, Soil Acidity Problems in Ethiopia: Magnitude, Current Awareness and Practices, and Policy Actions, 2016
[35] EIAR, Soil Acidity Management, 2019
[36] IFPRI, EIAR, CIMMYT, A Pilot Program to Rehabilitate and Enhance the Productivity of Acid Soils in Ethiopia, 2018
[37] Interview with Dejen Lime Factory, July 2021
[38] ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015

lack awareness of the multi-year effects of lime.[39] This results in inefficient lime practices and reduces farmers' willingness to pay.[40]

Demand is further dampened by limited farmer awareness of the potential returns of using lime. Most farmers think lime is an unnecessarily costly investment. This is partly because the reaction time of lime can range from 6 months to over 3 years, depending on soil composition and the level of acidity. In addition, reapplication is needed to maintain soil health and reach optimal pH, which imposes additional annual costs until full soil rehabilitation is realized. However, studies[41] show that every birr invested in purchasing agricultural lime results in a return of 5.2 ETB with a subsequent crop yield increase of 100%, on average, when applied alone, and by 300% when applied with other inputs. [42] As shown in the table below, experimental results indicate wheat and productivity improvements from just 0.9 ton/ha to ~1.6ton/ha due to soley to lime use. Accordingly, net return and net added value due to lime use (unsubsidized) are estimated at 27,600ETB/ha (USD 622)[43] and 21, 280ETB/ha (USD 479.5).

Table 3: Estimated returns to lime use in wheat cultivation based on experimental results[44]

	Without lime	With subsidized lime	With unsubsidized lime
Lime application (ton/ha)	-	2.2	2.2
Grain yield (ton/ha)*	0.9	1.98	1.98
Adjusted grain yield (ton/ha)*	0.9	1.584	1.584
Cost of lime at farm gate (ETB)*	-	1,760	5,280
Labor cost of application (ETB 50/day for 16 days)*	-	800	800
Total cost of lime	-	2,560	6,080
Grain price (ETB/ton)*	40,000	40,000	40,000
Gross value of output (ETB/ha)*	36,000	63,360	63,360
Net returns to lime use (ETB/ha)*	0	**27,360**	**27,360**
Net added value to lime use (ETB/ha)*	-	**24,800**	**21,280**

*The experimental wheat grain yield from lime application is adjusted downwards by 20% to account for what a typical farmer would most likely obtain under farmer conditions. The cost of subsidized lime at farmgate is assumed to be 80ETB/quintals (IFPRI, EIRA, 2018) and the cost of unsubsidized lime is 240ETB/quintals (data from Dashen Cement, 2021). Labor cost of application is assumed to be 16 labor days. Grain price refers to the farm gate price farmer receives and is assumed to be 4,000ETB/quintals or 40,000ETB/ton (data from wheat farmer in Dukem, 2021). Gross value of output is calculated by multiplying the Grain price with adjusted grain yields. Net returns to lime use is calculated by subtracting gross value of output without lime from gross value of output with lime. Net added value to lime use is calculated by subtracting the total cost of lime from the net returns to lime use.

The large quantities of lime required to treat soil acidity is a cost barrier to smallholder farmers. Around 2.0 to 2.2 tons/ha[45] is needed to treat low soil pH, though this amount varies depending on the level

[39] IFPRI, EIAR, CIMMYT, A Pilot Program to Rehabilitate and Enhance the Productivity of Acid Soils in Ethiopia, 2018
[40] Ibid
[41] MoA, Policy Brief: Unlocking the Potential for Transformational Agriculture Development of Acid Soils in Ethiopia, 2017
[42] ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015
[43] July 29, 2021 Dollar to ETB exchange rate = 44.38
[44] Methodology is adopted from IFPRI, EIAR, Soil Acidity Problems in Ethiopia: Magnitude, Current Awareness and Practices, and Policy Actions, 2016
[45] Ibid

of acidity. The recommended amount for lime is approximately two times the amount required to compensate for losses incurred during transportation and application of lime (due to its powdery and fine texture, ag lime is easily blown away by the wind).[46] Smallholder farmers have limited resources and often face competing priorities from other agricultural inputs, such as organic and inorganic fertilizers and improved seeds. They are therefore unable to purchase the large quantities of lime required.

Table 4: Average cost of lime required per farm size

Farm size (hectare)	1 ha	3/4th ha	2/4th ha	1/4th ha
Average cost of lime*	**ETB 8,800** (USD ~198)	**ETB 6,600** (USD ~149)	**ETB 4,400** (USD ~99)	**ETB 2,200** (USD ~50)
Key assumptions* ✓ The cost of lime per quintals is 400 ETB ✓ The average amount of lime needed is 22 quintals (2.2 tons) per ha				

July 29, 2021 Dollar to ETB exchange rate = 44.38; Cost of lime per quintiles is taken from stakeholder interviews, 2021

Information asymmetry between Regional Bureaus of Agriculture (RBoAs) and beneficiaries leads to erroneously high forecasted lime demand and a resulting wastage of lime. More recently, the RBoAs have been allowed to predict the demand for their respective regions and send that information to the Federal Ministry of Agriculture (MoA) for approval.[47] Once approved, the RBoAs have regional autonomy to procure agricultural lime (see Annex 1) directly. However, due to the lack of farmer awareness, even though the RBoA procures large amounts of lime with beneficiaries in mind, there is a disconnect between procurement quantities and lime quantities that farmers actually use on their fields.[48] For example, there has been instances in the Amhara region, , where when the lime trucks are delivered to farmers, (i) farmers refuse to offload trucks to the extent where farmer cooperatives would need to threaten withholding inorganic fertilizers just so farmers allow the offloading of lime trucks, and (ii) farmers state they are going to be using the lime to renovate their dwellings instead. As a result, this information asymmetry leads to wastage of lime.[49]

While access to credit is supply driven, actual utilization is determined by the interaction between demand and supply.[50] This interaction translates to actual uptake of agricultural products. Smallholder farmers in Ethiopia are characterized as having low credit market participation.[51] Most recent evidence suggests that only about 22% of adult Ethiopians held an account with any financial institution in 2014, as compared with the Sub-Sahara Average of 29%, and only 7% borrowed from formal institutions.[52] Out of these, only 12% borrowed for a farm or business.[53] This is attributed mainly to the lack of appropriate agricultural loans available to farmers.[54] Most Microfinance Institutions (MFIs) in Ethiopia have one-year agricultural loans from planting season to the harvest season. In contrast, agricultural loans are cheaper during harvest season, which makes production loans that mature during this period unattractive.[55]

