SOIL FERTILITY

Section 1: Context

- Background; Community Description; Problem Framing

Agriculture plays an important role in the economy of Tanzania, contributing significantly to the country's GDP, accounting for 60 percent of export earnings and employing 84 percent of the rural population. [1] And our case of study is no exception to this. Mbulumbulu is located in the Karatu district to the western side of Arusha, Tanzania. The project group focused on Kambi ya Simba, a village with a population of approximately five thousand habitants from which the majority is small-scale farmers. The main crops are maize, pigeon peas, wheat and beans, with an important number of flower planting by contract; cattle is maintained in relatively small numbers and mostly consists of cows, donkeys, sheep and goats. On the other hand, electricity at the moment is restricted to sun-power lamps and chargers; and water access is limited, with little to none purifying treatments.

Farmers in this community face similar challenges as many others in Sub-Saharan Africa. Population growth has led to land fragmentation. As a result, more intensive agricultural practices are needed to produce enough food for a growing population. Per-capita livestock herds have reduced, as there is less land available for grazing. Fewer cattle per household make supplies of manure too low to sustain high yield agriculture and that makes manure more expensive. Improvements in the precision of manure application are needed to maximize its agronomic value. Farmers report large yield increases of 50-80% when using synthetic fertilizers, but rarely have cash on hand to buy these at planting time. One of their major concerns also lies in the labor implications of the different farming stages and how to minimize them to lower costs, accountable both as in time and in money, as to increase household income. Finally, traditional plowing and grazing practices expose soil to rainfall, resulting in erosion that degrades the soil resources smallholders rely on. Solutions must be developed to improve short and long term soil fertility while conserving soil through practices that minimize erosion.

Section 2: Design Process

- Problem framing tree

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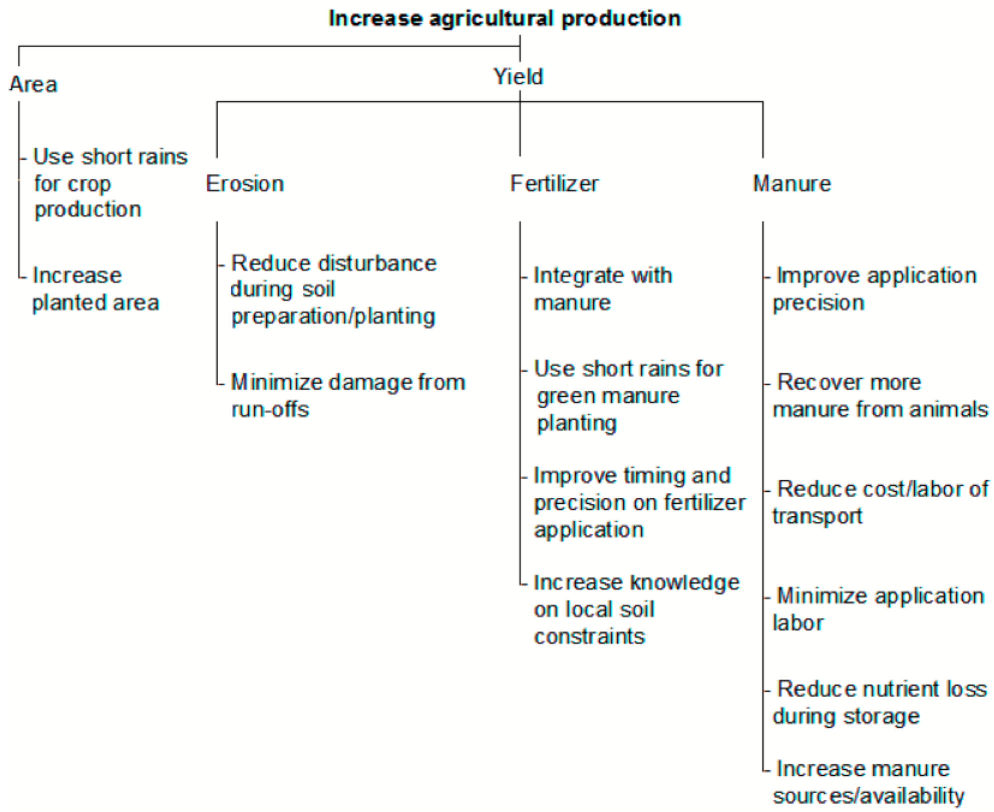

