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Study of Fertiliser Markets in Uganda

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Executive Summary

- Northern Uganda has enormous potential to become Uganda's breadbasket and a driver of export-driven growth in East Africa. While its recovery is moving in the right direction, agricultural productivity is still far below its potential. A key reason for this is the very low rate of adoption of productivity enhancing technologies including agro-inputs and fertilisers, especially by subsistence smallholders.
- Uganda's fertiliser consumption is among the lowest in the world. Its' market is small by African standards and currently well-below its potential. Uganda imported 61,000 mt fertiliser in 2016 and used 2.4 kg of nutrient per hectare in 2015, far from the Abuja Summit target of 50 kg of nutrient per hectare.
- This study analyses two distinct fertiliser value chains in Northern Uganda:
    1. The first is the most efficient path. Large commercial farmers and contract farming schemes import fertilisers directly from global traders and regional importers, minimising arbitrage. The delivered cost of 1 mt of UREA to Nwoya based commercial farms in May 2018 was $550, if it was directly sourced ex-Mombasa or ex-Nairobi, versus $595/mt via Kampala-based importers.
    2. The second path, which supplies small and medium sized farms, is far less efficient. National importers, based in Kampala and Mbale, import fertilisers from regional importers, where they are purchased by Northern Uganda based agro-dealers and sold on to farmers. This path involves considerable cost mark-ups and high prices to farmers. For example, in May 2018, the retail price of Urea at an agro-dealer in Gulu was $703/mt if sold in 50 kg bags and as high as $811/mt if broken down in 1 kg packs, which is a common practice.
- This study estimates the current size of the fertiliser market in Northern Uganda based upon point of sale data to be 6,083 mt/year in 2017. The vast majority of this (92%) is consumed by contract farming schemes (principally tobacco) and large and medium scale commercial farms (primarily rice and maize growers concentrated around Gulu/Nwoya/Amuru). Independent smallholder farms supplied by N. Uganda based agro-dealers account for only 1% (<100mt per year). Institutional buyers, the most significant of which is the Cotton Development Organisation, comprise the remaining 7%.
- The study explores the potential to expand fertiliser use in four key crops grown in N. Uganda – maize, sunflower, sorghum, and rice – chosen due to their significance to N. Uganda's agricultural sector. It analyses the production costs, profitability and market outlook for each crop, taking into account the differences for different farmer types and associated production techniques. The analysis concludes that the maize and rice sectors have the strongest market outlook and potential to drive fertiliser demand. Sunflower and sorghum will not play a major role for several reasons: sunflower mills and brewing companies prefer to maintain low input production methods and contract larger numbers of smallholders vs. increasing yields among a smaller set of farmers; the sunflower industry is promoting 'organic" and/or low input production (except improved seed); and the output market for commercial varieties of sorghum is limited to the brewery markets.
- The study projects that demand will grow over the next 5 years to an estimated 9,046 mt in 2022. Large and medium scale rice and maize farms will continue to be major drivers of fertiliser demand and will increase area planted by 3% for maize and 6% for rice annually. Tobacco production is expected to remain at 2017 levels due to regulatory barriers but demand from tobacco firms will continue to increase as they bring new land under maize and rice production to diversify their incomes. Smallholder demand will also remain negligible unless targeted schemes are launched in the region (e.g. the World Bank program that aims to subsidise fertilisers).
- The fertiliser value chain in Northern Uganda is constrained by a range of technical and political bottlenecks including:

    1. Low volumes, low and seasonal demand, and high transaction costs of dealing with small and medium scale farms limits the potential return on investment in fertiliser distribution in N. Uganda. This also creates opportunities for arbitrage that drive up prices to small and medium scale farms.
    2. High transport costs and lack of bulk handling capabilities (for commercial farms demand) result in higher prices.
    3. Lack of knowledge across the industry and at farm-level about the economics/profitability of fertiliser use for resource constrained

smallholders, as well as lack of soil testing and knowledge about the proper agronomic use of fertiliser (e.g. use of the wrong balance of nutrients for particular crops and soil conditions, e.g. pH) reduces benefits to farmers and profitability. This is compounded by the myth that Uganda's soils are perpetually fertile and messages promoted by the organic movement.

4. Fake, adulterated and low quality product is a pervasive problem (tests show quality problems at all points along the value chain including at import), which undermines farmers' trust and ability to realise the benefits of fertiliser use

- Despite these challenges, there is potential to expand the Northern Uganda fertiliser market. The study explored six investment hypotheses for expanding the Northern Uganda fertiliser market and prioritised and refined four[1], based on their feasibility (i.e. potential to attract private investment) as well as the potential for NUTEC to add value. Based on this analysis, ORI recommends that Palladium consider the following potential opportunities:

5. Establish an input-output hub in N. Uganda that would supply medium and smallholder farms with fertiliser and other inputs and purchase farm outputs. In line with this, Agriserv Ltd has indicated interest in investing in a hub that would sell fertiliser and other farm inputs and purchase or facilitate the brokerage/ buying of outputs (e.g. maize, sorghum and rice) from medium and small scale farmers, if NUTEC and others can provide catalytic grants for warehouse establishment and repayable working capital for the purchase of fertilisers.
6. Evaluate previous efforts to create demand with a view towards developing more effective approaches (e.g. soil analysis services, marketing a 'total package approach', debunking negative messages about inorganic fertiliser use).
7. Promote fertiliser packaging in quantities demanded by small farmers (1, 10, 25 kg packs in addition to the traditional 50 kg bags). This can be supported via underwriting additional capex investments and/or supporting marketing efforts to promote demand for the packs. In this regard, ETG is in the process of making the needed design and packaging investments. Grainpulse is already marketing 10 kg packs in addition to the 50 kg bags of its NPK blends. Both firms require assistance to create/enhance the demand of these packs, especially in N. Uganda where their penetration is still low.
8. Consolidate bulk fertiliser purchases by large-scale farms and contracting schemes to take advantage of scale efficiencies and obtain more competitive prices, for example by facilitating shipload purchases of fertilisers.

Uganda's fertiliser consumption is among the lowest in the world. Its' market is small by African standards and currently well-below its potential. Uganda imported 61,000 mt fertiliser in 2016 and used 2.4 kg of nutrient per hectare in 2015, far from the Abuja Summit target of 50 kg of nutrient per hectare.

[1]Investment hypothesis are those in which NUTEC and other actors can partner with 'pioneering firms'—firms that have the potential to transform the fertiliser and wider agricultural input industry through new or improved business models, new expertise or technologies, or other critical inputs and services. NUTEC can support the industry to overcome systemic bottlenecks by supporting these 'pioneering firms' through e.g. market development (e.g. via fertiliser demand creation), making catalytic investments to de-risk commercial capital and improve the attractiveness of the overall investment.

Purpose and Methodology

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This study aims to identify investment strategies that have the potential to catalyse large-scale adoption of fertilisers as a means to enhance the productivity and competitiveness of Northern Uganda's agribusiness sector.

	Approach	Activities
Value chain analysis	• Map the fertiliser value chain to identify points where there is greatest potential for innovation to unlock inefficiencies. • Calculate value chain actors' margins and the cost mark-up at each point along the value chain.	• Over 70 interviews with value chain actors including: Manufacturers, Global traders, Regional importers, National distributors, N. Uganda agro-dealers, Blenders, large commercial farms, contract farming schemes and smallholder farmers. • Gathered data on volumes traded, costs (esp fertiliser cost and transport) and margins.
N. Uganda demand sizing and growth	• Analyse the Northern Uganda fertiliser market outlook and demand growth drivers. • Estimate current demand and potential demand growth for four key crops (maize, rice, sorghum and sunflower) and for different types of farmer (large commercial, medium, small)	• Estimated current N. Uganda consumption based on volumes imported directly by large farm and contract farming schemes, and sold by N. Uganda ago-dealers. • Gathered data on key crops and farmer types and modelled potential demand growth.
Political economy & bottleneck analysis	• Analyse the political economy of N. Uganda and the fertiliser market to identify "hidden" constraints. • Identify the key technical and political constraints and value chain bottlenecks.	• Reviewed existing political economy analysis of N. Uganda and gathered primary information from industry experts and value chain actors on opportunities and constraints through interviews. • Interviewed key national, regional and district officials.
Investment hypotheses & prioritisation	• Identify and prioritise potential investment opportunities that are most critical to transforming the market. • Formulate recommendations for enabling private investment and boosting fertiliser demand and adoption in N. Uganda.	• Identified and analysed potential investment hypotheses that respond to market constraints and opportunities. • Prioritised 2-3 investment opportunities based upon criteria of (i) likely impact (ii) returns (iii) feasibility (iv) potential to attract private responsible investment (v) attractiveness and alignment for public/development sector support.

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The methodology included:

Primary data collection – This study is based primarily on on-the-ground interviews and surveys with farmers and fertiliser industry actors in Kampala and the three focus regions in N. Uganda (West Nile, Acholi and Lango). Primary data collected included:

- Point of sale data from importers, distributors and dealers supplying N. Uganda.
- Importers/distributors/dealers/transporters costs and margins.
- Farmer costs and margins for the four priority crops and by farmer type.
- Farmers' fertiliser use, including awareness of correct use (for safety and effectiveness).
- Perceptions of opportunities and constraints.

Secondary desk review – To complement this, existing fertiliser market studies, fertiliser policy documents, official sources of data on Ugandan agriculture and other materials were also reviewed.

Value chain and stakeholder mapping – The key value chain and political actors were identified and information gathered about their interests, constraints and opportunities to growth of the N. Uganda fertiliser market.

Data analysis and modelling – This included estimating current demand in N. Uganda, calculating the cost mark-up along the value chain, modelling the demand growth potential for key crops and farmer types, etc.

Triangulation and validation – Estimates and projections based on primary data were then triangulated and 'sense checked' against available official data.

Figure 1: Categories of stakeholders interviewed (See appendix for full list)

Global manufacturers and traders	**National importers and distributors**	**N. Uganda agro-dealers**
Fertiliser and agricultural market experts	**National ministries and regulatory authorities**	**N. Uganda regional and district officials**
Regional Importers	**Kampala and Mbale-based agro-dealers and distributors**	**N. Uganda commercial and small scale farmers**

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Uganda Fertiliser Market Overview

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Consumption versus targets

Uganda's fertiliser consumption is far below the targets required to meet agricultural productivity goals.

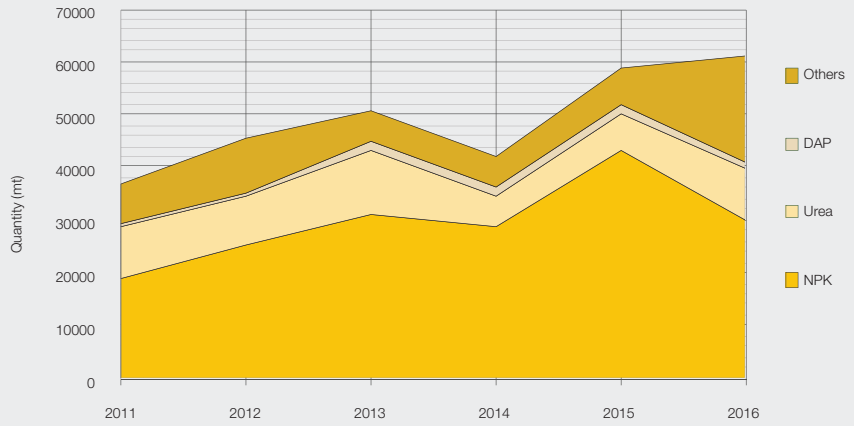
Overview

- Uganda's total market size was 61,000 mt in 2016. The overall trend for the last 5 years has been slow growth from about 37,000 mt in 2011.[1]
- Despite the global trend toward balanced crop nutrition and specialised fertilisers based on crop and soil conditions, Uganda's market is still heavily focused on straight fertilisers and basic NPK compounds.
- In 2016, 48.5% was NPK 17:17:17, and at least 27% were straight fertilisers. NPKs have been even more dominant in previous years (74% in 2015). [a]
- Uganda's use was approximately 2.4 kg nutrient/ha arable land in 2015 – an increase of about 1.1 kg/ha since 2002.[2]

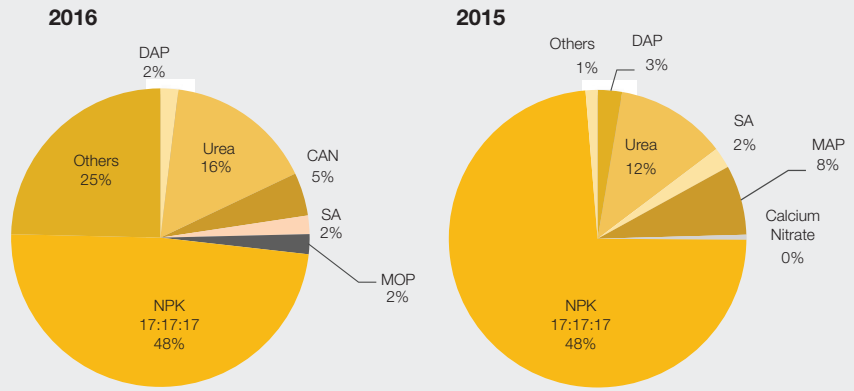
Fertiliser targets [3]

- At the Abuja Fertiliser Summit in 2006, African countries including Uganda committed to the target of 50 kg nutrient/ha per year.
- Uganda's nutrient depletion rates are among the highest in Sub-Saharan Africa, estimated at 80 kg nutrient/ha per year through topsoil erosion and nutrient export through harvested crop biomass.
- As is common throughout East Africa, Ugandan soils are very deficient in phosphorous. The MAAIF estimates Uganda will require 200 kg of phosphorus/ha per year.
- Kawanda Research Centre and other research institutions project that 30 kg nutrient/ha/year is a feasible target for Uganda by 2020. But there is little likelihood of achieving those targets with current efforts.

Uganda's fertiliser consumption (mt) by product. 2011-2016[1]



Top fertilisers used, 2015 & 2016[1]



[1]AFAP & IFDC, Fertilizer Market Situation Statement, 2015 & 2016. AfricaFertilizer.org, Uganda Fertilizer Statistics Overview, 2011-2014.

[2]World Bank Database, FAO data

[3]National Fertilizer Policy: Regulatory Impact Assessment, 2016.

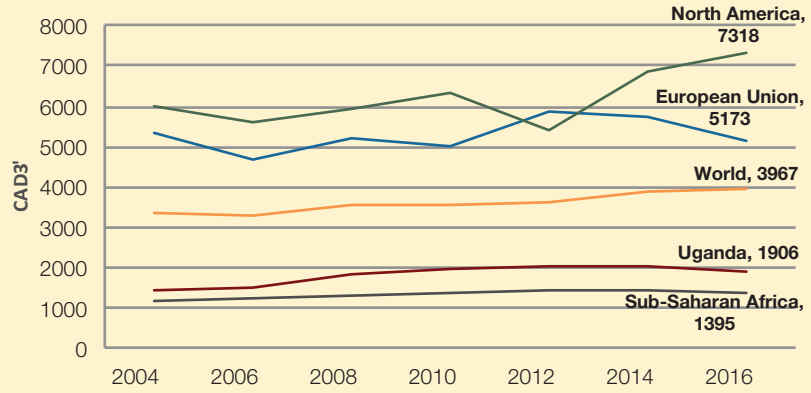
Consumption - comparison to global and African benchmarks

Uganda's fertiliser consumption is among the lowest in the world – low even by Sub-Saharan African standards. This is linked with its comparatively low yields and slow productivity growth.