[46] ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015
[47] Dalberg Analysis of Interview insights, 2021
[48] Ibid
[49] Ibid
[50] Oxford, The Oxford Handbook of the Ethiopian Economy: Rural Finance and Smallholder Farming, 2019
[51] Oxford University, The Oxford Handbook of the Ethiopian Economy: Rural Finance and Smallholder Farming, 2019
[52] Ibid
[53] Ibid
[54] Ibid; MasterCard Foundation, Smallholder Farmer Report Ethiopia, 2019
[55] Ibid

Supply side challenges

The lime sector faces numerous challenges across the value chain, affecting the commercial viability and accessibility of lime. The following section provide details of the challenges in the supply chain's production, distribution, and marketing segments.

Production/processing

Pre-production costs are prohibitively high for new producers. Pre-production challenges with convoluted rural land administration processes make it difficult to acquire land.[56] Once land is acquired, fees incurred including, land compensation fees (18 tons/ha per year for 15 years), quarry right-to-use fees (same as land tax), royalty charges (3%), and value-added taxes (15%), decrease investment appetite.*[57] These challenges collectively undermine the urgent need to establish more lime crushing factories as well as strengthen the small-scale lime production facilities (already mapped across-regions by the ATA), that are especially located within approximately 200 km radius from demand,[58]

Unreliable electricity is a significant constraint for ag lime producers and processors. In Ethiopia, power interruptions rank as one of the major constraints affecting the manufacturing sector as they cause, on average, 20-30%[59] loss of annual production. In a government-owned processing plant in the Amhara region, frequent power issues can make it a challenge even to start the lime-crushing machines.[60] This increases production inefficiencies, resulting in high cost inefficiencies.

Limited automation, lack of technical expertise, and inefficient procurement practices, underpinned by a lack of financial autonomy in publicly owned processing plants, limit lime production potential. In the Amhara and SNNP regions, excavation and transportation from the quarry to the processing plant are based on human labor.[61] This is due to both a lack of trained expertise to maintain machinery[62] and a lengthy procurement process (one to two months) for machinery spare parts needed to maintain machinery.[63] Aside from the government-owned processing plant in the Oromia region, the SNNP and Amhara region processing plants lack the financial autonomy to address all of these challenges in a timely manner.[64] This is due to the bureaucratic processes involved in the RBoAs as well as differences in levels of commitment between the processing plants and RBoAs to acidic soil reclamation.[65]

Production challenges are underpinned by limited demand, resulting in little private sector investment. As noted earlier, the supply of agricultural lime is predominantly public-driven with the government-owned processing plants in Amhara (Dejen lime factory), Oromia (Guder lime factory), and SNNP (Butajira lime factory). While demonstrations, funded by development partners, mainly GIZ, and the government, have taken place in certain Woredas within these regions, awareness remains limited to these Woredas. As such, despite these three factories only meeting about one-sixth of the total projected demand for lime[66], until recently, there have been limited efforts to involve the private sector in the supply chain. Nevertheless, domestic cement manufactures already have significant potential for lime manufacturing. For instance, Derba cement factory alone has 155 times the capacity of government-owned crushers *(see annex 2 for capacity breakdown)* and can meet 40% of all demand in the country.[67] Attracting private sector players

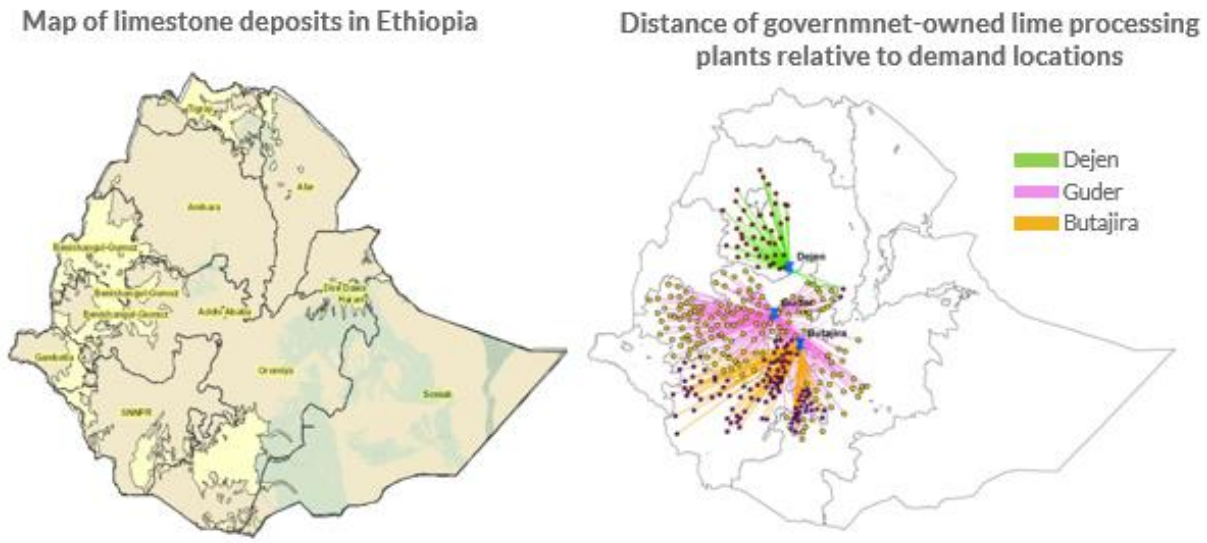
[56] Dalberg Analysis of Interview insights, 2021
[57] Interview with Dashen Cement, 2021; Note: these figures are for the Amhara region and there might be variance in fees in other regions. *Other stakeholders have identified high land tax, which depends on the size of operation. However, actual amount remains unknown.
[58] ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015
[59] Dalberg Analysis, 2020
[60] Interview with Dejen Lime Factory, 2021
[61] Ibid
[62] Ibid
[63] Ibid
[64] Interview with Amhara BoA, 2021
[65] Ibid
[66] ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015
[67] Ibid

can increase production efficiency, decreasing the end-price of lime due to the economies of scale achieved in production.