Value Proposition

Farmers in the Karatu area routinely spread manure on their fields prior to plowing to improve soil fertility. This practice requires a number of stages: First, farmers collect manure in kraals where their cattle spend the night. Second, they unload the kraal into a decomposition pile near the kraal. Third, they load the manure into a cart and take it to the field. Fourth, they make piles of manure from the cart throughout the field. Finally, they spread the manure using a shovel over the soil surface prior to first plowing. This method spreads manure unevenly throughout the field and ends up fertilizing beans and pigeon peas even though the target crop is maize. In addition, it requires a significant labor investment of at least 2 – 4 labor days per acre at the beginning of the planting season. The labor investment makes it difficult to complete all field preparation tasks in time to plant with the early season rains, which is critical for high yields.

Our technology will add value to farmers' current practices in two main ways. First, it will apply an even amount of manure to the maize lines where farmers want to target their manure. Assuming our data collected from farmers that doubling manure applications could raise yields by 50%, we expect better precision in applying manure using the spreader to raise maize yields by at least another 20%. This translates into an extra 2-3 sacks, or $60 – 100 per acre-season. Second, it will reduce labor cost by at least 2-4 days per season. At current wages, this saves users $8 – 16 per acre-season.

Based on these numbers and an expected maximum cost of ~$150 for the technologies, the payback period for the customer is roughly three acre-seasons. Because the technology is designed to be durable and easily repaired, each extra acre-season results in a profit to the customer.

· Summary of design process

During the first community visit, feedback was gathered around the soil fertility subject and the main concerns the farmers in Kambi ya Simba had regarding it. The main aspects that were talked about were labor, cost and yield, within the frames of erosion, manure application and inorganic fertilizers. There was some distrust towards the use of inorganic fertilizers because of its high cost and the possibility to reduce yield if the application stopped for a season, given the fact that a lot of farmers were not certain about their ability to come up with the funds at planting time. On the other hand, manure was looked upon with high value in general, both by big scale and smaller scale farmers. This is the reason why most of the ideas we generated were somehow related with manure and one with the reduction of labor during planting, suggested directly during our visit.

Our decision was to develop a simple prototype on four of our ideas and use the feedback during the second community visit to weigh our options in a more objective way. This is a summarized description of each of them:

Prototypes

1. Cow Diaper

The first prototype we exhibited was a cow diaper. The objective behind its implementation was to increase the amount of manure available, collecting it during the day as the cows go about grazing and defecating all over the community. It was also a very cheap and replicable option that could be developed alongside one of the bigger prototypes. However, the people had no interest in it, as they kept on saying that it was contrary to their tradition. Without any possibility to make it desirable to the user, we discarded this option.

2. Manure Briquettes

The second prototype we exhibited was a potential manure briquette maker, which could help in the efficient use of the manure with direct application to the seed. However, it wouldn't be feasible if they had to be pressed by hand, because it took too much time to make a reasonable amount of briquettes and it would even mean an increase in labor, which did not attract much positive feedback from the farmers. We pursued the idea of an engine-powered machine that could eventually be rented among farmers to share its higher cost. Nevertheless, such a design would take a longer time to develop than what we had available within the scope of IDDS.

3. Adapted Plow with Seed Planter

The third idea was related to reducing planting labor, by making a seed planter that could be easily attached to existing plows in a low cost way and to address a request that came directly from the farmers. This idea received good feedback as it multi-tasks existing plows and reduces labor in planting, but it had a high capital cost for the amount of saved labor and it had a lot of design issues that would take a long time troubleshooting, a resource that was very limited by the moment when we chose which prototype to follow up.

4. Manure Spreader

The fourth idea we started developing was a manure spreader. For its exhibition we built a works-like prototype with two small wood rolling bars with angled iron attached in a similar way to the final prototype (see the How it works section) and they where moved by hand to roll towards each other in between two boards that served as support on each side in representation of the ox-cart side boards, we also used some leaves during the presentation to show how the material would pass through the bars to get some feedback on the process. This prototype and idea had the most positive response from the community and the feedback led to most of the design requirements that we tried to keep into account later on. But there was quite a constraint with the comments because most of them expressed dissatisfaction at not being able to experiment with a finished product.

