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ADDRESSING FOOD INSECURITY IN TANZANIA

MARCH 2021

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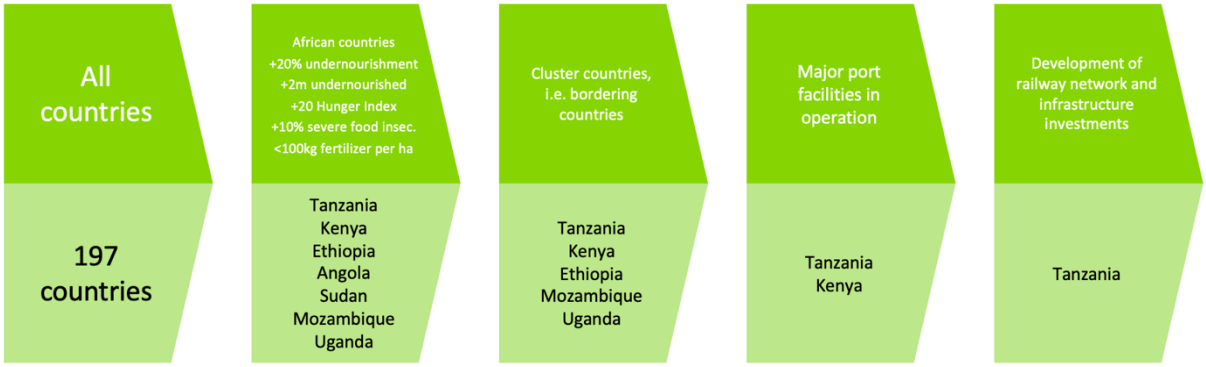
1 The Problem

1.1 Introduction

Our previous report led us to focus on helping some of the 246.4 million undernourished people in Africa by providing fertiliser access. We narrowed down our focus by first identifying the countries with the greatest food insecurity and the highest potential yield increase by adding fertiliser. This led to a smaller list of seven countries. Five of these are bordering each other, providing expansion opportunities. These are then filtered based on available port facilities. The final filtering is on the inland infrastructure, leading to Tanzania.

Figure 1 - Filtering of countries by food insecurity and feasibility



(FAO, 2021a) (PwC, 2018)

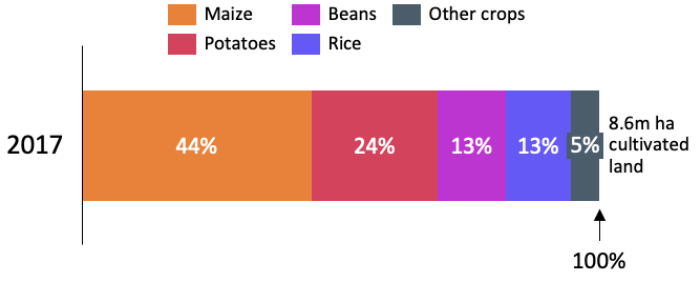
1.2 Narrowing down the focus within the country

We want to have a sizable impact on food insecurity. However, the solutions that have the greatest impact potential tend to be harder to implement. We, therefore, investigated the following three parameters to find a solid combination of high impact and feasibility.

1.2.1 Crop Type

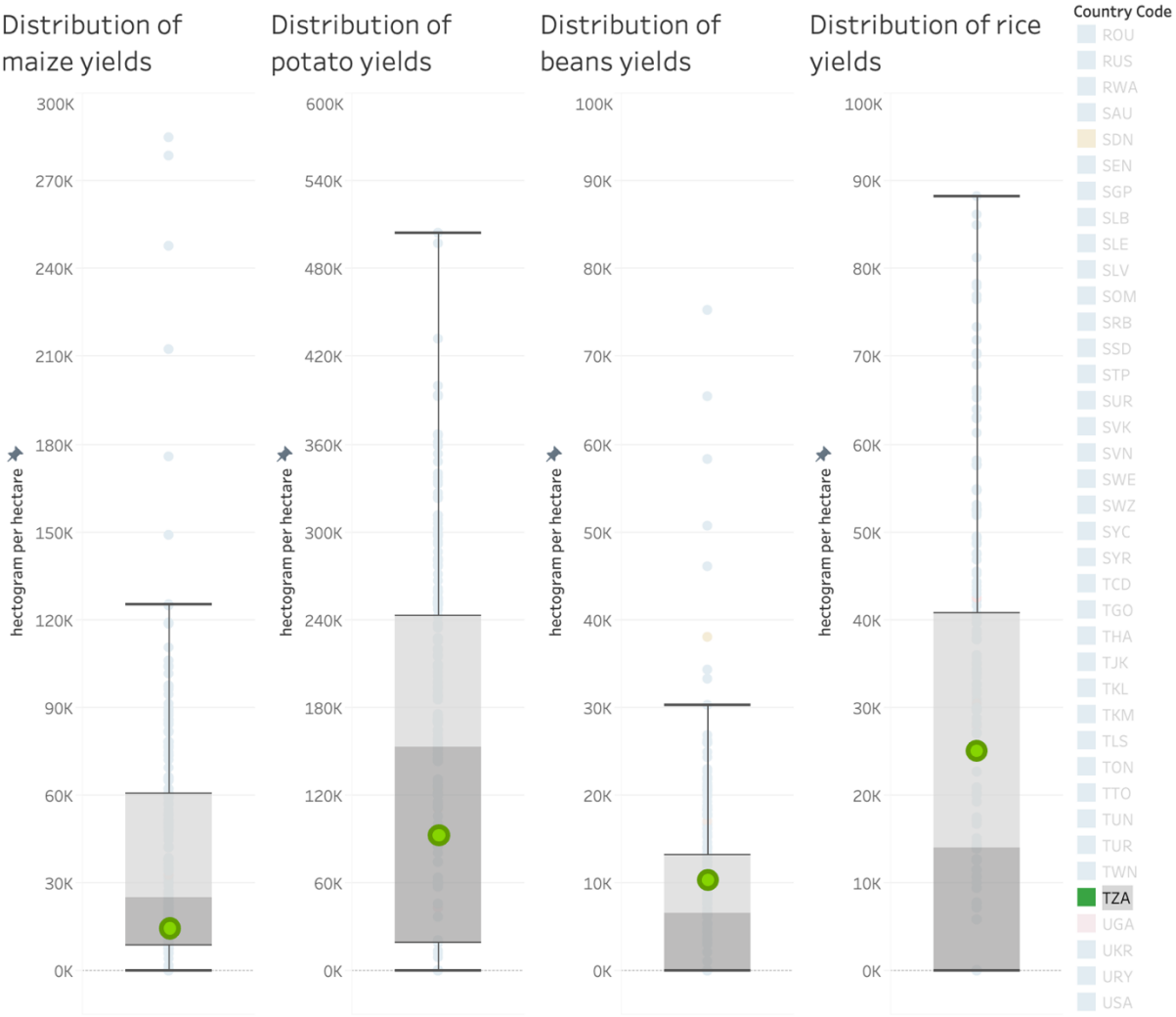
Just four crop categories account for 95% of cultivated land in Tanzania (Figure 2). Out of these, maize and potatoes have yields significantly below the global median (Figure 3). For this reason, Nutrien is likely to have the biggest potential for increasing yields by adding fertilizer – and therefore decreasing food insecurity – by focusing on these two crops.

Figure 2 - Cultivated land in Tanzania by crop type



(AFAP, 2019)

Figure 3 - Yields of main crops in Tanzania compared internationally



(FAO, 2021b)

1.2.2 Region

Within Tanzania, maise and potatoes production happens primarily in three regions: The Southern Highlands, the Lake Zone, and the North Eastern Zone. These areas have a major trade route and rail network, connecting them to Dar es Salaam's international port (Figure 4). However, the North Eastern Zone is not bordering a major freshwater lake that is crucial for irrigation and capturing fertiliser's full potential (AFAP, 2019).

Figure 4 - Map of railway connections in Tanzania

(PwC, 2018)

Because potatoes are not widely produced in the Lake Zone, the Southern Highlands might seem more attractive. Nevertheless, the price of fertilizer in the Lake Zone is up to 25% higher than in the Southern Highlands (Cedrez, et al., 2020). As this makes fertilizer even less accessible for farmers, we focus on maize farmers in the Lake Zone.

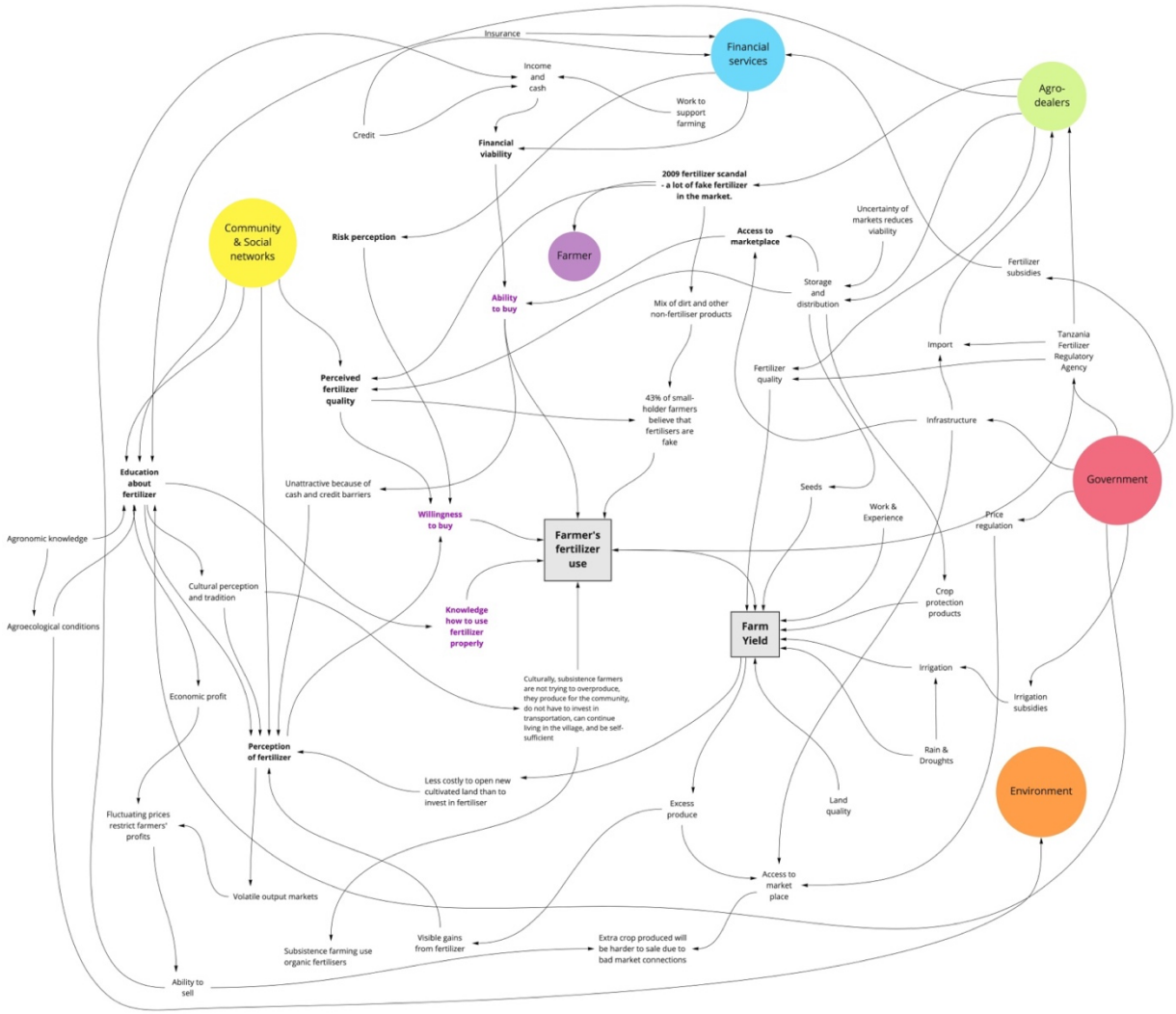
1.2.3 Farm Size

Farmers can be grouped into smallholder farmers and large-scale farmers. In this report, we will be focusing on the smallholder farmers as their access to fertilizer is more limited due to lack of economies of scale, poorer funding opportunities, and similar financial constraints (Benson, et al., 2013).

1.3 Understanding the Farmers

To better understand how farmers fit into the complex system of fertiliser use in Tanzania, the system Map seen in figure 5 was created.