Overview

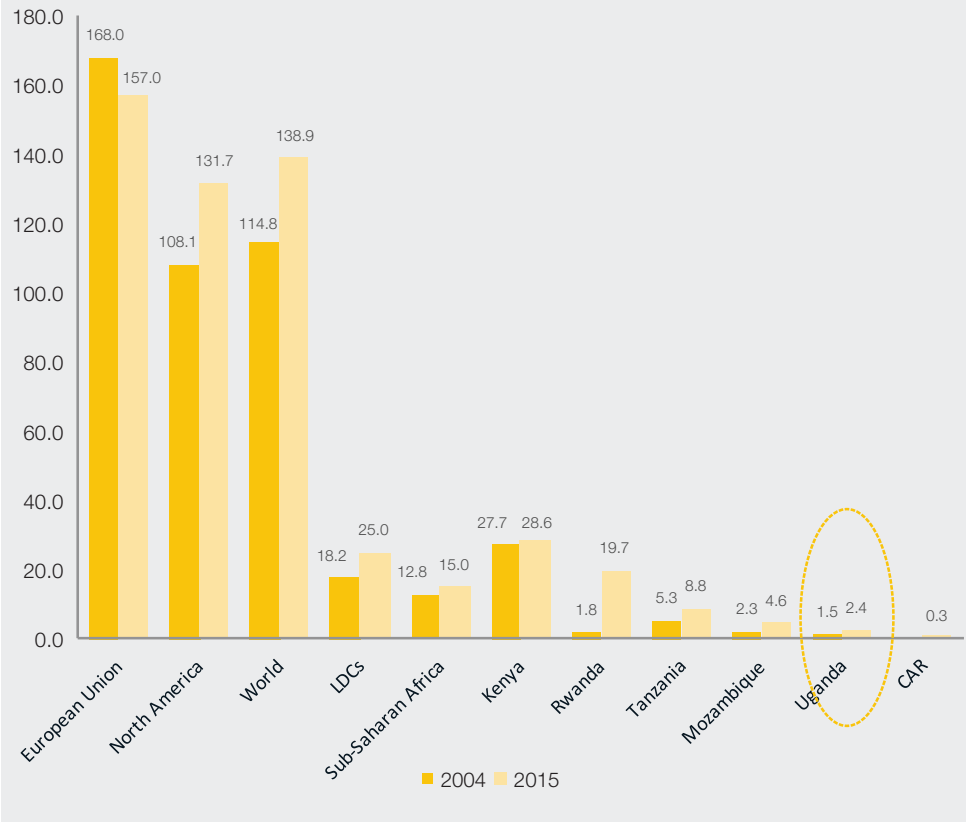
- Just ahead of Central African Republic, Uganda has among the lowest fertiliser consumption in Sub-Saharan Africa and the world.
- Uganda's crop yields are far below their potential and productivity growth has been slow over the last decade.
- For example, Uganda's cereal yield (incl. maize, rice, sorghum, wheat and other grains) was 1,906 kg/ha in 2016—up from 1,468 kg/ha in 2004 and above the Sub-Saharan African average—but less than half of the world average of 3,966 kg/ha. Sunflower in N. Uganda yields are on average approx. 950 kg/ha, compared with yields as high as 3,000 kg/ha in the US and Europe.[2]
- This is linked with its low fertiliser use, which can double or triple yields, as well as slow adoption of other productivity enhancing technologies.

Cereal yield (kg/ha), 2004-2016[1]



[1]World Bank database, FAO data.

Chart: Fertiliser use (kg/ha), 2004 & 2015[1]



[2]Impact Assessment of aBi Trust supported interventions, 2013, cited in NU-TEC Economic Appraisal, 2014.

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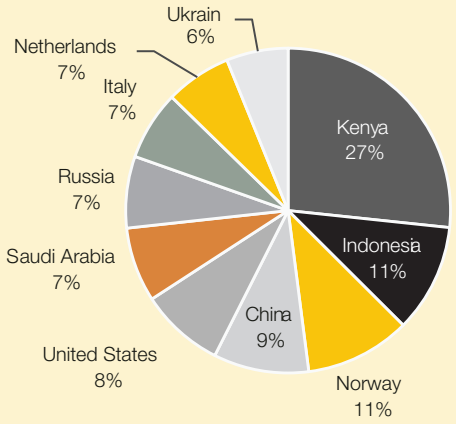
Imports and prices

All of the fertiliser used in Uganda is imported. Uganda pays the highest prices for fertiliser in the East Africa region.

Overview

- Uganda currently imports all of the inorganic fertiliser used in the country. Most Ugandan fertiliser imports are re-exports from Kenya.
- The Free on Board (FOB) price from international suppliers accounts for 44-53% of the Ugandan retail price (average prices Jan-April 2018) depending on fertiliser type. In other words, the Uganda retail price is around double the FOB price. This ratio has not changed dramatically since 2010-11.[1]
- Uganda pays more for fertiliser than Tanzania and Kenya. Although commercial prices are higher in Rwanda and Burundi, both subsidise fertiliser.
- Average retail prices per 50 kg bag are on average 31% higher in the Northern Uganda towns of Lira and Arua than in Kampala.

Fertiliser import by country of origin, (2014) [2]



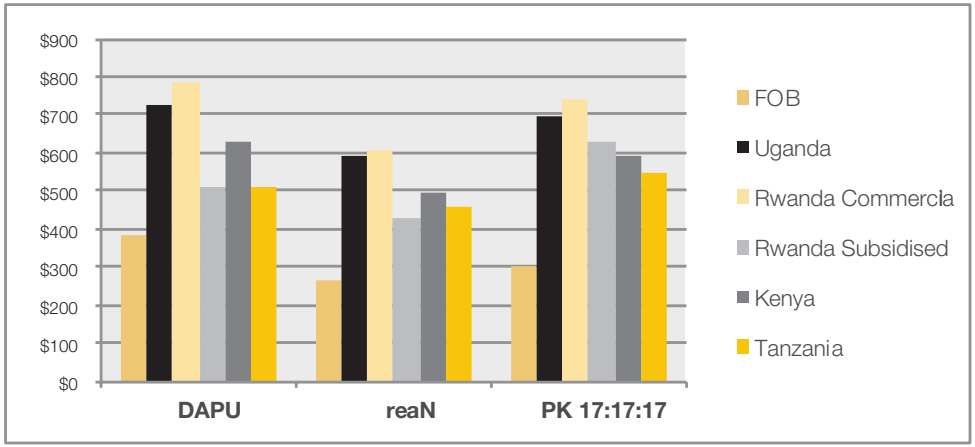
[1] IFPRI 2012. Compares FOB & Uganda retail prices for Aug 2010-Jan 2011.
[2] AfricaFertilizer.org, Fertilizer Statistics Overview, 2011-2014.

Average retail fertiliser price (Oct 2017-April 2018), US$ per 50 kg bag[3]

	DAPN	PK 17:17:17	Urea
Nairobi	$27.23	$25.25	$20.80
Kampala	$31.40	$30.25	$25.42
Lira	$41.04 (23.3%)*	$41.50 (36.9%)*	$32.31 (27.1%)*
Arua	$40.80 (29.9%)*	$37.82 (25.0%)*	$37.82 (48.7%)*

*Percent price increase compared with Kampala.

National fertiliser prices, US$/mt, Average prices Jan-Apr 2018[4]



[3] AfricaFertilizer.org, monthly fertilizer prices from dealers in towns in Kenya and Uganda & primary research.
[4] AfricaFertilizer.org. FOB price for Indonesian/Malaysian Urea and Russian/Baltic/Black Sea DAP.

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Consumption – Northern Uganda

Northern Uganda's represents 8-10% of Uganda's total market, with even lower consumption than Uganda's already low usage.

Overview[1]

- Northern Uganda's total fertiliser market size is estimated at 6,083 mt in 2017. Assuming Uganda's total market size is approx. 61,000 mt, this represents 10% of Uganda's market.
- Of this, in 2017 the main fertilisers used are NPKs of all types (45%), followed by DAP (19%), Urea (17%), and CAN (12%).
- Large and medium scale farms (primarily rice and maize) and contract farming schemes (primarily tobacco) represented 92% of the market in 2017 (and 95% in season 1 2018), while direct sales to smallholders were negligible (1%).
- Data from the 2008/09 Uganda Census of Agriculture shows that about 8 per-cent of smallholder farmers nationally use inorganic fertiliser on any of their crops, and that the proportion of households using fertilisers in N. Uganda was 0.7%. Fertiliser use by smallholders in remains uncommon.
- Given the high rates of fertiliser application by commercial producers, the average rate of use by small-scale farmers in Northern Uganda is almost certainly even much lower than Uganda's extremely low usage of 2.4 kg/ha.
- Our analysis shows that large and (especially) medium scale farms and contract farming schemes are going to be the key drivers of demand growth.

N. Uganda's inorganic fertiliser purchases (mt) by product[1]

Product	2018 (Season 1)	2017
NPK (all types)9	89	2,723
DAP2	92	1,157
Urea	416	1,060
CAN1	21	742
Other (TSP, MOP, AS)	55.5	3
Calciprill	1383	97
TOTAL	**2,011**	**6,083**

Northern Uganda's inorganic fertiliser purchases (mt) by buyer[1]

	2018 (Season 1)	2017
Contract farming schemes	638	2,424
Large and medium scale farms	1,280	3,180
Institutional buyers (NGOs, GoU)	64	409
Agro-dealers serving smallholders	10	70.2

[1]Based on ORI data collected from large scale farmers and N. Uganda distributors. The data collected for 2018 was only for season 1, but it is projected that annualised demand will be 3x higher, as season 2 is at least twice as large.

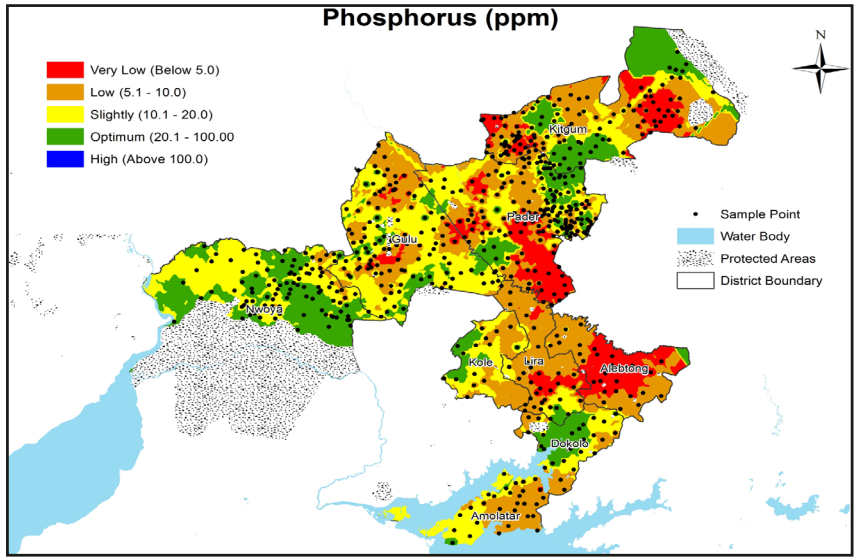
Northern Uganda context - soil fertility

N. Uganda soil fertility and nutrient deficiencies[1] (see Appendix 2)

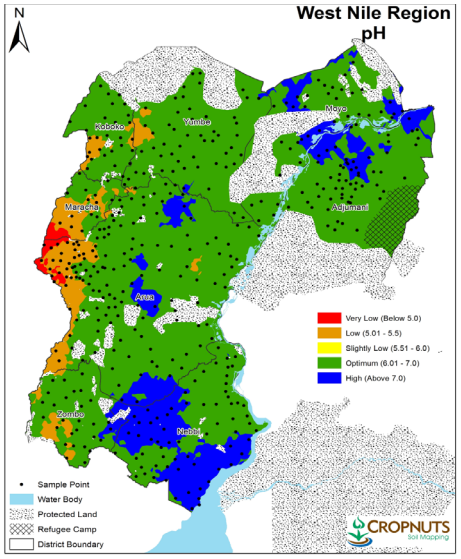
- Large areas of Northern and West Nile regions are deficient in phosphorous.
- Sulphur, zinc, boron and copper are also very low in N. Uganda. Problems associated with this can include reduced nitrogen uptake (Sulphur, Copper), yellowing (Sulphur, Zinc), stunting, distortion and reduced flowering and fruiting (boron), and susceptibility to disease (Copper).
- Low (and high pH) is also a problem in some areas of N. Uganda. Low pH (acidity) affects nutrient absorption.
- Potassium is present at optimum levels in most areas. In general, nutrient loss is less severe in N. Uganda than elsewhere in Uganda because soils lay fallow during the conflict and due to the practice of shift farming. But, this relative soil fertility will rapidly decline if fertiliser adoption is not increased.

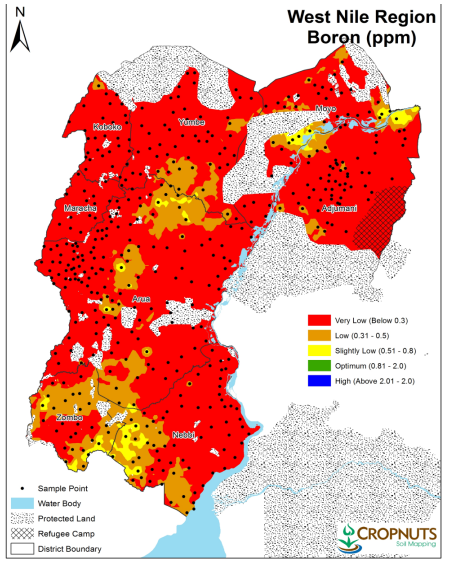
Fertiliser use versus actual soil deficiencies[2]

- Large scale commercial farmers in N. Uganda are attuned to soil analysis, remediation, and balanced crop nutrition and most use the state of the art in crop and soil-specific fertilisers and application techniques.
- Medium scale farmers lack this technical capability and tend to rely upon neighbouring large farms for information. Smallholders simply apply straight fertilisers and basic NPK compounds, or do not use fertiliser at all.
- Soil pH remediation is necessary in some areas, yet lime is not widely available. Caliciprill is one solution available as an alternative to large volumes of lime.
- Small and medium farms are not addressing micronutrient deficiencies. Ammonium Sulphate and Gypsum are good sources of sulphur, while other micronutrients may need to be added to blends.



[1] ISSD Uganda Soil Mapping Project, Initial Findings, 2014.





[1] ORI research in N. Uganda.

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Production and blending – emerging capacity

Grainpulse installed Uganda's first fertiliser blending factory in 2017. A Chinese company is developing a phosphate fertiliser plant, with production expected to come online in 2018.

The Sukulu phosphate project, Eastern Uganda - overview

- GoU awarded Guangzhou Dongsong Energy Group, a Chinese firm, a lease to mine and process phosphates in 2013.
- The planned industrial complex will contain a phosphate fertiliser plant with production capacity of at least 300,000 mt per year.
- Initially due to start production at the end of 2016, but construction delayed due to land disputes. Based on recent efforts to resolve the issues, inaugural production is planned in October 2018, initially at 100,000 mt per year.
- Information on types of phosphate fertilisers to be produced not publicly available. Likely to be Single Super Phosphates (SSP), Triple Superphosphates (TSP), or purified rock phosphates if sulphur can be obtained to make sulphuric acid. DAP unlikely due to the lack of natural gas to produce ammonia.

Grainpulse bulk physical blending factory - overview

- Grainpulse is Uganda's first fertiliser blending plant, based in Mukono with installed capacity of 300k mt annually. Plant produces NPK blends by physically mixing two or more macro-nutrient containing fertilisers, e.g. DAP, UREA, MOP.
- First blends launched in the market in 2017 for maize, beans and millet, and coffee. 10 blends have been developed covering 14 crops, and generic soil conditions, but majority not yet released.
- The top 3 blends already in the market are: NPK 20:20:18 (maize), NPK 16:02:31 (coffee), and NPK 11:29:23 (beans and millet). Percentage sales mix is 50%, 35% and 15% respectively.
- For the past 3 seasons in 2017/18, 1,800 mt has been processed. Consistent with the practice in the industry, production will need to rapidly grow to above 10,000 mt to enable commercial scale operations, as blending margins are small.

Sukulu phosphate project – Economics

- East African soils are very deficient in phosphorous, yet phosphate is the most expensive component of fertilisers. Sukulu has rock phosphate deposits which if successfully exploited could potentially supply Uganda and East Africa markets with phosphate fertilisers.
- However, unclear whether Ugandan fertilisers will be competitive in quality and price within East Africa compared with leading global manufacturers. Even when countries have the raw materials to manufacture of fertilisers, many prefer to import fertilisers, and use e.g. natural gas for domestic energy, because fertiliser has low margins.
- Fertiliser factories typically manufacture in 1 million tons to be scale efficient. However, the Ugandan and East Africa market currently not large enough to make manufacture profitable and Uganda unable to compete globally with exports.

Bulk physical blending - Analysis

- Operating costs in blending are raw materials (straight fertilisers), labour, power, and packaging, but the major cost is raw material. This is a low margin business (single digit gross margin percentage) and requires scale for attractive returns.
- In May 2018, 1 mt of NPK 20:20:18 costs $554 in raw materials, and generates a gross profit (pre SG&A, Opex, Depreciation) of $35 (6%), based on Grainpulse's wholesale price of $589/mt.
- Furthermore, due to the superior quality of Yara NPK brands (Milas, Beras, Amidas etc.), Grainpulse has to set its price points significantly lower than Yara's to ensure successful market entry, which appears to be the strategy.
- As an example, Yara Mila Cereal/NPK (23-10-5 +2 MgO, +3 S, +0.3 Zn), which is applied in maize directly competes with Grainpulse's basic NPK 20:20:18. Yara's wholesale prices are approx. $620/mt in Kampala.

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Political and policy context

Uganda's policy and regulatory framework has improved dramatically with the adoption of a national fertiliser policy and strategy in 2016. Yet policy implementation has lagged behind due to very low budget allocation in the agricultural sector . Due to its history of marginalisation, N. Uganda would require significantly more, and specifically targeted government investment to make progress.