Then we proceeded with the development of this fourth prototype into a looks like and works like prototype that could perfectly explain its use and even be presented as a usable product. During the second community visit we had a lot of co-creation spaces and even got to experiment with building a manure spreader on an existing ox-cart that one of the farmers provided. However, once we got back we had the main constraint of not having an ox-cart that we could use and work on to develop our product. We tackled this situation by renting a man-pulled cart and building a smaller representation of our design.

The main concern was to make it an addition to existing carts in a simple and replicable way, with the fewest resources possible, which eventually led to reducing the two bars to one. Also, to take advantage of the ox-power directly without having to install mechanisms (and more material) to direct motion in different ways, we decided to rotate the bar in the same direction as the wheel rotation. The next step was to make a reasonable size gap for the bar and then to avoid jamming of the manure while reaching this gap, which eventually came to the design of the slope, with the hope that it would also be a good way to take advantage of the natural agitation resulting from the movement of the cart. With some adjustments to this general idea, we ended up with our last prototype, which will be further explained in the How it works section.

· Analysis and experimentation

We experimented with a number of features in the design process. Although we were not able to gather quantitative data on these, the options we tried out are explained below.

è Slope & Weight supported

In the first designs and sketches, the slope was going to be kept as simple as possible, maybe even left to the farmer's discretion. However, we knew that we had to decide on some aspects to make our final prototype work and we ended up realizing that the slope had an important impact on the design, because it is one of the most expensive parts of it, given the amount of timber it requires and also because it limits the volume carried on the cart (the space under the slope is not exploited). Besides, it is directly related to the weight supported by the bar: with a steeper slope, there is more weight exerted on the bar. We made some qualitative trials on the angle of the slope needed to guarantee that the material would drop with some movement and used it for the slope on both sides. Nevertheless, it is important to take into account that we did not work with a full-scale model and couldn't try out the ox-power relation to the weight.

è Rate control: The initial idea & disengaging mechanism

As we designed a sprocket system to take advantage of the rotating motion of the wheel and transfer it to the bar, the better option to control the rate would be to experiment with different sprocket sizes. Another idea during the design process that could not be carried out and experimented in prototype form was the possibility to attach different size pallets to the rotating bar by drilling holes on the flat iron pieces.

This relates also to the possible disengaging mechanism. To disengage the spreading motion in the final prototype, the procedure was to remove the chain that connects the wheel to the rotating bar. However, this does not guarantee that the bar will be steady enough for the cart to maintain its usual function. Another idea suggested was to use a board to cover the gap in a way that was easily removed when needed.

è Particle size

Explained further in the troubleshooting section.

Section 3: Technology / Prototype

· Design requirements

User Need	What are you going to measure	How to measure it (units)
Manure rate control	Min/max manure release	carts/acre # of intervals
Disengaging mechanism	Ease of attachment & removal	Time of attachment & removal (seconds)
Adjustability to different rims	Rims the design cannot accommodate	Percentage of the total of different rims
Flexibility to particle size	Max particle size	Largest dimension in inches
Cart use remaining	Ease of conversion from cart to spreader	Time of conversion (hours)
Manure feeds continuously to the spreader	Jamming of the spreader	Jams/cartful
Affordable	Cost of parts and installation	TZS
Durability	Lifespan	Years
Maintenance	Maintenance costs	Percentage of initial cost per year

· How it works / functionality

The main piece of the design is the rotating bar. With the exploded view (Fig.1) it is possible to see how it was put together from its base pieces. The first step was to get a metal pipe with the appropriate size to fit the cart from side to side and to cut four pieces of flat iron 1.5'' to the same size, that were then welded onto the pipe in a symmetric way, at each end there was a small metal ring and then there are small rods welded, one longer than the other. These rods most have a diameter that fits the bearings perfectly. On the side of the longer rod, a long bolt was also welded, to subsequently place the sprocket in it, fixed with a double knot.

