Assessment of Fertilizer Distribution Systems and Opportunities for Developing Fertilizer Blends ETHIOPIA

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IFDC
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This assessment was conducted by the International Fertilizer Development Center (IFDC) and the African Fertilizer and Agribusiness Partnership (AFAP) for the Alliance for a Green Revolution in Africa (AGRA) as part of a consultancy for Assessment of Fertilizer Distribution Systems and Opportunities for Developing Fertilizer Blends. The views, information, and opinions expressed in this assessment are those of IFDC and AFAP and do not necessarily reflect the official policy or position of AGRA.

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Acronyms & Abbreviations

AFAP	African Fertilizer and Agribusiness Partnership
AGP	Agricultural Growth Program
AGRA	Alliance for a Green Revolution in Africa
AMDe	Agribusiness Market Development
ATA	Agricultural Transformation Agency
B	boron
CASCAPE	Capacity Building for Scaling up of Evidence-based Best Practices in Agricultural Production Programme
CIMMYT	International Maize and Wheat Improvement Center
CNLS	Conseil National de Lutte contre le SIDA
DAP	di-ammonium phosphate
EABC	Ethiopian Agricultural Businesses Corporation
EIAR	Ethiopian Institute of Agricultural Research
EthioSIS	Ethiopian Soil Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ha	hectare
ICL	Israel Chemicals Ltd
ICRAF	World Agroforestry Center
IFDC	International Fertilizer Development Center
ITS	Input Tracking System
IVA	Input Voucher Sales
K	potassium
METEC	Metals and Engineering Corporation
MoANR	Ministry of Agriculture and Natural Resources
MOP	muriate of potash
MT	metric ton
N	nitrogen
NGO	non governmental organization
NML	New Markets Lab
NPS	nitrogen phosphorus sulfur
OCP	Office Chérifien des Phosphates
OFRA	Optimizing Fertilizer Recommendations in Africa
P	phosphorus
RBoA	Regional Bureau of Agriculture
SNNPR	Southern Nations, Nationalities and Peoples' Region
SOP	Sulfate of potash
SSA	sub-Saharan Africa
TSP	Triple super phosphate
USAID	United States Agency for International Development

Assessment of Fertilizer Distribution and Opportunities for Developing Fertilizer Blends in Ethiopia

Introduction

In the performance of this assessment, we conducted interviews with key informants in Ethiopia, including representatives of the Agricultural Transformation Agency (ATA) including soil scientists, agronomists, the EthioSIS mapping team, and the Transformation Agenda Specialist; OCP agronomists and business project managers, representatives of GIZ, the Africa Rising (CIMMYT) project, and IPNI; and representatives of the Ethiopia Agricultural Research Institute. We reviewed documents from OFRA and communicated with the OFRA head in Ethiopia regarding specifics of implementation. We also reviewed literature relating to teff agronomy and fertilizer response in Ethiopia, and documents from the Africa Rising project in Ethiopia.

Available Soil Information

Soils in Ethiopia have been mapped in considerable detail using spectral methodologies, with nutrient concentrations calibrated with the Mehlich-3 method for P, K, Ca, Mg, S, Zn, B, Cu, Mn, and Fe. This work began under the Agricultural Transformation Agency (ATA) project and continued under EthioSIS. Soil fertility status and fertilizer recommendation atlases are completed for the regions of Amhara, SNNPR, Tigray, Harari and Dire Dawa Administration. Work is ongoing for Oromia region (soil fertility status and fertilizer recommendation atlas/ map production). Benishangul-Gumuz, Gambella, Afar and Ethio-Somali regions' atlas/map production are remaining.

Rationale for Why Available Fertilizer Products Were Developed

The fertilizers available in Ethiopia (Table 1) came about through a rather convoluted process. Based on the maps, Ethiopia came up with multiple fertilizer formulations based strictly on the mapping results. These were eventually narrowed to 7 formulations meant to cover the majority of Ethiopian soils. No trial work was done to validate these formulations, which were based strictly on the spectral data, and under the assumption that the analyses obtained therefrom were diagnostically correct, rather than indicative of response. The error in this assumption was further compounded by using the same deficiency criteria for all cereal crops; this is clearly not the case for maize and wheat, and the criteria for teff have not yet been developed.

Table 1. Fertilizers available in Ethiopia and volumes sold for the 2016-17 season, based on distribution

Fertilizer Formulation	Description	Volume Sold (MT) 2016-17 Season
NP 19 38 0 + 7S	NPS	238,191
NP 18.9 37.7 0 + 6.95S + 0.1B	NPS with added B	377,527
NP 17.7 35.5 0 + 7.6S + 2.2Zn	NPS with added Zn	12,652
NP 17.8:35.7+7.7S+2.2Zn +0.1B	NPS with added Zn and B	63,455
DAP NP 18:46:0	DAP	-
46:0:0	Urea	459,285
0:0:60	KCl or MOP	3,728
TOTAL		1,154,838

Omission trials conducted under the AMDe project (funded by USAID and designed by IFDC) showed that in wheat, response was often obtained to S, Zn, B, and Cu where strict interpretation of the soil analysis was not indicated. The implication is that using what are considered critical levels could be misleading regarding actual response, and that yield potential loss would result if soil analysis is used as a strict guide to address deficiencies, at least using the deficiency criteria employed. One reason more research was not carried out was poor funding and technical support for the Ethiopian Institute of Agricultural Research (EIAR). EIAR is mandated to conduct this research, which could not be done by ATA due to institutional mandates.

ATA did, however, evaluate 2 blended formulations and NPS 19:38:0 +7S at thousands of sites. The blends did well relative to DAP, though applied at twice the rate, as they contained K, S, and other micronutrients; thus, rates were doubled to maintain P equivalence. Blending was initiated at a facility run by a farmer's cooperative, as private operation of blending facilities was not permitted by the government. Some errors ensued, probably the most serious of which was the procurement of $10,000,000 worth of a boron (B) product of the wrong particle size, causing serious segregation in the bags, the result of which was no boron at the top of the bag and likely toxic quantities at the bottom. Because distribution channels were not well-established (now having to go through a blending unit rather than through already channels established for DAP and urea), the blends were reaching few farmers.