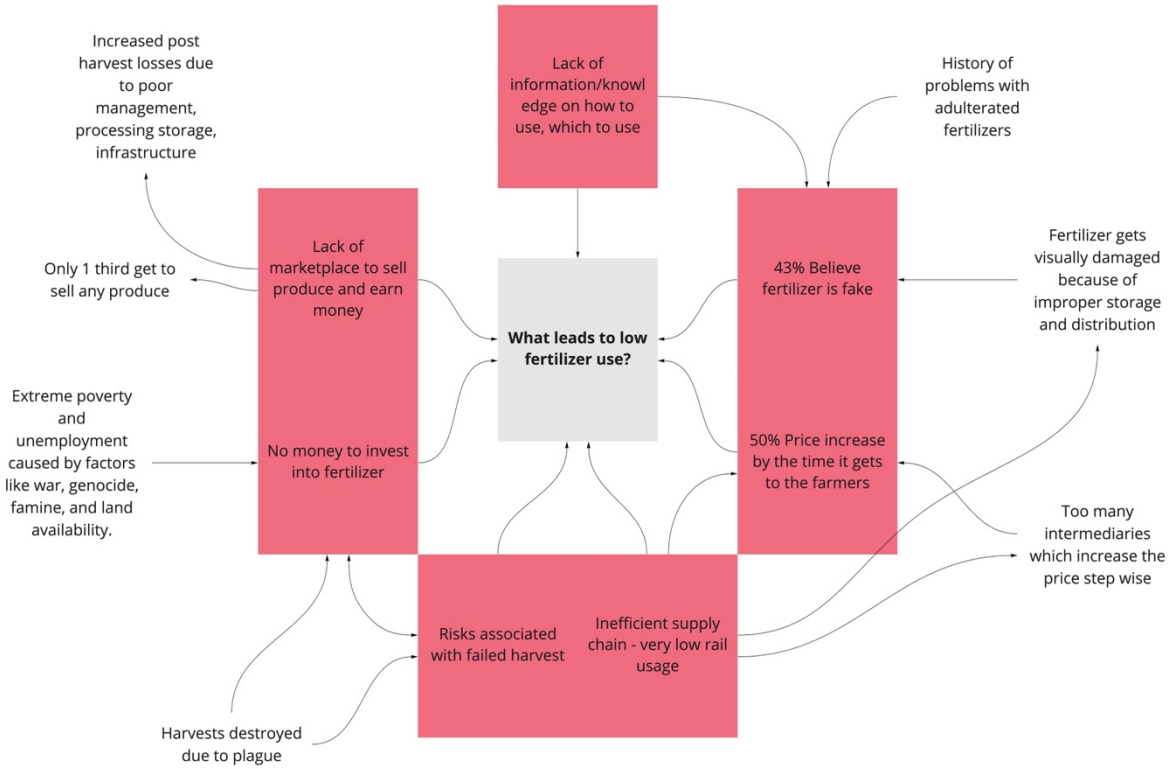
Figure 5 - System map of smallholder farming in Tanzania



(Benson, et al., 2013) (PwC, 2018) (Michelson, et al., 2021)

Based on these insights, a breakdown of the main reasons leading to our target farmers' low fertiliser use was created (Figure 6).

Figure 6 - Main reasons for low use of fertilizer by our target farmers



(Benson, et al., 2013) (FAO, 2018) (Michelson, et al., 2021)

It is crucial to note that in 2009 there was a fertiliser scandal that had lasting effects on farmer's perception and trust in fertiliser. Agro-dealers not regulated by the government sold bags of "fake fertilisers" (made of dirt and other non-fertiliser products) to farmers. In a study conducted in 2019, 43% of farmers still did not trust fertiliser.

Another central pain point is the lack of know-how. This makes farmers use the product inefficiently and thus do not achieve results they are satisfied with. This further adds to a negative perception of fertiliser.

Finally, a range of factors affect the economic feasibility of using fertiliser. Foremost, the price of fertiliser is consistently higher in rural regions due to poor infrastructure. This, combined with the price of maise, sometimes makes the use of fertiliser unprofitable. Even if profitable, using fertiliser poses a significant cash flow burden, as smallholders often do not have enough money to invest in fertiliser at the time of sowing. Finally, investing in fertiliser is risky for most small-scale farmers as they depend on their harvest for livelihood. However, there is then a risk of frequent natural disasters wiping out their investment without funds to rebuild it the following year.

This analysis is also based on the personas seen in Appendix 4.1.1.

2 Map of current solutions

2.1 Distribution initiatives

During the last few years, several operations have been launched by commercial and non-profit organisations to solve food insecurity in East Africa using fertilisers. Among those, we focus on the ones providing the most innovative solutions to address the problems related to fertiliser use and spread in the region. These solutions have two sub-goals: facilitate access to fertilisers for farmers and teach them to make the most out of it.

Firstly, OCP sold fertilisers and provided education to farmers in 7 East African countries, including Tanzania. They started the "School Lab project", allowing smallholder farmers to test soil and practice using fertiliser. This initiative makes sense as 84.5% of smallholder farmers are unfamiliar with these methods (FAO, 2018). They saw an increase of 37% in Ethiopia's maise yields (OCP AFRICA, 2021). Additionally, we can note that OCP makes 15% of their revenue from Africa, with a net margin of 30%, which shows it is possible to make money in this region (M'Bida, 2020).
Another similar initiative is the collaboration between ICL and USAID[1]. In 2018, they launched a one-year program in the Tanzanian regions of Mbeya and Iringa. The goal was to teach 3,000 smallholder farmers by practising on 30 ¾ acre parcels. They aimed for a 40% yield increases in various crops (ICL, n.d.). The result was a 46% yield increase in tomatoes, 47% for onions, and 57% for potatoes (ICL, 2019).

Finally, it is vital to mention Yara's 2015 construction of a fertiliser storage terminal in Dar es Salaam. This facility is used to import 350 000 tons of fertiliser per year (Yara, 2015). This investment, made nine years after Yara entered Tanzania, shows the potential Yara sees in this region.

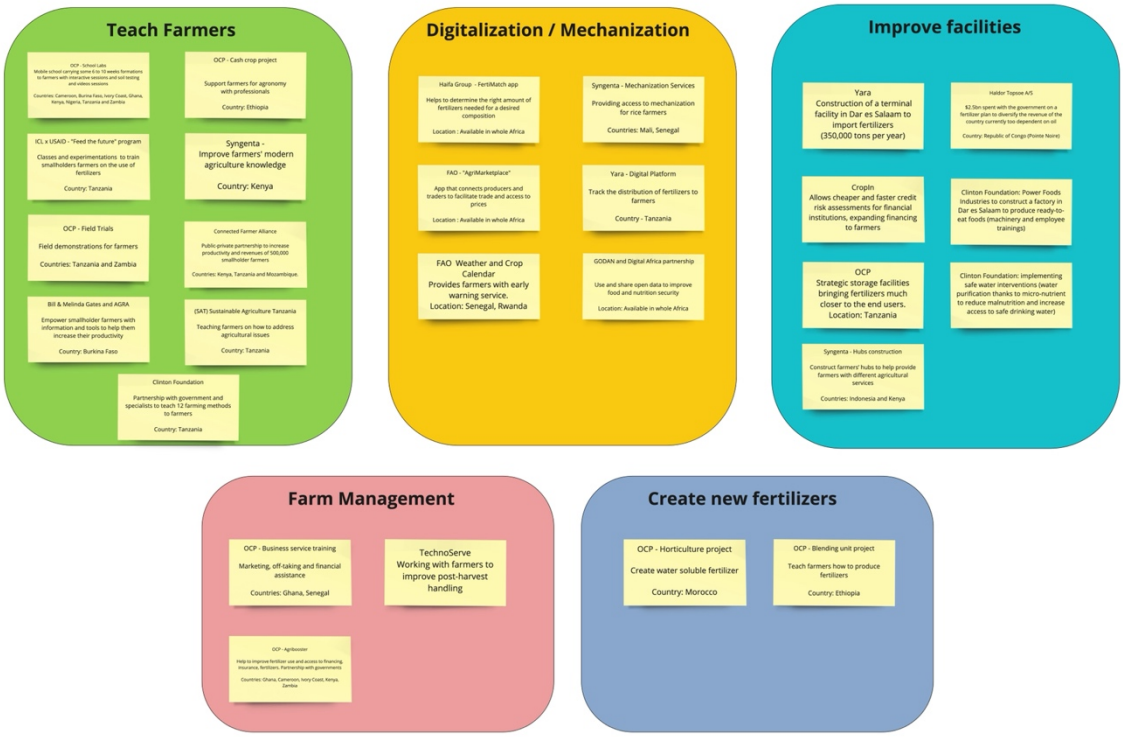
Some other examples of entities carrying out similar initiatives in East Africa are Haifa Group, Syngenta, Omni, Clinton Foundation, World Food Program, SGS, Victoria, Wemingsha, or Famunera.

2.2 Fertilizer Subsidies

The Tanzanian government has been running a fertilizer subsidy scheme targeted at maise and rice farmers since 2008[2], which has distributed 15 million vouchers to over 2.5 million farm households (World Bank, 2012), enabling the purchase of more than 500,000 tons of fertiliser. The World Bank is also investing US$25 million and has an additional US$30 million ready to boost productivity in Tanzania's agriculture sector through the delivery of fertiliser (World Bank, 2012).

[1] US Agency for International Development
[2] Tanzania's National Agricultural Input Voucher Scheme

Figure 7 - Map of existing innovations



3 Proposed solution

3.1 Overview

Having gone through the design thinking process described in section 4.1, we had a good understanding of the requirements our solution needed to fulfil:

- Tackle the issue of farmers not being able to pay for fertiliser upfront
- Tackle concerns of farmers over fake or poor-quality fertiliser
- Mitigate the additional risk farmers face when investing in fertiliser and the harvest fails (e.g. due to natural disasters)
- Profitable for the targeted farmers
- Profitable for Nutrien

We propose to offer small-scale farmers in the Lake Zone[3] the following deal: Nutrien supplies them with fertiliser on credit, meaning they only have to pay once they have sold their increased yield. This addresses the issue of farmers not being able to pay upfront. Additionally, what farmers have to pay is calculated as a share of the increased yield. This shifts the risk of the yield outcome from the farmer to Nutrien. Farmers, therefore, do not need to worry about the fertiliser being ineffective or fake or losing their investment in case of a harvest failure, as they would not have to pay for the fertiliser in this case. This solution is always profitable for farmers. To assess whether it would also be profitable for Nutrien, we created an economic model.

Knowing that the optimised fertilization of maize in Tanzania is using 175kg of fertilizer per hectare, that the break-even cost for Nutrien to provide a 50kg bag of fertilizer in the Lake Zone is around US$28.8 (appendix 4.3), the farmgate price of maize in the regions is US$0.35/kg, the current yield is 1,460kg/ha, and the fertilizer optimisation yield potential is a 42% increase, the results of our solution can be calculated (Chamberlin & Palmas, 2020) In figure 8, the key results are calculated assuming Nutrien owns 60% of the additional harvest, in figure 9 70%, and in figure 10 80%.

[3] See section 1 for scoping

Figure 8 - Results at 60% stake for Nutrien

	Per ha of land	Per kg of fertilizer
Cost for Nutrien, USD	97.30	0.56
Additional harvest, kg	608.00	3.47
Additional harvest, USD equivalent	212.80	1.22
Nutrien's share of gain, USD	30.38	0.17
Farmer's share of gain, USD	85.12	0.49
Farmer's share of gain, kg	243.20	1.39
Average yield increase that is break-even for Nutrien: 31.7%		

Figure 9 - Results at 70% stake for Nutrien

	Per ha of land	Per kg of fertilizer
Cost for Nutrien, USD	97.30	0.56
Additional harvest, kg	608.00	3.47
Additional harvest, USD equivalent	212.80	1.22
Nutrien's share of gain, USD	51.66	0.30
Farmer's share of gain, USD	63.84	0.36
Farmer's share of gain, kg	182.40	1.04
Average yield increase that is break-even for Nutrien: 27.2%		

Figure 10 - Results at 80% stake for Nutrien

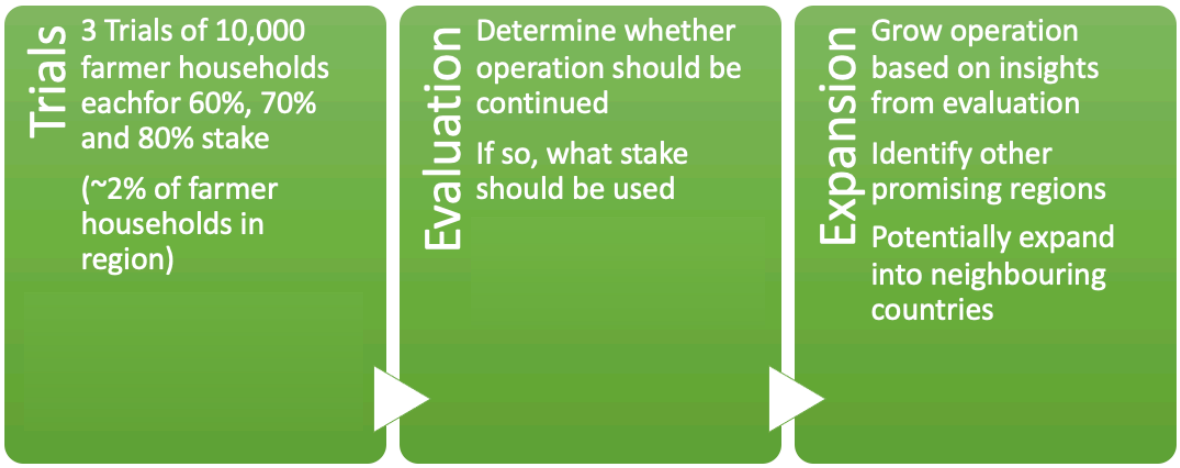
	Per ha of land	Per kg of fertilizer
Cost for Nutrien, USD	97.30	0.56
Additional harvest, kg	608.00	3.47
Additional harvest, USD equivalent	212.80	1.22
Nutrien's share of gain, USD	72.94	0.42
Farmer's share of gain, USD	42.56	0.24
Farmer's share of gain, kg	121.60	0.69
Average yield increase that is break-even for Nutrien: 23.8%		

From figure 8, 9 and 10, it is evident that this solution is both profitable for the farmer, who with their share of the extra yield increases their production by 8-17%, and Nutrien, whose profit ranges from US$0.17-0.42/kg.