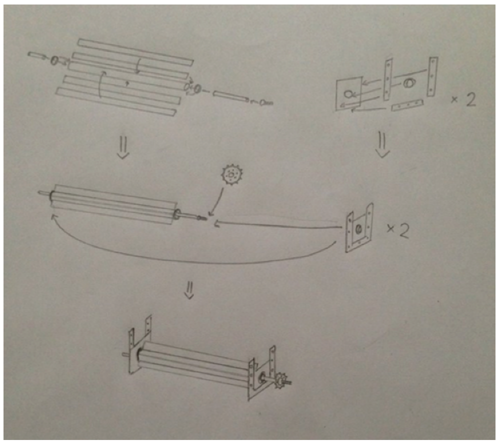

Fig. 1. Exploded view of the rotating bar and its attachment boards.

The bar was attached under the cart with the help of two squared boards that have a hole in the center and a bearing placed inside of it to locate the smaller side rods. These boards were drilled with some flat iron into the sides of the cart (Fig. 2).

Fig. 2. Rotating bar attachment to each side and wheel-sprocket connection.

Once the bar is connected, it was time to install the motorcycle sprockets. To place the bigger one on the wheel, two bolts were attached to the wheel knots. A scavenged metal plate was drilled with holes for the bolts that put the sprocket into place with one knot on each side; it was easily aligned with the small sprocket on the rotating bar just by moving the knots (Fig. 2).

Fig. 3. View of the ramps from the side of the cart.

The only addition left were the slopes on each side (Fig. 3). A frame of wood was put into place and the ramps that were measure, cut and put together were located on top of this frame, fixed later with some long nails. The lower edge of the largest ramp (and the one who received the material due to the motion of the rotating bar) was covered with rubber (Fig. 4).

Fig. 4. Top view of the rotating bar and the slopes with some soil after demonstration.

With the final product, we get a rotating spreader mechanism driven by the wheel's pull, that spreads the material carried on the cart uniformly due to the controlled amount placed between the pallets, and the spreader is fed continuously thanks to the slope and the natural agitation of the cart.

Fig. 5. Front view of the finished cart in movement.

- Performance

The trials that were made with the final prototype showed that the spreader provided what qualitatively seemed to be a uniform layer of manure throughout the covered area and a continuous motion of the mechanism throughout the heterogeneous material. However, no quantitative data was acquired due to time constraints, so the actual amounts of manure spread per area and a possible rate control is left to future analysis.

· Bill of materials

ITEM	DESCRIPTION	QUANTITY
Timber	57 x 200 x 25 cm	4
Timber	124 x 200 x 25 cm	4
Bolts	8mm x 13cm	3
Metal pipe	1.5" x 76.5cm	3
Flat Bar	1.5" x 76.5cm	5
Bearings	¾"	2
Nuts	13mm	3
Nuts	8mm	2
Bolts	8mm	4
Metal pipe	1.5" x 31.5 cm	1
Nails	3"	½ kg
Bolts	¼"	12
Nuts	¼"	12
Motorcycle sprocket & chain kit	1	1

· Self Assessment

User Desirability

Spreading manure in the traditional way is a laborious and time-consuming task for farmers. Nevertheless, it is undertaken because of its benefits related to yield increase. Our prototype answers the need to minimize labor at a reasonable cost and within the affordability ranges of a high percentage of farmers in Kambi ya Simba. It is easy to understand, use and pleasing to traditional ways because it is an addition to existing carts. Also, it responds to several design requirements given by the community's feedback. People's response and willingness to buy during Nane Nane shows the depth of desire from the user's point of view.

Technical feasibility

We realized it would not be sustainable to build this technology from scratch in the village due to lack of electricity, which implies a limited range of tools and slows down the whole process to an unsustainable rate. But this impediment was resolved with the decision of moving manufacture to Arusha and sending premade parts to be assembled on each existing cart at the village. The community members have pledged to sustain and improve on the technology since they have a need of spreading manure every farming season.

Environmental Sustainability

The main materials used to build the technology developed are metal and wood, chosen because of availability, price and durability. The lifespan of a regular oxcart can extend up to twenty years according to the feedback collected, with boards being the first parts to get damaged and characterized by being easily and constantly repaired. This tendency would probably be replicated by our technology and it shows that the waste related to each spreader might be low and the metal parts have the potential of being reused or recycled. The manufacture process does not have a high resource spent, as its main use of electricity relates to some welding and drilling needed and the assembly only requires an investment in labor.