To deal with this situation, the government formulated and procured 4 multi-nutrient compounds (shown in Table 1), and these were distributed based strictly on mapping units. All are NPS-based; that is, there are no compounds available in Ethiopia that do not contain S. Sulfur, being a secondary nutrient, displaces about 20% of the fertilizer P in comparison to DAP; this effectively means that to maintain the P application compared to DAP, rates must be increased by 20%.

Types of Fertilizer Recommendations that are Available, and Their Suitability for Staple Crops and Agro-Ecological Zones that are Targeted by AGRA

Table 2 shows the nutrients extracted for given yield targets we believe routinely achievable for AGRA priority crops in Ethiopia, along with nutrients supplied in government and fertilizer company offerings.

We heard several accounts that the new compounds are performing under expectations relative to DAP in initial evaluations, though these accounts are not firm data. We also had reports that some farmer cooperatives wanted DAP back. This seems to be because the same application rates are being advised for the new compounds as for DAP (100 kg/ha). As the table shows, these rates will necessarily lead to lower and sub-optimal P application. We are also not clear that this is well-understood in the Ethiopian agricultural community. In order to evaluate the effects of S and other micronutrients and for farmers to receive their full benefit, their addition cannot be at the expense of P. A clear understanding needs to be developed and communicated that when additional nutrients are added to formulations, somewhat higher overall application rates are required to realize their benefits.

Generally speaking, this amounts to 125 kg of NPS-based compounds per 100 kg of DAP (as shown in Table 2). The original DAP/urea application recommendation of 100 kg of each basically amounts to 2 bags of each; while a simple recommendation to understand, it does not provide sufficient P relative to other nutrients when applied to the new compounds. Our best estimate is that it would require 125 kg/ha of any of the basal formulations and 150 kg/ha of topdress urea to offset nutrient uptake of yields of 5 MT//ha of either maize or wheat or 4 MT/ha of sorghum.

Table 2. Nutrients extracted for given yield targets and nutrients supplied in government recommendations for AGRA priority crops

Crop	Yield	Appl. rate (kg ha^{-1})		N	P_2O_5	K_2O	Ca	Mg	S	Zn	B	Cu	Mn	Fe
		Basal	Top dress											
	Mt/ha			----------Nutrients removed in crop and residue, kg ha^{-1}----------										
Maize	5			100	46	121	13	21	13	0.23	0.24	0.07	0.73	0.36
Wheat	5			155	53	124	8	23	20	0.43	0.12	0.07	0.57	0.92
Teff	3			Unknown, tentatively assumed to be similar to wheat										
Sorghum	4			120	41	86	14	11	14	0.13	?	0.02	0.11	?
Beans	2			96	27	80	63	15	7	0.10	0.10	0.01	0.16	0.07
			(urea)	----------Nutrients supplied in recommendation, kg ha^{-1}----------										
Previous reccommendation /DAP		100	100	64	46									
Government recommendations at DAP rate		125 DAP	100											
NP 19 38 0 + 7S		100	100	65	38	0	0	0	7	0	0	0	0	0
NP 18.9 37.7 0 + 6.95S + 0.1B		100	100	65	38	0	0	0	7	0	0.10	0	0	0
NP 17.7 35.5 0 + 7.6S + 2.2Zn		100	100	64	36	0	0	0	8	2.2	0	0	0	0
NP 17.8:35.7+7.7S+2.2Zn +0.1B		100	100	64	36	0	0	0	8	2.2	0.10	0	0	0
Balanced for N and P (Maize, sorghum, wheat)				----------Nutrients supplied in recommendation, kg ha^{-1}----------										
NP 19 38 0 + 7S		125	150	93	48	0	0	0	9	0	0	0	0	0
NP 18.9 37.7 0 + 6.95S + 0.1B		125	150	93	47	0	0	0	9	0	0.13	0	0	0
NP 17.7 35.5 0 + 7.6S + 2.2Zn		125	150	91	44	0	0	0	10	2.8	0	0	0	0
NP 17.8:35.7+7.7S+2.2Zn +0.1B		125	150	91	45	0	0	0	10	2.8	0.13	0	0	0
Additional KCl		50				30								
		100				60								

We learned that farmers in areas with high potential may apply up to 300 kg/ha of the basal formulations, while poorer farmers apply less or no fertilizer (one estimate is that 40% of farmers do not use fertilizer, with accessibility, package size and lack of credit being major constraints). Our sense of the new compounds is that they have too much Zn in them, which can in a few years result in excess Zn accumulation in the soil. It is also expensive and wasteful. In compounds, 0.5-0.8% Zn is usually adequate, since the Zn is well-distributed. In blends, rates of 1 to 1.5 kg Zn per ha may be more beneficial because the Zn sulfate granules are poorly distributed. This is less a problem for maize, where fertilizer is concentrated near the plant, than for crops such as wheat and teff, where fertilizers are broadcast.

Regarding the B rate, it may be too low to maintain B, given crop removal levels, and may not be giving optimal response. One cannot assume 100% B use efficiency, as it is a somewhat mobile nutrient, subject to leaching.

No fertilizers have potassium. Potassium is available as KCl, which can be applied separately at basal application. There is some logic behind not including it in any blends. Potassium is not required everywhere, and thus far, response to K has shown to be difficult to predict: Some farms are responsive, and some farms not, and that response seems to be difficult to predict by region or by crop, soil maps notwithstanding. This may be due to inherent farm-level variability. If it were in blends, it would add substantially to the rate of fertilizer that needs to be applied. Nevertheless, K response has been demonstrated on a number of AGRA priority crops—particularly wheat, beans, maize, and teff; it is only that the response has not been sufficiently consistent or predictable to include it in a blend.