Distribution

Long distances and poor road infrastructure result in transportation costs equating to ~64% of the total cost of lime. The vast distance from where the reserves are located relative to beneficiaries drives up distribution costs, increasing the end-user price of lime. Lime reserves are primarily located in the eastern part of the country, while soil acidity issues are in the north-western and southern regions.

Figure 5: Distance of limestone deposit maps relative to government-owned lime-processing plants and demand location[68]

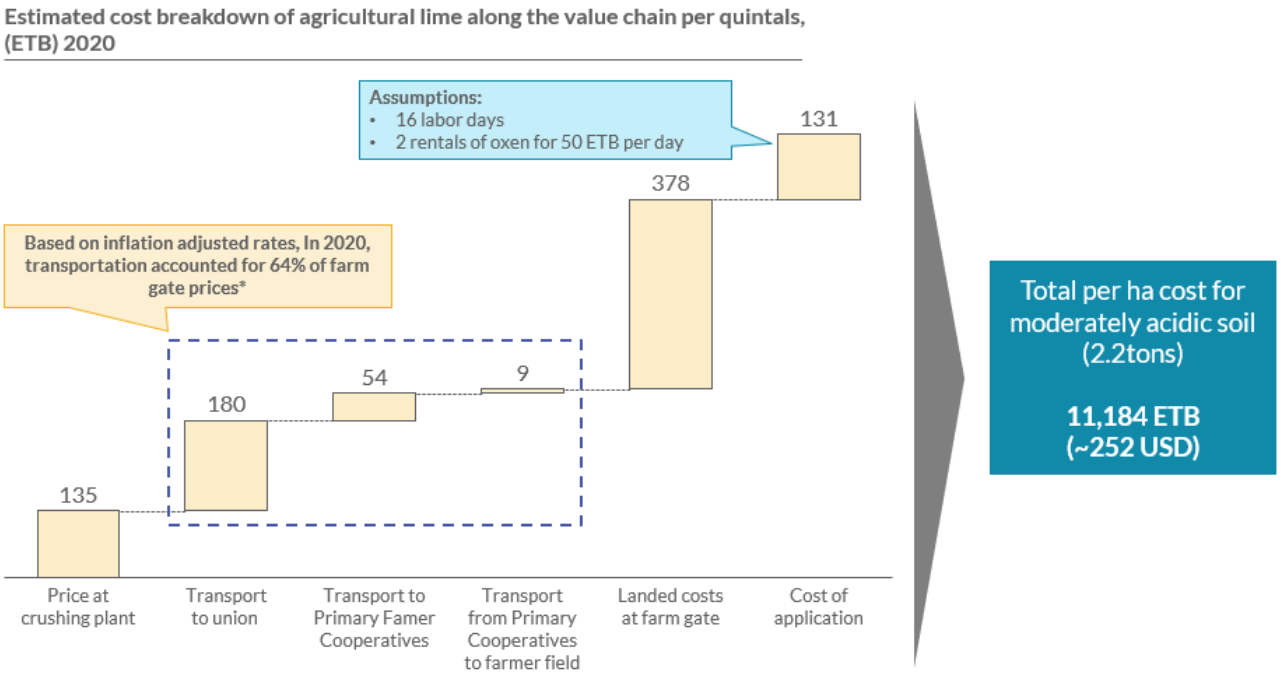


Distance (KMs)	Amhara (Dejen)	Oromia (Guder)	SNNP (Butajira)
Longest	389.06	363.38	429.84
Shortest	17.02	9.4	5.16
Average	203.04	186.39	217.5

For farmers located in remote areas, rugged terrain coupled with poor road infrastructure increase the cost of last-mile delivery. Farmers often use donkeys to transport lime and other inputs from the cooperatives/Woredas to their farms. However, the quantity of lime required often makes it unviable to transport lime using donkeys.[69] Embedding modern transportation on poor road infrastructure has a steep cost implication as it increases the overall cost of vehicles in terms of maintenance frequency (depreciation). The limited demand and extensive distance to beneficiaries mean that the few vehicle owners located in remote Woredas do not view transporting small amounts of lime as a viable business opportunity. Similarly, farmer cooperatives have limited appetite to invest in providing resources for transportation.[70]

[68] Ministry of Mines and Petroleum, Ethiopia Mining Cadastre eGov Portal, 2021
[69] IFPRI, EIAR, CIMMYT, A Pilot Program to Rehabilitate and Enhance the Productivity of Acid Soils in Ethiopia, 2018
[70] Ibid

Figure 6: Inflation-adjusted cost-breakdown of agricultural lime along the value chain



Note: calculations are inflation adjusted using this formula: old price(New 2020 CIP Index value of 179.8/Old 2016 CPI Index value of 100). Source of CPI Index value: Open Data for Africa: Ethiopia Data Portal, 2020 ; July 29, 2021, exchange rate = 44.38
Source: REAP, Soil Acidity Problems in Ethiopia: Magnitude, Current Awareness and Practices, and Policy Actions, 2016

The cost of loading and unloading also adds to the final price of lime; however, it is essentially an issue limited to the few private sector players. For government-owned processors, distribution, loading, and unloading are handled mainly by farmer cooperatives. Private sector processors that have contracted distribution to third parties often face challenges with loaders and unloaders who increase their fees from 10 ETB per 50kg bags to 15 ETB once they realize a private processor pays for their labor.[71]

Challenges in distribution result in frequent untimely pick-ups of lime from Woreda offices, limiting storage spaces and delaying the application of lime. In the Amhara and Oromia regions, the delay in pick-ups contributes to the delay in applying lime to farms[72], for which recommended application is up to six months before planting season. The delay in lime pick-ups also limits the storage space in Woreda offices and prevents the storage of more lime.[73]

Marketing

Despite farmer cooperatives being the only actors involved in marketing, they suffer from technical, financial, and managerial capacity.[74] There are a series of gaps in agricultural finance regulation, such as the lack of a dedicated regulatory framework for financial cooperatives.[75] Additionally, due to the limited professional support and follow-up by regional bureaus of agriculture, farmer cooperatives lack technical and managerial capacities.[76]

[71] Interview with Dashen Cement Factory, 2021
[72] ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015
[73] Ibid
[74] IFPRI, EIAR, CIMMYT, A Pilot Program to Rehabilitate and Enhance the Productivity of Acid Soils in Ethiopia, 2018
[75] ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015
[76] European Journal of Business and Management, Challenges and Prospects of Cooperatives in Ethiopia, 2019

III. CHALLENGES IN THE ENABLING ECOSYSTEM

In the current regulatory and macro-economic environment, most supply side actors do not see the business case for further extending their capacity from competing industries (such as cement) to agricultural lime production.[77] This is due to the absence of a supportive enabling environment for lime, restricting appetite for investment.

