Field Test Results and Analysis

Executive Summary

This report presents the results, analysis, and discussion of the quantitative and qualitative field test results, laying out the impact the Smart Agri-Centre has had on the community of Mbata. Analysis of field test data shows the SAC has had a significant agricultural impact over just one year:

- **increase in farm sales/revenue of 171%** (25% in control community)
- **increase in farm profits/earnings of 283%** (10% in control community)
- **average yields increased by 32%** despite adverse circumstances for some significant crops (yields fell by 12% in the control community)
- **average reduction of farmer costs of 30%** (97% increase in the control community)
- **significant reduction in post-harvest losses**, completely eliminating losses for some key crops (in control community average losses increased for almost all crops)

Analysis of qualitative data which asked 93 end users about how the SAC had directly impacted their lives revealed significant social impact:

- social impacts on economic planning and livelihoods
- improved skills and opportunities in the community
- improved ability to invest in children and education
- improvements in farming practice and knowledge
- improved health and environmental benefits
- Improved quality of life, satisfaction and enjoyment

In addition the data demonstrates a greater resilience in the community and in individual farming practices as a result of the SAC services and infrastructure. People are more willing to take risks and try new things (jobs and farming practices), are better able to adapt to changing situations (e.g. particular perennial crops failing during the season), and are able to build up personal and community savings which increase the economic resilience of the whole community.

Methodology

As detailed in our Field Test Protocol document, the results collected and demonstrated in this document were gathered through surveys with farmers which were performed by Kiima Foods using Kobo Toolbox survey tool.

Survey Location and Timing

These surveys were performed in 2 locations:

1. Mbata village, Kasese district, Uganda. This community had a completed Smart Agri-Centre building by January 2022.
2. Kambeho village, Kasese district, Uganda. This community has no Smart Agri-Centre, and is the control community.

These surveys were performed over two different time periods in each location.

1. Survey Round 1 - requesting data from farmers over the time period from Jan 2021-Jan 2022.

2. Survey Round 2 - requesting data from farmers over the time period from Jan 2022-Jan 2023.

The survey questions in both locations were identical, apart from the addition in Survey Round 2 in Mbata of questions asking about the specific impacts of the Smart Agri-Centre on their lives and livelihoods. The survey has been attached to the Field Test Protocol Document as an Appendix.

Sample Sizes

	Round 1	*Round 2*
Mbata	*99*	*93*
Kambeho	*20*	*39*

Survey Questions

The questions asked of farmers were split into the following categories.

1. General
   e.g. name, farm size etc.
2. Productivity
   e.g. types of crop grown, quantity of seeds bought, quantity of crops sold, quality of harvest
3. Loss
   e.g. Quantity of crop used as animal feed, wasted, sold at lower than market price etc.
4. Operating costs
   e.g. land rental, employee labour, cost of equipment and agri-inputs
5. Realised value
   e.g. total money received for selling crops
6. Impact of the SAC (for Mbata farmers in Survey Round 2)
   e.g. impact on disposable income, family life, education, opportunities, the environment, children, knowledge, and future plans.

Questions in sections 1-5 were designed to gain detailed and accurate quantitative data. Questions in section 6, carried out just for Mbata in Round 2, were carefully designed not to be leading in terms of suggesting a positive or negative response In addition, many were left intentionally broad, such as asking about ‘opportunities’, so that they could be interpreted by the responder according to what it meant to them. Enumerators were trained to help respondents elaborate on their answers, searching for the meaning behind initial simple statements. This has led to a very rich qualitative dataset which contains multiple stories of change associated with the SAC, where key themes emerge throughout, and where the myriad of ways the SAC has been engaged with, and thus the myriad ways in which it has led to lasting change in Mbata, can be observed.

Each survey took up to 2 hours to complete as farmers grow many different crop types and enumerators aimed for accurate quantitative data and deep qualitative data. The range of questions asked was essential to fully capture the impact of the SAC on the lives of farmers in Mbata.