There is no specific bean formulation, and we were told that it is not a government priority; farmers are relying on residual fertilizer from their cereals fertilization for most legumes, including beans. The current fertilizers could reasonably meet N, P, S, Zn, and B demands of beans if applied at 50-100 kg/ha, and like cereals may benefit from KCl. Inoculation with rhizobia should be encouraged to supply N. Beans would certainly benefit from lime in acidic regions, as they are sensitive to both Ca deficiency and aluminum toxicity at low soil pH values.

Teff is a more complicated crop for several reasons and needs some research. Yields of new teff varieties have achieved yields of up to 3.6 MT/ha in isolated field experiments, but no systematic omission trials have been done. In one innovative experiment, yields of a remarkable 8.8 MT/ha were achieved, but with some practical constraints: the heads were so heavy that plants had to be supported with ropes to prevent lodging losses. Plant spacing was a major factor in attaining high yields in that experiment and was achieved by transplanting to a 20 x 20 cm pattern, also a major practical labor constraint. In that same experiment, response to Zn and Cu were noted; from other experiments, response to S and K can be inferred. The main constraint to increased teff yields seems to be genetic: the plant cannot support heavy heads, and hence lodges. Some efforts have been made to breed short-stature teff to reduce lodging but have yet to be finalized. While a short-stature variety was achieved, it was rejected due to the number of tillers; however, this may not be a constraint in a line- or pocket-planting arrangement, as in such an arrangement, tillering is still far above that achieved with broadcasting, the traditional way of teff planting. The high yield potential suggests that both agronomic work around plant spacing and breeding work to achieve stockier plants could drive teff yields higher. Using varieties that exist, a well-designed omission trial could provide vital information on maximizing fertilizer response to teff.

Gaps that Need to be Addressed to Come Up with Area and Crop Specific Blends

The most serious constraint to area- and crop-specific formulations is that, due to the history of how the current compounds came to the market, they have never been properly validated, and it is very possible that they are not being properly targeted. We are particularly concerned about the low threshold for soil Zn (<1.5 ppm) that was applied for targeting Zn-containing fertilizers. Experimentation on wheat (Ethiopia) indicated profitable and significant response to Zn when soil Zn levels as high as 25 ppm. Yet, Zn is only in 11% of the NPS-based fertilizers being sold to farmers (calculated from Table 1). Targeting is based on strict map interpretation, with usually only 2 blends available for farmers to choose from. Lack of Zn resulted in significant wheat yield loss in IFDC trials. In SNNPR, the region where highest soil Zn levels were recorded, omission of Zn (costing about $4/ha) nonetheless resulted in average loss of wheat of 800 kg/ha, valued at $188/ha. This low threshold might also affect maize, sorghum, and teff.

The consumption of K fertilizers in Ethiopia is the lowest in Africa relative to N and P, in spite of the fact that KCl is available to farmers. Yet, K response has been observed in a number of crops in Ethiopia. A serious gap exists in predicting where K will respond, and on which crop.

We received some initial feedback regarding validation work being undertaken by EIAR that in some locations, new blends were under-performing DAP—this is similar to farmer feedback and a cause for concern. There may be several reasons for this:

1. If validation work is undertaken using the same rates for DAP and the blends, then the P being applied in the blends will be less than the P applied in the DAP. This may reflect a lack of understanding of the fact that because the new fertilizers have additional nutrients in them, they must be applied at a slightly higher rate to get the added benefits of the secondary and micronutrients in them.
2. The B concentration in those blends that contain B may be too low to induce optimal response.
3. The blends are poorly targeted. Blends are targeted based on the EthioSIS maps and assumed critical values; the critical values chosen are the same for all crops. It is possible that Zn and B are not being applied where they should be, and some evidence exists to support this from IFDC trials with wheat and maize. Critical values to target need to be validated rather than assumed to be an absolute guide.

In severely acidic soils (primarily in western Ethiopia), addressing acidity constraints is important. Blends will be only marginally effective where soil acidity constraints limit fertilizer response. Based on Ethiosis current spatial prediction of soil fertility status (preliminary), nearly 25% of Ethiopian crop lands are acidic ($pH \leq 5.5$). Identified lime sources in Ethiopia are calcitic, and will not address magnesium (Mg) deficiencies which become more prevalent in low pH soils. Probably the least expensive way to address Mg deficiencies is with foliar applications.

Fertilizer Companies and/or SME Blenders Existing in the Country and the Geographies Targeted by AGRA

Five blending plants exist in Ethiopia that are well-equipped to produce blends. However, for practical purposes, they are not engaged in blending and distributing fertilizers for smallholders for reasons mentioned above. Our understanding is that arrangements are being made between OCP and the government of Ethiopia to operationalize these blenders, but that the current strategy centers around using blends to supply farmers in close proximity to the plants. We calculate that these 5 blenders, operating 8 hours per day and 150 days per year, could blend 300,000 MT annually. The current demand (excluding NPS, which does not need to be blended) is 450,000 MT. Fertilizer demand is expected to almost double by 2020.

Inventory of Partners and Ongoing Efforts or Investments that are Promoting the Availability of Appropriate Blended Fertilizers that AGRA can Leverage in the Target Countries

A list of potential partners and key country contacts is in Appendix I.