Heavy taxation and charges for agricultural lime processors hinder sector development. Fees are incurred at every point of the value chain, including land compensation fees (1.8 tons/ha per year for 15 years), quarry right-to-use tax (same as land tax), royalty fees (3%)[78] and Value Added Taxes (VAT - 15%)[79] further discourages increased private sector participation. There is recognition from investors that these fees increase production costs and may be passed along to consumers. However, investors also know that consumers generally lack awareness and have little to no willingness to pay for lime; thus, there is no demand or sufficient market for agricultural lime.

Significant distances between soil testing laboratories and affected areas contribute to the untimely application of lime. Soil testing facilities are located in regional capitals, which are a significant distance away from where acidic soils are located.[80] For example, in the Oromia region, soil testing labs are ~250 – 300kms away from affected areas.[81] As shown in annex figure 1, the process development agents have to follow in order to get soil tested is archaic and time consuming. Once the sample soil arrives at the regional capitals, the analytics of measuring soil testing involves old technologies, which are costly and contribute to further delays.[82] Therefore, by the time soil testing is completed, demand is assessed based on lab results, and a formal request is made for the RBoAs to issue tenders and procurement is done, the planting season for the farmer would have already passed.[83]

Lack of infrastructure to further support the development of the lime industry results in high distribution costs. General lack of basic infrastructure such as reliable power, water, and telecommunication services in remote places decreases processor appetite to set up factories close to beneficiaries. [84] Poor road infrastructure coupled with the absence of transportation cost-reducing mechanisms, especially for farmers located in remote areas, have resulted in the farmer bearing the total cost of last-mile delivery.

Limited access to finance for both the demand and supply side of the lime industry stifles the sector's growth. On the demand side, the repayment horizon for lime received on credit is only one year, the same as fertilizers. This fails to consider the bulky amount of lime needed to treat acidic soils, which averages 2.2 tons/ha (~8,000 ETB or 180 USD) compared with approximately less than 0.3 tons/ha (~3,500 ETB or 79 USD) of fertilizer needed per planting season. On the supply side, financing options are limited to standards financial products which are often unviable for the lime sector, due to the risk of limited demand.

The ag lime sector's numerous risks limit growth since investors have low-risk tolerance and are unlikely to consider venturing into a risky industry. From an investor perspective, the ag lime sector is nascent with an unstructured value chain and does not present sufficient evidence for commercial viability. The absence of a well-defined value chain increases the risk of entering the agricultural lime sector as it is largely ambiguous, and therefore fails to guarantee investor confidence.[85] Consequently, large and more established cement manufactures and lime crushers view their production of agricultural lime as a call to action rooted in goodwill and Corporate Social Responsibility (CSR) rather than a viable business

[77] Dalberg Analysis of interview insights, 2021
[78] Interview with Dashen Cement, 2021; Note: these figures are for the Amhara region and there might be variance in fees in other regions. *Other stakeholders have identified high land tax, which depends on the size of operation. However, actual amount remains unknown.
[79] Interview with MoA, 2021
[80] IFPRI, EIAR, CIMMYT, A Pilot Program to Rehabilitate and Enhance the Productivity of Acid Soils in Ethiopia, 2018
[81] Interview with Oromia BoA, 2021
[82] IFPRI, EIAR, CIMMYT, A Pilot Program to Rehabilitate and Enhance the Productivity of Acid Soils in Ethiopia, 2018; Interview with OCP Ethiopia, 2021
[83] Ibid
[84] Interview with Amhara BoA, 2021
[85] Dalberg Analysis of interview insights, 2021

opportunity.[86] This is evidenced by only five of the 19 private lime crushers taking up the government's call to produce agricultural lime.[87]

Investor low-risk tolerance is exacerbated by the absence of the financial and non-financial incentives extended to the sector.[88] With no tailored incentives identified for the sector to de-risk private sector investments, agriculture lime fails to attract big enough players in the market, which is also underpinned by limited demand.

On a more macro-level, the absence of a regulatory framework and supportive policies that signal government priority deprive supply-side private sector actors the certainty they need to enter the sector. The lack of (i) national farmland management policy that governs soil health in the country, (ii) integrated policy framework for industrial land use, and (ii) well-defined supply chains with clearly identified investment entry-points and returns for the private sector fails to guarantee government commitments for the sector. This lack of clarity increases the risk associated with an investment.

The newly established Lime Supply System (LSS)[89] aims to address supply-side challenges by creating a conducive environment for private sector engagement. It seeks to align private sector lime suppliers, such as the cement processing plants, and microfinance institutions to make sure that farmers can access lime through direct purchase or loans. Within the LSS, the government will make lime available through its partnership with farmer cooperatives, unions, and woreda offices. To jumpstart implementing the new Lime Supply System, the government has allocated a total of 732,844 ETB to Oromia, Amhara, SNNP, and Sidama*.[90]

However, government efforts are hindered by a lack of coordination and shared vision of commercialization, affecting the root cause of the problem: lack of demand. While some areas in the Oromia[91] and SNNP regions are still engaging in the free-handing of lime[92], other areas are providing lime on either a cash or credit basis, aligned with the new Lime Supply System.[93] This undermines the commercialization efforts as farmers would resort to skipping current planting season lime application in hopes of getting lime for free for the next planting season, delaying acidic soil rehabilitation.[94] This lack of coordination has, in one region, resulted in a breach of contract with a private supplier as the region forecasted its need to be 30,000 quintals (~3,307 tons). Still, once the private supplier produced the amount, the region only bought 19,000 quintals of it (63%).[95] These fragmented efforts adversely impact the larger efforts of increasing demand.