3.2 Implementation

We propose to experiment to run this scheme with a 60%, 70% and 80% stake in the additional yield. This allows Nutrien to gauge the effect of farmers' potential gain on the number of farmers cheating. Based on these trials, Nutrien can identify the ideal stake. After one year, an initial evaluation will determine if and how to continue the project. In the long term, the project can be evaluated and tweaked after each harvest season. If successful, it can first be expanded to other regions in Tanzania, later also into neighbouring countries.

Figure 11 - Overview of implementation plan



In the trial, we recommend establishing a distribution network of Nutrien centres every 10 km in the Magu district of the Lake Zone. This would cost ~$244 000. We propose testing different densities of distribution centres to understand the customers' preferences better.

The trial reaches 30 000 small farms. The initial $244 000 investment would constitute long-term assets (storage facilities, trucks, and employees). Additionally, almost $1.4 million need to be invested in fertilizer for the trial. This could lead to a potential profit of $728 000[4] on the fertilizer sold, which would easily cover the investment in assets. We account for some significant overheads, such as the shipping to Tanzania and the cost of delivery from the port. However, it is crucial to be aware of other potential overheads, such as gas and taxes.

[4] More detail on these calculations in appendix 4.2.

3.3 Impact Assessment

3.3.1 Pilot with 30,000 smallholder farms

Conducting the three trials of 10,000 smallholder farms will foremost decrease food insecurity. Assuming an average farm size of 2 hectares amongst the pilot farms, an additional 36,480mt of maise is produced[5] (Mafuru, et al., 1999). This extra production is equivalent to around 94 million kcal per day[6], which in turn can feed around 42,000 people in the region[7].

The farms in the pilot will each have between 243.2 and 486.4kg extra maise available. This represents an 8-17% increase and is equivalent to US$85-171.

Selling 10,500mt[8] of fertiliser evenly distributed across the three models will yield a profit of around 3.1 million USD[9]. This is the best case, and the number is likely to be smaller due to a lower average increase in yield, and 1-2 million USD is thus more realistic.

3.3.2 Increments of 50,000 smallholder farms

Similar calculations can be made for increments of 50,000 smallholder farms, 2.5% of the target group each[10]. For every increment, the benefits are (using the 70% stake model):

- An additional 60,800mt of maize is produced
- That is equivalent to around 157 million kcal per day
- Another 71,300 people can be fully nourished (1.8% of the undernourished in the region (FAO, 2021a))
- Farmers combined have an economic benefit of around 6.4 million USD
- Nutrien profits by around 5.2 million USD (~1% increase (Nutrien, 2021))

[5] 30,000 farms * 2 ha * 608 kg extra maize per ha
[6] There is approximately 944kcal per kg of maize (Weightlossresources, 2020)
[7] Recommended kcal per day is around 2,200 (NHS, 2019)
[8] 30,000 farms * 2 ha * 175 kg of fertilizer per ha
[9] 3,500,000 kg fertilizer in each model * (0.17 + 0.30 + 0.42)
[10] There is around 2 million smallholder farms producing maize in the region (Mafuru, et al., 1999)

4 Appendix

4.1 Design Thinking approach

4.1.1 Empathize

Stakeholder Empathy table

We have decided to build a stakeholder empathy table to understand better the role of all the stakeholders and factors that can positively or negatively affect smallholder farmers' fertiliser use. When creating this empathy table, we wanted to gather all the information related to the system's stakeholder in order to rigorously understand their behaviours and attitudes and the factors (people, decision, processes) that could, in a way, influence the fertiliser use system in Tanzania.

The way the table is organised has helped us better understand what each stakeholder does, wants, and thinks about the fertiliser use problem in Tanzania.

Overall, we have identified 12 stakeholders grouped into people (such as farmers, family and community, ethnic groups), businesses (agro-dealers, importers, markets, job, banks and financial service providers), institutions (government, ethnic groups, NGOs, infrastructure), and aspects (environment).

For instance, understanding what small-scale farmers are doing, what they want, and think helped us point out one of our system's major pain points: the fact that a fertiliser scandal engendered a misperception about fertilisers.

Figure 12 - Stakeholder map

Stakeholders

Stakeholder	Split	Does	Wants	Thinks
Farmers	**Small scale (84%)**	Has a small farm. Doesn't sell much of his produce (33%). Works another job to support his farming activities.	Feed their family & produce a little extra. Authentic fertilizer and less risk.	Fertilizer on the market is fake (43%). Fertilizer is too expensive & risky. 10% believe they are experiencing food shortage because of lack of farm inputs.
	Large scale (16%)	Has a larger farm with employees and more advanced machinery. Usually also has an irrigation system.	Maximize production and sell most of his crops.	Fertilizer should be cheaper.
Agro dealers (distributors)	**Small scale**	Single person, usually sells in only one location as he doesn't have a vehicle. Doesn't have sufficient storage for all the fertilizer he sells.	Increase his sales and reduce risk. Buy at a larger scale as he could then get a better deal.	His cost of obtaining fertilizer is too high. Suppliers ask for too much money and transport fees are too high. Doesn't want to offer credit because the risk is too high.
	Large scale	Sell fertilizer in more than one locations and own vehilces to transport over longer distances.	Cheap import costs at the port and better roads so they can reach a larger area.	He should only focus on large scale farmers as they don't require subsidies and financial support services, while also making larger orders.
Government	**TFRA**	Monitors imported fertilizer & checks fertilizer distributed throughout the country.	No fake / low quality fertilizer in Tanzania. Enable everyone access to proper fertilizer.	A lot of imported fertilizer is bad, so need to impose large markups to check.
	Other • **Subsidies**	Provides subsidies to farmers.	Increase the use of fertilizers throughout Tanzania.	Financial support through subsidies will allow more farmers to buy fertilizer.
Importers		Import fertilizer from Europe & Asia into Dar es Salaam.	To make profits on the fertilizer they import and sell it to dealers.	Fees at Dar es Salaam port are way too high.
Infrastructure	**Rails & Roads**	---	---	---
Environment	**Rain, Water, Seasons, Climate, ...**	---	---	---
Family & Community	**---**	Live with (and around) farmer in very close ties. Communicate and share knowledge together.	Wants farmer to produce enough food for dependents and earn money for school/health care. Doesn't want farmer to take risks.	Traditional ways of farming are better and investments in fertilizer are too risky.
Markets	**Local & Country wide**	Provide sales of fertilizer and trading of farm produce.		Farmers don't have enough produce to justify transporting to distant areas.
Job	**Most farmers also work**	Farmer works an extra job to support his farming activities.		
Banks & Financial service providers	**---**	Provide financial services to farmers and distributors.	Make profits and minimize risk.	It's too risky and not worth it to provide credit and insurance to smallholder farmers.
NGOs	**---**	Very varied	Improve access to credit for small farmers to be able to purchase fertilizer	It's important to improve the living conditions in Tanazania in many ways.
Ethnic groups	**More than 100 different ethnic groups**	They are in charge of perpetuating the traditions, values, norms. They exerce a political, social and economic role. They are consulted for important decisions. The most important ethnic groups gather a large part of subsistence farmers.	They want to continue to have their words regarding the decision taken by the community, wether politically, socially, environmentally, economically.	New advances in technology and approaches are too disruptive and risky, and conventional approaches should be stuck to.

System map (figure 5 in section 1.3)

Based on our previous scoping, we decided to enlarge our vision and understanding of the problems behind the use of fertilizer in Tanzania by building a system map of small-holder farmer's fertilizer use in Tanzania. This system map aims to combine all our previous findings and information that we collected thanks to design thinking tools. By structuring the map around five major factors (Community & Social Networks, Farmer, Financial Services, Agro-dealers, Government, Environment), we created connections between the personas and stakeholders, influencing them to focus on how the "people" factor is influenced in the system. We also connected people, governmental or business components to processes such as market or environmental processes.

4.1.2 Define

Personas

We developed some personas to understand our target market segment. We used the following diagram to scope our audience. We chose to focus on the rural and small-scale farmer segment and designed two personas basis their perception of fertilizer, a key problem in this context. Rural farmers have been chosen as they are made to pay more for fertilizer, which is a significant pain point for them that we have the potential to solve. Additionally, small scale farmers account for 84% of the population of Tanzania.

Our two personas helped us understand the goals, needs, and pain points of two different groups: one that distrusts the quality of fertilizer and another that believes in its value but is too poor to afford it. This allowed us to tailor our solution to these groups and add real value to their lives by satisfying an unfulfilled need.