Bottlenecks in Fertilizer Distribution Systems, and Interventions that AGRA and Its Partners can Implement to Help Farmers Access Quality Fertilizers

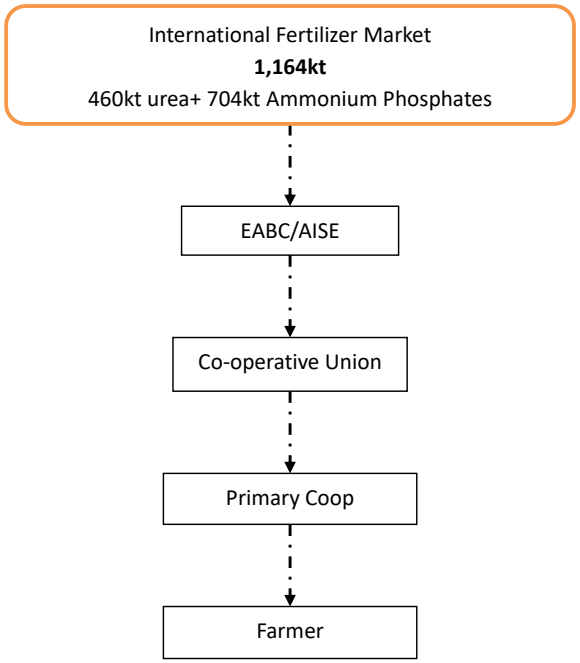
The fertilizer market structure and SWOT analysis of the market are shown in Figures 1 and 2 respectively.

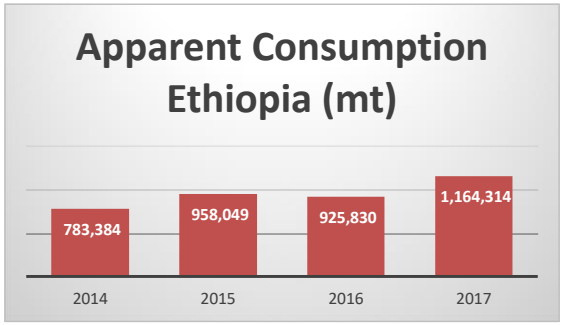
Market Characteristics

The Ethiopian Fertilizer market is characterized by strong growth, with volumes increasing from 350k tons in 2004 to 1.1 million tons in 2017 and forecast to grow to 2 million tons by 2020 (GPT2 forecast). The developed market from 2 products (DAP and urea) in 2012 to 11 in 2017.

The Ethiopian Government puts strong focus on the fertilizer sector, which includes recognition of soil acidity constraints a liming program to rectify them. Ethiopia led the development in soil-specific fertilizers (targeted to cereals) beginning in 2014. Operational and capacity issues within government institutions and poor interactions between them initially led to weaknesses in the blended fertilizer value chain, including challenges in ingredients procurement, distribution of blended product, and research support. Adjustments were quickly made, which led to an agreement with OCP to manufacture and import 4 NPS-based compounds, containing various combinations of Zn and B to address combinations of deficiencies identified from soil analysis and verified to a degree by fertilizer response trials. This led to a surge in NPS-based (no K) products from 2015, which now have completely replaced DAP, as per Government policy. Potassium (K) is provided separately to farmers, who can supplement the granular fertilizers according to perceived need. Fertilizer choice is limited at individual distribution points and is based on interpretation of soil spectral maps.

ETHIOPIA FERTILIZER DISTRIBUTION SYSTEM





	Fertilizer system	Volume (mt)	%
	Bulk Plantation		
	Bulk Anchor		
	Bulk Government	1,164,000	100%
	Private		
		1,164,000	

Figure 1. Ethiopian fertilizer distribution, system, apparent fertilizer consumption, and distribution volumes through various fertilizer systems

	Strengths	Weaknesses	Opportunities	Threats
Manufacturer	• Strong international interest by multiple parties	• High logistical cost for Potash from the Danokil may prevent development	• Both Yara and ex ICL(released rights) have SOP/MOP deposits in the Danokil depression. These are being evaluated currently, Opportunity for export and domestic use. • OCP evaluating a 2.5 Mill ton NPK complex at Dire Dawa • Yalu (Metec) urea plant suspended	• Government policy regards private sector participation and protection • Gas availability from Ogaden basin doesn't materialize
Importer	• EABC Sole importer, low cost build up • Relationship with the international fertilizer community • Strong Government relationships • Good relationships with wholesalers	• Port restrictions, trucking restrictions, meaning 12 month imports—high working capital • Single price point for year • No capacity or incentive in the distribution chain • Significant drain on Forex. Restricted access to private importers	• New Prime Minister who has questioned some of the controls in the distribution system • Approval of the Draft Fertilizer Proclamation as outlined in the 'legal Guide to strengthen the Ethiopian Fertilizer market" • Explore finance opportunities	• Government failure to adopt new Fertilizer proclamation • Forex scarcity or control
Blender	• 5 Blending Plants • Significant soil mapping done • Strong support from OCP with compounds	• Blending plants not operational. OCP discussing proposal to operate—need change to regulations • Lack of operational capacity of blending plants. • Lack of technical knowledge of soils, blends and blender management • Poor coordination between research/extension departments—limited validation • Constrained by centralised decisions	• Specialty blends to improve productivity with the introduction of micro-nutrients—build range, validate formulations • Build capacity/training in fertilizer technologies, plant operations (commercial and technical), fertilizer quality and farm advisors. • Draft Fertilizer proclamation allow expert participation in the fertilizer space	• Operational efficiencies in blending plants cannot be achieved
Distributor	• Broad distribution network of Primary coops • Low cost operations	• Product knowledge • Governance (management systems and capacity)	• Farmer finance • Retail (last mile) development –demand creation • Farmer education	• Crop specific blending will shorten the distribution chain

Key Takeaways:

1. Ethiopia fertilizer demand has increased rapidly to 1.1Mill ton in line with GTP2 targets, placing pressure on forex availability.
2. The development of the blending industry has stalled because of capacity constraints in all sectors of the value chain(product knowledge, technological requirements, validation of formulations, blender operations and farmer demand creation, disjointed approach between partners)
3. OCP Government to Government agreement have assisted in alleviating many of the constraints and building confidence in private sector assistance. Providing compounds that address a number of the nutrient deficiencies, terms to assist, develop local manufacture capacity, propose to manage blending plants. Has made it difficult for multiple partners to develop competitive approaches

Figure 2. SWOT analysis of the Ethiopian fertilizer value chain

The arrangement with OCP is ground-breaking, and a good example of technology and product change that has occurred to satisfy a market need. Prior to the Ethiopian need, few international phosphate manufacturers manufactured ammonium phosphates with sulfur and micronutrients. Currently most of the major manufacturers manufacture these products. The supply chain is public sector controlled through a number of government institutions (Figure 3).