Recent policy and legal progress

- **Fertiliser Control Regulations adopted in 2012** (under the Agricultural Chemicals (Control) Act 2006) aims to regulate fertiliser manufacture, storage, distribution and trade, importation and use.
- **National Fertiliser Policy adopted in 2016** for the first time puts in place a comprehensive fertiliser policy that is consistent with Uganda's agricultural and development goals. It aims to enable the fertilizer industry to make fertiliser affordable and accessible to farmers.
- **National Fertiliser Subsector Strategy and Investment Plan 2015/16 – 2019/20** aims to operationalise the above policy and regulations and help the GoU meet the Comprehensive Africa Agriculture Development Program (CAADP) targets of 6% agricultural growth. The Strategy revolves around four areas: (i) Creating a conducive fertiliser business environment (ii) Increasing demand and use of fertilisers (iii) Enhancing the supply and distribution of quality fertilisers; and (iv) Effective fertiliser related knowledge management.
- **The World Bank funded Agriculture Cluster Development Project (ACDP)** is supporting the MAAIF's Agricultural Chemicals Board (ACB) to operationalise the fertiliser legal framework particularly by strengthening capacities for quality control of fertiliser and other agricultural inputs (i.e. spot inspections, quality assurance laboratories, analysis along the marketing chain).
- **ACDP is piloting an e-Voucher scheme** under which rural producer organisations/cooperatives will distribute e-Vouchers to farmers engaged in the production of maize, bean, rice, cassava and coffee. Subsidy will cover part of the cost of key farm inputs including fertiliser and seed. This will target about 450,000 households over 3-years and includes 3 clusters in N. Uganda.

Ongoing political and policy challenges

- **Very low government investment in the agricultural sector** has held back policy and strategy implementation. In 2018/19, the MAAIF received 862 billion shillings out of the total GoU budget of 32.367 trillion shillings – far below the sector's needs. N. Uganda is particularly hard hit by the under-investment in agriculture due to its greater needs.
- **Implementing key elements of the Fertiliser Policy and Strategy would require much more substantial government investment**, particularly the demand-creation measures including awareness-raising and putting in place a voucher system for poor farmers.
- Under ACDP, the e-Voucher system will reach only a sub-set of capable farmers due to its criteria and cost-share design. The e-voucher system is designed to be time-bound and phased out after 3-years – its wider impact on demand will depend on the success of the pilot, whether it has the intended systemic affects and whether the GoU invests to scale it up.
- **Counterfeiting and poor quality of fertiliser and seed** remains a major problem with tests showing sub-standard quality at all points along the value chain including at import. Fake and poor quality fertiliser and seed remains a significant barrier to adoption of input-intensive farming methods and fuels distrust in the industry.
- **Despite stronger regulation in place, GoU has not invested in an effective quality control regime.** There is suspicion that some government officials benefit from kickbacks from poor quality suppliers and therefore lack incentives to promote enforcement of quality standards.

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Role of market distortion

The over-riding challenge in northern Uganda is low demand. The fertiliser market is too small for market distortion (e.g. through provision of subsidised inputs) to be a problem. Furthermore, inhibitory regulations (e.g. taxes, import duties) are not a major factor constraining supply or pushing up prices.

Key issues related to potential market distortion

- Uganda's policy framework is generally designed to facilitate the supply of fertiliser through the private market – it neither inhibits nor actively promotes the industry.
- Uganda is a signatory to the East African Community (EAC) zero-rated tax on fertilisers. Nonetheless, fertiliser imports attract a 6% withholding tax, which importers and agro-dealers are entitled to reclaim when they submit their tax returns, however this does not always occur in practice. While this issue should be addressed, ORI did not find that it affected the supply of fertiliser at competitive prices to large-scale farms nor was it a binding constraint to the affordable supply of fertiliser to smallholders. It was more of an issue of timely tax return filing than a general market constraint. This was only mentioned once, and by a small enterprise.
- Uganda does not have a fertiliser subsidy. Although the Fertiliser Policy and Strategy proposes a voucher system, this has yet to be implemented beyond the pilot ACDP e-voucher scheme. The e-voucher scheme is designed to minimise potential for misuse and dependence and to stimulate rather than operate in parallel to private input markets. However, the selection of farmers for ACDP has potential for bias, given the role of public sector in their initial identification, and the selection criteria, e.g. upfront payments of farmer share. This caution is consistent with experiences from other input subsidy programs implemented in other parts of Africa.
- There have been several efforts by NGOs to distribute fertiliser start-up packs as a means to stimulate demand. The success of these efforts in demonstrating the value of fertiliser to farmers and stimulating demand has been questionable (see discussion under Investment Hypothesis 2). Given the very low level of demand and the small scale of these initiatives, the negative distorting affect of initiatives such as these is also negligible. On balance, such initiatives – when designed explicitly to stimulate demand – are likely positive.
- Northern Uganda history of conflict and dependence on humanitarian aid has nonetheless slowed the development of a vibrant agricultural sector and markets for agro-inputs and outputs. There remains a subsistence mindset and culture of dependency and of waiting for hand-outs that may inhibit farmers from going to the shops and buying fertiliser or otherwise adopting productivity-enhancing techniques and market-oriented strategies.
- The organic movement has had a strong influence in Uganda and has had a major impact on attitudes towards fertiliser and other inputs in a context in which trust in new technologies is already very low. This is however not purely ideological but also based upon real market opportunities for organic produce and the economics of adopting input-intensive production methods versus maintaining lower-input systems for certain crops (see analysis of sunflower in Section 5).

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The Fertiliser Value Chain

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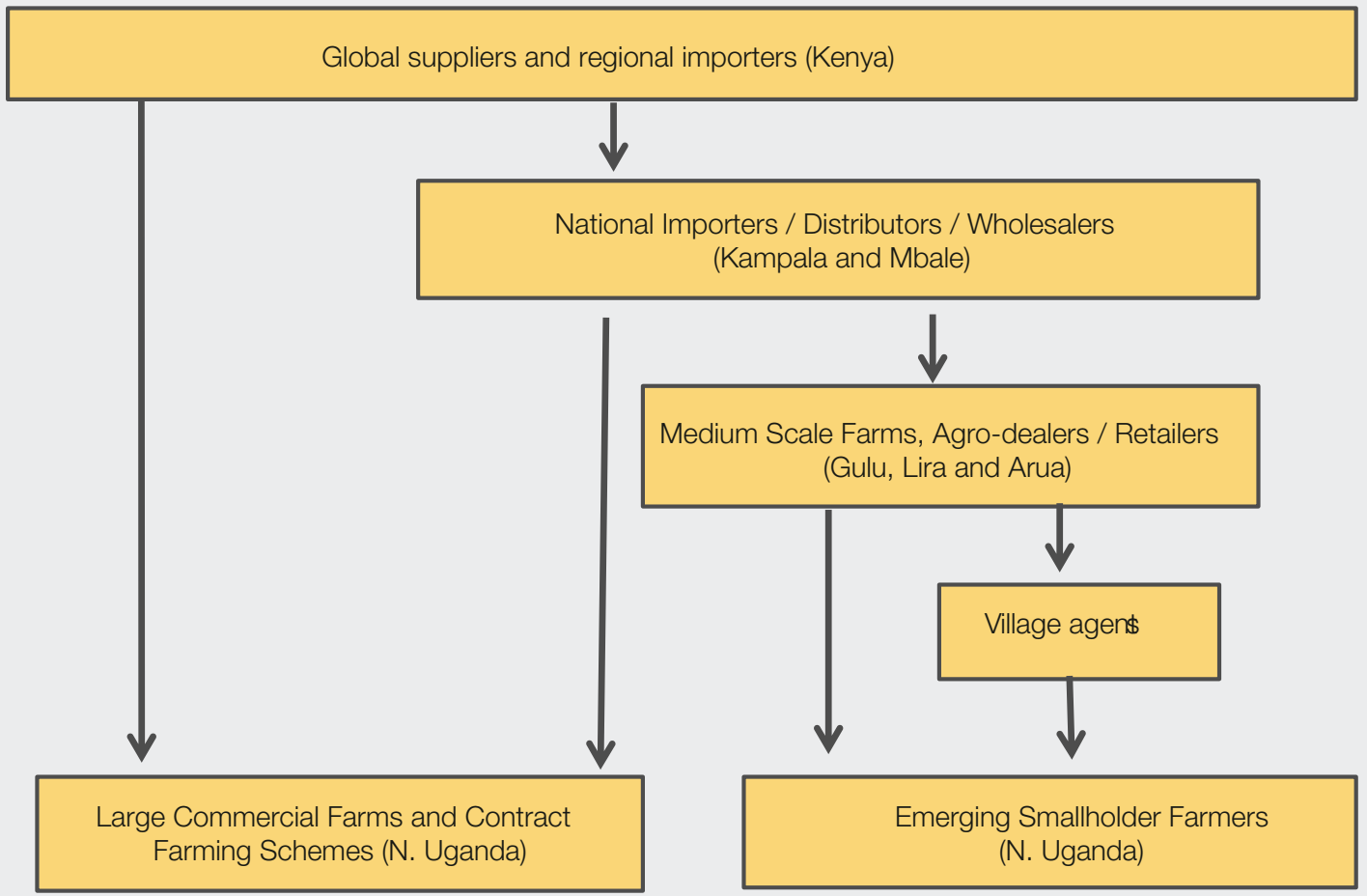
Fertiliser supply routes to Northern Uganda

Overview

There are two value chains for fertiliser supplied to Northern Ugandan markets:

- **The direct route -** Large commercial farms, and contract farming schemes that serve smaller growers, tend to purchase directly from global traders, Kenyan-based regional importers or enterprising national distributors - if they can negotiate favourable terms.
- **The indirect route -** National distributors import and warehouse fertiliser in Kampala and Mbale, where it is purchased by Northern Uganda based agro-dealers, and medium scale farms. Agro-dealers sell it on to emerging smallholder farmers directly and via village agents outside the major towns.

Figure: Main fertiliser supply routes to Northern Uganda

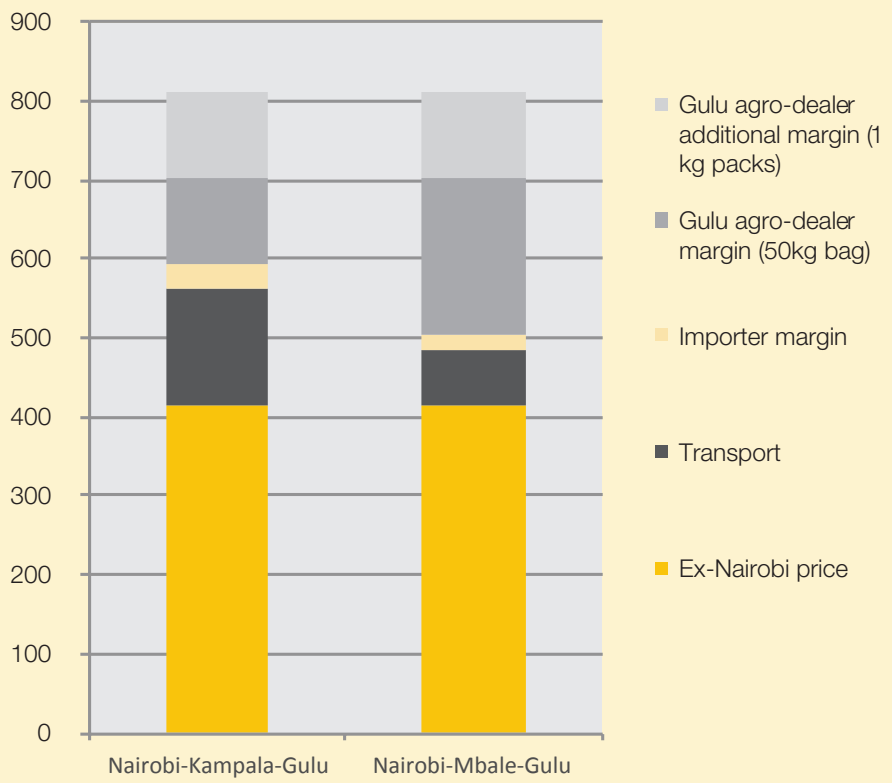


The indirect route

The indirect route is inefficient and results in substantial cost mark-ups across the value chain.

Global suppliers & regional importers → **National importers / distributors** → **Agro-dealers / retailers / village agents** → **Farmers**

Cost build-up for Urea, (US$/mt)



Analysis

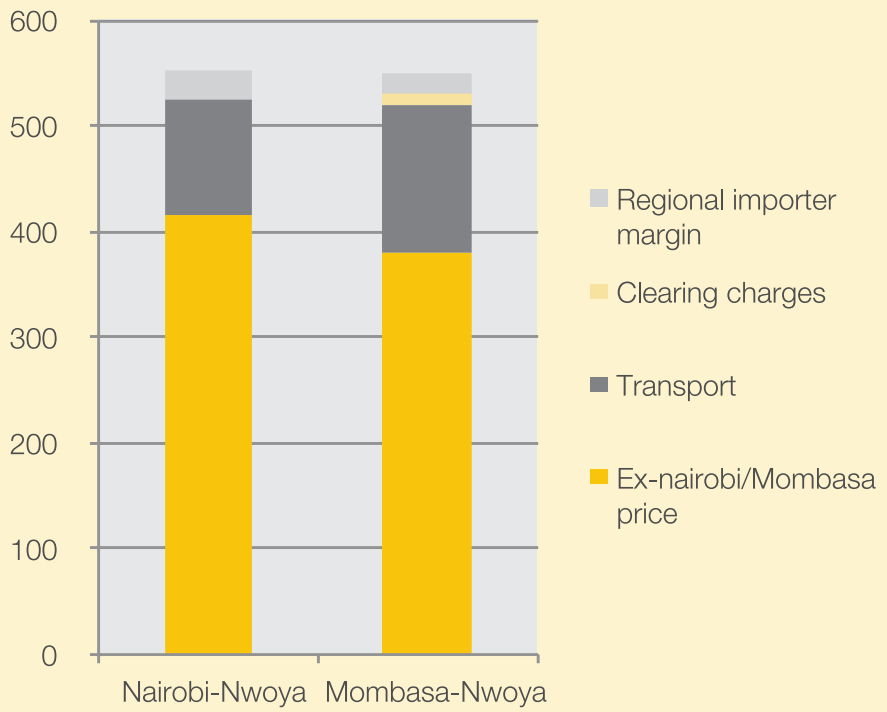
- Fertiliser import and distribution is a high volume, low margin business. Efficient logistics is key to profitability and maintaining fair prices to farmers.
- Fertiliser is imported to N. Uganda either via Kampala or Mbale. The Mbale route is more efficient due to lower transport costs and is increasingly popular. Transport costs from Nairobi to Gulu via Mbale account for 10% of the sales price of a 50 kg bag in Gulu, compared with 21% for the route via Kampala.
- Both Kampala and Mbale-based importers' gross margins are relatively low, around 5%. Even then, the rationale for stocking fertilisers is to "retain clients" by offering a full package of farm inputs, that includes fertiliser. Other farm inputs (especially crop protection technologies), provide more attractive margins. For this reason, none of the national importers have a business model exclusively based on fertiliser marketing.
- N. Uganda agro-dealers engage in significant arbitrage and do not necessarily pass on cost savings from more efficient transport to farmers. Their gross margins range from 18-40% for 50 kg bags and 36-61% for 1 kg bags. A key reason for this is that they deal in very small volumes. The larger Gulu-based agro-dealers sell between 5-25 mt annually.
- N. Uganda agro-dealers derive significant revenues and profits from inorganic fertilisers, but other farm inputs e.g. crop protection solutions are more profitable and require less handling compared with fertilisers.

The direct route

Large commercial farms and contract farming schemes tend to purchase directly from global traders or Kenya-based regional importers and transport directly from port or Nairobi to farms in Northern Uganda. In the cases where they buy from Kampala based distributors, incentives have to be agreed and included

Global suppliers & regional importers → **Large commercial farms & contracting schemes**

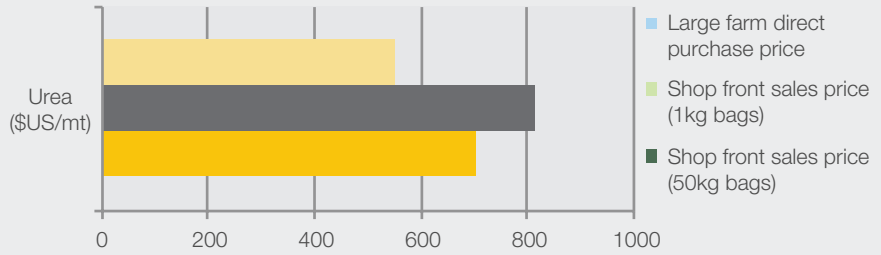
Cost build-up, Urea (US$/mt), direct farm purchases



Analysis

- By purchasing large quanitities (e.g. 26 mt truck load) directly from regional importers, large scale commercial farms and contract farming schemes achieve much lower prices than those available to smallholder farmers from local retailers for small quantities (1-50 kg bags).
- Transport costs are the key driver of costs, representing 20-25% of the delivered price.
- Regional importer margins are low, around 5%, but focus is on volumes.