Figure 13 - Mapping personas

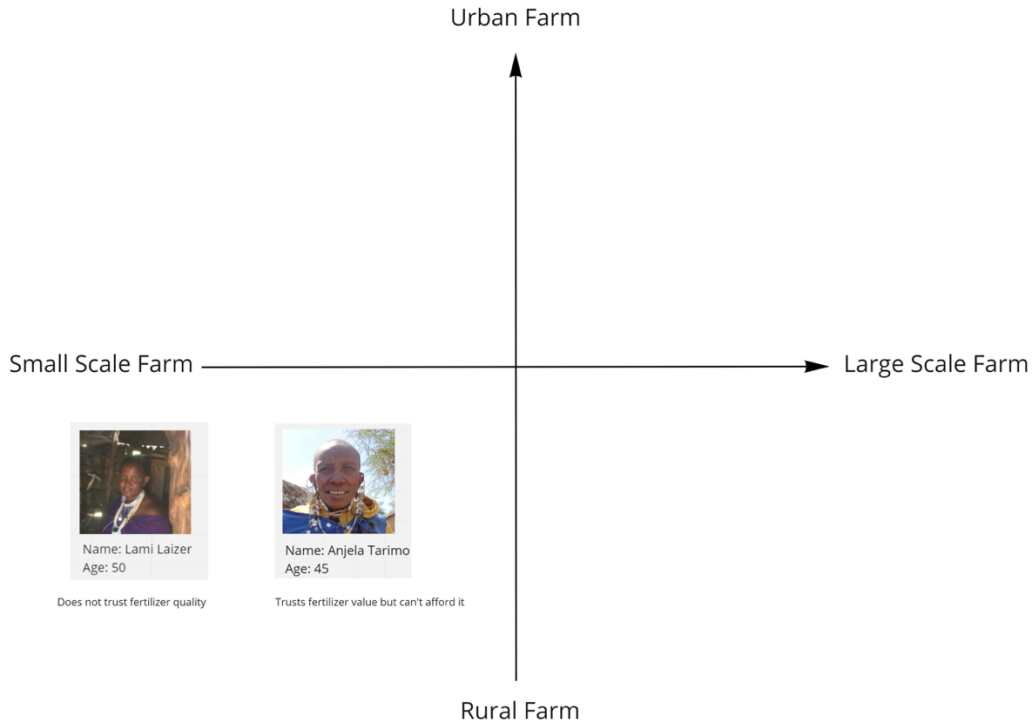


Figure 14- Empathy map and persona for Lami

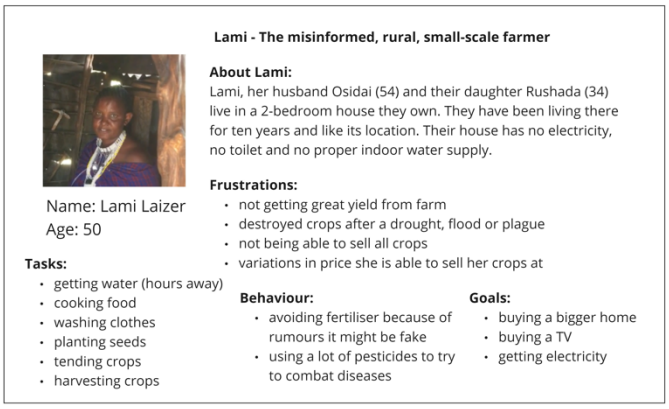


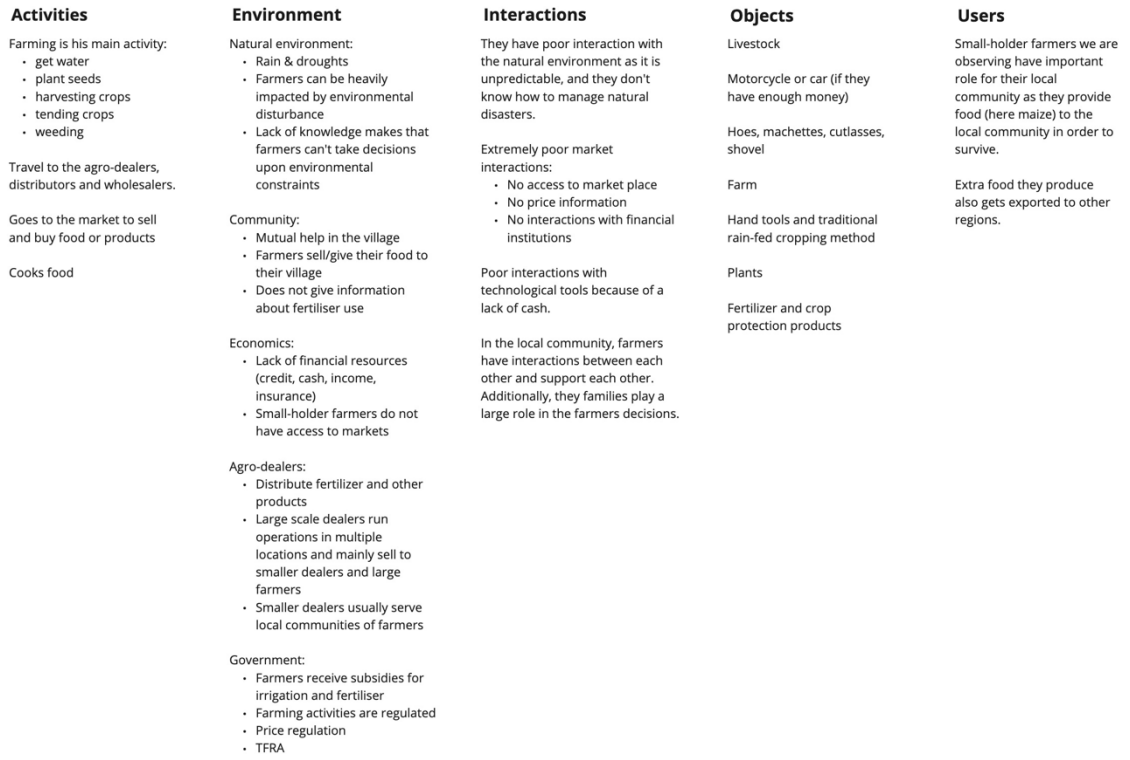
Figure 15 - Empathy map and persona for Anjela

AEIOU

Then we considered the Activities, Environments, Interactions, Objects, and Users, for our personas.

The AEIOU process needs to be realised through primary field observations and complemented with secondary research and observations. However, being unable to fly to Tanzania and observe our users and personas first hand, we built our AEIOU observations based on our research, interviews, secondary observations, and personas profiles.

Figure 16 - AEIOU

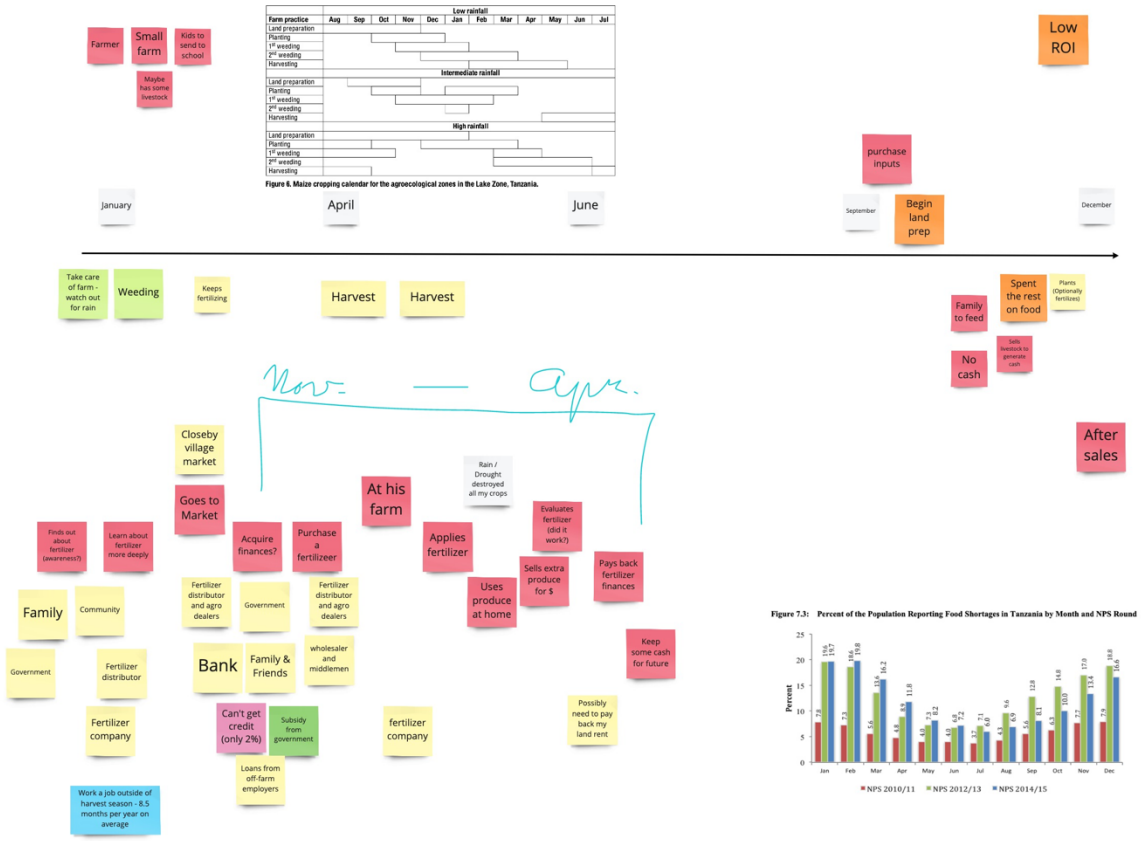


The AEIOU process enabled us to understand what small-holder Tanzanian farmers are doing regarding fertilizers and the role of the environment in regard to their farming activities. Then, we tried to consider how our personas are interacting with the system, objects and environment. The object section helped us to understand the workaround in the environment and the system. Finally, we observed and considered the system users: who are they, what are their roles?

Customer Journey Map

To better understand how our customers obtain fertilizer, we decided to map it out on a customer journey map. We began by mapping a “year in the life” of a typical farmer in Tanzania (Mafuru, et al., 1999). On average, they begin preparing land in October and start planting in November. They begin harvesting in April, which coincides with the lowest periods of food shortages in Tanzania (Tanzania National Bureau of Statistics, 2020).

Figure 17 - Customer Journey Map work



After having a better understanding of the farmers annual cycle, we extracted the steps related to obtaining and using fertilizer. We only focus on farmers who do obtain fertilizers, as those are our customers. Many potential customers end at any of the intermediate stages, for example if they fail to obtain financing for their fertilizer, or if they don't have access to a marketplace. Improving those services and providing access to those customers is our goal. The "Opportunities" sections of our analysis was crucial to the development of our solution.

Figure 18 - Customer Journey Map

Phase of journey	1 Pre-Planting	2 Getting finance	3 Acquiring fertilizer	4 Using fertilizer	5 Harvesting	6 Post-harvesting
Actions What does the customer do?	Takes care of the farm Weeding Finds out about fertilizer and learns more	Collects Farm Inputs Looks for financing Gets a subsidy	Goes to the marketplace Acquires fertilizer	Regularly applies fertilizer	Uses produce at home Sells extra produce to get the dollars rolling in	Evaluates Fertilizer Pays back fertilizer finances Saves some cash
Customer Thought What is the customer thinking?	What's fertilizer? Does it work? How do I use it?	How to get a subsidy? Where can I get alternative sources of credit?	Too expensive. It might be fake. Which one should I get? How much should I get? Market is too far away.	Am I applying correctly? Who should I ask about how to use? Are there different ways to use it?	What should I do with the extra produce? Where can I sell for the best price?	Can I increase yields even more if I use more fertilizer? Why didn't I use this earlier?
Customer Feeling What is the customer feeling?	🥳 Hopeful that fertilizer will help increase yield	😕 Demotivated by no access to credit. Unsure about the financial risk.	😕 Wondering if it will work. Worried about the risk.	🥳 Excited about using fertilizer. Hopeful & worried whether it'll works.	🎉 Very happy with the higher yield she got after using fertilizer.	🙂 Satisfied with the extra cash she saved this year.
Key Stakeholders Who else is involved in this step?	Community, Family, Fertilizer distributors and Agro-dealers, Government	Banks, Agro-dealers, Family, Government	Agro-dealers & fertilizer distributors	Family	Family, Local market & food distributors.	Banks, Agro-dealer
Overall Experience	Experiencing low yields and food insecurity. No cash or savings.	Impossible to put together enough money to afford a worthy amount of fertilizer.	Market too far away making it hard to participate Quality is not guaranteed.	Lack of knowledge and information regarding fertilizer options and usage	Enjoys a larger harvest, but still lacks a good market to sell extra produce.	Recommends fertilizer to acquaintances
Opportunities What are Nutrien's opportunities in this step?	Spread awareness of fertilizer	Provide credit & financing options to farmers Optimize existing subsidies	Improve the distribution network, especially in rural areas	Provide guidance and know-how on fertilizer use	Improve produce markets and distribution throughout the country.	Provide recommendation incentives.

Additionally, it is essential to keep in mind several crucial factors that can impact the farmer's final yield. For example, extreme droughts or rains can destroy the farmer's harvest.

4.1.3 Ideate

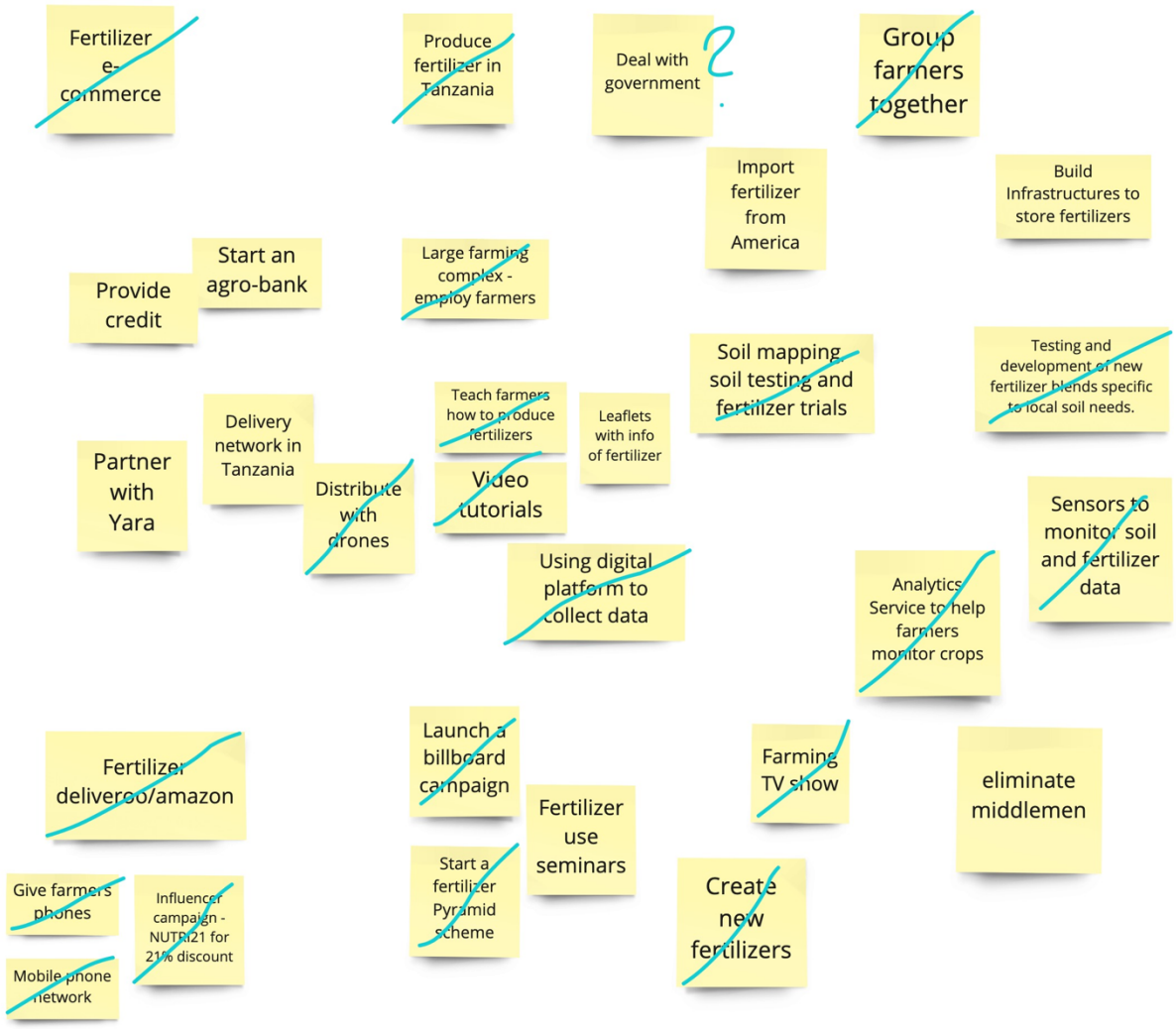
Brainstorm

After having a good idea of the system, our customers, and the problems they face, we went to Miro to brainstorm potential solutions. We began with a general brainstorming session and put out many "crazy" or unrealistic ideas, of which some proved helpful alter.