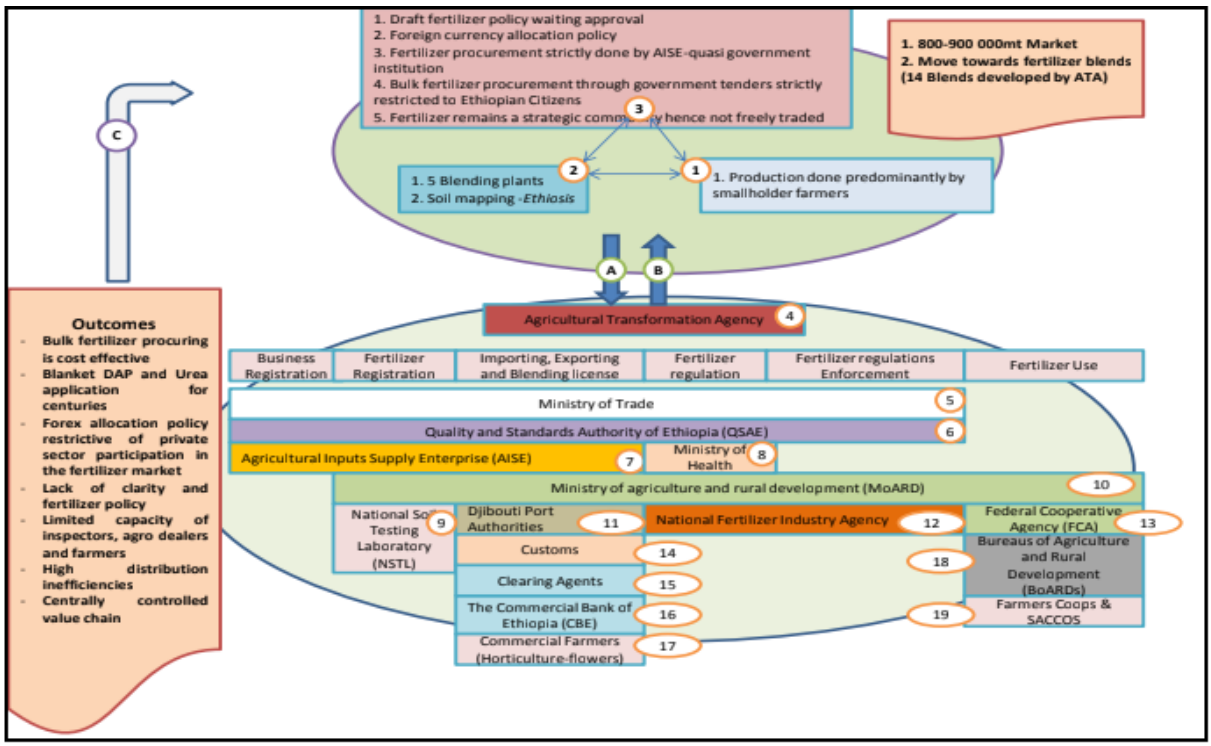


Figure 3. Ethiopian Fertilizer Institutional framework. (Source "A Review of National Fertilizer Regulatory Authorities in Ethiopia" –USAID, AGRA, NML AFAP 2016)

There are a number of inefficiencies in the overall fertilizer supply chain that will likely impact on balanced fertilizer products simply because they are part of the product mix. These will likely be exaggerated as the growth targets in AGP2 increase. They include high carry-over of stock, freight inefficiencies associated with a 12 month import cycle, logistical constraints and inefficiencies associated with low compensation paid for activities undertaken by cooperatives. These need deeper evaluation as part of developing a country roadmap.

Supply Side Constraints for Blended Fertilizer

In Ethiopia limited volumes of blends are available, because plants are not operating, as outlined above. This should not be construed as a lack of availability of multi-nutrient fertilizers, which are supplied as 4 compounds which can be combined with K by farmers to form 8 multi-nutrient combinations. It should be noted, however, that few farmers purchase K (supplied as KCl) despite its availability, and on a per-nutrient basis, Ethiopia is the lowest

K consumer in sub-Saharan Africa. Targeting K application to achieve response is a challenge.

Previous government estimates were that up to 18 blending plants would be required to supply Ethiopia's markets efficiently. However, the landscape has changed with multi-nutrient compounds, which Ethiopia can import in sufficient volume to be economical. The compounds being delivered are highly concentrated, so it is not clear that blends will offer an advantage in cost, but could still offer advantage in terms of product diversity and fast response time; a blender can make a blend to order in a matter of days, which is much more responsive than annual procurement.

Lack of stock of blending ingredients, however, may hinder this. Products such as polysulfate, TSP, and other micronutrients (Fe, Mn) not currently in formulations may be required to meet the various demands posed by Ethiopia's diverse soils and crops but requires some research backing. Getting ingredients for research purposes is challenging in Ethiopia compared to many SSA countries.

Demand Side Constraints

- Farmer finance: MoANR/ATA are addressing this through various systems including regional direct financing, support for microfinance Institutions, and the development of an Input Voucher Sales system (IVS).
- Poor demand forecasting: ATA/MoANR are addressing this through the development of an Input Tracking System (ITS) to help Regional Bureaus of Agriculture (RBoA) to manage inventory. It is unclear at what stage this is at.
- Sensitization or awareness creation at farm level on the new blends, including training of cooperative members

Potential AGRA Activities in Building the Distribution System

There is a mandatory requirement to work with MoANR/ATA on the fertilizer systems delivery issues. This may require embedding staff with the organizations and providing professional support to the leads. This requires a team with fertilizer skills that is respected and can fulfill the different country and private partner needs, and importantly provide independent input.