[86] Ibid
[87] Interview with MoA's Soil Fertility Directorate Director, 2021
[88] Dalberg Analysis of interview insights, 2021
[89] AgriProFocus, High Level Officials Meet to Discuss New Lime Supply System, 2020
* Sidama, previously a part of the SNNP region, became Ethiopia's 10th regional state in 2019 post referendum
[90] Ibid
[91] According to interviews with the Oromia BoA, the continued free handing of lime is strictly limited farmers that have been identified as having no financial means to pay for lime
[92] Dalberg Analysis of interview insights, 2021
[93] Ibid
[94] Ibid
[95] Private sector interviews, 2021

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

A thorough understanding of the supply chain and its imminent challenges provides the basis for the recommendations – addressing supply chain constraints. The focus for this section is developing disaggregated and actionable recommendations, highlighting the role of various stakeholders (public sector, private sector, development partners, etc.)

Figure 7: Summary of opportunities and recommendations for the lime value chain

Binding constraints	Challenges	Opportunities
Demand 	• **Lack of demand** due to low awareness creation and uncoordinated provision of lime	• **Raise regional campaigns** to raise awareness • **Capacity building** of extension workers • **Targeted utilization of EthioSIS** woreda-level soil mapping data to address issues related to demand creation
Supply 	• **High transportation costs** increase the total cost of lime for farmers and rendering it financially unviable for the commercial value chain • **Publicly-owned lime processing plants lack the financial autonomy** to increase production efficiency by adopting new technologies	• **Conduct spatial review of farmer adoption** of lime and likelihood of further adoption to assess commercial viability • **Explore options of leveraging large cement manufacturers** to support the sector as part of their CSR efforts • **Coordinate national logistics campaign** to identify magnitude of need and mobilize public and private sector support • **Identify modalities of financial autonomy** for governmnet-owned processing plants
Enabling environment 	• **Absence of a national farmland management policy and regulatory framework** • **Right-to-use fees charged at** various parts of the value chain adds up to end-user cost of lime • **Unreliable electricity** lags and increases production costs • **Lack of soil testing laboratories** close to affected areas as well as **archaic testing methods** • **Lack of coordination** amongst main actors identified in the implementation of LSS	• **Introduce a national farmland policy** • **Reduce/remove tariffs and royalties** for processors involved in production of agricultural lime • **Develop a tailored financial modality** for lime • **Introduce improved planning and coordination mechanisms** amongst entities in charge of power provision as well as key LSS actors • **Innovate soil testing** by allowing tech companies to participate and **establish soil testing labs at Woreda-level** • **Undertake a scoping study to identify constraints and opportunities to scale** through a 'build, expand, or partner' approach

Demand side opportunities

Limited demand for lime is **driven by a core set of interconnected factors, including lack of awareness and inefficient supply resulting in high end-user cost.** Without sustainable demand, there is little incentive for investment to improve the supply chain's processing/production, distribution, and marketing. As a result, it is critical to build demand by prioritizing activities and interventions that will increase awareness and reduce end-user costs.

Interventions to jumpstart efforts to address demand include (i) regional campaigns that can raise awareness; (ii) capacity building of extension workers; and (iii) targeted utilization of the Ethiopian Agriculture Transformation Agency's (ATA) EthioSIS soil mapping data:

- **Embedding acidic soil awareness campaigns under the Prime Minister Office's on-going Green Legacy Initiative**[96] could help build more targeted nationwide awareness.
- **Undertaking extensive capacity-building efforts for agricultural extension workers and development agents (DAs)** could equip them with the necessary knowledge and skills required for yield-enhancing techniques and technologies and diffusing this knowledge to farmers
- **Utilizing the wealth of Woreda and Kebele level soil information from EthioSIS** could help address many challenges in the supply chain.

[96] Greenlegacy.et, 2021

- First, the data could be used **to financially model the costs associated at each value chain stage relative to farmer income**. This will help forecast farmer elasticity of demand and identify which supply chain stages need government and development partner support.
- Second, **mapping the proximity of limestones reserves** to the nearest processing plants and beneficiaries could help identify where new processing plants need to be located to ease access and reduce distribution costs.
- Third, by **identifying Woredas with critical levels of soil acidity** and plummeting agricultural productivity, model farmers could be selected within those Woredas to serve as the entry point into a community for the diffusion of lime knowledge and serve as community champions.

Financing interventions for demand-side challenges include (i) capacity building of MFIs to develop expertise in agriculture finance and create appropriate loans to farmers[97], and (ii) creating tailored financial products for women and young farmers as they have specific challenges in accessing credit.

- Capacity building of MFIs to develop expertise in agriculture finance as well as create financial mechanisms to de-risk agriculture from their loan portfolios would ease financial constraints in the demand side. This will allow MFIs to:
  - First, **design flexible payment options** for farmers that will allow them to make repayments according to their harvest cycle and cashflow
  - Second, **avail inputs and/or loans at appropriate times**, which would enable farmers to increase yields and returns
  - Third, **undertake a farmer segmentation study**, which will inform the creation of targeted financial products

- Creating tailored financial products that give special attention and find appropriate solutions to the challenges women and young people experience in the quest to access credit is critical to the success of resolving demand-side challenges. This can be done through:
  - **Training of loan officers on gender issues in rural homes**, which will enable them to ask the right questions to fully understand a women's financial contribution to household cash flows[98]
  - **Tailoring of messages from financial institutions about their financial offerings** would benefit women farmers as they tend to rely more on word of mouth and/or using informal community social networks[99]
  - **Supporting women in land acquisition** can increase their asset ownership, increasing their access to collateral-based loans
  - **Strong institutional commitment** starting from the leadership of the financial institution is crucial as re-orienting staff to serve new market segments, at times, could face cultural barriers and norms.[100] Constant reinforcement of commitment to serving this segment of the population is needed to create an institutional culture that values women and young people as clients[101]

Supply side opportunities

In parallel, supply side actors need to improve the commercial viability of supplying lime at a reduced cost by addressing the steep costs associated with the last-mile transportation from Kebele/Woreda offices to farm plots, through a cost-savings approach. This can be done through support from the government that anchors on reducing transportation costs and improving the timely availability of lime. Three main activities need to be undertaken to ensure the successful adoption of this cost-saving approach:

[97] MasterCard Foundation, Smallholder Farmer Report Ethiopia, 2019
[98] IFC, Financing to Support Women in the Agricultural Sector, 2015
[99] Ibid;
[100] Ibid
[101] Ibid

- First, it is vital to **conduct a spatial review of current farmer adoption of lime** to assess the likelihood of adoption for farmers in remote locations and determine commercial viability. This is because, for very remote regions where the cost of transportation is much higher than the 64% estimated in this report, it might be more viable, pre-conditioned on sufficient research, for farmers to change their enterprise to acid-resistant crops[102].
- Second, **leveraging large competing industries**, such as large cement manufacturers, to support the agricultural lime sector as part of their Corporate Social Responsibility (CSR) effort would help support the industry in the short term both to raise awareness through promotion efforts as well as producing sufficient supply. Once the sector reaches early stages of commercial viability, these selected manufacturers could be rewarded for their cooperation by a time-bound exclusive contract with regional governments
- Third, **coordinating a national logistics campaign** by identifying the magnitude of need and mobilizing government-supported private sector transport would help private sector actors that have achieved economies of scale in transport to enter the market. Broadly, providing longer-term government contracts for private actors could ensure stable supply and improve commercial viability.