Enumerator Training and Survey Design

Prior to delivering the survey, all enumerators took part in a half-day training session in survey technique. This involved training on how to make sure that questions were not delivered in a leading way and ensure accuracy when estimating quantities of produce for the various productivity questions. Prior to running the second survey round, enumerators had a refresher half-day training to remind them of best practice and also train them on how to encourage responders to give full and comprehensive answers to the qualitative questions about SAC impact on their futures, families, livelihoods, and opportunities.

Data Analysis Method

Quantitative: The quantitative data was downloaded from Kobo Toolbox and analysed in excel. First the data was cleaned (eg converting text fields into numeric, querying/correcting typos and converting different units used). Then the data was combined to allow tables and graphs to be produced, using pivot tables and data analysis functions to show the patterns emerging for all the different categories of questions asked, and to measure and graphically represent changes over time (different growing seasons, where the SAC was present) and also to represent differences and similarities between Mbata and the control community, to try to better determine what was causal from the use of the SAC, and what was not. We used the farmer comments that were entered into the survey to try to identify particular external factors influencing the data (for example insect predation or anomalous rainfall) to be able to consider and eliminate those factors in our analysis of the results.

Qualitative: The answers to the qualitative questions were analysed on a per question basis. For each question, the responses were 'coded' by looking through the question and tagging according to common themes that came up. These themes were then documented, described, and illustrated with some example quotes drawn directly from the responses. Because we analysed on a per question basis, it is common that the same themes come up across multiple questions. For example, nutrition was part of answers given about how the SAC had impacted their future plans (in connection with improved health being something they looked forward to), and also part of their answers about the impact of the SAC on their children. This is to be expected, given the multiple pathways to impact the SAC offers.

Attributing survey outcomes to the presence of the Smart Agri-Centre

The Smart Agri-Centre is a community-wide solution which has positively affected the lives not just of a small number of farmers, but of the entire farming community of Mbata. This is important to note, as it made selection of a control community a complex process. The purpose of using a control community is to ensure that any changes seen in farmer yields, income, lifestyle etc. can be attributed to the presence of the Smart Agri-Centre in Mbata.

This methodology uses Kambeho village as a control community. We justify this choice of community as Kambeho is similar to Mbata in multiple ways, including

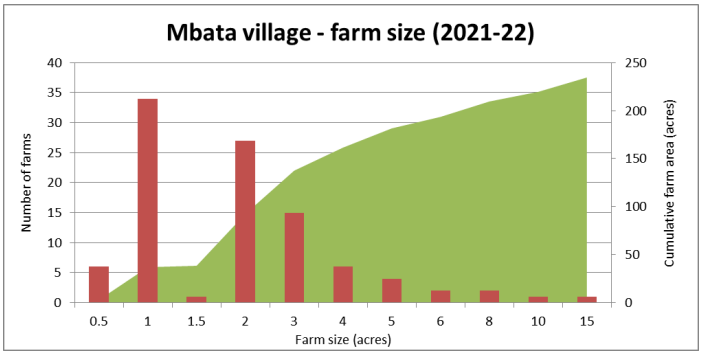
- The vast majority of residents are farmers and grow very similar crop types
- They are close in location, at approximately 25km apart
- Prior to installation of the Mbata Smart Agri-Centre, both communities were a similar distance from the nearest services such as welding, milling machines, salons etc.
- Both communities have schools, and at least one church and mosque.