Nwoya large scale farm delivered price vs. Gulu agro-dealer shop price, Urea, US$/mt



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Transport

Overview

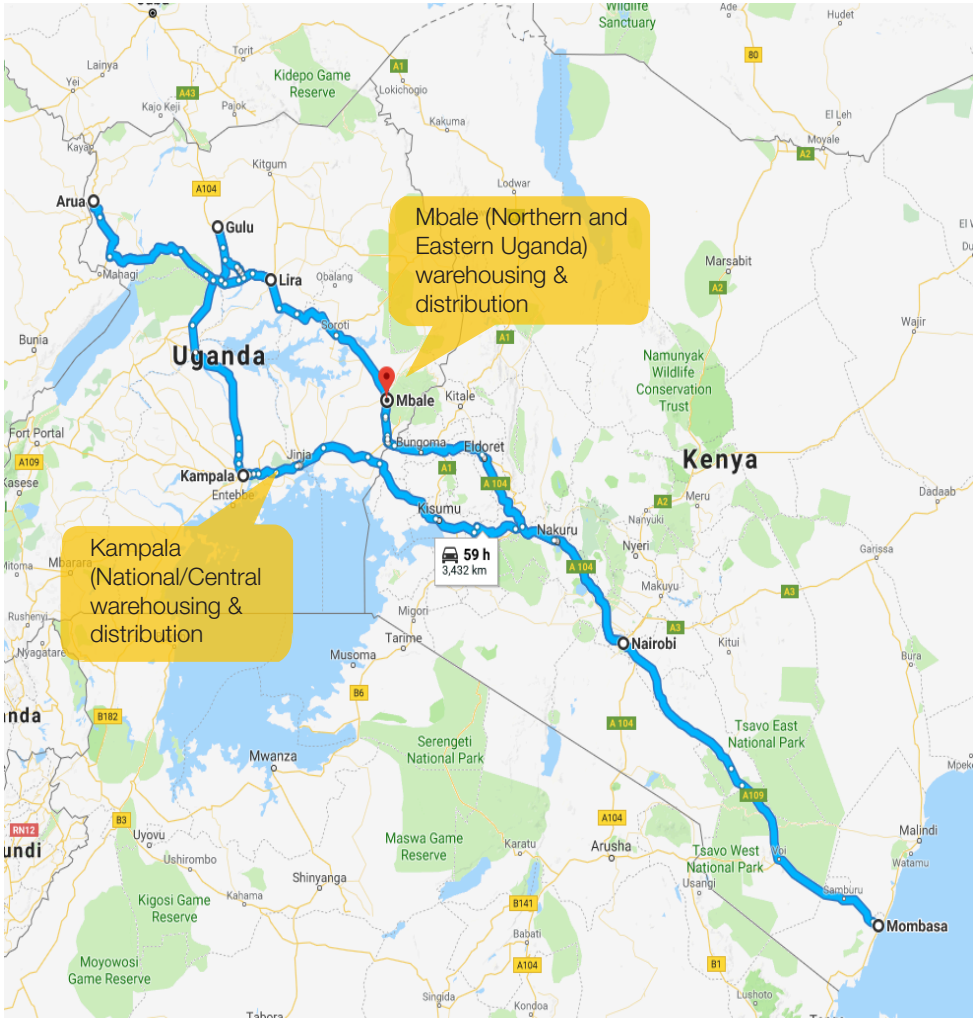
- Kampala and Mbale are the two main distribution points for fertiliser supplied to N. Uganda from Mombasa (usually via Nairobi).
- The Mbale route is more efficient. Fertilisers transported via Mbale are delivered at $2.50-$5.50 less per 50 kg bag than those sent via Kampala.
- Mombasa to Lira via Mbale is 110 km shorter than the route via Kampala. However, there is little Kampala-Lira trade. Kampala-Gulu/ Nwoya and Kampala-Arua is more common.
- In addition to shorter distances, Mbale distributors lower transport costs by utilising trucks' backhaul load capacity to transport food to Nairobi (maize, matooke, melons, pineapples, etc.) rather than returning empty.

Transport costs[1]

	$US/mt	$US/26 mt load
Mombasa – Kampala (direct or via Nairobi)	$81 - $110	$2,106 - $2,860
Mombasa – Mbale (direct or via Nairobi)	$78 - $80	$2,028 - $2,080
Mbale - Lira	$22	
Mbale - Gulu	$27	
Kampala - Gulu	$30 - $54**	
Kampala - Arua	$33 - $38	
Kampala - Nwoya	$25 - $33	

[1]ORI interviews with importers, dealers, and transport firms.
**High price is quoted from Gulu-based agro-dealer for transport of a 50kg bag by bus compared with more efficient transport of 8 – 18 mt loads by truck or 20+ mt loads in trailers.

Fertiliser transport routes from port to N. Uganda



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Fertiliser value chain – overview of actors

Global suppliers & regional importers

Key activities – global supply of fertiliser to East Africa market; import and handling at Mombasa; transport from port to Nairobi; wholesaling from Mombasa or Nairobi; assembling of fertiliser orders and prioritising deliveries.

Actors –

- Small number (< 5) global manufacturers also act as importers in East Africa (e.g. Yara, Ma'aden, OCP).
- ½ dozen Kenya-based importers involved in regional wholesaling (e.g. ETG, Yara, OCP, MEA, Samsung C&T, Elgon). Uganda based importers include Tata and Grainpulse.
- Most purchases by large commercial farms are from regional importers. Very rarely purchases are made directly from manufacturers if volumes are large (>5,000 mt).

National importers / distributors

Key activities – import to Uganda; transport from Mombasa or Nairobi to Kampala or Mbale; warehousing and wholesaling within Uganda, and occasionally sells small quantities to Rwanda and parts of DRC. Majority of Ugandan fertiliser is re-exports from Kenya.

Actors –

- Small number (<10) Kampala-based distributors (e.g. Balton, UCCL, container village based actors (Africa One Ltd, Nakivubo Farmers Centre, Vingross Agro, Mefai Agro, etc).
- 5 Mbale based distributors (Faith Agro, Home of Farmers, Bulugenyi Agro Input Suppliers, ElShadai, Bugeza Agro Inputs).

Agro-dealers / retailers / village agents

Key activities – transport from Kampala or Mbale to Gulu, Lira and Arua in N. Uganda; retail from shop fronts in major towns; last mile sales in small trading centres

Actors -

- 5 large agro-dealers in Acholi, 3 in Lango, and 2 in West Nile sell at shop fronts in major towns (some have several shops in larger towns) and hire salespeople.
- 33 small agro-dealers in small trading centres in Acholi, approx. 15 in West Nile and approx. 30 in Lango who purchase less than 5 bags per season from larger agro-dealers. Fertiliser is not a key line.
- NGOs/donor projects, GoU projects, e.g. Cotton Development Organisation, and farmer co-ops/ associations also play a role in N Uganda distribution by providing direct deliveries of subsidised fertiliser to farmers.

Farmers

- <50 large scale and 300 medium scale commercial farms on more than 75,000 ha under crop per year in N. Uganda, primarily producing rice and maize.
- 9 contract farming schemes working with tens of thousands of smallholder and medium scale farmers, 7 of which produce tobacco and two producing barley for brewing.
- Hundreds of thousands smallholder farmers in N. Uganda.

Fertiliser value chain actors – global suppliers and regional importers

Global manufacturers and traders and regional importers

Global manufacturers and traders - Background and key players

- East Africa is supplied primarily by global traders that hold contracts with manufacturers in the Middle East, North Africa, and the Baltics. International manufacturers will ship loads over 30-40 mt., while global traders (e.g. Mekatrade) supply smaller quantities.
- Yara (Norway), SABIC (Saudi Arabia), and Russian and Baltic manufacturers are the major suppliers of Nitrogen fertilisers (Urea, CAN) in East Africa. OCP (Morocco) and Ma'aden (Saudi Arabia) supply phosphate fertilisers (e.g. DAP). K+S AG (Germany) is the major supplier of potash. These firms have annual revenues over USD 1 bn.
- Global suppliers see Uganda as a small and slow-growing market. The smallest order size for a ship load of fertiliser is typically 30-40K mt. Uganda's market size is estimated at 61K,1 meaning two ship loads a year is sufficient to meet annual demand.

Regional importers

- Recently, some manufacturers (Yara, Ma'aden, OCP) are venturing further down the value chain and acting as regional importers/ distributors, but this does not impact on price.
- Importers involved in regional wholesaling include Tata, ETG, MEA, Samsung C&T, Elgon, Omya etc.).
- Fertilisers are imported into the region in bulk, and bagged and branded at the port. Although it is less expensive to import into the hinterland in bulk, most fertiliser is imported to Uganda in 50 kg bags loaded in containers.
- Theft and inclement weather make bulk imports problematic. In addition, bulk requires handling equipment at the port as well as trucks capable of transporting bulk to farms.

Fertiliser value chain actors – national importers and distributors

National importers and distributors import and warehouse fertiliser in Kampala and Mbale.

Background and key players

- The largest importers (e.g. Yara, ETG, Tata) are East Africa region focused and have the financial and logistical capability to import and wholesale 10k mt fertiliser/year to Uganda with an est. value of $5-10m/yr. They have offices in Kampala and elsewhere in the region, or are subsidiaries of regional importers.
- ETG also operates as a national distributor, supplying smaller quantities to agro-dealers from its Namanve base in Kampala and Tororo in eastern Uganda. Grainpulse, a relatively new firm, effectively acts as a national importer and distributor, importing straight fertilisers and selling NPK blends.
- Medium scale importers include subsidiaries of international and regional agribusinesses (e.g. Balton, Uganda Crop Care, Twiga Chemicals). These primarily import to Uganda from the regional importers, and trade in 1-3k mt/yr. with a value of $0.5m to $2.0m.
- Small-scale locally owned importers are primarily based at the container village in Kampala and in Mbale (e.g. Faith Agro Inputs), and purchase smaller loads (10 mt) of fertilisers from Nairobi, Nakuru and Eldoret

Business model

- The gross margins of national importers such as Balton are in the range 5-10%
- The business model of importers and distributors such as Balton and Uganda Crop Care is to supply not only fertiliser, but also other farm inputs (e.g. seed, crop protection), in order to enhance profitability.
- Due to increased competition, and strong negotiations by large-scale farms, the current trend is to supply fertiliser on credit terms to be settled within a period of 30-90 days, and in some cases after the sale of farm outputs.
- Although fertiliser itself is low margin, these firms supply it as part of a strategy to supply all of farmers input requirements, making their real profits on other products.

Fertiliser value chain actors – global suppliers and regional importers

Northern Uganda based agro-dealers purchase fertiliser from Kampala and Mbale-based distributors and sell it on to smaller scale farmers directly or via village agents outside of the major towns.

Background and key players

- 5 larger agro-dealers in Acholi, 3 in Lango, and 2 in West Nile sell less than 100 mt annually to small and medium scale farms.
- 33 small agro-dealers in small trading centres in Acholi who purchase less than 5 bags (250 kg) per season from larger agro-dealers.
- An example of a large agro-dealer is Okado Investments located in Gulu town. Okado has been in operation for the past two years, and runs an additional branch agro-dealer shop in Anaka, and a village agency in Paleya.
- Okado purchases fertilisers in bulk from Mbale and Kampala based distributors, e.g. Faith Agro and Balton. The business also stocks and sells a wide range of seeds, crop protection solutions and basic farm implements.
- Large agro-dealers have annual revenues in the range of ugx 100m ($27k) to ugx 200 m ($54k). Fertiliser contribution to total revenue is in the range of 30-40%.

Business model

- N. Uganda agro-dealers purchase 50 kg bags and typically break these down into smaller packs (e.g. 1, 5 kg) for sale to the smallholder market.
- The mark-up is typically 30% for sale of 50 kg bags and 50% for 1 kg bags. Although gross margins are high, volumes traded are very low.
- These are small businesses, typically with low product know-how, weak business management capabilities and limited access to working capital.
- Sales are done primarily from the shop-front, with little investment in marketing and sales beyond the immediate vicinity. Additional sales are made to local NGOs, organised faith based groups, and local learning institutions that order several bags per season.
- Compared to other agro-inputs, fertilisers contribute relatively high revenues because of the relatively high unit price.

Fertiliser value chain actors – farmers

Large commercial farms and contract farming schemes tend to purchase fertilisers directly from global suppliers and regional importers, while small scale farmers purchase from N. Uganda based agro-dealers.

Global suppliers & regional importers → National importers / distributors → Agro-dealers / retailers / village agents → **Farmers**

Large-commercial farms & contract farming schemes

- Largest fertiliser consumers are large commercial farms and contract farming schemes.
- 11 large and medium scale commercial farms in N. Uganda (e.g. Amatheon, Oola Lolim, NUAC, Omer), primarily producing rice and maize, but also cotton, chia, tobacco, sugarcane and legumes. Fertiliser is widely used in commercial rice, maize, and tobacco production.
- 8 contract farming schemes, 6 of which produce tobacco (e.g. Alliance One, Meridian Tobacco Company) and two producing barley for the brewing industry (Uganda Breweries, Nile Breweries).
- Contract farming models are also applied in sunflower production, and to a lesser degree in sorghum and chia. Currently almost all sunflower is produced without fertiliser/naturally. Fertiliser use in sorghum is minimal, and uncommon for chia.

ALLIANCE One · AMATHEON AGRI · NUAC · Omer Farming Company

Business model

- Contract farming is based on buyers and growers commitment to agreed terms for at least one season. Terms may include provision by off-taker of inputs, e.g. seeds, fertilisers, crop protection solutions and guaranteed purchase, and commitment to grow crops based on good agricultural practices – as advised by company agronomists, and avoidance of side selling.
- Heavy investment in equipment and machinery by large commercial farms calls for production of crops with potential for mechanisation in production, harvesting and storage; and that offer attractive returns, e.g. maize, rice, and white sorghum (if an attractive price can be negotiated with brewery off-takers)
- Regular review of profitability due to price volatility is leading to shifts in crop focus. For example, the weak performance of maize crop in 2017/2018 season due to the infestation by the fall army worm and low prices is leading to shifts towards rice, which has had more stable prices for the past 4 years.

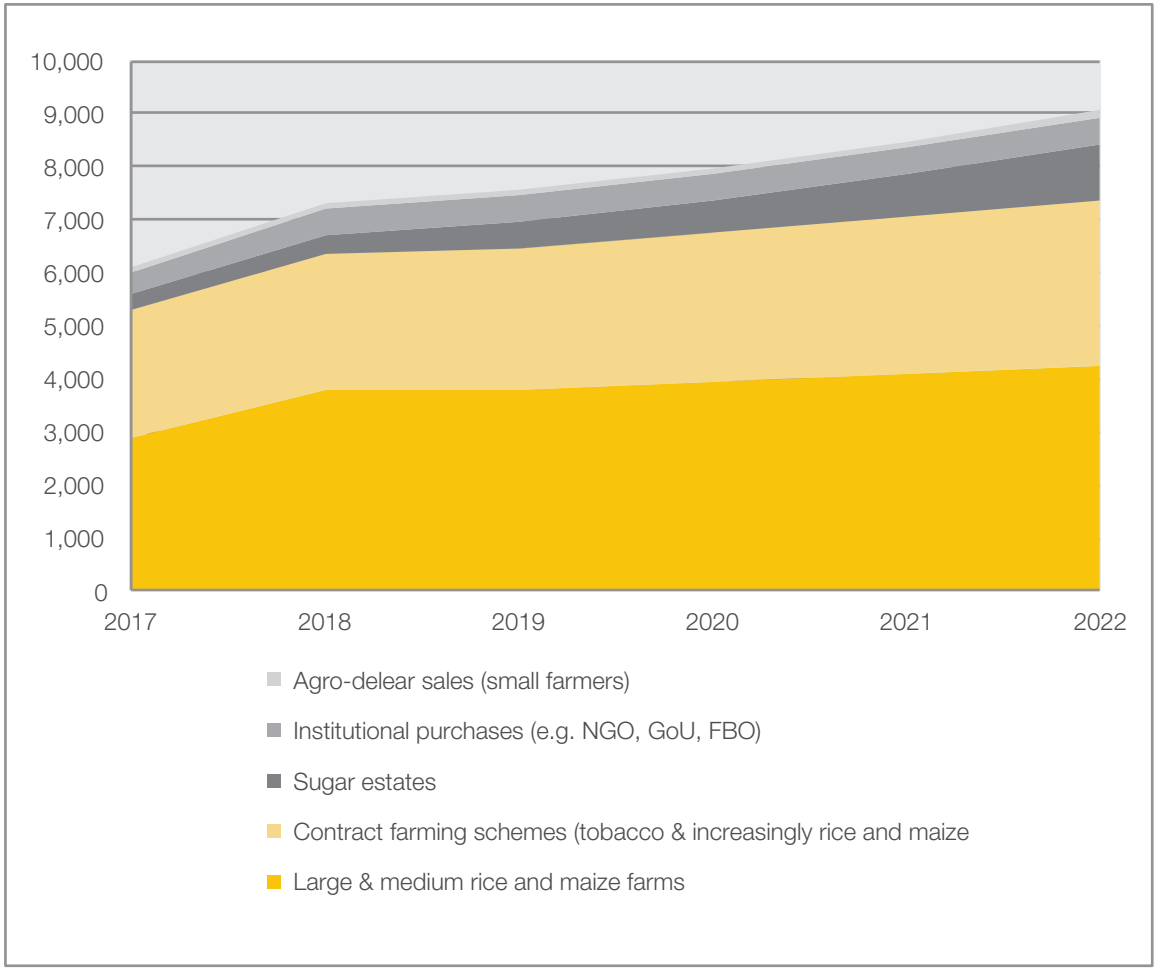
Northern Uganda fertiliser demand and growth potential

Fertiliser value chain actors – farmers

Analysis

- Current demand is 6,083 mt based on ORI 2017 point of sale data. Demand is projected to rise to 9,000 mt by 2022.
- Large and medium scale commercial farms (mostly rice and maize) accounted for 52% of the fertiliser purchases in 2017, while contract farming schemes (mostly tobacco) accounted for 40%.
- Large and medium scale rice and maize farms and tobacco firms will continue to drive fertiliser demand in the next 5 years. Tobacco production is expected to remain at 2017 levels due to regulatory barriers, and weak long-term prospects. However, tobacco contract farming schemes will increase fertiliser purchases as they bring new land under rice and maize production, as part of their diversification strategy.
- Based on the promising market outlook for maize and rice, we project area planted under rice by large and medium scale farms in N. Uganda to increase at a CAGR of 6%, while for maize we project the CAGR to be 3%.
- Despite land transfer hiccups, sugar estates will continue to set up in Amuru (e.g. Atiak & Kakira) and their demand for fertiliser will increase, although their role in 2017 was small.
- Smallholder demand will continue to be negligible, unless targeted schemes are successfully launched e.g. the ongoing World Bank initiative to subsidise fertilisers.
- Sorghum and sunflower will not be significant demand drivers. Vegetable gardens and seedling nurseries will continue to be important to agro-dealers' sales, but will remain small in terms of overall demand.