Figure 19 - Solution brainstorming

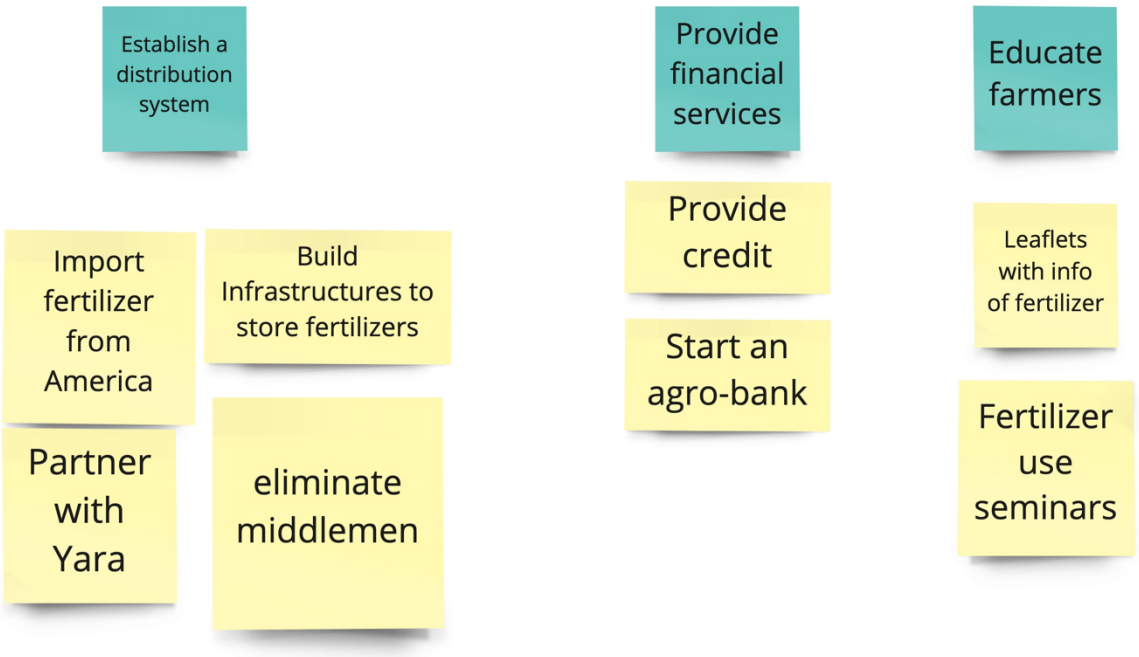
We then discussed some of these and eliminated the ones that were not practical.

Figure 20 - Brainstorming filtering



Many of these ideas were not very practical, but a few of them were ones we decided to pursue further and consider in our implementation. Those include: **establishing a distribution system in Tanzania**, **providing credit services**, and **teaching farmers about fertilizer**.

Figure 21 - Filtered solutions



These groups formed the basis for our implementation plan, which we describe in detail in the main report.

4.1.4 Prototype, Test and Evaluate

We understand the importance of testing a solution first, which is why we propose starting with only a small test targeting 30 000 households. This would allow us to test whether the overall solution has any purpose at a relatively low cost. Additionally, we propose choosing three different rates of yield collection to determine which minimise farmers cheating.

These solutions need to be tested over multiple seasons, as the plant – fertilise – harvest cycle only happens once a year in Tanzania. Further steps and changes in direction should be made at the end of each season.

Nutrien should evaluate the results of the project at the end of each harvest season and plan the strategy for the following years based on the insights gained from this evaluation.

4.2 Recap of Scenario Week 3 report

From the problems assessed in the previous report (figure 22 and 23), solving some of the Food Insecurity, particularly in Africa, by providing access to fertilizer seemed to offer the biggest potential for enhancing the Global Food System (Barone, et al., 2021).

Figure 22 - Problems in the Global Food System

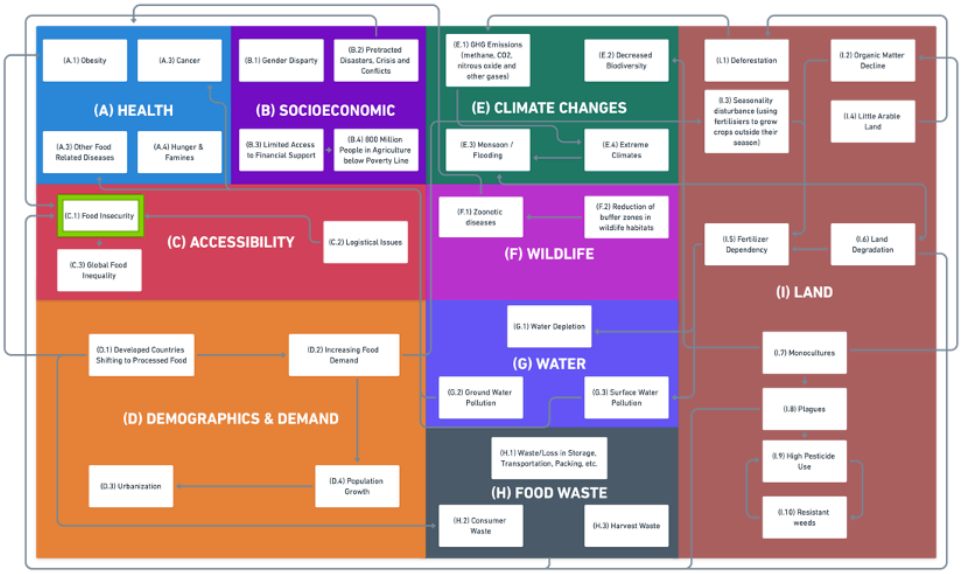


Figure 23 - Nutrien's Problem Footprint in the Global Food System

(C.1) P+R+U Food Insecurity	(D.2) P+R Increasing Food Demand	(B.3) R Limited Access to Financial Support	(I.4) U Little Arable Land	(I.5) U Fertilizer Dependency	(I.9) U High Pesticide Use
820 million malnourished people in the world The global cost of undernourishment is estimated to be **$1.4-2.1 trillion** Application of fertiliser an enabler in solving this, which Nutrien is experts in	Global population expected to reach **10 billion in 2050** Food insecurity has to be solved first, but right application of fertiliser can improve yield	**800 million people** working in agriculture **under poverty line globally** Only 1% of bank lending goes to agriculture Nutrien are in position to provide funding	Earth has lost more than 30% of arable land in the last 40 years Again, Nutrien are in a position where they can go in an optimise the use of land	Fertilizer use **increasing by 20% in 4 years** worldwide Modern farming practices make it impossible to stop Nutrien are world-leading in supply of fertiliser, and users believe it is an only-positive ingredient	**90% of water** in the US has 1 or more pesticides **34% increase** from 2000 globally Kills natural bacteria Nutrien sells pesticides in retail but it is not their main area of expertise
(G.1) P+U Water Depletion	**(G.2) U Ground Water Pollution**	**(G.3) P+U Surface Water Pollution**	**(E.1) P+R+U GHG Emissions**	**(H.3) U Harvest Waste**	**How are the problems related to Nutrien?**
Agriculture represents **70% of global water consumption** Overuse of irrigation in certain areas is caused by lack of knowledge about the seeds farmers buy, something Nutrien is positioned to change through their retail	Nitrogen levels higher than regulatory recommendations in **15% of US water sources** Nutrien is supplying the polluting resources, and are thus in position to intervene	**46% of US** (38% of EU) water bodies are under pressure from agricultural production Most of this is caused by overuse of fertiliser, so if Nutrien helps farmers apply fertiliser more cleverly, it can help	24% of global emissions from agriculture Green space created which reduces GHGs Fertiliser and pesticide accounts for 13% of agriculture emissions, Nutrien's two main products	14% of food harvested globally is lost between harvest and retail Nutrien is doing education with their farmers, and actively engages in avoiding harvest waste	P – **production activities** (how we make our products) R – **retail activities** (how we provide access to products) U – **product use** (how our customers use the products)

(Barone, et al., 2021)

It is the most as Nutrien has excess capacity and fertilizer is a key to more food being produced in the region (figure 24) (Nutrien, 2021, pp. 31, 37, 42).

Figure 24 - Overview of enablers in African food insecurity

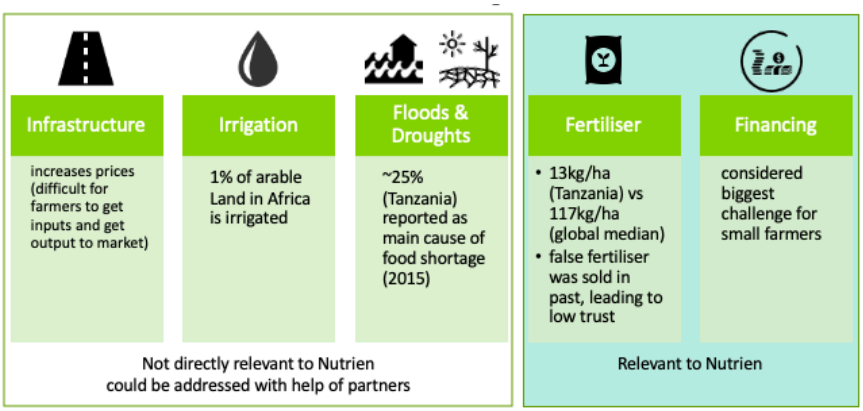
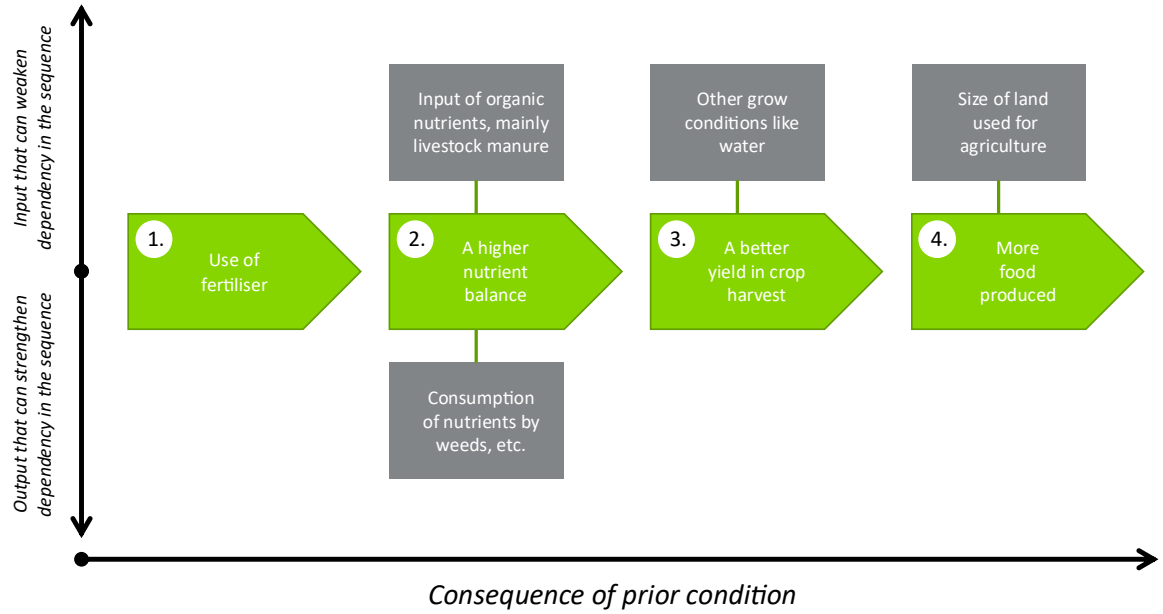


Figure 25 - Simplified Effect of Fertilizer



(Barone, et al., 2021)

4.3 Our own distribution network calculations

Nutrien Distribution Centres (NSDs) would play our local distribution network's primary role. These are the main interaction points for small farmers, who would apply for credit and get fertilizer. Additionally, they could also serve as points for the sale of the farmer's produce in the future. These local points would generally consist of a fertilizer storage facility, a truck to bring the fertilizer from major storages, distribute it to local farmers, and a few employees overseeing the operations (interacting with farmers, driving, security, etc.).

We approximate the price of one of these centers at $50 000, which includes costs for the storage building, the truck, and 5 employees annual salaries. Larger centres, or centres

with more vehicles, would be significantly more expensive, but these should serve as a good starting point for our tests.

The next important step we considered is the range we think farmers can travel to our centres. A third of farmers doesn't have any vehicle (Benson, et al., 2013). We assume farmers could walk 10 km to our centres. Larger distances, like 15 and 20 km, would make it very difficult for farmers without vehicles, but we will consider these in our calculations as well.

Once we know the range of one of our centres, we can calculate the area it serves as a circle area. For the 10 km radius, the area a centre can serve is 314,16 km2. We consider the other ranges in the table below. Generally, ranges above 20 km would be inaccessible to farmers without vehicles, so we don't consider them.

Nutrien Centre radius	**Area covered (km^2)**
10 km	314.16 km^2
15 km	706.86 km^2
20 km	1 256.64 km^2

We understand that these would not always fit perfectly into circles on the map, but these approximations should be a reasonable estimate.