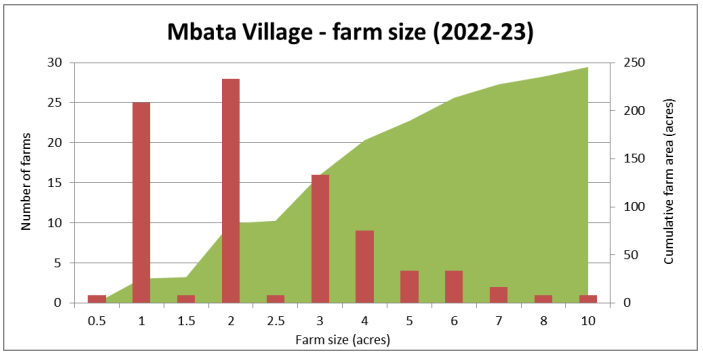
In addition, it is far enough away from Mbata that it is very unlikely that the people of Kambeho would visit Mbata Smart Agri-Centre to access the new services there.

It is also important to highlight that there have been no large external changes to the community of Mbata over the course of the two years of survey. For example, the electricity grid has not reached Mbata, the road to Mbata remains unimproved by government, and the population has not changed drastically in size.

Quantitative Results

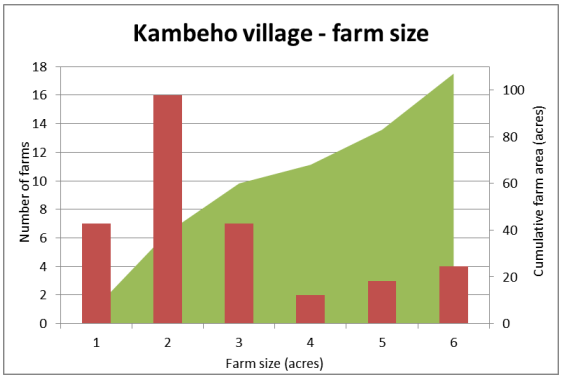
Demographics





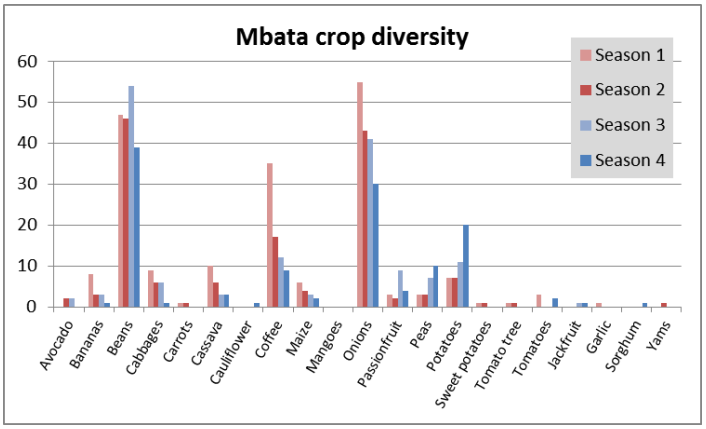
We surveyed all the farmers/farming families in the community - 99 for the baseline survey, farming 235 acres. Every family in Mbata is involved in farming (from a previous survey taken in 2020, we measured 220 households in the village, but this is because families can have multiple households - for example for different generations - but still work together to farm the same land. Thus head of a farm is not the same as head of a household).

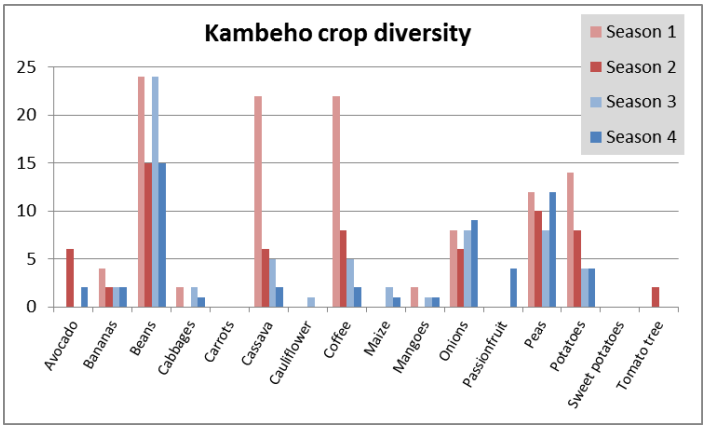
The impact (follow-up) survey was taken with 93 farmers, farming 245 acres. Some farmers were unavailable at the time the final impact survey was administered, because the timeframe was more restrictive. In addition, as can be observed by the change in the profile of farm sizes reported, some land was bought and sold, and farms/families combined through deaths and marriages in the community. Additional land was also brought into farming use. This may have been because of the additional economic opportunities perceived from the Smart Agri-Centre and our activities in the community, but there is insufficient data to establish whether or not this was definitely the case.