Projected fertiliser demand (mt)



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Fertiliser value chain actors – farmers

	Definition	Characteristics	Fertiliser use
Large scale commercial	• At least 100 Ha of land under row/ broad acre crops • Highest level of return optimisation via intensive use of modern farming technologies, precision agriculture and mechanised operations	• Most farms over 500 Ha (some as large as 1,000 – 4,000 Ha) • <50 in N. Uganda on an estimated 40,000-60,000 Ha • Preference for broad acre crops/cereals (e.g. maize, rice, chia). Also sugar estates & cotton	• Typically 26 mt (1 truck load) mixed fertiliser per season purchased from regional importers • Minimum application rates of 250-300 kg/ha • Specialised fertilisers and applied based on soil analysis and crop nutrient requirements (incl. acidity & trace element remediation)
Medium scale commercial	• 20-100 Ha of land under row crops or broad acre crops • Relatively modern farm technologies and inputs and a mix of farm labour and partial mechanisation – using basic farm machines either owned, but mostly hired	• Approx. 300 in N. Uganda on a total of approx. 15,000 Ha • Broad acre/row crops (rice and maize primarily and also sorghum, sunflower, chia & cotton) • Typical SME challenges, e.g. lack of growth capital, low agronomic knowhow	• 5-10 mt each season (4 farmers for 1 truck of 26 mt load) purchased from national distributors • Application rates of 100-150 kg/ha • Soil analysis uncommon, although aware of the value. Mostly takes advice on fertiliser use from suppliers + neighbouring large scale farms
Emerging smallholder[1]	• 2-20 Ha of land under crop • Mostly entrepreneurial and open to learning, but lack correct information and necessary networks	• Approx. 1,000 in N. Uganda on a total of approx. 5,000 Ha • Commercial crops are maize, rice, sorghum, sunflower and vegetables e.g. tomatoes, leafy vegetables and seasonal fruits, e.g. watermelon	• 0.3-1mt/season on row crops or vegetables purchased from local agro-dealers • Application rates of 50-100 kg/ha • Lacks technical knowledge and follows traditional extension messages (e.g. 50kg/ acre)
Subsistence smallholder	• Under 2 Ha of land under crop grown primarily for subsistence purposes • Mostly women and poor members of the society, growing crops on communally owned land. Also provides labour services to neighbouring farms	• Approx. 1 million in N. Uganda on a total of approx. 1.2 million Ha • Mostly operate outside the cash economy • Food security crops – cassava, millet, local maize varieties, sweet potatoes	• Virtually no fertiliser application and unlikely to take the risk with locally untested technologies • Group for which the organic message and "our soils are fertile" has permeated the most • Struggles with the cost benefit of fertiliser use

[1]An example of an emerging smallholder farmer is Peter Makumbi (see slide 32), who planted 2 ha maize in 2017, applied 325kg Yara Mila Cereal per ha, and realised yield of 4.2mt/ha.

Four priority crops: three cereals and one oil seed

The land is well-suited for these crops – "there no inherent reason why productivity cannot someday equalise with the rest of Uganda"

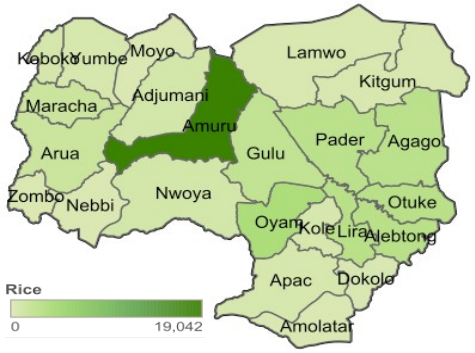
Rice[1]

Ha planted: 25,913

Av. yield/Ha: 1,690kg

Share of Uganda's production: Approx. 23%

With government support, Uganda's rice production doubled within a decade from approx. 120k mt in 2002 to 233k mt in 2011, primarily driven by a near doubling of area under production. Amuru is the largest rice producing district.



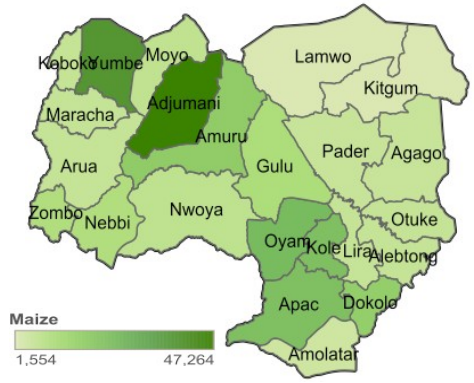
Maize[1]

Ha planted: 208,849

Av. yield/Ha: 1,380kg.

Share of Uganda's production: 12%

Maize has become a major cash crop during the last 5 years and is traded in East Africa (Kenya primarily). Productivity in N Uganda less than half of any other region.



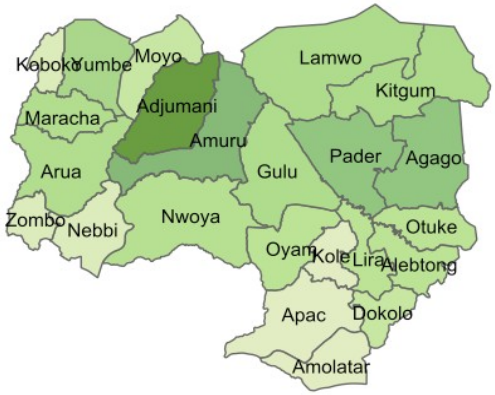
Sorghum[1]

Ha planted/all varieties: 131,926

Av. yield/Ha: 1,010kg

Share of Uganda's production: Approx. 35%

White sorghum grown primarily for the two main breweries. Red sorghum and other varieties are local staples with limited market potential (beyond baby weaning foods processing)



Sunflower[2]

Ha planted: 224,734

Av. Yield/Ha: 950kg/ha

Share of Uganda's production: Approx.90%

Sunflower is primarily grown in Lango

[1]UBOS, 2008/2009 Census of Agriculture https://www.ubos.org/wp-content/uploads/publications/03_2018UCACrop.pdf, contains the most recent district level data for maize, rice & sorghum.

[2]Sunflower was not included in 2008/9 Census, however as approx. 90% of Ugandan sunflower production takes place in N. Uganda, it is calculated based on UBOS 2016 national production data.

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Profitability of fertiliser - Maize

Overview

- Very attractive cost benefit for fertiliser use if combined with improved hybrid seeds, crop protection (weed, pest and disease management) and post harvest handling and storage. Maize is a "heavy-feeder" – high nutrient requirements and therefore driver of fertiliser use.
- Sector lends itself to the efficient use of mechanisation for large-scale farming. It is also attractive to small-scale production
- High demand for maize driven by its many uses: food (including relief market demand), inputs for animal feeds, use in industrial starch production, e.g. for the brewing industry.
- As a global commodity, maize markets experience significant price volatility, and production is vulnerable to climate variability.

Analysis

- Fertiliser represents 52% of total costs for a typical large scale maize farm (Amatheon) and 60% of costs for a typical emerging smallholder.
- Profitability depends heavily on the maize price, as input costs are reasonably stable. Farmers made losses or earned below market rate returns due to the crash in maize prices in the 2017/18 season (ugx 700-900 ugx compared with ugx 1,200-1,500 in the 2016/2017 season).
- Sector hit by the fall army worm infestation which lowered yield from 6,000 kg/ha to 5,000 kgs/ha in the 2017/18 season even for best farms.
- Despite this, maize will be a significant commodity and driver of fertiliser use.

P&L, Large scale maize farm with fertiliser and other technologies[1]

Description (1 ha under maize)	Oola Lolim (season 2, 2016)	Amatheon (season 2, 2017)
Cost of fertiliser (DAP/NPK blends/UREA/ Calciprill/ground Lime)	$450	$501
Other costs (labour, herbicides, pesticides, equipment running, repairs and maintenance, security, storage, drying and cleaning)	$460	$460
Total costs/ha	$910	$961
Average price per kg (1,550 in Apr/May 2017; 830ugx in Apr/May '18)	$0.432	$0.2243
Average yield (kgs/ha)	5,500	5,000
Revenue per ha	$2,376	$1,122
Operating profit/ha	**$ 1,466**	**$161**

P&L, Emerging small-scale maize farm with fertiliser and other technologies[2]

Description (1 ha under maize, season 1, 2017)	Peter Makumbi
Cost of fertiliser (Yara Mila Cereal – 0.33 mt/ha)	$267
Other costs (seeds – Monsanto DK 308 Hybrid, labour, herbicides, pesticides, storage, drying and cleaning)	$180
Total cost of production/ha	$446
Average price per kg (900 ugx in Aug '17)	$0.254
Yield (kgs/ha)	4,244
Revenue per ha	$1,078
Operating profit/ha	**$ 632**

[1]ORI analysis. Av. maize price was ugx 1,550/kg at ROE of 3585 in Apr/May 2017; and ugx 830/kg at ROE of 3700 in Apr/May 2018 when sales were made. In addition, the maize yields in season 2 2016 (harvested in early 2017) were higher (5.5mt/ha) than in 2017/18 (5mt/ha) because there were no infestations by the fall army worm. [2]Peter planted 2 ha with maize and applied 6.5 bags (325 kg) of Yara Mila Cereal per ha. Price per bag was ugx 140,000 in Gulu/Okado plus transport of ugx 7,000 to the farm, 90 kms away in Alingi, Nwoya district. ROE for Apr' 17 was 3585 when fertiliser was purchased and 3545 for Aug '17 when grain sales were made. Other costs are based on Peter's farm records.

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Profitability of fertiliser - Rice

Overview

- Strong government incentives have made rice increasingly attractive. Uganda has a high duty on imported rice to encourage domestic production, supported by good rice seeds.
- Uganda consumes more rice than it produces domestically – still imports rice – so the market for rice is strong.
- With strong government incentives, rice production has more than doubled over the last decade.
- Rice producers get good returns (see financials) e.g. compared with maize.

Analysis

- For large scale rice farms, fertiliser represents 27% of total costs.
- Medium scale farms tend to use 100-150 kg/ha in rice production (NPK & Urea), while large scale farms use 250-500 kg/ha. Emerging smallholders use 50-100kg/ha while subsistence smallholders use almost nothing. This results in significant yield differences.
- Most smallholders use NERICA seed but over time some are adopting better yielding NAMCHE varieties which have higher yield potential and also require additional inputs.
- Strong potential for growth in fertiliser use driven by the growth of the rice sector. Rice, like maize, is a heavy feeder and the sector lends itself to fertiliser use because profitability depends on high yields.

P&L – Large scale rice production with fertiliser and other technologies[1]

Description (1 Ha under crop, season 2, 2017)	Amatheon	OlSeeden
Cost of fertiliser/ha	$185	$162
Other costs (labour, equipment running, repair and maintenance, security, storage, drying and cleaning)	$495	$438
Total costs/ha	$680	$600
Average price un-milled rice/kg (ugx 1300)	$0.35	$0.35
Average yield (kgs/ha)	4,200	4,000
Total revenue/Ha	$1,476	$1,405
Operating Profit/Ha	**$796**	**$805**

P&L – Medium scale rice production with average use of fertiliser and other technologies[1]

Description (1 Ha under crop, season 2, 2017)	Global Trendz Farm
Cost of fertiliser/ha (CAN, DAP, NPK (Yara Mila Cereal))	$120
Other costs (labour, basic equipment running costs, repair and maintenance, security, drying and cleaning, storage)	$302
Total costs/ha (1 kg of rice costs ugx 600 to produce)	$422
Average price un-milled rice/kg (ugx 1300)	$0.35
Average yield (kgs/ha)	2,600
Total revenue/Ha	$900
Operating Profit/Ha	**$478**

[1]ORI analysis.

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Profitability of fertiliser - Sorghum

Overview

- The two major breweries, Nile Breweries and Uganda Breweries, are promoting commercial sorghum production. The main limitation with white sorghum is that the market is small – the breweries demand is unlikely to grow rapidly.
- Sorghum is grown in Eastern and Northern Uganda regions.
- The breweries contract small and medium small scale farms to grow sorghum, and may supply key inputs on credit, especially seed. Model is to contract large number of small farmers for political capital as well as to keep sorghum price down.
- NGOs and private sector aggregators manage farm inputs, production, harvesting and delivery logistics for smallholder production.
- Sorghum is rarely grown by large scale farmers because the production costs, especially equipment deployment, are far too high for the yield levels and price points that sorghum delivers.

Analysis

- Key challenges in the supply chain include: limited capacity and loyalty among supply chain players (including aggregators, agents and farmers), low farmer productivity, side selling, and limited empowerment among women and youth.
- The low yields from the current available seed and the low sorghum price do not enable the profitable application of fertiliser and other technologies or the deployment of equipment and machinery. However, yields of upto 4mt/ha can be realised with better seed varieties.
- Sorghum not currently attractive to large-scale farms, compared to other enterprises such as rice and maize. Large scale farmers would need to be offered a higher price than that offered to smallholders – at least ugx 1,200/kg for realisable yields of 4mt/ha – to justify their higher cost structure due to their reliance on hired labour and expensive farm equipment, although sorghum requires fewer inputs than rice and maize.

[1]ORI analysis. [2]Technoserve sorghum program with NBL.

P&L, Large scale sorghum production with fertiliser[1] and other technologies

Description (based on 1 ha of land under white sorghum – based on a trial production on 4.5 ha by Oola Lolim in 2016)	Oola Lolim Farm, Season 2, 2016
Fertiliser costs (NPK (17:17:17), NPK (Yara Bera Sulfan)	$269
Other costs (seed, land prep and planting, equipment running and maintenance, crop protection, drying, cleaning and packaging)	$542
Total costs/ha	$811
Realised yield kgs/ha	3,772
Average price UGX 850/kg (at ROE of 3649 to USD in Apr/17)	$0.233
Revenue per ha	$879
Operating profit/ha	**$68**

P&L, Small scale sorghum production, with and without fertiliser[2]

Description (based on 1 ha of land under white sorghum), 2017 season 2	Line planted + Fertiliser (Emerging SHF)	Line planted without Fertiliser (Regular SHF)	Broadcasted without Fertiliser (Subsistence Farmer)
Fertiliser costs (DAP and Urea)	$167	$0	$0
Other costs (seed, labour, land hire, crop protection)	$407	$407	$276
Total costs/ha	$574	$407	$276
Average yield kgs/ha	2965	2100	1236
Average price UGX 1,000ugx/kg	$900		
(ROE of 3700)	$0.27	$0.27	$0.27
Revenue per ha	$801	$568	$334
Operating profit/ha	$227	$160	$58

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Profitability of fertiliser - Sunflower

Overview

- Sunflower was introduced to Uganda as a low input cash crop, targeting farmers with relatively larger pieces of land. Within Uganda, sunflower is grown almost only in Lango.
- Large scale farms that grow sunflower are typically factory owned or associated estates such as Mukwano, Ngetta and Mt Meru. Sunflower is also grown through contract farming schemes, e.g. Ngetta Tropical (sunflower mill).
- Hardy crop that doesn't require a lot of fertilisers and pesticide. In Russia for example, the rates of application are approx. 120 kg of Nitrogen per hectare.
- All sunflower is currently produced without inorganic fertiliser. As is also the case with sorghum, focus has been on improved seed and good agricultural practices, rather than fertiliser or other technologies.