To estimate the number of centres needed in a region, we divide the area of the region with the area covered by an NDS with a specific range. We approximate one centre's cost at $48 840, which is made up of the storage building, truck, and five employees for a year. Multiplying these gives us the total investment in assets needed to achieve the desired coverage.

The number of farms is found by taking a % of farmers from the population in that region and dividing it by the number of household members. Specifically, these numbers are 70% of people are farmers. Out of those, 84% are part of a smallholder farm (Tanzania National Bureau of Statistics, 2020). Generally, these are usually made up of 5 people, so we can divide the number of smallholder farmers by 5 to find the number of farms.

After we know the number of farms in the area, we can find the amount of fertilizer they need. On average, these farms consist of 2 ha of land (FAO, 2018). In Tanzania, the use of 175 kg/ha would lead to optimal yields (Chamberlin & Palmas, 2020). At $27.8 per 50 kg bag of fertilizer, this would be $194.60 per household – out of that $103.32 profit for Nutrien.

When calculating profit and costs, we also understand that we cannot expect to reach all the farmers. Because of this, we only estimate that 20% of farmers in those areas would use our services when estimating costs and profits. If more farmers decided to use our services, this would lead to higher total profits.

We look at a few examples below where we apply this logic. Magu and Muelba districts are small, mainly rural, districts in the Lake Zone. They have a good level of connectivity and, as such, would be a good starting point for experiments (CITYPOPULATION, 2012).

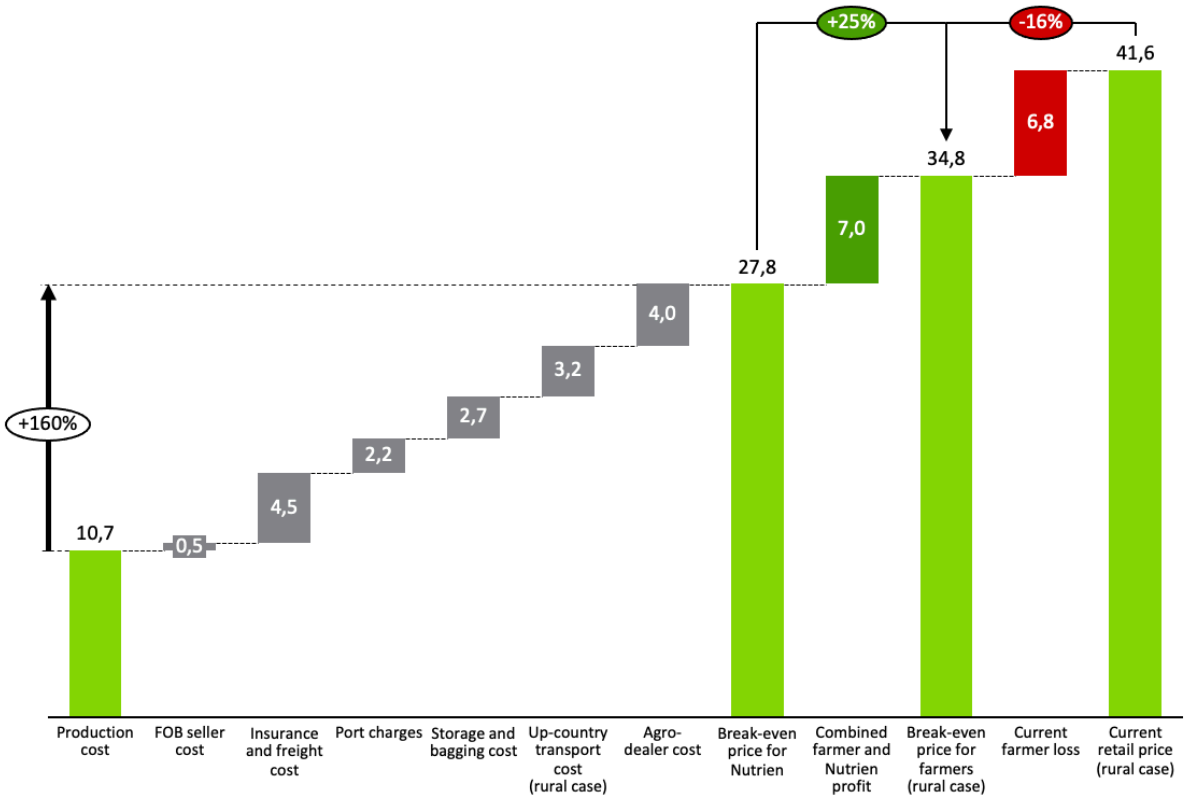
Magu District	Range		Needed		Assets $	Annual profit $
		10		5	244 200	728 440
		15		3	146 520	
		20		2	97 680	
Area	**Farms**				**Fertilizer cost $**	
1 530 km^2		35 252			1 371 995	

Muleba District	Range		Needed		Assets $	Annual profit $
		10		12	586 080	1 288 699
		15		5	244 200	
		20		3	146 520	
Area	**Farms**				**Fertilizer cost $**	
3 518 km^2		62 364			2 427 225	

Lake Zone	Range		Needed		Assets $	Annual profit $
		10		385	18 803 400	28 754 865
		15		171	8 351 640	
		20		97	4 737 480	
Area	**Farms**				**Fertilizer cost $**	
120 659 km^2		1 391 544			54 158 892	
					Return	49.65%

4.4 Cost break-down of Nutrien providing fertilizer to the Lake Zone

Figure 26 - Break-down of price of 50kg NPK fertilizer bag



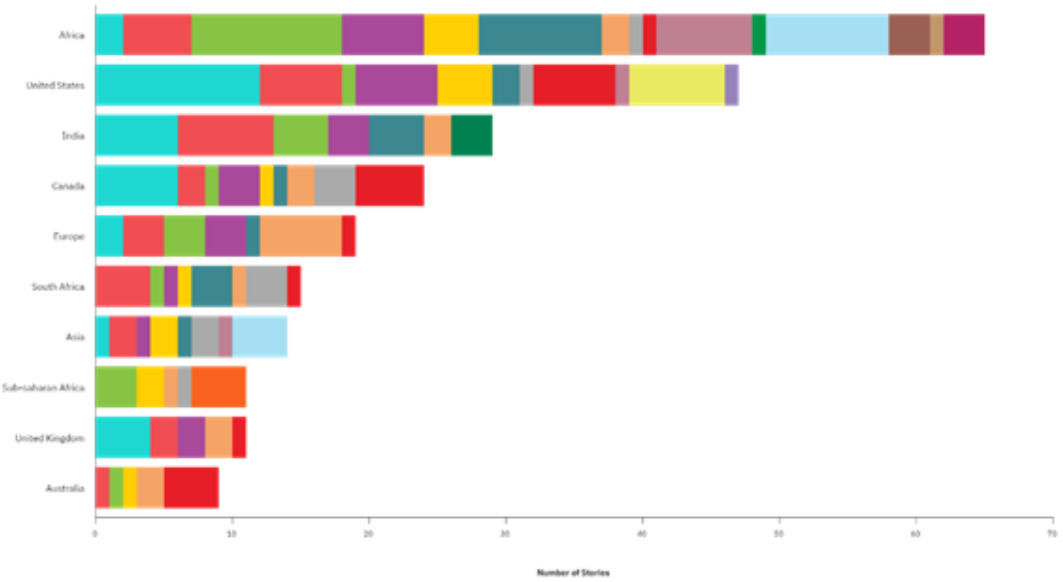
(Chamberlin & Palmas, 2020) (Nutrien, 2020) (FAO, 2015) (IFDC, 2012) (FAO, 2017)

Figure 26 provides an overview of the price break-down of Nutrien importing fertilizer to Tanzania themselves. As can be seen from the graph, there is a 160% build up on the initial production cost for shipping and distributing the fertilizer to rural areas of Tanzania. The total cost for Nutrien, and thus their break-even cost, is 27,8USD per bag of 50kg of NPK. This is below the break-even price for rural farmers, meaning that Nutrien actually solve one of the pain points of rural farmers: That it is often not profitable for them to use fertilizer.

4.5 Quid

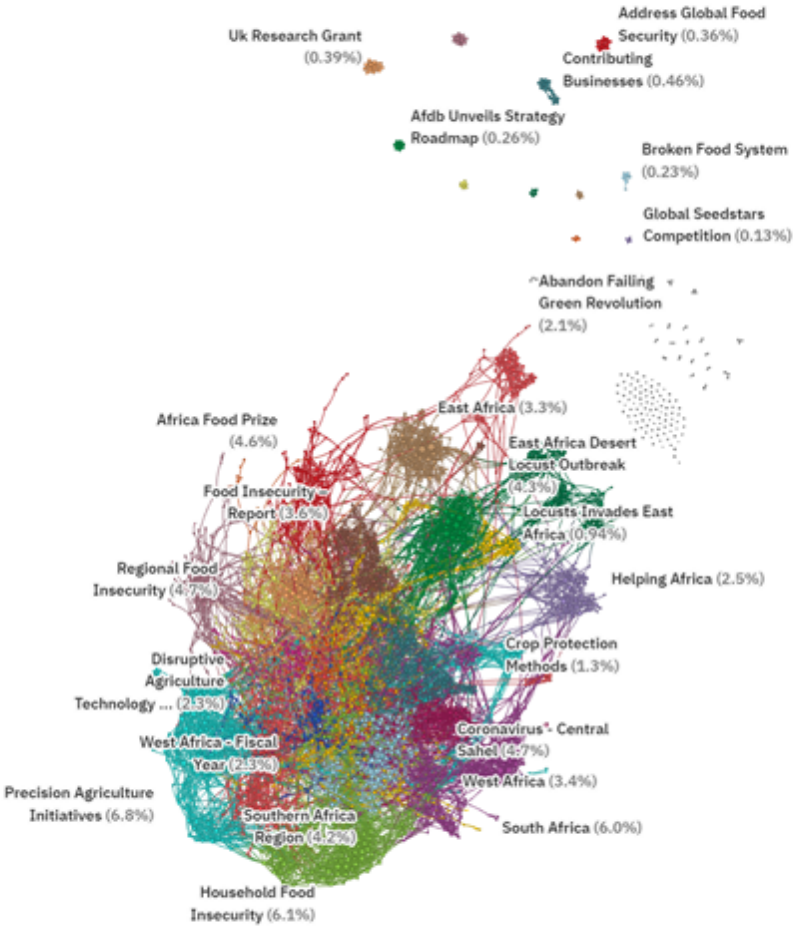
1. As discussed in our Scenario Week 3 report, we chose to focus on solving the problem of food insecurity, as we believe this is the area with maximum potential impact for Nutrien. To recap, we chose Africa as it has the worst case of food insecurity, as supported by our analysis, as well as existing analysis by firms like McKinsey and academic research. We visualised the most mentioned countries to know which ones are most relevant and created a bar chart of our searched and displayed by Country (Primary Mention). Discrepancies in terms of "any mention" of some countries were accounted for by updating the network (thus our analysis can be concluded to be accurate). Although we searched for countries, we only received results in the form of continents or areas in Africa.
    - Database: News/Blogs
    - Search: (Food Insecurity OR Security) AND Country

Figure 27 - Quid search: Countries related to food insecurity



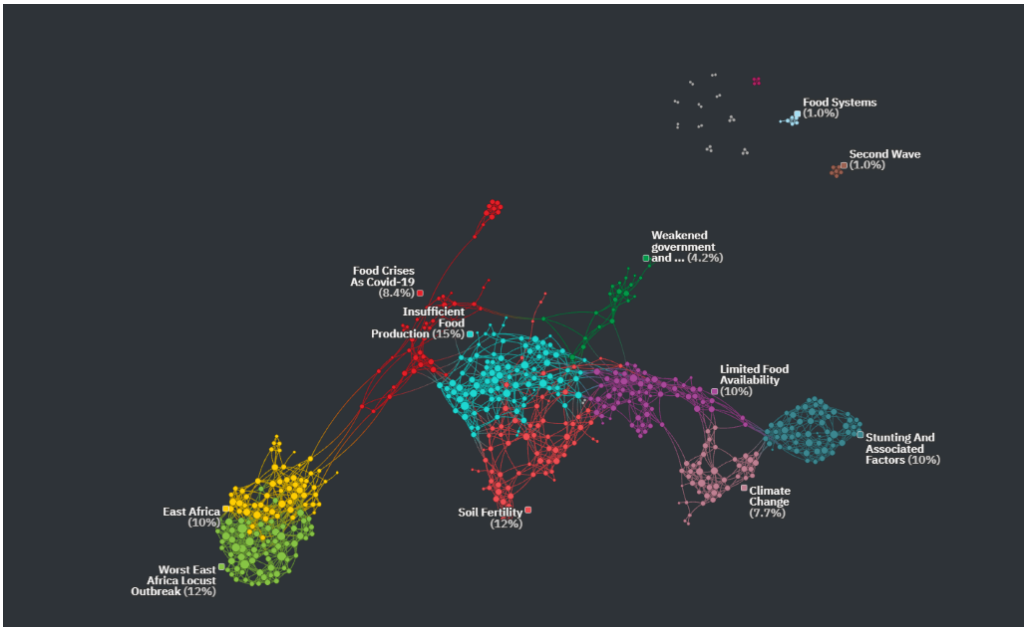
2. We sought to understand more about the food landscape in Africa and identify clear examples of innovations in the area of food insecurity in Africa. This search yielded multiple beneficial results in terms of focus areas (West Africa, South Africa), some of the contributing factors (locusts attack, failing green revolution, climate change) and most importantly, innovations (Precision Agriculture, Advanced Fertilizers, and Vertical Farming). This further strengthened our conviction that Nutrien could help Africa through the use of its advanced fertilisers.
    a. Database:News/Blogs
    b. Search: Africa AND Food Insecurity AND (innovations OR technology OR product OR service OR intervention OR Solutions)