For the control site, Kambeho village, a similar pattern can be seen. We did not survey the entire village, just a random sample of farmers, but a similar distribution of farm sizes and average farm size can be observed.

Crops & diversity





Overall crop diversity showed little change across the two years, though some new crop types were introduced in both Mbata and the control community. One in particular - cauliflower - started to be grown in both villages.

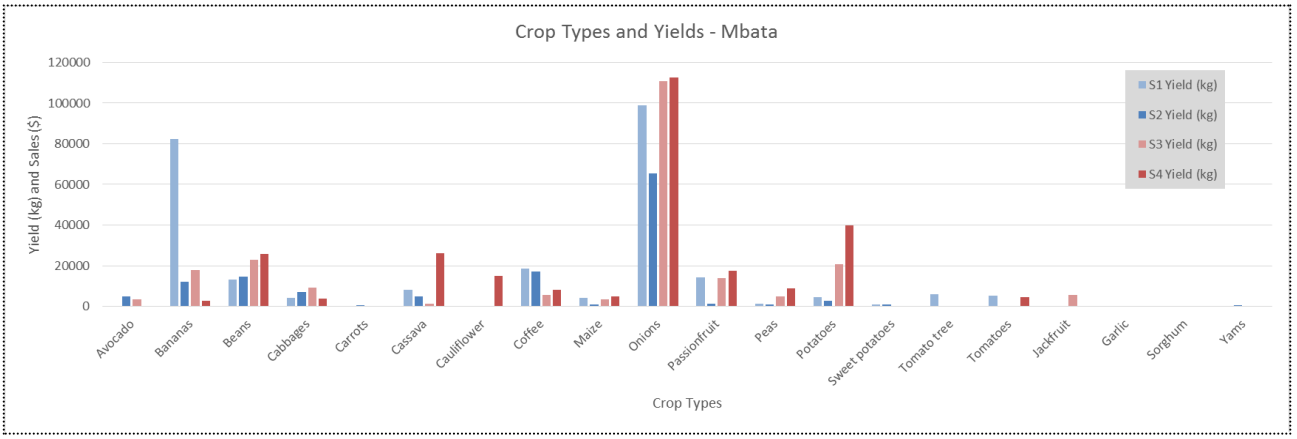
It is noticeable where the seasonal patterns differ between the communities though. In Kambeho, the control community, more farmers began to grow peas and onions (key cash crops) in the second year. In Mbata, on the other hand, beans and onions experienced a decline in the number of farmers that grew them, whilst peas and potatoes (another key cash crop) saw an increase.