Analysis

- Sunflower industry in N. Uganda is not using fertiliser and there is limited potential to promote it.
- This is because the mills want to produce organic sunflower and are sceptical about getting into inputs because the economics don't make sense. Fertiliser and pesticide would increase the cost of production and push up the price the mills pay for sunflower. In addition, side selling creates disincentive to supply inputs on credit. Instead, the mills prefer to contract more farmers.
- Broadly, the key focus of sunflower crushing firms is on the yield of oil/mt of seed milled vs. farmer productivity. The choice of seed varieties and agronomic practices are heavily influenced by that outcome.
- N. Uganda's Av. yields with current varieties is quite low – 950 kgs/ha, although advertised seeds claim yield potential in the range of 1.3 – 2.0 mt/ha.

P&L, Emerging Smallholder sunflower farm, no fertiliser[1]

Description (1 ha under crop), season 2, 2017	Ayo Francis-Odolo-Amido Coop[2], contracted by Ngetta Tropical Holdings
Fertiliser costs	$0
Other costs (seed, planting material, labour, land hire, drying, bagging, transport, storage)	$243
Total cost of production for 1 ha	**$247**
Yield kgs per ha	1,675
Average price UGX 1,000ugx/kg (ROE of 3700)	$0.27
Revenue per ha	**$452**
Operating profit/ha	**$205**

P&L, Large-scale sunflower farm - description

- Sunflower is not currently produced by large-scale farms as it is unprofitable, hence no proper financial data exists to model its attractiveness at large-scale.
- Given the low yields/ha of current available varieties in the market (1.3-2.0 mt/ha range), and a low price point of ugx 1,000/kg, it is clear why sunflower is not a crop for large-scale farms.
- By practice and as a business model, large-scale farming entails the full deployment of farm equipment and machinery across key operations, and the use of maximum levels of nutrients and crop protection solutions to maximise yields. All factors, including seed must have the potential to maximise returns.
- Assuming 2mt/ha yields ($540), a fertiliser cost of $100/ha, and total cost of $500, the operating margins are no more than $40-50/ha, which is unattractive

[1]Actual records from farmers co-ops and farmers who grew sunflower in season 2, 2017.
[2]Ayo Francis-Odolo-Amido Coop grew 15 acres (6 ha) under sunflower.

Bottlenecks

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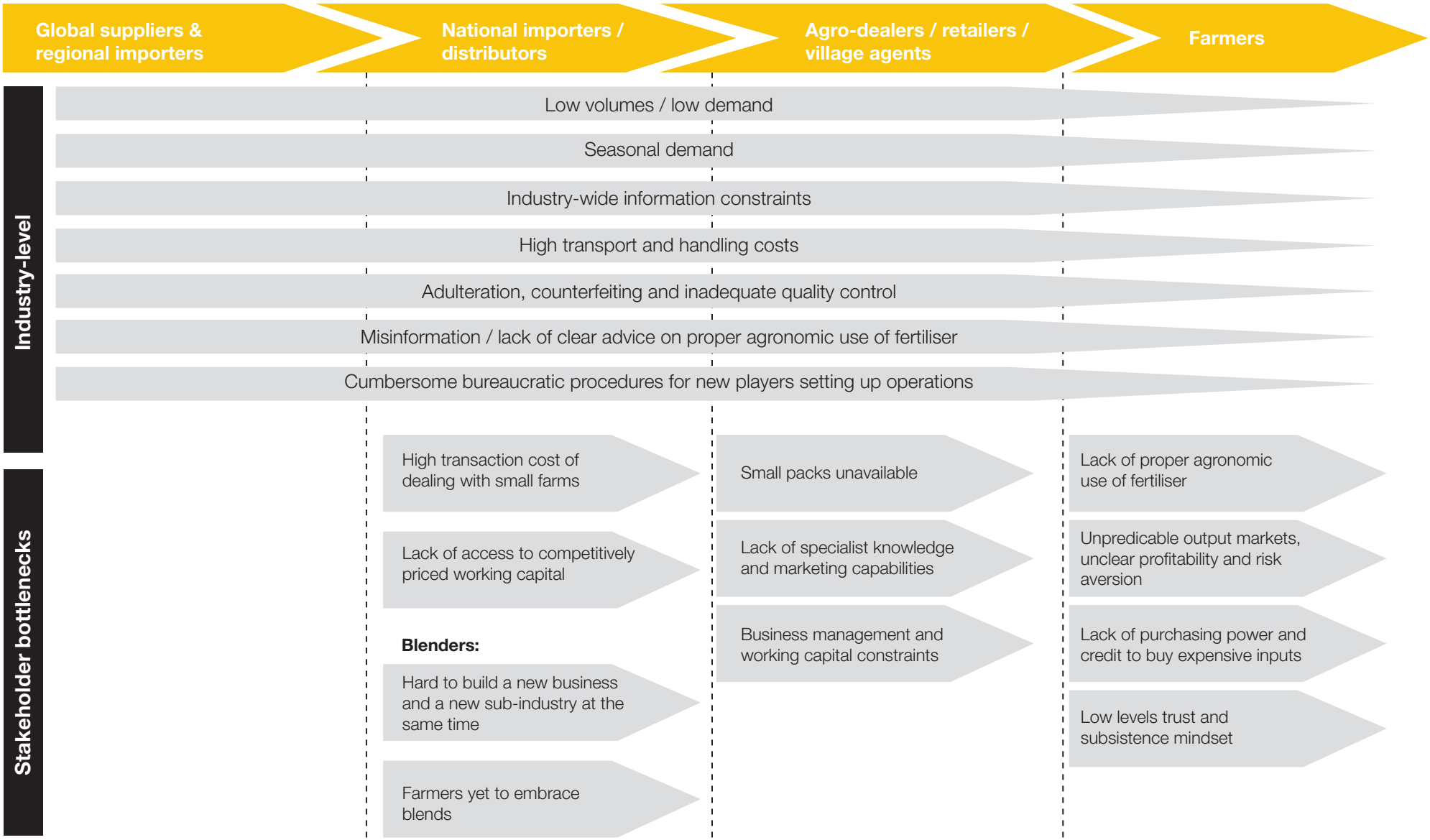
Value chain bottlenecks - overview



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Bottleneck analysis – Industry-level

A number of industry-wide bottlenecks affect all fertiliser value chain participants.

Industry-level bottlenecks	
Low volumes / low demand	• Despite some growth over the last 20 years, the total size of Uganda's market remains small and N. Uganda's market is even smaller. • Large volumes are required for fertiliser trade, including blending to be profitable as a stand-alone business. • Fertiliser distribution outside the major cities in N. Uganda is virtually non-existent due to extremely low demand. For example, Okado Investments (Gulu and Nwoya agro-dealer) could only recall the purchase of a handful of bags by agents outside of Gulu town.
Seasonal demand	• Fertiliser demand is seasonal – planting/top-dressing season lasts 4-5 months/year and the business is largely idle for the rest of the year. • This affects return on investment and reduces attractiveness of large investments such as in fertiliser warehousing and distribution. "What do you do with the warehouses after the planting season?" Agnes Kabwisho, GM Agriculture, Balton Uganda Ltd.
Industry-wide information constraints	• Industry lacks accurate information on the economics of fertiliser use for resource-constrained subsistence smallholders. Few smallholders (in the absence of targeted programs) know how to determine if fertiliser use will be profitable on their farms. • Fertiliser use messaging has been around generic persuasion on use vs. selling specific business cases in which fertiliser is one among a set of key technologies. • Low levels of use of modern technology to improve the use of fertilisers, and to measure and analyse soil data.
High transport costs and lack of bulk handling logistics	• Long distances and poor infrastructure leads to high transport costs across all segments. • Fertilisers are typically imported into Uganda in containers loaded with 50 kg bags despite the fact that this is more expensive than importing in bulk (e.g. 1 MT packages).[1] Key reason for this is the lack of specialised bulk handling capabilities at the port as well as capabilities to securely transport bulk fertilisers, especially to large-scale farms. There's also lack of awareness of the existence of this option, especially by large estates

[1]This is due to additional costs of bagging, including VAT because bagging is considered value add, as well as more time required to organise large loads.

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Bottleneck analysis – Political economy

Although the policy and regulatory framework has improved, a range of political factors continue to hold back the fertiliser industry.

Political economy bottlenecks	
Adulteration, counterfeiting and inadequate quality control	• Tests show problems with fertiliser quality (nutrient and moisture content) at all points across the value chain including at import. • Pervasive problem with fake and counterfeit fertiliser and seed, mislabelling and tampering. Repackaging 50 kg bags into smaller quantities contributes to problem. • MAAIF lacks capacity to monitor and assure fertiliser quality at point of entry let alone down the value chain. Farmers lack analytical tools such as fertiliser quality testing tool kits and importers/dealers lack incentives to self-regulate.
Misinformation / lack of clear advice on proper use of fertiliser	• Organic movement has promoted idea that inorganic fertiliser is harmful. Organic fertiliser brands have also been sold with misleading information about nutrient content.[1] • Myth that Uganda has fertile soil is even more pervasive in N. Uganda than elsewhere in the country.[2] • Public sector has not taken the lead in soil fertility mapping that would enable correct application of fertilisers – instead farms are left to conduct own testing. Most advice is out-dated and based on soil fertility from the 1960s/70s.
Cumbersome bureaucratic procedures	• Although the National Fertiliser Policy and Strategy (2016) and Fertiliser Regulations (2012) provide a much more coherent policy and regulatory framework for the fertiliser industry, however they have yet to be fully operationalised. • Some bureaucratic procedures are cumbersome for importers/dealers and do not do enough to facilitate the supply of fertiliser at affordable prices especially to the smallholder market. These include the requirement to register e.g. small packs with MAAIF, a process that is bureaucratic.

[1]Organic brands such as Fertiplus presented nutrient content in a confusing way to mask the fact that the N available is only 4.2%, P is 3%, and K is 2.8%. These nutrient levels are not sufficient to increase crop yields. To their credit, organic fertilisers do have a range of trace elements, which are not provided by straight inorganic fertilisers, as well as large amounts of organic matter (65%), but they are also more expensive per kg and large quantities need to be applied to achieve the same yield uplift as inorganic fertilisers.

[2]Luswata & Mbowa (2015). In the 2013/14 Uganda National Panel Survey, about 75% of respondents from northern Uganda indicated that soil quality was good, compared with the national average of 66%.

Bottleneck analysis – National importers/distributors & blenders

	National importer / distributor & blender bottlenecks
	High transaction cost of dealing with small farms
	• Smallholder farmers with the capacity to purchase fertilisers are few and widely spread out, making the business case to supply them weak. While this is broadly the case across the country, N. Uganda is an especially difficult market for fertilisers. "Everybody asks me to set up fertiliser distribution in Uganda and I ask: why do it for less than 20% of the market when I can already directly supply over 80% of the market by simply working with a dozen or so large scale farms?" - John Magnay, African Agribusiness Expert • Logistical challenges of "last mile" fertiliser distribution, even when the demand exists • delivery
	Lack of access to competitively priced working capital
	• "The dealer needs inexpensive credit if adequate stocks of the types of fertiliser required by the farmer are to be available at the time they are required. The farmer has to finance the period between the application of the fertiliser and the harvesting and sale of the resulting agricultural product. An insufficient availability of credit, at an affordable price, is … a constraint on fertiliser use." (FAO, 2006) • Distributors have to meet large scale farms' need for long credit periods, usually around 120 days, in order to be competitive. • Cost of capital available in the market too high for a low margin business (typically 5-15% gross profit margins) for importers and distributors.
Blenders	**Hard to build a new business and new sub-industry**
	• Building a new business in a new sub-industry is expensive, takes long to become profitable, and requires key strategic partnerships to drive growth. • For large scale commercial farmers familiar with the concept of crop and soil specific blends, local blenders have to demonstrate their capability and be ready to compete with more established suppliers.
	Farmers yet to embrace blends
	• Fertiliser blends are a new concept in Uganda. Leapfrogging to blends when many farmers are not even familiar with the traditional straight fertilisers, means high cost of marketing. • The case for unconventional blends still unclear among smallholder farmers, especially when not accompanied by soil testing and balanced crop nutrition.

Bottleneck analysis – Agro-dealers

Agro-dealers bottlenecks	
Small packs unavailable	• N. Uganda agro-dealers typically purchase 50 kg bags and repackage them, illegally, into smaller packs as many small farmers want to try smaller quantities and cannot afford 50 kg bags. This contributes to problems of tampering and mislabelling. It also results in a substantial mark-up (around 50% for 1 kg bags). • Major agro-dealers (esp in Kampala) typically only stock 50 kg bags, despite the fact that smaller (25 kg and 10 kg) bags are also available from their suppliers (i.e. ETG).
Lack of specialist knowledge and marketing capabilities	• Agro-dealers tend to have generic information (supplied by large agribusinesses) about products stocked, but are unable to provide more sophisticated advice (e.g. about kind of soil remediation needed based on soil deficiencies and crop needs. Most recommendations for fertiliser application are out-dated and generic. • Several of the agro-dealers could not satisfactorily explain the benefits of inorganic fertilisers vs. organic fertilisers.
Weak business management skills and working capital constraints	• Due to their small size and low credit track record, agro-dealers find it difficult to access supplier credit and struggle to grow their businesses. • While most agro-dealers keep daily sales records, they do not use this to manage their inventory. Few agro-dealers know the shelf velocity of their fertilisers or other products. To avoid the risk of the "wrong" inventory, they tend to stock in small quantities <10 bags. As a result, stocks run out frequently and farmers do not trust them as reliable suppliers.

Bottleneck analysis – Farmers

Small scale farmers	
Lack of proper agronomic use of fertiliser	• Smallholder farmers do not use fertiliser at all or use it in an uninformed way. (e.g. Contract tobacco farmers need information on the correct use of N which can destroy product quality if used excessively). • Farmers lack information about soil fertility required to determine the correct application of nutrients, and even in cases in which soil testing has been provided for free, need to be convinced of its benefits due to the pervasive belief that Uganda's soils are fertile. • Farmers unable to determine the level of fertiliser use that would be profitable for them or which nutrients and/or remediation to prioritise given resource constraints.
Unpredictable output markets, unclear profitability and risk aversion	• While fertiliser increases yields, investment in fertiliser does not necessarily leave farmers better off financially. The investment is only worthwhile if the farmer can sell the additional yields at a price that justifies the cost of the input. • Farmers' decision to invest in fertiliser and other inputs depends on the strength and reliability of output markets. • Farmers may not want to take the risk of investing in fertiliser if they are uncertain about their ability to achieve additional yields, (e.g. due to pests, disease, or weather uncertainties), to get those yields to market (e.g. storage, transport, reliable purchasers) or if they an unsure they will get a good price for additional output (e.g. price volatility).
Lack of purchasing power and credit to buy expensive inputs	• Low purchasing power, and lack of credit mechanisms to purchase farm technologies. Quote: A normal fertiliser bag costs approx. 130,000 – 175,000 UGX in N. Uganda. How many farmers have that kind of money in Uganda? Agnes Kabwisho, General Manager Agriculture, Balton Uganda Ltd • Most smallholders not engaged in activities that earn them cash, and are therefore not a market for fertilisers. • Outside the tobacco sector, there are hardly any structured farm input mechanisms to enable farmers access farm inputs on credit.
Low levels trust and subsistence mind-set	• Low levels of trust and conservatism inhibit technology adoption. Trust especially low in N. Uganda due to history of conflict. • Subsistence mind-set, history of humanitarian assistance and myth that Uganda's soils are fertile undermine willingness to purchase fertilisers. • Emerging smallholders understand the benefits of fertiliser especially in fruit and vegetable production, but are sceptical about benefits for cereals

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Investment Hypotheses and Prioritisation

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Investment hypotheses - Overview

Six initial investment opportunities were considered, of which four (#2 combined with #6, #3, #4, #5) were prioritised and refined based on their feasibility and potential for NUTEC to add value.