Financial

Cost calculations are described below, with a break-even sale of 6 units per season at a price of 230 000 TZS, which was well received by customers at the Nane Nane presentation.

Manure Spreader

Materials	**Cost**	**Units**	**Subtotal**	**USD**
Pipe	30,000	0.25	7,500	$5
Paddle Bar	20,000	0.35	7,000	$4
Chain / Sprockets / Bearings	28,000	1	28,000	$17
Nuts, Bolts, & Washers	25,000	1	25,000	$15
Centering Bar	5,000	1	5,000	$3
Timber	5,000	12	60,000	$36
4mm Plate	4,000	1	4,000	$2
Nails / Screws	5,000	1	5,000	$3
Rubber strip	1,000	1	1,000	$1
Total			142,500	$86
Labor and Fees				
1 day workshop labor	20,000	1	20,000	$12
Electricity	10,000	1	10,000	$6
Total			30,000	$18
Transport				
Arusha – Kambi ya Simba	5,000	1	5,000	$3
Total			5,000	$3
Installation Costs				
1-day Fundi labor	10,000	1	10,000	$6
Total			10,000	$6
				USD
Unit Cost			187,500	$113
Markup			20%	
Sales Price			230,000	$139
Gross Margin			42,500	$26
Break-even unit sales per season			6	
Expected Extra Sacks / Acre			2	
Expected Extra TZS / Acre			60000	$36
Expected Labor Cost Savings			18000	$11
Expected value per acre			78000	$47
Payback Acre-seasons per customer			2.9	

Section 4: Lessons Learned

- Community engagement

In the first visit, the team interviewed a number of farmers both individually and in focus groups, as well as visited their farms to observe their normal practices and try out their common soil management practices such as spreading manure, plowing, and planting. During the second visit, we spent the initial two days visiting farms, exhibiting and gathering feedback from the farmers in other to narrow the four prototypes to one. After exhibiting and gathering feedback, we selected the technology to focus on and spent the other two days co-creating with strategic people as well as discussing how we could improve upon it.

We started working on the spreader at the Kambi ya Simba workshop with additional materials sourced from Karatu. Welding was completed in Karatu, and materials were bought there, while all the modifications to the ox-cart was done in Kambi ya Simba. We worked with two local fundis (Paulo and Alex) to build local expertise on materials and methods into the design. During our initial attempts to attach the modification to the existing cart of Paulo, community members aided in the work and offered feedback to improve the design. We made a presentation about the manure spreader to a larger community on our final day in the village.

- User feedback

From the four initial prototypes the group presented to various farmers in Kambi ya Simba, we narrowed down to the modified ox-cart / manure spreader. This was selected after considering user interest and feasibility within the scope of IDDS during the initial visit to the community. However, we received valuable feedback on all the technologies, and members of the community displayed interest in future work on some of them in addition to the ox-cart manure spreader.

During the community feedback sessions, the group presented the basic design and operation of the manure spreader. We received a number of comments and questions that helped us focus on design considerations important to users. These included:

- Minimize the number of people needed to use the technology (preferably to one)
- Cost should be as low as possible, but many farmers would be willing to pay up to 350,000 TZS
- It is critical to show the technology working before giving out detailed opinion (complaints were heard about not seeing a finished product)
- Interested in the function of the slope when it is finished. Many farmers showed positive reactions towards the simplicity of the mechanism, and understood how it works immediately.
- Adjustable rates for different crops and different soil is needed
- The cart must still be able to perform normal uses for the cart

· Troubleshooting

On the final prototype some functionality problems were identified. The first performance trial with regular soil provoked a jam in the mechanism due to the bigger particles getting stuck in the pinching point of the blades in the rotating bar and the sides of the ramps, which were covered with angled iron. By continuing the wheel motion, the pressure eventually bent the bar that was connected to the bearing.

As a first step towards fixing this problem the smaller bar was replaced by a stronger rod with the same diameter; but it was also necessary to allow the bigger particles in manure texture to go through the mechanism. One of the ideas suggested was to place a mesh that could control the particle size before the material entered the mechanism, but this was discarded given the high possibility of clogging in very little time. The final decision was to replace the angled iron with a rubber covering on the lower side of the ramp and a performance check with manure proved the idea to be successful.