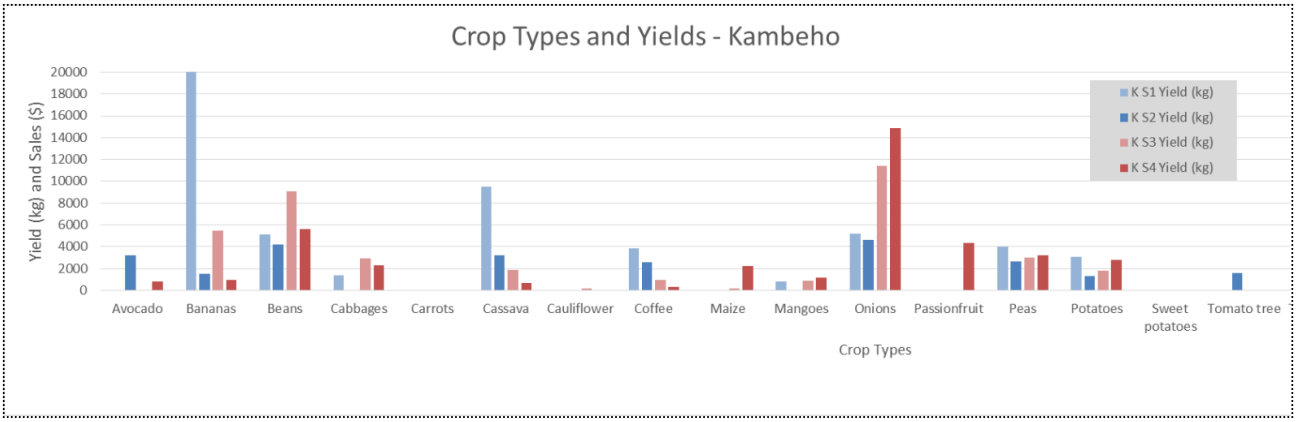
Coffee, a significant cash crop in the region, demonstrated a decline in farmers reporting growing it (though because it is a perennial crop, this almost certainly means a decline in farmers harvesting/selling it - they will not have uprooted the bushes!). One key factor for this is Uganda's withdrawal from the International Coffee Pact in February 2022 which significantly affected the market.

Mbata also saw a marked decline in banana farming - as with coffee, this almost certainly means a decline in harvesting/selling, since banana is a staple food item in the region, and almost all farms and households will have banana trees on them.

The seasonal difference data suggests that in Mbata, where farming has become more organised and coordinated thanks to the advent of the SAC and the support services, farmers are happy to specialise more (even though this is at a higher personal risk) and make their farming more efficient.

Yields





Farming across a whole community is a complex process, so the data for yields paints a varied picture. The most significant annual cash crops for the community - beans, onions and potatoes - all experienced large increases in yield. The same was true for smaller-volume but high-value crops like peas and passionfruit.

Coffee, perhaps traditionally the most "prestige" cash crop for this community showed a significant yield decline however. This is caused by the decrease in farmers reporting it as a crop (see above), coffee disease was an issue during 2022, and some farmers indicated other problems such as lack of rain.

Bananas (these are the "matooke" local staple type, not the higher-value fruit sort) also experienced a significant reduction in yield. However, this crop is, by weight, low value and presents complex sales

challenges (farmers have to get the bunches weighing upwards of 50kg down a very long and muddy road to be able to sell it). Looking more closely at the data, the yield reduction came because there was a dramatic reduction in the number of farmers farming/harvesting bananas - those that did reported good crops and sales. Thus the reduction in yield represents a change in inclination and practice, because farmers didn't feel a need to grow/harvest so much of this "difficult" crop for sales. Because matooke is a staple food, it also seems likely that farmers who only used it for self-consumption (since almost everyone in the community has banana trees by their houses and on their farms) did not report it, contributing to the "artificial" yield reduction as well.

Crop (Mbata)	2021 Yield	2022 Yield	% Yield Change
Avocado	5000	3360	-34.9%
Bananas	94446	20565	-83.3%
Beans	28126	48788	78.2%
Cabbages	11260	13100	17.4%
Carrots	650	0	
Cassava	13050	27330	116.5%
Cauliflower	0	15000	
Coffee	35510	13880	-64.8%
Maize	4980	8465	74.5%
Onions	164264	223400	38.3%
Passionfruit	15600	31520	108.6%
Peas	2275	13640	531.8%
Potatoes	7255	60470	780.8%
Sweet potatoes	1950	0	
Tomato tree	6350	0	
Tomatoes	5400	4700	-13.8%
Jackfruit	0	6000	
Garlic	280	0	
Sorghum	0	55	
Yams	500	0	

Interestingly, in general, perennial (tree) crops performed worse at both the trial and the control sites, with the exception of higher-value fruits (mangos and passionfruit). This demonstrates the importance of annual crops for farmer livelihoods, and therefore the ability to access appropriate training and reliable information about which crops to grow, and how, should it be necessary to compensate for poor performance in perennial crops. In addition, appropriate storage and marketing support, such as that offered by the SAC, is important for farmers to fully realise the value of their annual crops.