Changes to the Fertilizer Proclamation are likely to see more private sector participation in the fertilizer industry in Ethiopia. There will likely be several international companies that will seek to participate in the market, requiring help in a number of areas.

OCP proposed to take over the 5 blending plant operations. The following skill sets will need addressing

- Development of agreed soil/crop fertilizer formulations, and interaction with ongoing research
- Stock management: demand planning, and proper storage to assure quality
- Commercial aspects
- Operational processes: how to run blending plants.
- Building markets: training extension and farmer sensitization

- Logistics

AGRA should work with OCP and other private companies to help deliver on mutually defined goals.

Policy Bottlenecks that are Affecting the Availability of Blended Fertilizers, and Interventions that AGRA and Its Partners could Design and Advocate for Implementation to Help Farmers Access Appropriate Blends

The Country Action Plans outlined in the AFAP (2016) document "Support for the Establishment of a Regional Policy and Regulatory Framework" and in the AGRA/NML/AFAP document "Legal Guide to Strengthen the Ethiopian Fertilizer Market, Dec 2016" are all relevant and well-articulated. These are presented in Appendix II. In summary the key issues relevant to development of blends are:

- The need for "one-stop shop" for regulation.
- The need for regulations in the Fertilizer Proclamation.
- The need to develop standards for blends.
- The need to build the capacity of cooperatives to be able to operate in an efficient manner, including review of margins for activities.
- The need to streamline the requirements for fertilizer registration.
- The requirement to review forex currency allocation laws that currently are prohibitive for private sector to partake in the fertilizer sector.

Many of these manifest themselves in the distribution constraints listed above.

AGRA can support MoANR/ATA with technical expertise to:

- Support the development of regulations.
- Develop fertilizer specifications and blending standards.
- Build the capacity of cooperatives. Depending on the outcome of the OCP proposal to operate the blending facilities or not, AGRA can provide assistance to train in operation. (This was originally a component of the USAID grant but failed because the grantee did not have the capacity to undertake the work).
- Provide technical support on fertilizer registration regulations.

AGRA should support a highly professional and experienced fertilizer operations team that can provide independent advice at a high level and source implementation teams and skills as required. This team can operate across countries and build a strong brand that governments can rely on for advice. This team should develop a road map for the country based on stronger understanding of the needs and actors.

There are signs the new Prime Minister of Ethiopia is receptive to outside interests in Ethiopia, having opened up of telecommunications and state-owned airlines. This could open up significant opportunities with a number of international entities interested in playing a role in developing a manufacturing base and growing the domestic market. It is not possible (nor correct) to guess what the outcomes may be, but they may occur quickly, and include a number of the activities outlined above. These are all positive and AGRA should be

positioned to assist the Ministry of Agriculture and Natural Resources (MoANR) and ATA with technical support that allows these institutions access to respected independent advice that can assist in supporting quick transitioning plans to implementation.

There is an opportunity for AGRA to position itself to support the Ethiopian Government and private sector to assist this transition.

Manufacturing opportunities in Ethiopia that will play a big role in how the fertilizer systems develop:

- OCP is to build $3.7 billion NPK fertilizer plant at Dire Dawa by 2022, using gas from Ogaden Field, phosphates from Morocco, and potash from deposits in the Danakil depression.
- There are a number of potash deposits in the Danakil. ICL have walked away from their deposit. Yara has announced that they will proceed with a feasibility study on their deposit and should have a definitive decision in 2019. The export terminal at Tadjoura (Djibouti) is completed.
- The Ethiopian Government has cancelled the contract with METEC (The Ethiopian Military industrial complex) to build a urea plant at Yaya (based on coal). OCP has expressed some interest in taking on this role—it would seem they could do this from the Dire Dawa facility if they were to proceed based on Ogaden gas.
- Completion of the Grand Renaissance dam and the generation of excess electricity could potentially could be used for nitrogen manufacture.

Recommendations and Interventions that AGRA could Implement to Address the Availability of Quality Fertilizers

Huge investments in Ethiopia have been made in soil mapping, but practically no investments have been made in proper map interpretation and consequent development and validation of available fertilizer formulations, or development of critical soil test values that are indicative of deficiencies. Thus, the mapping done to date is under-utilized and perhaps mis-used, resulting in poor fertilizer targeting.

To address these gaps, we suggest the following as intervention areas for AGRA:

1. **Fertilizer formulations need to be evaluated regarding Zn and B levels** required for optimal response, as these nutrients seem out of balance. Partnerships are IFDC, OCP, and EIAR.
2. **Rigorous omission/best-bet trials** need to be conducted to validate and improve fertilizers to improve fertilizer targeting. In the Ethiopian context, these trials can be combined into best-bet trials with omission treatments. These are simple trials that have the appearance of a demonstration—one replication of 4-5 fertilizer treatments per site. Partnerships are EIAR, ATA, OCP, and IFDC. These trials should be combined with soil analysis so as to determine crop-specific critical values. In particular, we suspect that the Zn critical value is too low, resulting in Zn-containing fertilizers not being made available where Zn response is likely; they constitute only 11% of basal fertilizers. Additionally, the soil S analysis is suspect; the Mehlich-3 procedure used to evaluate S deficiencies has never shown a strong correlation with either S response or S uptake. Further, CNLS has since halved the critical Mehlich-3 S value based on their own experimental evidence.

This would show much of Ethiopia to be S-sufficient. Yet, there are no fertilizers without S, which takes a significant volume in the fertilizer and displaces P in formulations, thus increasing optimal application rates.