Opportunity # 1: Invest in domestic fertiliser manufacture by supporting the Sukulu phosphate project.	Despite initial delays, project appears to be underway. But the project is not transparent and unlikely that NUTEC will be able to partner with the Chinese firm leading the project.	Feasibility: Low Potential to add value: LowSustainability: High
Opportunity # 2: Establish large, professionally managed agro-input distributors in key N. Uganda towns (Lira, Gulu, and Arua) to supply medium and emerging smallholder farmers.	Strong potential for NUTEC to develop this concept with ETG or with large scale farms, e.g. Agriserv.	Feasibility: High Potential to add value: High Sustainability: High
Opportunity # 3: Create demand through soil analysis services, marketing a 'total package approach', debunking negative messages about inorganic fertiliser use.	Previous efforts to promote demand have not been successful therefore recommend that NUTEC evaluate past efforts and determine what approaches will have greater chance of success.	Feasibility: Medium Potential to add value: Medium Sustainability: High
Opportunity # 4: Promote fertiliser mini-packs (1, 10, 25 kg packs in addition to the traditional 50 kg bags) to serve subsistence smallholder market.	Strong potential for NUTEC to partner with ETG or other distributors to promote small packs. Requires further analysis of the business case for small packs.	Feasibility: High Potential to add value: High Sustainability: High, but long-term
Opportunity # 5: Consolidate bulk fertiliser purchases by large-scale and medium scale farms and contracting schemes to take advantage of scale efficiencies and obtain more competitive prices, for example by facilitating a shipload of fertilisers.	Potential exists to reduce prices for large scale farmers and increase their competitiveness, but on its own would not impact emerging smallholder market. Requires further cost/benefit analysis.	Feasibility: Medium Potential to add value: Medium Sustainability: High
Opportunity # 6: Develop crop specific-solutions that link input and output markets and promote most profitable use of fertiliser and other inputs (e.g. maize millers provide fertiliser and inputs on credit, to be settled on purchase of outputs).	Potential to develop this approach for rice and maize together with the establishment of agro-input/output hubs in N. Uganda as per Opportunity 2 above	Feasibility: High Potential to add value: High Sustainability: High

Investment hypothesis 1 – Establish a fertiliser/input and output market hub

Establish large, professionally managed agro-input hubs in key N. Uganda agricultural corridors that would supply medium and emerging smallholder farms with fertiliser and other agri-inputs and purchase farm outputs.

Existing initiatives / interest of investors & partners

- ETG has the most attractive synergy (see case study) and could engage to influence their Uganda strategy to increase focus on N. Uganda.
- Another approach is to support large commercial farms (e.g. Agriserv/ Oola Lolim) to do bulk fertiliser purchases for their requirements as well as for the wider market as NUAC is currently doing on a small scale.
- AFAP is promoting super-dealer development, but not yet in N. Uganda.

Gaps

- Kampala-based distributors lack warehouses and staff close to farms.
- Small N. Uganda based agro-dealers are not sufficiently specialised and lack the skills to market fertilisers and other inputs.
- Lack of linkage of input and output market inhibits uptake of fertiliser (e.g. credit constraints and weak value offer due to unclear returns from technology adoption).

Potential return / business case

- One Stop Shop/Super Hubs could both supply agro-inputs and purchase crops, helping link input and output markets and address farmer credit constraints, if capable private sector partners are found.
- Importing bulk quantities direct from port to key N. Uganda towns would reduce the farm fertiliser price and mitigate quality problems due to tampering along the value chain.

Risks

- Current demand insufficient for fertiliser distribution on its own to make economic sense, but potentially viable economically if also supplying other inputs and purchasing crops.
- Adoption may be slow therefore question of whether/or how long it will take for 'one-stop-shop' to become economically viable without catalytic support.

Likely impact

- By linking input and output markets, increase the attractiveness of fertiliser use by small farms.
- Increase the availability of fertiliser to small and medium scale farms.
- Enable small farms to take advantage of knowledge (e.g. soil analysis, correct application of fertiliser) that large scale farms have.

Feasibility

- Potential private sector partners (e.g. ETG) may be more interested in leveraging current investments in, e.g. Kampala, Tororo, and the region, than growing distribution networks and demand in N. Uganda.
- Requires alignment of strategy with an appropriate capital structure that makes the investment attractive and supports first years of the business.

Investment hypothesis 1 – Establish a fertiliser/input and output market hub

Agriserv Ltd1 has indicated interest in investing in a hub that would sell fertiliser and other farm inputs and purchase or broker farm outputs (e.g. maize, sorghum and rice) from medium and small scale farmers, if NUTEC and others can provide catalytic grants for warehouse establishment and repayable working capital for the purchase of fertilisers.

Overview

- Large scale farms in N. Uganda have the technical and financial capabilities to deploy state of the art production methods, and have the negotiating power to obtain fertilisers and other inputs at the most competitive prices and terms.
- Meantime, neighbouring medium scale farms producing similar crops lack knowhow on correct fertiliser application and purchase fertilisers at much higher prices – resulting in lower yields and profitability.
- Pioneering firms' capabilities can be leveraged to enable medium and emerging smallholders to achieve higher yields and financial returns.
- Catalytic grants can help to de-risk the investment and enable access to commercial capital, in effect making the investment attractive. Without grants, the commercial case is weak, and investment unlikely to materialise.

Agriserv Ltd – a potential investment partner[1]

- Agriserv manages Oola Lolim Ltd, a sister company with different shareholders. Plants 500 ha per year of cash crops (maize, rice) and a similar area of cover crops and is in the process of expanding to approx. 1,000 ha of cash crops.
- Agriserv provides grain drying, cleaning and storage for other commercial farmers, and farm is located at the heart of the Nwoya/Gulu/Amuru farming cluster.
- Agriserv operates a workshop and parts centre at Oola Lolim farm for its own equipment and also other farmers. Agriserv is also a dealer for Engineering Solutions (U) Ltd and sells parts and lubricants. It also provides, on a limited scale, tractor and combine hire services.

Preliminary[2] investment structure for a fertiliser hub

Description (these are high level estimates, primarily based on preliminary discussions and analysis)	Working capital (USD)	Grant capital (USD)
Establishment of warehouse (500mt capacity - (materials+ works for a 24mx36m warehouse)		400,000
Cost of permitting[3] (Independent EIA report, NEMA license, Ag. Chemicals Board license, etc.)		6,000
Season 1 financing of 500mt fertiliser stock purchase @ approx. $640/mt delivered at warehouse	320,000	
Sales agronomist employment, travel and demo plots set up @$1,000/mnth for 3 seasons/1.5 years		18,000
Subsidy on the cost of soil testing (includes costs for a remote soil lab and a soil agronomist to enable accurate fertiliser recommendations) – 1.5 years		50,000
Strategic marketing and outreach costs		10,000
Total sales (calculated at @681/mt to medium scale farmers and emerging smallholders)	340,500	
Operating profit for 2 seasons (@$41/mt)[4]	**41,000**	-
Total investments (working capital and grants)	**320,000**	**484,000**

[1] Jim Middleton, is the MD and is a reputable agribusiness entrepreneur.
[2] This is a high level preliminary analysis and is not intended as a detailed due diligence or an endorsement of the proposed investment. NUTEC should undertake its own analysis to satisfy itself about the attractiveness of the investment.
[3] The cost of completing an independent Environmental Impact Assessment, obtaining a NEMA license, and an Agricultural Chemicals Board license is $6,000 (Source: Stephen Byantwale/MAAIF, Jim Middleton, and Independent EIA consultant
[4] This margin does not include that generated from other agri-input sales and other services. Furthermore, 500mt of fertiliser sales is only the base case

Case study - ETG

ETG has one of the most efficient fertiliser importation for Uganda and is a potentially attractive partner for developing N. Uganda distribution.[1] Here's why:

- An integrated agricultural supply chain group, ETG procures, warehouses, processes and distributes agricultural commodities. With strong transport and logistics capabilities, ETG is one of the leading fertiliser traders in East Africa. Fertiliser is now ETG's single largest product line, with sales of 10,000-15,000 mt/year in Uganda.
- ETG aspires to offer a One-Stop Shop solution for farmers. In this model, it supplies all farm inputs including seeds, agrochemicals, fertilisers and agronomic services – and purchases agricultural outputs.
- A key to ETG's efficient transport and logistics is that fertilisers and other inputs are delivered to farmers using the same assets and routes that bring their commodities to market. ETG is able to achieve low transport costs, including by taking advantage of two-way transport of commodities from Mombasa to Kampala and Uganda's regions.
- The majority of ETG's fertilisers are marketed directly to farmers through ETG warehouses in Nairobi, Tororo, and Kampala and also directly sold from their blending facility in Mombasa especially for larger farms. A significant percentage is also sold to dealers, wholesalers, co-operatives and NGOs. The remaining volumes are imported to fulfil government requirements.
- ETG supplies both straight fertilisers and various grades of compound and blended NPK fertilisers. ETG has expanded its capabilities to supply balanced nutrients through its recent investments in the acquisition of Kynoch Fertilisers, a South African fertiliser manufacturer and distributor that offers a range of crop and soil-specific blends, as well as in a handling, blending and bagging operation in Mombasa.
- Providing competitively priced fertiliser fits within ETG's broader business objectives of improving yields of its farmer suppliers. Hence, ETG has the incentive to land fertiliser at farm gate at affordable prices.
- ETG is uniquely interested in the smallholder market. Only ETG - of the large fertiliser companies - has gone the route of small packages – 5, 10, 20 -25, kgs packs. Smallholders sell surplus crops to ETG and purchase affordable fertilisers and other products.
- ETG plans to enhance its Tororo distribution centre to more efficiently serve the fertiliser market in Northern and Eastern Uganda. ETG sees the typical route of importing fertiliser to Kampala and then distributing it onward to other regions as wasteful. ETG plans to serve N. Uganda through Tororo and may also consider opening a shop/ distribution point in Lira, Gulu and/or Arua.

With strong transport and logistics capabilities, ETG is one of the leading fertiliser traders in East Africa. Fertiliser is now ETG's single largest product line, with sales of 10,000-15,000 mt/year in Uganda.

[1]Grainpulse aims to build a model close to ETG's. However, Grainpulse currently is unable to achieve the same level of efficiency in transport and logistics due to its one country focus for fertilisers and one fertiliser category/NPK.

Investment hypothesis 2 – Create demand through marketing, soil analysis, etc.

Evaluate previous efforts to create demand with a view towards developing more effective approaches (e.g. soil analysis services, marketing a 'total package approach', debunking negative messages about inorganic fertiliser use).

Existing initiatives / interest of investors & partners

- AGRA project creating awareness on the benefits of crop and soil specific fertiliser blends by financing and facilitating demos by fertiliser firms, e.g. Grainpulse provides fertiliser samples in 10 kg bags and sufficient for 400 demo plots. Northern Uganda is not currently covered by the project.
- Sasakawa Global Mobile Farmer Training Centre (see case study).
- World Bank project is working to support smallholder commercialization

Gaps

- Unclear why previous efforts to promote demand have not had a greater impact and a range of hypotheses re why adoption rates have been low need to be investigated.
- Messaging has not previously been tailored to particular regions, crops, etc.
- Pervasive negative messaging about the harmful effects of inorganic fertilisers by the organic movement and myth that 'our soils are fertile and do not need fertiliser' influencing smallholders.

Potential return / business case

- Over a long time horizon, the aim is to improve agricultural productivity.
- Long term behavioural change to promote adoption of fertilisers as well as other technologies needs to be supported by development actors although private sector may participate to promote their brands (e.g. Grainpulse).

Risks

- Uganda has a history of fertiliser market development programs (e.g. IDEA, IFDC, Sasakawa) whose impact is questionable, therefore need to evaluate these initiatives in more depth and determine what could be done differently.
- Ideological conflict with the organic movement.

Likely impact

- Increased adoption of fertilisers and other inputs and technologies in smallholder market by breaking myth that Ugandan soils are fertile, thereby improving productivity and overall returns.

Feasibility

- Depends upon public sector and development actors taking the lead and being willing to engage over a long time horizon.

Case study – Sasakawa Global 2000 Mobile Farmer Training Centre

- With funding from K+S fertiliser company of Germany, SG 2000 acquired a Mobile Farmer Training Centre with a soil testing laboratory and a farmer training facility.
- The mobile laboratory tests the major nutrients (N, P, K); secondary elements (Ca, Mg, S) and soil pH. It operates in the Lango sub-region in Dokolo and Apac districts, alongside a farmer development project focused on food staples and oil crops, including soya, sunflower, maize, rice and sorghum.
- Based on the tests carried out, phosphorous (P) and nitrogen (N) are deficient in approx. 70% of soils and need remediation via inorganic fertilisers if commercial yields are to be realised. In addition, approx. 20% of the soils are deficient in potassium (K), and another 10% are deficient in boron and zinc. The soil pH shows slight acidity, with the lowest pH being 4.0, and the average range being 5.5-6.0, which is okay for now for most staple food production, but requires close observation.
- To address this, SG 2000 is advising farmers to apply diammonium phosphate (N-18%; P-46%), and is working with K+S to address the potassium deficiencies through Kornkali brands from K+S (K-40%; Mg-12%). Balton has been supplying the DAP, and Grainpulse is working on an NPK blend (DAP+UREA+KornKali) that addresses all the deficiencies with one product.
- SG 2000 is taking into account profitability of fertiliser use for resource-constrained farmers and their field teams have demonstrated that profitability was highest when farmers applied fertilisers at the rate of 50% of the recommended amounts. The modeling was conducted at three tiers: Tier 1: Zero application, (least profitability), Tier 2: 50% rate (highest profitability), and Tier 3: highest rate of application (mid range profitability). These rates were also modelled based on commodity prices at harvest and at 4 months after harvest.
- Despite soil testing services being offered free of charge, many smallholders initially did not understand the benefits of soil testing or want to participate. During the past 3 years, only 400-450 samples have been presented for testing. The main reason for this is that farmers believe their soils are fertile and attribute low yields to disease and pests, rather than nutrient deficiencies. SG 2000 is addressing this by demonstrating to reluctant farmers that their soils are deficient, and that they need remediation. At a later stage, SG 2000 hopes to begin charging a fee per soil sample tested, although it is unclear whether this will be viable given reluctance of farmers to participate even when the service is being offered for free.
- This scenario mirrors other efforts to promote fertiliser demand that have not succeeded in changing farmers' behaviour. For example, the IDEA project in the early 2000s provided subsidised trial packs to farmers, and although farmers appeared to appreciate the benefits of fertiliser, they did not embrace the technology as demonstrated by low demand for fertilisers after the close of the program.

Despite soil testing services being offered free of charge, many smallholders initially did not understand the benefits of soil testing or want to participate. During the past 3 years, only 400-450 samples have been presented for testing.

Investment hypothesis 3 – Promote fertiliser mini-packs

Promote fertiliser packaging in quantities demanded by small farmers (1, 10, 25 kg packs in addition to the traditional 50 kg bags).

Existing initiatives / interest of investors & partners

- ETG is the primary actor thinking about mini-packs and has a roll-out plan.
- Grainpulse already packs the blends in small packages of 10 kgs.

Gaps

- Agro-dealers typically break up 50 kg bags into smaller quantities although this is illegal. This contributes to nutrient loss (fertilisers are highly hygroscopic) and quality control issues, including adulteration.
- Small farms interested in testing out fertiliser in smaller quantities and also can't afford or do not always need 50 kg bags.

Potential return / business case

- Business case to be informed by analysis of cost implications of making fertiliser available in smaller packs in terms of labour, materials, manufacturing and transport costs (based primarily on ETG data).
- Anticipate that the price per kg of fertiliser will increase, but will not be out of reach for farmers and should be lower than agro-dealers' current mark-up for illegal small packs.

Risks

- All bags need to be registered making the registration of small packs cumbersome.
- Investments in the promotion of small packs needed to enable commercial offtake, and make the investments attractive.
- Misalignment, whereby the targeted market segment is that which does not already purchase fertilisers, and unclear if small packs is the solution

Likely impact

- Minimise adulteration and quality loss due to illegal re-packaging .
- Promote higher rates of adoption due to the smaller cost outlay of smaller packs and opportunity for farmers to try fertiliser on small plots.
- More options for farmers and increase ease of transport.

Feasibility

- Industry has been ambivalent about the smallholder market and small packs (including due to outdated traditional fertiliser application recommendations), but players such as ETG and Grainpulse are exploring the opportunity to capture a greater share of the market.

Investment hypothesis 4 – Consolidate bulk fertiliser purchases

Consolidate bulk fertiliser purchases by large-scale farms and contract farming schemes to take advantage of scale efficiencies and obtain more competitive prices, for example by facilitating half-shipload purchases of fertilisers.

Existing initiatives / interest of investors & partners

- No tangible efforts currently – as each farm tends to negotiate deals separately, although the large-scale farms especially those clustered in Nwoya are aware of each others efforts.
- All large-scale farms see the value in pooling their requirements and sourcing for the best possible deals, given that fertiliser is a major input.

Gaps

- Large farms are missing out on potential discounts from purchasing in larger quantities (i.e. shipload or half shipload), or directly buying from global traders.

Potential return / business case

- Economies of scale on freight as well as transport from port to farm favours larger purchases.

Risks

- Private sector originated bulk procurement is difficult to pull through because competitors do not typically like to work together.
- Fertilisers orders are fragmented by type (and therefore source) and needed at different times making it difficult to consolidate orders.