Identifying modalities of financial autonomy for government-owned processing plants has the potential to sufficiently increase their capacity. Understanding that public processing plants do not generate profit, exploring options for commercialization to the extent that it improves their efficiency will be worthwhile. For example, granting them financial autonomy in some parts of their operations, such as procurement up to a certain threshold, could streamline the purchase of machinery spare parts (that takes more than two months) and decrease machinery downtime.

While large cement factories are relatively better off when it comes to accessing capital, in order to attract smaller scale producers into the sector and build a competitive, sustainable and level playing field, a study focused on the needs of SMEs (accounting for 79% of enterprises)[103] involved in the value chain needs to be carried out. Options of flexible financing vehicles, such as, patient equity investment, concessional debt for working capital, credit guarantees backed by development partner, supplier agreements/purchase orders, or a mix of these financing vehicles, would ease SMEs access to finance. However, each of these would need to be thoroughly studied through the following approach;

- First, **conducting a survey to better understand the profile, financing needs, and ability of SMEs to absorb capital available to them** will give an overview of financing needs
- Second, **identifying the barriers to accessing finance** would help prioritize the most binding constraints to SMEs accessing finance
- Third, **identifying and segmenting by enterprise size and business model** will help identify the various supply chain actors involved in each segment of the value chain including excavation, input/production, distribution, and marketing
- Fourth, based on this segmentation, **tailoring financial products to supply-side actors** can increase private sector participation and make the sector more competitive, reducing the cost of lime.

Enabling environment opportunities

There is a need to de-risk private sector investment through Public-Private Partnerships (PPPs) and introducing tailored incentives that have significant potential to encourage large-scale players to join this nascent sector. Lessening the risk of engaging in a nascent market with loosely defined value chains would require clearly identifying which part of the agricultural lime value chain (excavation, production, distribution, and marketing) needs a robust public-private partnership. Once identified, undertaking an extensive stakeholder engagement plan to gauge private sector appetite would be critical. Consequently, embedding the PPP unit within the Ministry of Finance and Economic Development (MoFED) in charge of

[102] Interview with GIZ, 2021
[103] IFC, SME Finance Forum, 2018

facilitating the coordination of PPP projects will streamline the formation of successful partnerships. In addition, identifying use-cases of guarantee modalities in more mature markets could help reveal insights and introduce guarantee mechanisms in which private sector producers would receive government guarantees for their supply, significantly de-risking their investment.

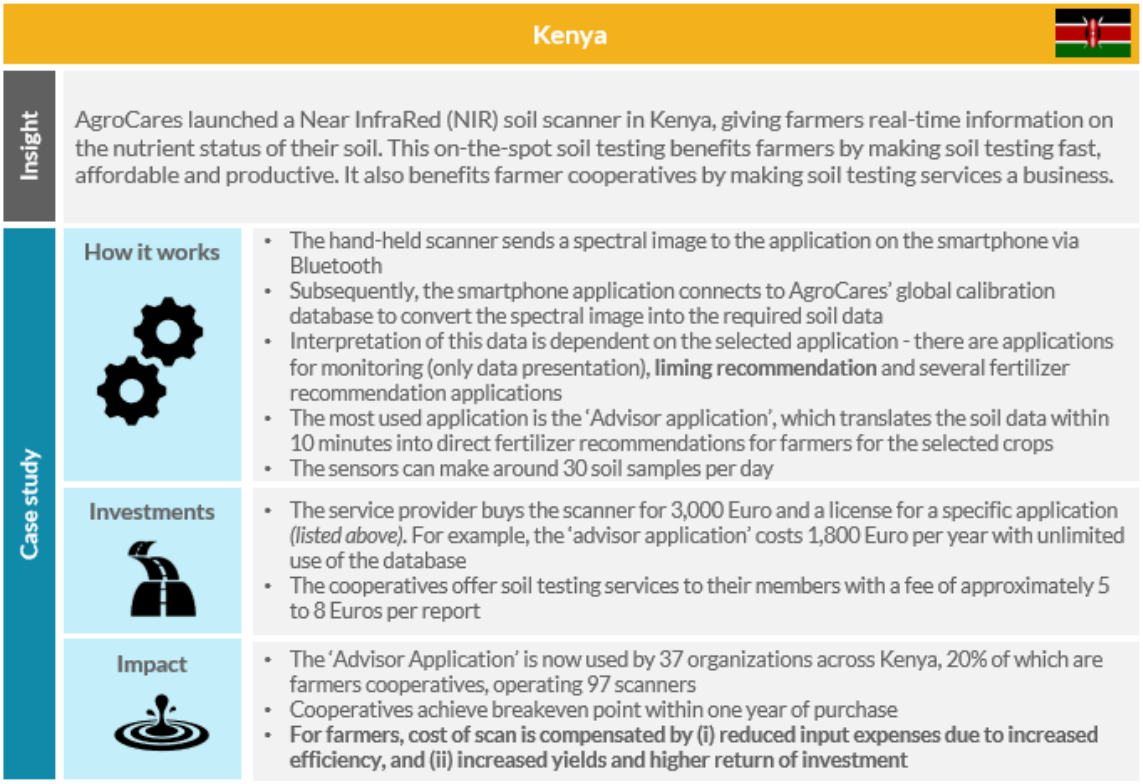
Easing access to finance challenges for both the demand and supply-side of the sector and introducing tailored financing would help kick-start the commercial viability of the industry. On the demand side, the repayment horizon of agricultural lime in the Amhara region is one year, which is too short considering the cost of lime.[104] Standardizing financial products for inputs and expanding these to include lime fails to consider the unique characteristics of lime, such as quantities required that drive up costs.[105]Lessons could be learned from the Oromia region, whereby lime credit is extended to farmers with a 3-year repayment period. The farmer pays back 40% within the first year, 35% in the second year, and the remaining 25% in the third year.[106] Among Oromia Woredas, where awareness is high, farmers understand that it is worth the investment when they compare this repayment period to the yearly yield increase[107]**.** On the supply side, the absence of tailored incentives, despite the government's commitment to the sector's growth, does not guarantee the commercial viability of the nascent industry. As with other industries, such as the floriculture industry, which grew from near zero in the early 2000s to earning about USD 196 million in exports[108] and is now ranked as the second-largest flower exporter in Africa, the government can provide timebound and targeted incentives that are guided by the private sector to drive the sector's growth.