Figure 28 - Quid search: Solutions to solve food insecurity in Africa



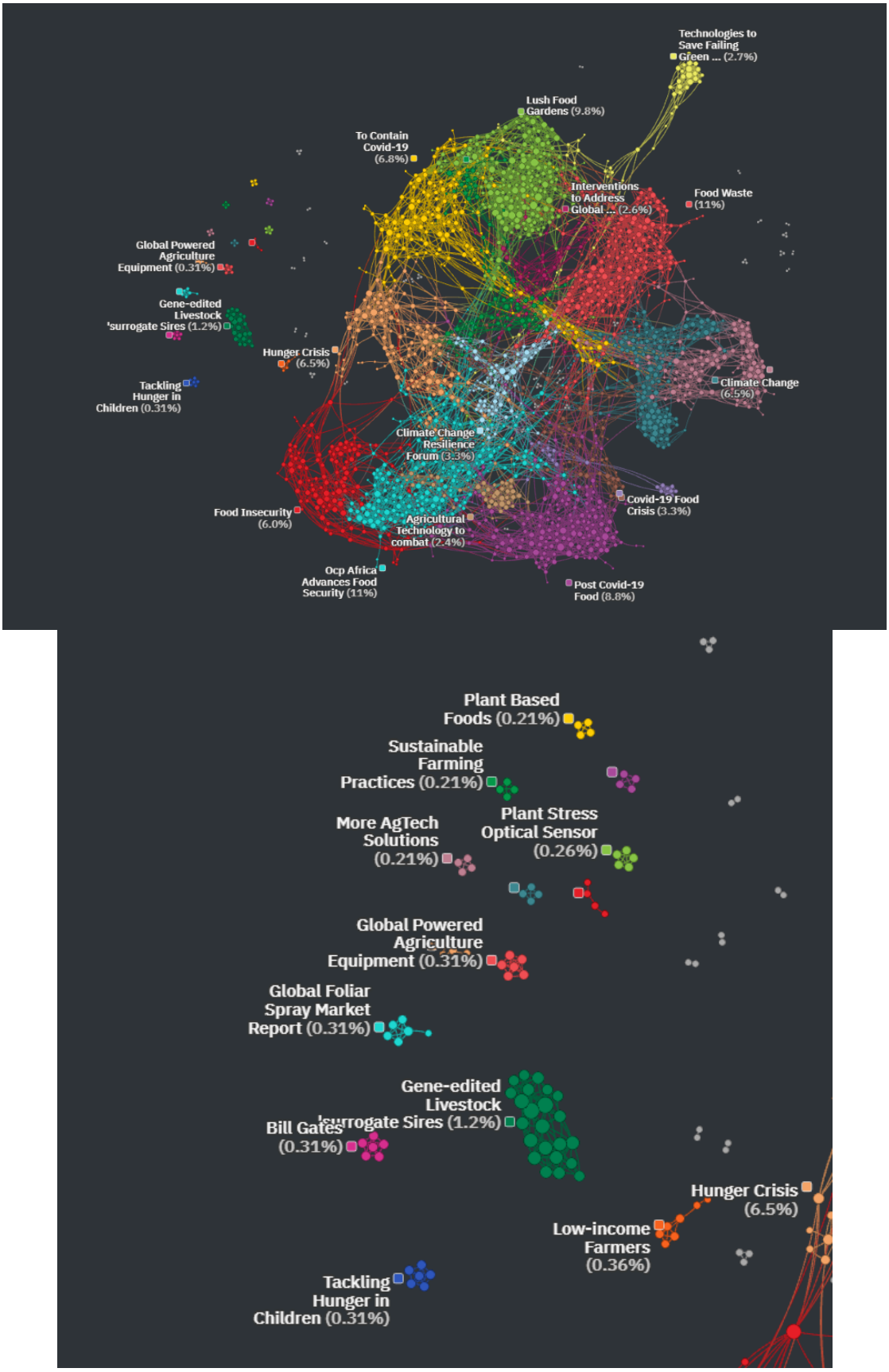
3. This Quid network was generated to find the factors contributing to food insecurity in Tanzania, and to find out what role fertilizer access plays in the whole system. A key insight that we got from this search was “Weakened government”. Investigation into this issue made us realize the incompetence of government subsidies and keep that pain point in mind. The cluster “Insufficient Production” included problems faced by farmers like misperceived value. Next, we decided to dive deeper into the fertilizer landscape in Tanzania, including the innovations which are currently set in place to solve this problem.
    - Database: News/blogs
    - Search: Tanzania AND Food Insecurity

Figure 29 - Quid search: Topics related to food insecurity in Tanzania



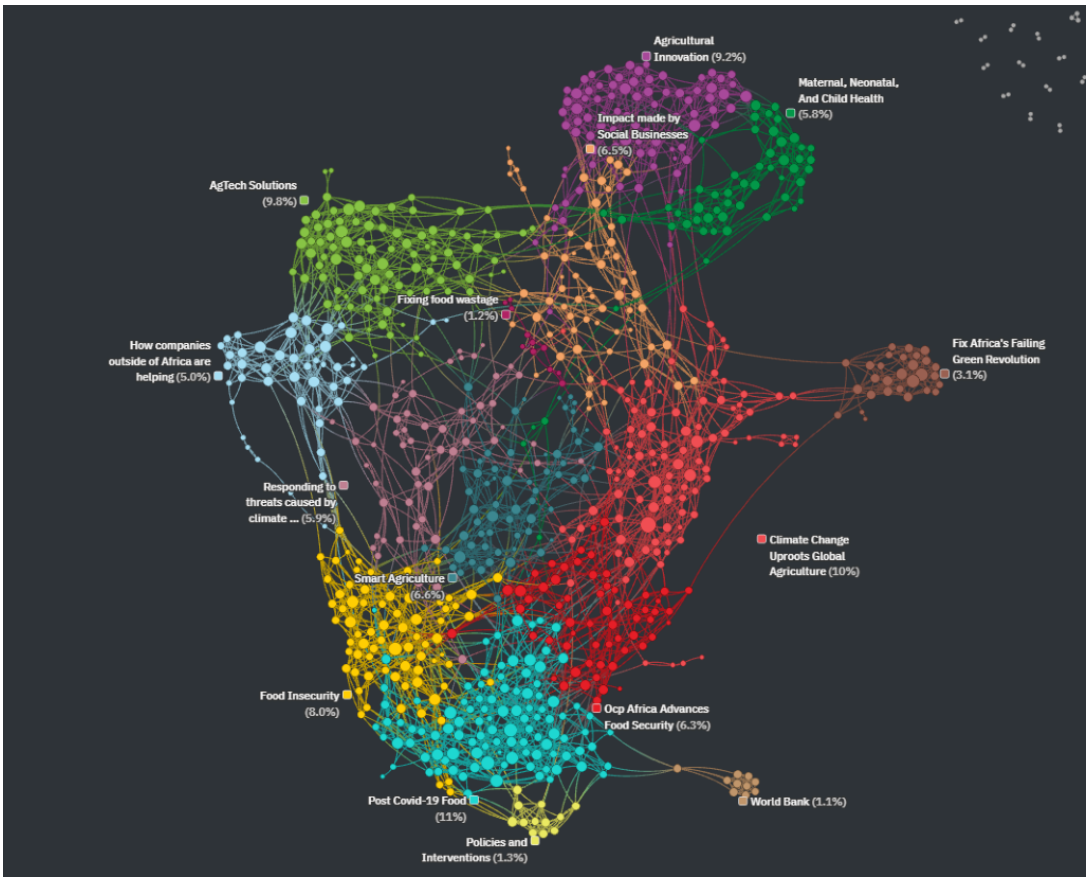
4. We then sought to discover the different transformative innovations all over the world to combat food insecurity, particularly related to the fertilizer industry. This allowed us to deepen our understanding of the subject and potentially gain inspiration and identify glaring deficiencies in existing solutions.
    - Database: News/Blogs
    - Search: Food Insecurity AND (Innovation OR Solution OR initiative OR intervention OR technology OR proposal OR combat OR product OR service) AND Fertilizer

Figure 30 - Quid search: Solutions to food insecurity related to fertiliser



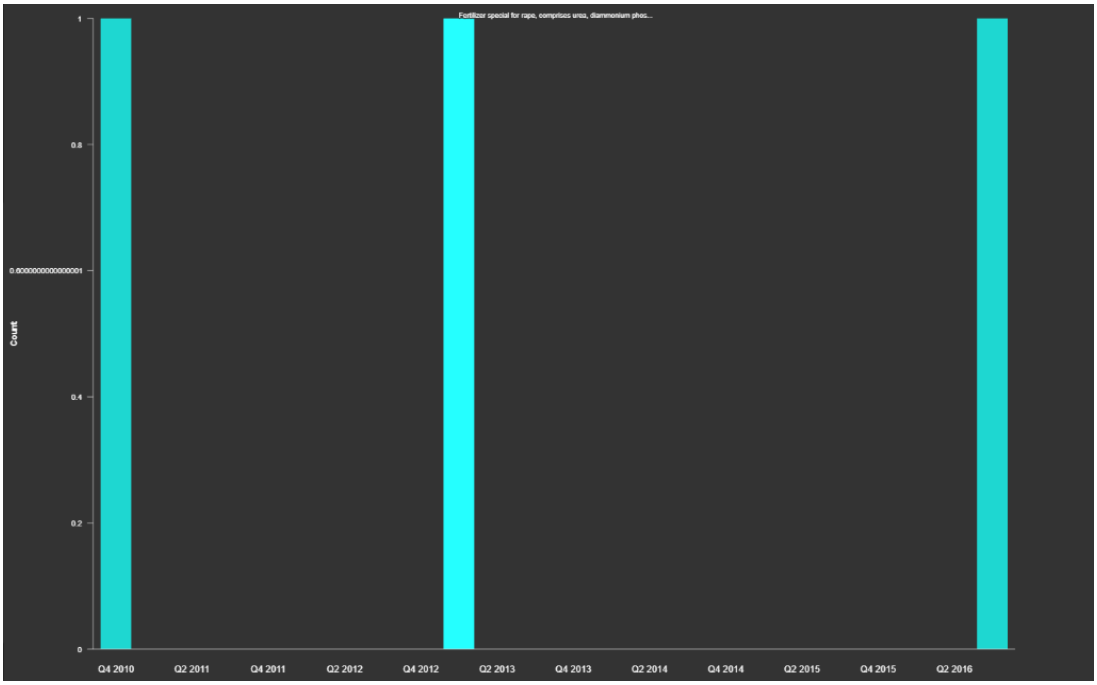
5. While knowing about the inventions all over the world was pivotal to our understanding of the issue and existing solutions, our next step was to focus on the innovations in Africa specifically, to witness the state of the art in our chosen location, and find out what value we can deliver that is not being met at the moment. While we had looked into the transformative innovations in Africa previously, this search was tailored to provide most relevant results to Nutrien as a fertilizer company. This was useful in identifying some potential technology categories,
    - Database: News/Blogs
    - Search: Food Insecurity AND (Innovation OR Solution OR initiative OR intervention OR technology OR proposal OR combat OR product OR service) AND Fertilizer AND Africa

Figure 31 - Quid search: Solutions related to fertilizer and Africa



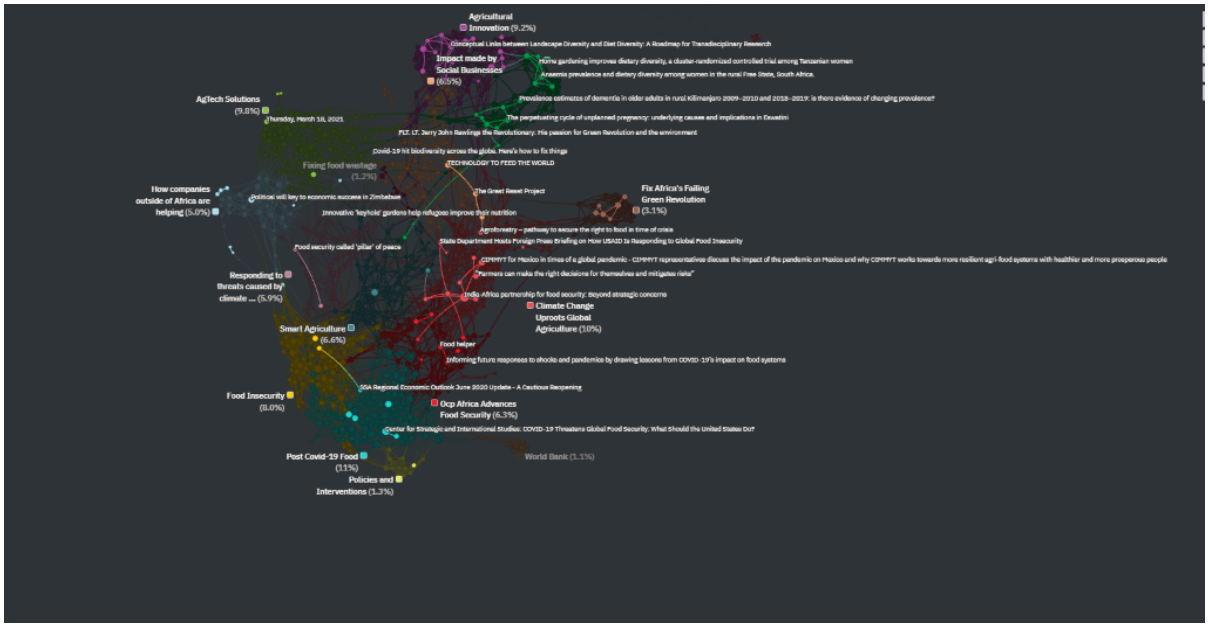
We also looked at existing patents in Africa to discover which players actively develop new technologies. To gain insight into the timeline development, we used the timeline view of these patents.