Omission treatments will shift the understanding regarding critical levels for different crops, provided that soil analyses are done at trial sites. This will aid in better fertilizer targeting.

Further, omission treatments will develop a better understanding of K response in relation to soil testing. Currently, the same K criterion is used for all soils and crops. Yet, for soils high in Ca and Mg, a different criterion needs to be used. Different crop criteria are also required; we know already that wheat is responsive at higher soil K levels than maize, though Ethiopia uses the same criteria for both crops (one that is more appropriate to wheat). No K critical value has been established for teff.

In areas where soil pH is low, lime should be used in best-bet and omission trials.

These trials can have a very simple design, such that they can be implemented on a massive scale by the extension services. In combination with soil analysis, these trials can potentially be used to re-define critical nutrient levels. This will require some capacity building in trial design, implementation, fertilizer mixing, and laboratory skills. AGRA must consider full-time project support to assure that these trials are implemented correctly, as it is a large and important investment in Ethiopia, and a necessary one to make the best use of the maps. It is the essential validation that has never been done in Ethiopia.

3. **Agronomy, breeding, and soil fertility constraints for teff need to be addressed through well-designed trials, in collaboration with universities and EIAR**: Agronomy, breeding, and fertilizers play complementary roles. Short-stature varieties are necessary to support heavy head weight and prevent lodging. We suggest that rejection of short-stature varieties already developed due to low tillering may have been premature, as high tiller numbers may not be required in a revised line planting arrangement—which still results in greater tillering than when broadcast. Omission trials in teff will help develop critical values while maximizing yield potential.
4. **Capacity-building in the fertilizer sector**: The capacity at OCP (the primary fertilizer provider) EIAR and agricultural universities needs to be developed to design and implement omission and best-bet trials. Trainings should be supplemented with implementation support when ingredients are selected, rates are determined, fertilizers are mixed, trials are designed, and soil test results interpreted. We believe that there are many Ethiopian agronomists and soil scientists with the technical capability to learn these skills, given our past interactions. EIAR has requested technical support, so the need is internally recognized.
5. **Capacity to analyze soil and plant material in-country**: The government has a substantial network of soil and plant analytical facilities, but the technical and business skills capacity to run these laboratories is weak. Methods and equipment differ from lab to lab, and no standards of quality control exist. As an initial step, the state of the laboratories needs to be evaluated. We would suggest a joint team including those with wet chemistry, spectral, and private sector (for business experience). CNLS Nairobi may possess all of these capabilities, but we suggest that their expertise would be well-supplemented by experts from ICRAF and IFDC to come up with recommendations

relating to renovation, a business plan, and accurate procedures for the diversity of soils that exist in Ethiopia. ICRAF has made remarkable progress in the area of spectral analyses of plant samples. This initial assessment should result in a joint proposal with the government of Ethiopia for lab renovation and staff training, which could form the basis for further AGRA investments.

6. **Lime commercialization**: There are two aspects to lime commercialization that AGRA can support. The first is lime demonstrations (in conjunction with balanced fertilizers) to create demand and gather data on economic returns to liming, which if done using different lime rates, could assist in eventual lime scaling up strategy. Both the government and GIZ are good implementing partners, as well as a variety of projects shown in Appendix I. GIZ's work on lime have indicated yield increases of 80%, with lime rates varying between 2-6 MT/ha.

   The second concerns investments to increase lime supply. Demand is estimated at 1.2 million tons annually. The government has 3 small lime crushers, each with a capacity of 60 MT/day; only one is functional intermittently due to a host of problems including power supply. Even with all three working at full capacity 300 days a year, these can only supply about 54,000 MT annually, or less than 5% of potential demand.

   Cement companies are better positioned to meet this demand. They have professional mining equipment and cement distribution channels that can usually deliver cement, a more expensive product than lime, at lower cost per MT than the current government lime facilities, where mining is still done by manual labor. AGRA should support this more commercialized approach. Discussions between the government and cement companies are underway, so how AGRA can support it could take many forms. GIZ is already involved in lime demonstrations, which could be expanded. Developing field test kits that can estimate lime requirements is another possibility.

7. **Fertilizer small packs of KCl**: AGRA has a fertilizer small pack intervention to create demand; in the Ethiopia context, this should be applied to KCl. Ethiopia has the lowest ratio of K to NP use in Africa. Since KCl is sold separately rather than as part of a blend or compound, many farmers do not invest in it. Small packs are a good way to increase demand. We understand that some of this is already being undertaken by Sasakawa Global 2000.

The Ethiopian agricultural sector is heavily government-controlled and undergoing rapid evolution. There as well may be other players in the suggested interventions. This means that investment priorities and partnerships can change rapidly, and some may be working on the suggested interventions. We advise thorough consultation with government and other partners to understand the investment landscape to maximize efficiency and find opportunities for co-investment.

Appendix I.
Potential Partners and Key Country Contacts in Ethiopia

Organization and Contact Details of Key Personnel	Organization Type	Regions of Activities	Brief Description of Activities as Related to AGRA Priority Crops
OCP Dr. Selamyehun Kidanu selamyihunkidane@gmail.com +251 966270092 Bogale Walelign bogalealene@gmail.com +251 916844119 Edosa Tamiru edmanlove@g,ail.com +251 967882275 Birkneh Abebe birkneh27@gmail.com +251 929531695	Fertilizer Company	Addis Ababa	OCP is the main basal fertilizer supplier in Ethiopia, and is finalizing agreements to manage blending facilities.
Agricultural Transformation Agency (ATA) Khalid Bomba khalid.bomba@ata.gov.et Mulugeta Demiss mulugetadem@gmail.com +251 911367005 Tegbaru Belete tegbish@gmail.com +251 912650175 Dr Awoke Mulualem aweke.mulualem@ata.gov.et +251 920803761	Public	Addis Ababa	Working on different projects related to fertilizer, including EthioSIS, blended fertilizer and other soil health related initiatives.
Ministry of Agriculture and Natural Resources Tefera Reta Wagary reta.wagary@ata.gov.et +251 911957585 Seifu Assefa seifuassefa68@gmail.com +251 911372467	Government	Addis Ababa	The Ministry has a soil health directorate which is working on fertilizer policy and regulation and fertilizer sector development