Addressing the current policy gaps and improved coordination between federal and regional government entities is required to achieve growth. There is a general disconnect on priorities amongst the regional and federal entities that oversee and govern the agricultural sector, which results in the disaggregation of efforts.[109] At a federal level, introducing national farmland management and regulatory framework that can govern the farmland ecosystem would give way to institutionalizing good farmland practices across regions, addressing the root cause of acidic soils. Coupled with this, reducing or removing tariffs and royalties for processors involved in the agricultural lime sector could increase the sector's commercial viability. Better planning and coordination amongst entities in charge of infrastructure, such as power, to limit machine downtime by ensuring constant power provision would increase investor confidence in joining the sector. Another alternative is identifying strategic locations of lime processing plants; for example, locating lime plants near existing or planned industry parks would enable them to use the park's dedicated power sub-stations. Additionally, streamlining soil testing processes by investing in soil testing kits as well as establishing soil testing laboratories at Woreda-level, can reduce the delay in application.

To further drive demand, private sector actors can use technology and mechanization to drive awareness and encourage use of lime. While, lack of demand and enabling environments are key constraints, private sector investment into the mechanization of different segments of the supply chain including the excavation, processing, distribution, and application segments of the value chain, has the potential to increase efficiency in production and lower distribution and application costs, thereby increase demand. For example, farmers high-end user cost, partially due to recommendation to purchase two times the required amount due to loss during transportation and application[110], could decrease by approximately 50%. Private sector investment into automized systems that provide farmers with real-time information on the nutrients of their soil and acidity status can help the farmer (i) reduce input expenses due to increased efficiency and (ii) increase yields and earn higher return of investment.[111] Kenya displays a good example of private sector involvement in demand creation through AgroCares soil testing, which commercializes an essential service in the value chain.

[104] Interview with Amhara BoA, 2021
[105] Interview with MoA's Soil Fertility Directorate Director, 2021
[106] Interview with Oromia BoA, 2021
[107] Ibid
[108] UN Comtrade Data, 2020
[109] Dalberg Analysis of interview insights, 2021
[110] ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015
[111] ICT Update Issue 89, Data4Ag: New Opportunities for Organized Smallholder Farmers, 2018; Dalberg Analysis of Interview insights, 2021

Figure 8: Fast, accessible, and easy soil testing for smallholder farmers in Kenya[112]



It would also be helpful to understand whether current capacity constraints and scalability to reduce cost could best be solved through a 'build, expand, or partner' approach.

- For example, a mix of 'build and partner' approaches would be appropriate in the Amhara region.
    - Building more processing plants and strengthening already identified, by EthiSIS, small-scale production facilities, to ease accessibility access to farmers in remote areas could be a feasible way to decrease end-user costs in the region[113]
    - With the government-owned crusher in the Amhara region severely suffering from lack of automation as well as a series of structural problems, it can easily benefit from a public-private partnership
- In contrast, in the Oromia region, with the government-owned crusher factory already having the capacity to address the 154 million quintals of lime needed to treat all of the acidic soils in the region, an 'expand' approach to supply other regions would be more appropriate to strengthen the state-owned crusher further[114]

With a large-scale, well-planned, focused, and integrated acid soil reclamation program, Brazil was able to rehabilitate and reclaim more than 60 million hectares of acidic soil in just five years[115] (see case study below). Ethiopia could also overcome soil acidity by understanding the interlinkages of the various dimensions that affect the supply-side and working in a well-coordinated manner towards clearly defined Key Performance Indicators (KPIs).

[112] Ibid
[113] Interview with Amhara BoA, 2021; ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015
[114] Interview with Oromia BoA, 2021
[115] EIAR, Soil Acidity Management, 2019; Ibid

Figure 9: Success story from the Cerrado region, Brazil[116]

CIMMYT is well placed to guide and manage the lime ecosystem to generate the knowledge required. With its focus on two of the country's primary food and cash crops, maize and wheat, CIMMYT already has the necessary on-the-ground analytical knowledge to drive change in these sectors. Additionally, CIMMYT's focus on integrated development through the development of nutritious, sustainable, and resilient food systems aligns with the Ethiopian government's 10-year plan.[117]

[116] Conservation Strategy Fund, Infrastructure and Conservation Policy in Brazil, 2005; CIFOR, Land-use Trends and Environmental Governance Policies in Brazil, 2014; The Economist, The Miracle of Cerrado, 2010; ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015; EIAR, Soil Acidity Management, 2019; Interview with Oromia BoA, 2021

[117] Planning and Development Commission, Ethiopia 2030: The Pathway to Prosperity – Ten Year Perspective Development Plan (2021 – 2030), 2021

V. NEXT STEPS

In Ethiopia, the agricultural sector accounts for 33.3%[118] of gross domestic product, provides a livelihood to 75%[119] of the country's labor force, and accounts for over 80%[120] percent of foreign exchange earnings.

Acid soils threaten these critical indicators and the country's ambition to become a resilient and diversified lower-middle-income economy by 2025[121]. As such, lime is a crucial and viable agricultural input to address soil acidity.

This study focused on identifying the key challenges in the supply side and opportunities to address the challenges. Our analysis revealed that the lack of awareness and the high cost of lime are the core factors causing the low demand for lime in Ethiopia.