Section 6: Next Steps

6.1 Reflection on viability and other design opportunities

The manure spreader presents a good chance on being well accepted in its target market and keeps a positive feasibility perspective on technical aspects that have been taken into account. On the other hand, it still has a lot of potential for developing a better fulfillment of the design requirements, given the fact that most of them couldn't be explored due to time constraints. Some aspects that are worth experimenting with are:

- Disengaging mechanism to maintain the usual use of the existing cart and rate control, keeping the cost low.
- A system that improves on the precision of the application, perhaps adjustable openings to place manure directly on the planting lines.
- Amount of manure applied on each load and best possible slope angles to avoid jamming and good weight control.

6.2 Continuity / dissemination model

The dissemination model will focus on establishing a business that will offer the key components needed to assemble the spreader to the Mbulumbulu community and others more broadly. The business will be operated by two members of the project team in collaboration with the other members through email. To pilot the feasibility, the local members will construct the parts and send them to the team's partner workshop in Mbulumbulu, who will assemble it for a fee for client farmers. Within Mbulumbulu, our contacts will form a project coordination team that promotes the technology, trains farmers, and takes details (e.g. cart-measurements) for individual customers' orders. At this stage, the team will fabricate using the Twende workshop in Arusha and use jigs made based on the initial prototype. The model for getting to customers will be to train local tradesmen to measure their customers' existing ox-carts, send the measurements to our local team members, who will custom-fabricate the key components in Arusha. They will then hire space on existing transport lines (e.g. lorries, dala-dalas) going to village of the partner tradesman's workshop.

As products get used in the communities, the Arusha-based team members will move to the field with our local NGO partner, ECHO. In these site visits, they will gather more user feedback and adjust design requirements in collaboration with non-Tanzanian team members engaged from their home countries. These visits will also serve as demonstration days that promote the value of the equipment to farmers in the area. Our local contact in the national extension office will help set up these demonstrations with influential farmers' groups. As the design requirements change, alterations on the parts and assembly of the machine will be an ongoing collaboration through email between members. We expect a series of updated design models to be agreed upon over time to clearly track the evolution of the product.

We plan for sustainability by ensuring our sales price can cater for the time invested by local partners in fabricating the parts, as well as set aside a fund for ongoing design prototyping. This design fund will pay for materials, local transport, and communication expenses of local partners. If sales and revenues become regular and large enough for the Arusha-based team members to devote a significant amount of time to fabricating and marketing the product, we will consider registering a local business, or offering it through an existing partner such as Twende or AISE. When this occurs, design funds will also be used for more aggressive marketing using radio, flyers, and announcements at events in high-potential regions for the equipment.

6.3 Six month plan and team engagement

Target Date	Activity	Team / Partner Engagement (* = Activity Lead)
September 1, 2014	Complete building and delivering one or more prototypes for trainings & demonstrations in Mbulumbulu	- Local team members - ECHO * - Mbulumbulu Coordination Team
September 30, 2014	Changes to first prototype completed with user feedback at Kambi ya Simba workshop	- Local team members * - ECHO - Mbulumbulu Coordination Team
October 31, 2014	First commercial design fabrication and installation instructions documented	- International & local team members *
November 31, 2014	Jigs for component-part fabrication completed	-Twende/AISE staff - Local team members *
December 31, 2014	Partner workshop in Mbulumbulu trained in installation of commercial model	- Local team members - ECHO *
December 31,	First commercial product installed	- Local installation partner (Kambi

2014	for a customer	ya Simba workshop) - Local team members * - ECHO

6.4 Anticipated risks and challenges

6.5 Stakeholders (community members, organization, partners)

Stakeholder	**Description/ Involvement**
Farmers	Community members with technology adopting interest and purchasing power
Arusha-based team members	IDDS participants that will take over on design, manufacture and collaboration aspects in the continuity plan of the project
TWENDE	Provider of utilities and workshop space for the manufacture stage
Local workshop	Assembler and local link with the customer
Extension Office	Collaboration with its representative
Women's Association	Early adopters of new technologies to increase agricultural production and household income, interested in the product demonstration in their common farm
ECHO	Partner for continuity, community engagement and consultation