Figure 32 – Quid search: Timeline of patents relevant to mapped solutions



6. We then looked at the main transformative innovations in Tanzania in particular to identify which innovations are most relevant to us. This was done by tagging Tanzania in our previous search, as well as a new Tanzania specific search for better coverage of information.

Figure 33 - Quid search: Relevant patents in Tanzania



Our search targeted at Tanzania also yielded some useful insights:

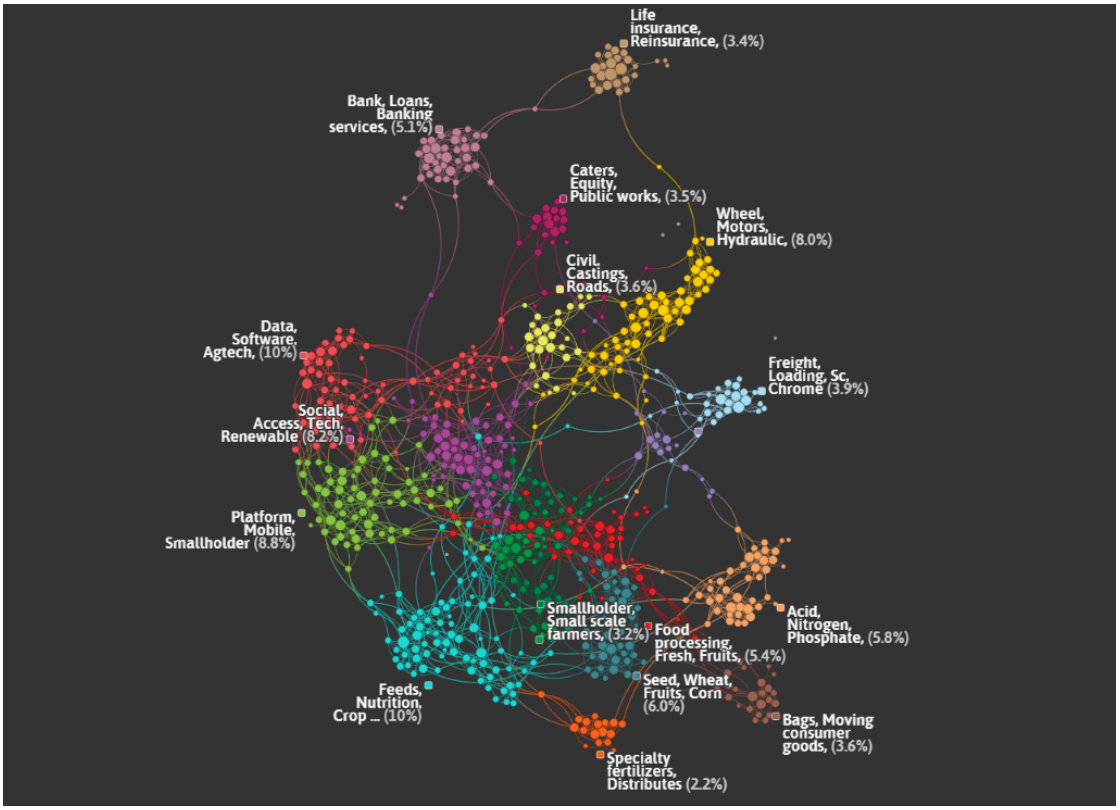
- Database: News/Blogs
- Search: Food Insecurity AND (Innovation OR Solution OR initiative OR intervention OR technology OR proposal OR combat OR product OR service) AND Fertilizer AND Tanzania

Figure 34 - Quid search: Solutions in Tanzania relevant to fertiliser

This was highly useful in identifying which of the players found by us are the most dominant and have gained the most traction, namely Yara and USAID.

7. In order to explore potential companies to partner with, we explored the companies database. This visualization yields useful insights in terms of not only fertilizer producing companies, but also companies that could help us ship them, provide equipment etc.
    - Database: Companies
    - Search: Fertilizer OR Agriculture

Figure 35 - Quid search: Exploring potential partners

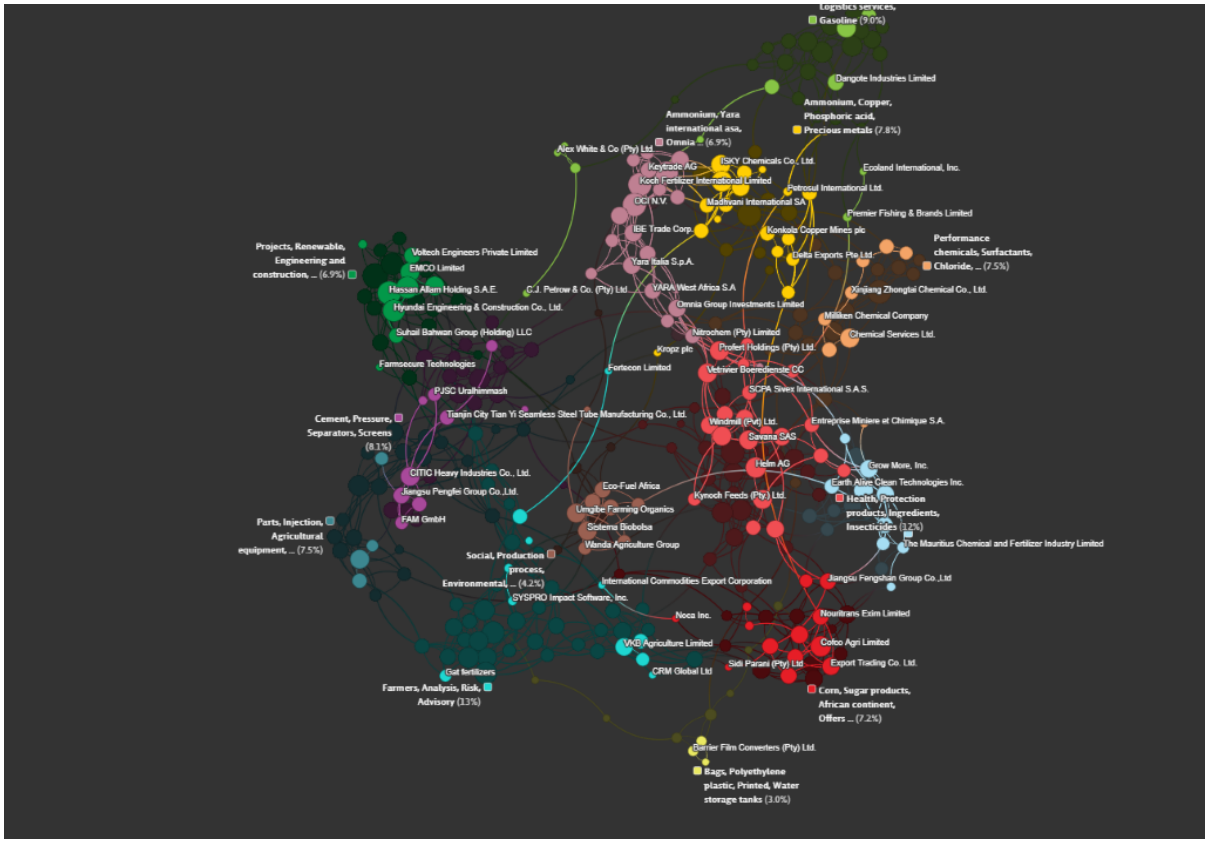


An added functionality was the information on companies catering to different kinds of fertilizers, crops and well as farmers.

8. To take our analysis of the innovations in Africa (fertilizer companies information was not available solely for Tanzania) a step further, we looked at the key players in the Africa food insecurity innovation market. To identify competitors, we used the tag feature provided by Quid in order to filter our results in the companies database. Filtering was required to draw attention away from the companies that are not competitors but simply provide ancillary services. The highlighted companies below are the ones that are worth looking into in Africa from our standpoint. The advisory cluster also helped identify competitors in our area of educating farmers and spreading awareness.
    - Database: Companies
    - Search: Fertilizer AND Agricultural Technology AND Africa

    Tagging was done using keywords “fertilizer”, “production”, and “manufacturing”.

Figure 36 - Quid search: Relevant potential partners on a higher level



This search, coupled with organic searches, helped us identify key players, potentially competitors like Haifa, Yara, Omnia and OCP.

4.6 Feedback

4.6.1 Feedback to Nutrien Analyst Team

Feedback	Action
Explain the economics of a representative farmer (e.g. small scale maize farm): If this specific farmer changes their farming practices, how does this impact their economics?	We have implemented this in relative terms, so under impact assessment there is how big of an increase in their economics using our proposed solution will lead to.
For the scale of Food Insecurity in Tanzania: Don't provide numbers on potential impact when transforming every single farm – this is unrealistic. Instead, provide numbers for the impact at different scaling targets (e.g. 10% of small farms)	This has been addressed two places: 1) We have decided to narrow down our focus to smallholder farms in the Lake Zone area of Tanzania that produce maize. This is a much more realistic scope, and the pain points likewise more homogenous. 2) The impact assessment is done in increments of 2.5% of the target farmers in the defined area. This allows for scaling impact accordingly.
For system diagram: include counterfeit fertiliser in map;	Added fertiliser scandal to system map (figure 5)
For profitability of fertiliser: Make the main point (currently many farmers are making the right financial choice to not use fertiliser) clearer.	Highlighted the this insight in other design tools seen in section 4.1 as well as used it as a main consideration for the solution discussed in section 3.
Be careful of loaded language. There is no price hiking. There simply is a multi-tiered distribution system.	Addressed in appendix where the waterfall chart has been addressed as a price break-down. It has likewise been considered throughout the report.
If we propose to partner with Yara, we need to make this proposal attractive to the CEO. He should not have an image in mind where he is photographed in front of fertiliser bags with the logo of our biggest competitors on them	Our solution diverted from this idea, and we are now solely focusing on using our own fertilizer production capacity and building our own distribution system. (see section 3)
We can use different sources (interviews, reports) to get an understanding of the needs of the farmers.	Looked at interviews and reports on farmers and used these insights to understand the farmers better (see section 4.1.1 and 4.1.2)

4.6.2 Relevant Feedback given to other Teams

Feedback	Action
Visualise quantitative information to make it easier to understand	Addressed in cases with multiple data points, like the waterfall chart in appendix 4.3
Be clear about what we are trying to improve and how are we measuring changes	Clearly explained goal in section 1 and explicitly mentioned requirements for solution in section 3. Clearly described how we assess the impact in section 3.3.
Make sure breakdowns are MECE	Checked our breakdowns to ensure they are MECE
Explain specialist terms when using them for the first time	Avoided specialist terms were not necessary and added footnotes or explanations in appendix where they were necessary.
Put metrics into context	We have done this particularly in the solutions part (chapter 3) were resources available have been considered against the investment needed, as well as in the impact assessment where the impact has been compared to the size of the problem(s)
Understand the root causes for the beliefs of different personas. Showcase the different things that affect their perception.	Identified causes of beliefs our personas hold. Also added influences to the system map (figure 5) and to the influence map (figure 6)
Instead of showing the journey map of the product, show the journey map of the customer	Made sure we are staying focused on the customer for the customer journey map seen in section 4.1.2
Identify how other solutions failed and how we can make ours better	Researched a range of other solutions and investigated what made each of them successful or not. Used these insights to create the solution seen in section 3.
Determine measure to assess our impact	Defined three measures through which we assess our impact: 1) Increase in Nutrien's profit 2) Increase in target farmers wealth/food availability

Feedback	Action
	3) Decrease in number of undernourished people
Describe the root causes of the problem we investigate	Narrowed down the system map (figure 5) to an influence map (figure 6) which was then used to identify key requirements for our proposed solution in section 3.
Use customer journey to identify how the solution tackles issues within it	Created a customer journey seen in section 4.1.2 and used it to aid the development of the solution seen in section 3.
Assess the size of the problem and put it into context	Addressed in the assessment section in which we have quantified the impact of our solution in incremental steps, and put it in context of the wider problem

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