- Lack of demand is the key binding constraint to the supply of lime in Ethiopia
- Demand, supply, and the enabling environment are strongly interlinked

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 focused 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. Engaging with different work package teams will ensure 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.

Recognizing the importance of agriculture to the economy, there is a need to build commitment to increase resource allocations to the sector- to improve demand and supply (including through capacity-building) to enable liming to deliver clear results and outcomes at a grassroots level.

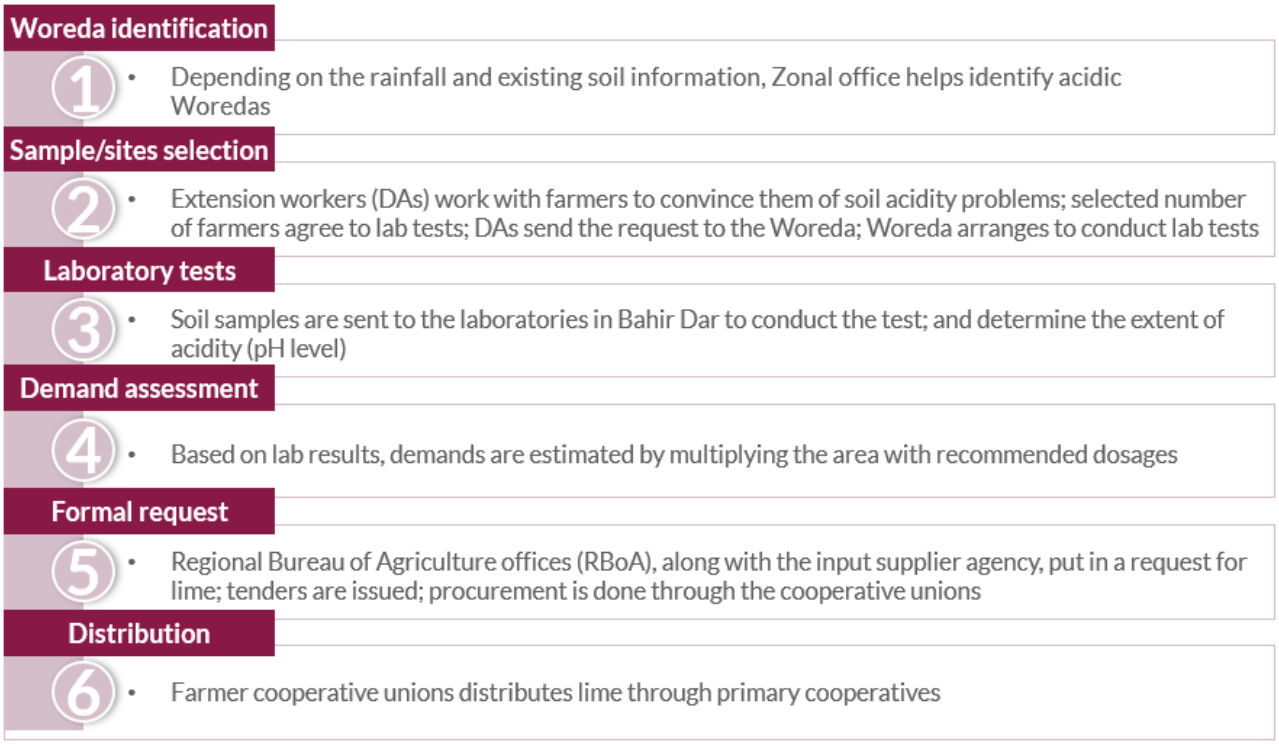
As noted in this report, this requires supportive policies, informed by a diagnosis of the current situation and relevant financing mechanisms to enable private sector investment to achieve sustainability and growth in the sector. Based on our findings on the supply side, the specific technical areas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

- Supportive policies, incentives, and regulatory environment to encourage investment in all segments of the value chain
- Strengthened government support for the training and capacity building of extension workers, farmers, and input providers, including farmers cooperatives, unions, and private sector actors
- Effective multi-sectoral coordination for the implementation of the newly established Lime Supply System
- Improved access to quality inputs at reasonable costs and when required by a wide range of farmers
- Improved access to and use of mechanization services by the current government-owned lime processing plants
- Improved access to agricultural finance by all target groups at a reasonable cost.

[118] National Bank of Ethiopia Annual Report, 2018/19
[119] USAID, Agriculture and Food Security: Ethiopia, 2021
[120] MoA, Agriculture Sector 10-year Development Plan, 2020
[121] National Planning Commission, Growth and Transformation Plan II, 2016 [GTP II], pg. 80

VI. ANNEX

Six Distinct Steps Involved in the Planning process of lime production, marketing, and distribution[122]



Production capacity of government-owned lime processing plants for production year 2010/11[123]

	Dejene Lime Crusher – Amhara region	Guder Lime Crusher – Oromia region	Butajira Lime Crusher – SNNP region
Number of crushers	2	2	1
Average annual production plan	5,000	4,000	3,0000
Annual crusher capacity (tons)	7,488	7,488	3,744
Actual annual production (tons)	2,400	1,600	600
Deposit location from production site	1 kms	50 meters	1 kms

[122] IFPRI, EIAR, Soil Acidity Problems in Ethiopia: Magnitude, Current Awareness and Practices, and Policy Actions, 2016

[123] ATA, Strengthening Acid Soil Management System in Ethiopia, Sub-sector Diagnostic, Production, Distribution, Use and Application of Lime, 2015. Note: there is a need to undertake further research to update this data

Stakeholders consulted

Name of Organization	Job title
Ministry Of Agriculture	Director of Research in the Natural Resources Management Department
Ministry Of Agriculture	Director of Soil Fertility Directorate
Ministry Of Agriculture	Director of Input and Marketing Directorate
Ministry of Trade and Industry	Director of Chemicals and Construction Inputs Industries Development Institute
Agricultural Transformation Agency	Associate Case Team Lead
Amhara Bureau of Agriculture	Director of Amhara Bureau of Agriculture Directorate
Oromia Bureau of Agriculture	Director of Oromia Bureau of Agriculture Directorate
Dejen Lime Factory	Manager of Dejen Lime Factory
Dashen Cement	Marketing Lead for Dashen Cement
GIZ	Project manager
GIZ	GIZ experts
International Food Policy Research Institute	Senior research staff
OCP Ethiopia	Junior analyst
OCP Ethiopia	Agroeconomists

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