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Organizations in Fertilizer Supply and Distribution Ministry of Transport Ethiopian Maritime and logistics Ethiopian quality and standard Agency Ethiopian conformity assessment Agency Gashawu Tasfaye +251 911226446 gashawtesfaye@yahoo.com National Bank of Ethiopia Teshome Gebremariam Maritime affairs Authority Transport Authority Ministry of Economics and Finance Custom Authority RBoANR Representatives Tesfahun Mengistie/ Amhara tmengiste@yahoo.com +251 918701513 Tilahun Kebede/SNNPR Kiros Bitew / Tigray Seleshi Getahun /Oromia		Addis Ababa	Members of steering committee under the Ministry of Agriculture developing strategy and policies for fertilizer sector.
Ethiopian Agricultural Business Corporation Kafyalew Berhanu kefyalewberhanu@yahoo.com +251 911636810 Berhanu Awoke birhan.da@gmail.com +251 93009875	Government Parastatal	Addis Ababa	Sole importer of Fertilizer for the country.
Agricultural Growth Program II Keberu +251 911487092	Government	Addis Ababa	Largest government program working on increased agricultural productivity, commercialization, and dietary diversity at HH level. Also contributes to higher-level objectives of poverty reduction, climate change mitigation. Has a research component working on fertilizer.
CIMMYT Kindie Tesfaye k.tesfayefantaye@cgiar.org **Dr. Sam Gemeda** +251 930109573	International NGO	Addis Ababa	

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Ethiopian Institute for Agricultural Research (EIAR) Misteru Woldeyohanes misterutw@gmail.com Dr. Abebe Atlaw abebe.atilawg@eiar.gov.et +251 91103486	Government	Addis Ababa	Undertakes research on fertilizer and soil health. Technology Multiplication and Seed Research Directorate
Federal Cooperative Agency Osman Surur ussiraj@gmail.com +251 930106133	Government	Addis Ababa	Development and regulating cooperatives which are distributing 98 % of fertilizer in the country
USAID +251 111242438 +251 111306002	US government development	Addis Ababa	Supports fertilizer development projects including the blended fertilizer program in the country
ACDI/VOCA- FEED II project SNV +251 111262100	NGO		Involved in the blended fertilizer promotion and demonstration trials
Africa Rising Dr Kindu +251 911469056 Peter +251 922786316	CGIAR		Undertakes research on fertilizer recommendations
Eco-Green Liquid Fertilizer +251 912409799 +251 920 537828	Private		Liquid Fertilizer marketing
Farm Africa Ethiopia +251 115573325/317	NGO		Support farmers in different regions including fertilizer
Ethiopian National Soils Laboratory **Fikre Mekuria** +251 911348283	Public Lab		They undertake soil test Director
CASCAPE Dr. Eyasu Elias +251 911216258 eyasu.elias@CASCAPE.org	NGO		Dutch Government (Wageningen University) supported project working on transformation of appropriate agricultural technologies, value addition and scaling up of country wide proven technologies. They are implementing their project in collaboration with the Ministry, six Universities and other partners. Have fertilizer trials in different regions.
Becho Woliso Farmers Cooperative Union Tsehaye Kassaye +251 911003026 arsemasun@gmail.com	Cooperative	Oromia	The first blended fertilizer factory was established here. They have the Urea briquette project and also support from AGRA (teff, wheat)

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Gibe Dedesa Farmers Cooperative Union Negash Deti negashdeti@gmail.com	Cooperative	Oromia	Have a blended fertilizer plant and involved in Fertilizer distribution (maize, wheat, teff)
Oromia Farmers Cooperative Federation Askeberech Belayneh +251 929904689 askebelayineh@gmail.com	Cooperative		Involved in Fertilizer distribution and planned to import
Erer Farmers Cooperative Union Aklilu Metekia +251 930 516796 aklilumetekia@gmail.com	Cooperative		Fertilizer distribution (teff, wheat, chickpea)
Lume Adama Farmers Cooperative Union Tadele Abdi +251 911399595 tadeleabdi@gmail.com	Cooperative		
Merkeb Farmers Cooperative Union Setotaew Abaye +251 918341125 nardos52abate@gmail.com	Cooperative	Amhara	Have blended fertilizer factory and involved in fertilizer distribution (wheat, maize)
Damot Farmers Cooperative Union Getachew Eshetu +251 918082626 damotfcu@gmail.com	Cooperative		Fertilizer distribution (teff, maize)
Admas Farmers Cooperative Union Meserte Workie +251 918779122 admasunion@gmail.com	Cooperative		Fertilizer distribution (teff)
Melik Seltie Farmers Cooperative Union Kelifa Oulsero +251 911710760 kelifallzi@gmail.com	Cooperative	SNNPR	Have a blended Fertilizer factory and distribute Fertilizer to farmers through the primary cooperatives (wheat)
South Farmers Cooperative Federation Abebayehu Abebe +251 930069199 a_abebayehu@yahoo.com	Cooperative		Fertilizer distribution (wheat, teff, soybean)
Enderta Farmer Cooperative Union Goitom Tekeste +251 914301479 goitomkessete@yahoo.com	Cooperative	Tigray	Own Blended fertilizer factory and distribute fertilizer (wheat)

Organization and Contact Details of Key Personnel	Organization Type	Regions of Activities	Brief Description of Activities as Related to AGRA Priority Crops
Tigray Multipurpose Cooperative Federation Tewdrose Tesfahunenge +251 914721084 tedi1967n@gmail.com	Cooperative	Tigray	Distribute Fertilizer