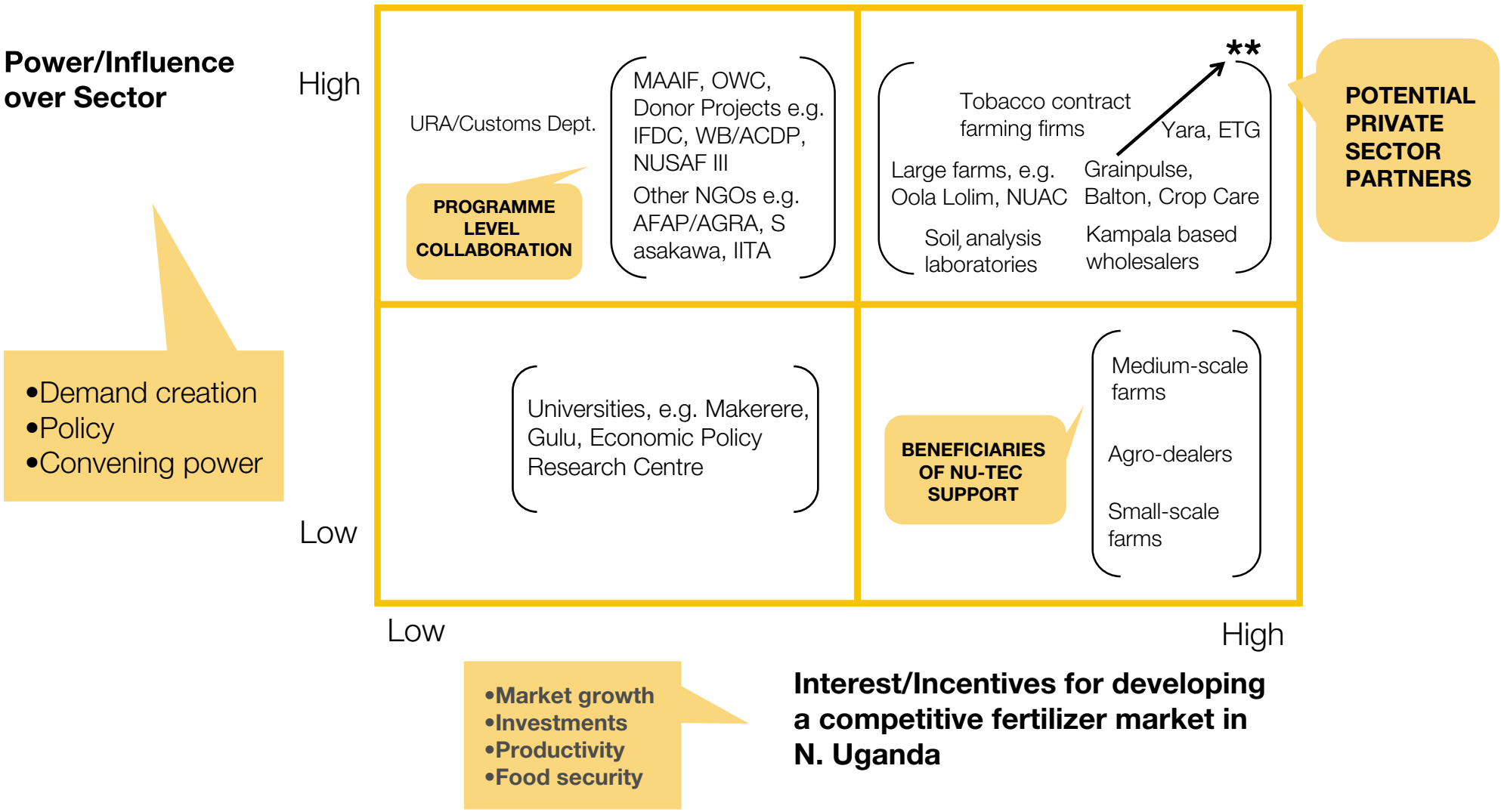
Likely impact

- Lower cost of fertiliser to large scale farms and lower cost of production which is a major challenge (e.g. maize) to increase competitiveness.
- Potentially also could lower cost to smallholder farms if linked with strategy to supply smallholders.

Feasibility

- Large farms negotiate long credit periods of up to 120 days, which is essentially payments after crop sales. This is the common practice for all other crop inputs. Unclear whether they would receive as favourable terms for bulk purchases.
- Large farms don't currently have logistical capability and international fertiliser trade knowledge to engage in bulk importation.

Power/interest matrix and potential for NU-TEC partnership roles



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Non-private sector players in N. Uganda

While there are several non-private sector players in Northern Uganda, the ORI research team did not find at-scale projects currently being implemented in the region. Potential partnerships with NU-TEC will require a long-term view and financial investment

Name of Actor	Brief Project Description	Gaps relative to N. Uganda	Fit for NU-TEC Partnership
Agriculture Cluster Development Project (ACDP)/ MAAIF/World Bank	ACDP is a 6 year project funded by the World Bank, and focuses on 5 crop commodities i.e. maize, beans, rice, cassava and coffee. Project objective is to raise on-farm production, productivity and markets for selected commodities. A relevant component to NUTEC's fertilizer market interventions is "Support the intensification of on-farm production through enhanced access to and use of key agricultural inputs (seeds, fertilisers, pest control products and on-farm storage facilities) via E-Voucher system".	• Pilot project in 2 districts – Amuru (rice) and Nebbi (cassava) • Rollout to Gulu, Pader, Kitgum, Agago and Nwoya	Low: Public sector focus and longwinded timelines not a good fit for NU-TEC
African Fertiliser and Agribusiness Partnership (AFAP)	Implementing a hub agro-dealer development project in Western, Central and Eastern Uganda. Project funded by Bill and Melinda Gates Foundation for 5 years. Key activities are: demand creation support to private sector fertiliser wholesalers, linkages to finance, fertiliser suppliers, and expansion of downstream rural agro-dealer network. Also helps in soil testing, technology development sites and output marketing.	• Project does not focus on N. Uganda. • Traditional focus on major agro-dealers	Medium: Project is focused on traditional NGO interventions, but there may be potential to identify private sector opportunities for partnership, and support to expand project in N. Uganda.
Others – e.g. JICA, Sasakawa, various NGOs managing small fertiliser projects or components	Several NGO projects supported by a variety of donors exist in N. Uganda. A common focus is on improving food security and/or nutrition via increased use of fertilisers among other yield increasing technologies. For example, the Sasakawa project has a specific focus on the promotion of potassium fertilisers for K+S company working in close collaboration with Grainpulse in Lango, with a view to improve soil fertility, but also to support the increased use of potassic fertilisers by Ugandan farmers.	Major gaps include: • Limited impact and geographic reach in N. Uganda • Narrow focus in r4egards to crops/objectives and goals	Low: Limited private sector focus

Recommendations

Recommendations

- Conduct a detailed assessment to understand how medium scale farms can be best served by input/output hub – especially those producing rice and maize (and to lesser degree sorghum). This would aim to understand their fertiliser and input needs and their potential to participate in output markets, their access to commercial capital, and potential linkages with large scale producers.
- Carry out a market study to understand the dynamics of the watermelon industry and leverage the already strong momentum to drive fertiliser demand among emerging smallholders engaged in this enterprise.

Appendix 1: Literature and sources

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Literature and sources – selected list

- Feasibility Study on the Potential for Fertiliser Manufacturing in Kenya and the East African Region, Government of Kenya, conducted by Maxwell Stamp Plc, 2012
- Uganda Census of Agriculture, 2008/2009, Volume III, Agricultural Household and Holding Characteristics report, UBOS, 2010
- The supply of Inorganic Fertilisers to smallholder Farmers in Uganda - Uganda Strategy Support Program, IFPRI, 2013
- Agriculture Cluster Development Project, Project Appraisal Document, World Bank/ GoU, 2015
- Uganda Fertiliser Assessment, AFAP and IFDC (2014).
- Fertilizer Market Situation Statement, 2015 & 2016, AFAP and IFDC.
- Uganda Fertilizer Statistics Overview, AfricaFertilizer.org, 2011-2014.
- The Supply of Inorganic Fertilisers to Smallholder Farmers in Uganda: Evidence for Fertiliser Policy Development., IFPRI (2012).
- Revisiting Uganda's Inorganic Fertiliser Supply Chain: Need for a Stronger Regulatory System. EPRC Research Report #13, Luswata & Mbowa (2015).
- In the 2013/14 Uganda National Panel Survey, Luswata & Mbowa (2015).
- National Fertiliser Policy: Regulatory Impact Assessment, Republic of Uganda (2016).
- National Fertiliser Policy, Republic of Uganda (2016).
- National Fertiliser Sub-Sector Development Strategy and Investment Plan (NFS): 2015/16 – 2019/20, Republic of Uganda (2016).

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Stakeholders consulted

Global manufacturers and traders			
YARA	Global/Uganda	Gilbert Kato	Sales Agronomist - Uganda
Maaden	Global/East Africa	Henry Ogola	East Africa Representative
OCP	Global/East Africa	Julius Rotich	Sales Manager
UralChem	Global/East Africa	Stanley Tiony	Africa Representative
Omya	Continental	Alvin Otieno	Agronomist, East Africa Region

Regional importers (& blenders)			
MEA	Regional/Kenya Traders/Blender)	Eustace Muriuki	Managing Director
MEA Ltd	Regional/Kenya (Trader/Blender)	Francis Kiragu	Area Sales Representative
ETG	Regional/Mombasa/Kampala	Shem Odhiambo	Regional Head, ETG
Samsung C&T	Kenya	Sebastian	Country Manager

National importers and distributors (& blenders)			
Grainpulse	Uganda (Blender)	Eustace Muriuki	Managing Director
ETG Inputs Uganda Ltd	Uganda	Ravi	General Manager
TATA	Uganda	Rammano Har	Country Manager
Balton Uganda	Uganda/Kampala	Omar Kagoro	Agronomist
Balton Uganda	Uganda/Kampala	Agnes Kabwisho	General Manager, Agriculture
Balton Uganda	Uganda/N. Uganda	Paddy Kisembo	Sales, Northern Uganda
Uganda Crop Care Ltd.	Uganda/Kampala	Sharad Kumar Singh	Country Head (Agronomist)
East Africa Seed Company	Uganda	Reddy	General Manager
Twiga Chemical Industries (U) Ltd	Uganda/Kampala	Sanjeev Malhotra	General Manager

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Stakeholders consulted

Kampala and Mbale-based agro-dealers and distributors			
Keith Associates	Kampala	Fredreck Muduuli	Managing Director
Home of Farmers	Mbale		
Faith Agro	Mbale	Mike Walyawula	Director
Elshaddai	Mbale		
Mayiira Farm Supplies	Mbale	Godfrey Matshete	Director

N. Uganda agro-dealers			
Gang Pur	Gulu	Walter Komakech	Owner
Pur Lonyo	Gulu	Patrick Lumumba oola	Owner
Okado Investments Ltd	Gulu	Anne Kipolwa	Managing Director
Munguyiko Stores Ltd	Arua		Director
Matua Family Investments Ltd	Arua		Shop Manager
Green Life International Ltd	Arua		Director
Jalson Foundation and Agro Dealers	Lira		
Farmers Link Ltd	Lira		

N. Uganda regional and district officials			
Gulu District	Gulu local government	Dr Okidi Ochora	District Production officer
Lira District	Lira local government	Mrs. Dorcus Alum	The District Agriculture Officer

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Stakeholders consulted

N. Uganda commercial and small scale farmers			
Northern Uganda Ag. Centre/NUAC	Nwoya/Alingi - large commercial farm	Knud Nielsen	Farm Manager
Amatheon Agri Ltd	Nwoya - large commercial farm	Propser Maphosa	Farm manager
Oola Lolim Ltd	Nwoya/Pulongo - large commercial farm	Bully Dunn	Farm Manager
Oola Lolim Ltd/AgriServ	Nwoya/Pulongo - large commercial farm	Jim Middleton	Managing Director
Kingdom Rice/FOL	Nwoya/Anaka – large commercial farm	Stephen Byandala	Agronomist
Olseeden Ltd	Nwoya/Alingi - large commercial farm	Samuel Baden Powell	Farm Manager
Vinayak Agro and Victoria Agro Ltd	Nwoya - large commercial farm	Ranjeet Bhansali	Managing Director
Churchil Ojok	Nwoya - medium scale farm	Churchil Ojok	Owner
Global Trendz Ltd	Nwoya - medium scale farm	Bharath Baregowda	Owner
Fredrick Markburridge Tumuhairwe	Nwoya – medium scale farm	Fredrick Markburridge Tumuhairwe	Onwer
Paul Omara	Lira - medium scale farm	Paul Omara	Director
Melon Farmer	Gulu - emerging smallholder	Denis Oturi	Owner
Maize Farmer	Gulu - emerging smallholder	Peter Makumbi	Owner
Leaf Tobacco/Meridian Tobacco Co.	West Nile - contract farming scheme	Gilberto Kohn	Leaf General Manager
Alliance One International Ltd	N Uganda - contract farming scheme	Tom Sawyer	Head of Agronomy
Gulu Agricultural Development Co.	N Uganda - contract farming scheme	Gerard Sands	CFO
Global Leaf Holdings UgandA LTD	N.Uganda - contract farming scheme	Perine Tumusiime	Agronomist
Uganda Ginners Association/CDO	N.Uganda - outgrower farming scheme	Douglas Bhosopo	National Production Manager
Uganda Tobacco Services (UTS)	N.Uganda - outgrower farming scheme	Albie Edwards	General Manager
Uganda Breweries Ltd/Diageo	N.Uganda - outgrower farming scheme	Joseph Kawuki	Head of Agriculture

National ministries and regulatory authorities			
Operation Wealth Creation	National	Lt. Gen. Charles Angina	Deputy Chief Coordinator
MAAIF	Entebbe	Okaasai Opolot	Director, Crop Resources, MAAIF
MAIIF	Entebbe	Beatrice Byarugaba	Director, Agricultural Extension
MAIIF	Entebbe	Stephen Byantwale	Commissioner, Crop Protection
MAAIF	Entebbe	Sunday Godfrey	Statistics Department

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Stakeholders consulted

Fertiliser and agricultural market experts			
African Fertiliser and Agribusiness Partnership (AFAP)	International/Africa based NGO	Paul Makepeace	Senior Fertiliser Specialist
IITA	International ag. research institute	Peter Ebanyat	Legume Agronomist
IFDC	International NGO	David Slane	Chief of Party
IFDC	International NGO	Jabber Abdul	Agribusiness Manager
Sasakawa Global 2000	International NGO	Daniel Oloo	Programme Officer, Lango
Africa Agribusiness Expert	Independent	John Magnay	Independent expert
East Africa Fertiliser Expert	Independent	Daniel Ndegwa	Independent expert
USAID/CPM/Chemonics	International NGO	Robert Anyang	Formerly CoP of CPM
TechnoServe	International NGO	Abdallah Waluboinea	Senior Business Advisor, ABInBev/NBL
NARO/Kawanda	National ag. research institute	Charles Kayiizi	Soil Agronomist

Other industry actors			
East Africa Seed company	Kampala (Seed company)	Reddy	General Manager
AFGRI/KAI	Nwoya/Pulungo (commodity logistics)	Richard Otim	Grain Manager
AgDevCo	Agribusiness Dev. Finance	Rebecca Sankar	Associate Director/Uganda
Yield Fund/Pearl Capital Partners	Agribusiness Dev. Finance	Edward Isingoma	Managing Director
Occupational Q&C Management Services Ltd	EIA expert – specialised in agrichemicals	Joseph Agumacon	Managing Director
Independent Transporters	Raboni Group, BT Ltd, Transporters	Henry Makumbi	Director
Mitchel Cotts Freight Kenya Ltd	Transport and logistics	Victor Mwango Kiema	Chief Accountant
USAID/CPM/Chemonics	International NGO	Robert Anyang	Formerly CoP of CPM
TechnoServe	International NGO	Abdallah Waluboinea	Senior Business Advisor, ABInBev/NBL
NARO/Kawanda	National ag. research institute	Charles Kayiizi	Soil Agronomist

Appendix 2: Soil fertility background

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Soil fertility – nutrient requirements and fertiliser application

Maximising yields requires application of each category of nutrients in a balanced manner. Excess application of some nutrients can be harmful to crop health, while insufficient application can lead to nutrient deficiencies causing serious yield losses.

Primary or main nutrients	**Nitrogen (N)** **Phosphorous (P)** **Potassium (K)**	Required in large quantities often in the range of hundreds of kilograms per hectare.	**Nitrogen --** Enables the plant to grow faster **Phosphorous --**Enables root formation and plants to grow stronger **Potassium --** Enables the plant to grow flowers, fruits and vegetables
Secondary elements	**Calcium (Ca)** **Magnesium (Mg)** **Sulphur (S)**	Required in quantities of tens of kilograms per hectare	**Calcium –** Important for cell division and membrane function **Magnesium –** key component during photosynthesis **Sulphur –** supports Nitrogen uptake. S deficient crops often show yellowing.
Trace elements	**Iron (Fe)** **Boron (B)** **Manganese (Mn)** **Zinc (Zn)** **Copper (Cu)** **Chlorine (Cl)** **Molybdenum (Mo)**	Required in much smaller quantities, often below 3kgs per hectare.	**Boron –** Supports flower induction and arrests flower abortion. **Copper –** deficiency in cereals leads to poor grain infilling

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