Data from the control site paints a similarly complex picture. Yields are strongly up for key cash crops like beans, cabbages and onions, but unlike Mbata, this is often because more farmers are growing them. Banana yields are also down, even though, again unlike Mbata, the same number of farmers were growing them. This suggests the market for banana from these remote, difficult to access communities may have declined. The data for coffee also supports the trend observed in Mbata.

Crop (Kambeho)	2021 Yield	2022 Yield	% Yield Change
Avocado	3200	800	-75.0%
Bananas	31500	6400	-79.7%
Beans	9350	14694	57.2%
Cabbages	1360	5250	286.0%
Cassava	12680	2540	-80.0%
Cauliflower	0	180	
Coffee	6420	1270	-80.2%
Maize	0	2390	
Mangoes	800	2100	162.5%
Onions	9800	26290	168.3%
Passionfruit	0	4310	
Peas	6680	6194	-7.3%
Potatoes	4400	4600	4.5%
Tomato tree	1600	0	

Mango yields also improved in Kambeho. This is a fruit which, although it is grown in Mbata, is not reported as a crop by farmers because they do not sell it other than internally in the community. The volume of mangoes is still small as a proportion of Kambeho's overall productivity.

But overall, yield is up by around 32% across the community in Mbata, whereas in Kambeho, despite increases in farming of some of the key cash crops, yields are down overall by 12% (because of the adverse performance of coffee and banana in particular). Access to the storage services and agronomic training available in the SAC has allowed farmers to grow more despite challenging markets and growing seasons, and has made them better able to adapt their farming and crop choices to prevalent market opportunities and trends.

Sales

The most significant impact demonstrated by this data is that the sales volume for every crop grown in Mbata last year increased, with the exception of coffee (which experienced the combined problems mentioned above, in particular the market impacts of Uganda leaving the International Coffee Pact, which led to fewer farmers focussing on it).

Even crops which saw a lower yield across the community still showed an increase in revenue generated, because of higher selling prices.

Crop (Mbata)	2021 Yield	2021 Sales	2021 $/kg grown	2022 Yield	2022 Sales	2022 $/kg grown	% Sales Change	% $/kg Change
Avocado	5000	$ 1,120	$ 0.22	3360	$ 1,225	$ 0.36	10.1%	62.9%
Bananas	94446	$ 5,218	$ 0.06	20565	$ 6,202	$ 0.30	20.1%	445.9%
Beans	28126	$ 14,174	$ 0.50	48788	$ 31,221	$ 0.64	128.0%	27.0%
Cabbages	11260	$ 3,054	$ 0.27	13100	$ 3,232	$ 0.25	6.2%	-9.0%
Carrots	650	$ 438	$ 0.67					
Cassava	13050	$ 2,967	$ 0.23	27330	$ 9,881	$ 0.36	248.0%	59.0%
Cauliflower				15000	$ 3,750	$ 0.25		
Coffee	35510	$ 52,491	$ 1.48	13880	$ 14,761	$ 1.06	-76.5%	-28.1%
Maize	4980	$ 1,881	$ 0.38	8465	$ 3,188	$ 0.38	74.0%	-0.3%
Onions	164264	$ 31,316	$ 0.19	223400	$ 159,787	$ 0.72	436.7%	275.2%
Passionfruit	15600	$ 3,724	$ 0.24	31520	$ 17,860	$ 0.57	404.1%	137.4%
Peas	2275	$ 2,850	$ 1.25	13640	$ 35,713	$ 2.62	1227.3%	109.0%
Potatoes	7255	$ 1,749	$ 0.24	60470	$ 23,227	$ 0.38	1307.1%	59.3%
Sweet potatoes	1950	$ 192	$ 0.10					
Tomato tree	6350	$ 434	$ 0.07					
Tomatoes	5400	$ 1,584	$ 0.29	4700	$ 2,538	$ 0.54	64.1%	84.1%
Jackfruit				6000	$ 2,013	$ 0.34		
Garlic	280	$ 184	$ 0.66					
Sorghum				55	$ 26	$ 0.47		
Yams	500	$ 136	$ 0.27					