6.6 Lean business canvas

PROBLEM STATEMENT	Farmers in Mbulumbulu, Tanzania face similar challenges as many others in Sub-Saharan Africa. Population growth has led to land fragmentation. As a result, more intensive agricultural practices are needed to produce enough food for a growing population. Per-capita livestock herds have reduced, as there is less land available for grazing. Fewer cattle per household make supplies of manure too low to sustain high yield agriculture and makes manure more expensive. Improvements in the precision of manure application are needed to maximize its agronomic value. Farmers report large yield increases of 50-80% when using synthetic fertilizers, but rarely have cash on hand to buy these at planting time. Finally, labor requirements in using

manure and fertilizer discourage farmers from applying them in the right quantity, time, and placement. Solutions must be developed to improve short and long term soil fertility while conserving soil through practices that minimize erosion.

SOLUTION	We have developed a low-cost manure spreader that allows farmers to accurately apply the right amount of manure to their target crops. This saves farmers labor and increases yield through more precise application of manure. The technology is the lowest cost manure spreader available, by making small changes to farmers' existing ox-carts and minimizing materials cost, using simple, easily available parts. Our team will fabricate key components in a modern workshop, and partner with local tradesmen to install it for farmers in their villages.
KEY METRICS	1) Break-Even Acre-Seasons for customers – we expect 3 acre-seasons to pay back through better crop yields and reduced labor costs 2) Break-Even units sold per season – If we sell 8 or more units per season, the business earns a net profit after paying local team members' time and overheads. This is required to continue with new prototype development and ongoing product development and marketing. 3)
VALUE PROPOSITION	Our technology will add value to farmers' current practices in two main ways. First, it will apply an even amount of manure to the maize lines where farmers want to target their manure. Assuming our data collected from farmers that doubling manure applications could raise yields by 50%, we expect better precision in applying manure using the spreader to raise maize yields by at least another 20%. This translates into an extra 2-3 sacks, or $60 – 100 per acre-season. Second, it will reduce labor cost by at least 2-4 days per season. At current wages, this saves users $8 – 16 per acre-season.
COMPETITIVE ADVANTAGE	Compared to competing manure spreaders, we offer the lowest cost technology, customized to individual farmers fields. Our product is convertible to a transport-cart, which makes it an attractive multipurpose tool. No other manufacturer can lower costs by using local installation rather than factory-assembly. Compared to local labor

costs, our technology is lower cost and more accurate in how it applies manure. This allows a farmer to save money on labor while increasing yield

DISTRIBUTION	We reach the client through partner workshops in rural areas. Our partner workshops take orders from customers, measure the dimensions of the existing cart, and request the set of 'key components' needed for assembly based on these measures. Our team in Arusha fabricates the key components to the customer's specs and rents space on local transport lines to deliver to our partner shop at low cost.
CUSTOMER SEGEMENT	Our customers are small commercial farmers, growing 2-4 acres of maize, bean, and pigeon pea intercrops. They also grow wheat, barley, and flowers as cash crops in rotation with maize/bean/pigeon pea. In order for them to sustain decent yields, they must use all the manure they can collect from cattle kraals near their homestead. They apply it by throwing it with shovels using ox-carts they, which are also use for crop and water transport. Their farm earnings are only enough to cater for household needs, and small farm-capital improvements (such as repairing tools and purchasing animals). They rely on hired labor at key times, and look for ways to reduce labor costs while maintaining good crop yields.
COST STRUCTURE	We operate under a variable cost structure that minimizes fixed costs by renting workshop space, and works on small, customized orders. We will not invest in vehicles, but hire space on local transport instead. Our sales force will come from local inhabitants of target areas, and partners will be workshops based in these agricultural regions. All of this will allow us to base our costing on variable materials, labor, electricity, and transport costs.
REVENUE MODEL	The revenue model is to sell assets to partner shops, and supplement with after-sales service. Partner shops benefit from earning money from installation fees, while we earn from selling product components. After sales services will be done by project team members as requested by customers, for troubleshooting problems that come up for users.

[1]

[1] Owenya, M., Mariki, W., Stewart, A., Friedrich, T., Kienzle, J., Kassam, A., et al. (2012). Conservation Agriculture and Sustainable Crop Intensification in Karatu District, Tanzania. *Integrated Crop Management, 15*.