Dividing total sales by total yield to give $/kg is a crude measure (because of the self-consumption and spoilage of some of the crop. But especially for all those crops that are not staple foods of the local population (staples in Mbata are banana, beans, cassava) we can observe significant increases in the farm-gate price realised by local farmers. The banana anomaly has been discussed above, but the significant increase in $/kg grown is due to fewer farmers selling bananas, and exclusive self-consumption therefore not being reported.

For the control community, there were some similarities. Sales in general were up, reflecting the general global increase in food prices that has also been observed in Uganda. And the anomalies for coffee and banana are still observed.

But there are some significant differences - revenues declined for potatoes, which were a key crop. And in general, $/kg grown amounts were lower for almost every crop.

Crop (Kambeho)	2021 Yield*	2021 Sales*	2021 $/kg grown	2022 Yield	2022 Sales	2022 $/kg grown	% Sales Change	% $/kg Change
Avocado	3200	$ 255	$ 0.08	800	$ 110	$ 0.14	-57.0%	72.0%
Bananas	31500	$ 747	$ 0.02	6400	$ 1,480	$ 0.23	98.1%	874.8%
Beans	9350	$ 4,805	$ 0.51	14694	$ 8,722	$ 0.59	81.5%	15.5%
Cabbages	1360	$ 179	$ 0.13	5250	$ 1,223	$ 0.23	583.2%	77.0%
Carrots								
Cassava	12680	$ 2,790	$ 0.22	2540	$ 970	$ 0.38	-65.2%	73.6%
Cauliflower				180	$ 34	$ 0.19		
Coffee	6420	$ 14,509	$ 2.26	1270	$ 1,374	$ 1.08	-90.5%	-52.1%
Maize				2390	$ 1,255	$ 0.53		
Mangoes	800	$ 179	$ 0.22	2100	$ 219	$ 0.10	22.6%	-53.3%
Onions	9800	$ 2,948	$ 0.30	26290	$ 19,459	$ 0.74	560.1%	146.1%
Passionfruit				4310	$ 1,916	$ 0.44		
Peas	6680	$ 15,734	$ 2.36	6194	$ 17,336	$ 2.80	10.2%	18.8%
Potatoes	4400	$ 2,990	$ 0.68	4600	$ 2,298	$ 0.50	-23.1%	-26.5%
Sweet potatoes								
Tomato tree	1600	$ 126	$ 0.08					

In Mbata, with the benefit of the SAC and the related services, farmer revenue increased by an average of 171% (ie 2.7 times that of the previous year). In Kambeho, on the other hand, the average revenue improvement was just 25% (figures are adjusted for the variation in numbers of farmers surveyed in baseline and impact surveys). We can attribute the significantly better performance in Mbata to the use of the SAC, access to storage services, and in particular the aggregation and marketing support that the SAC was able to offer.

Costs and profitability

Farmers reported their costs on tools, seeds and other inputs, labour, land and transport to market for each season. Compared to the control site of Kambeho, costs were very high in Mbata for the first year of survey data. A possible reason for this is that, although the two communities are equidistant from main agricultural centres (where inputs and tools were available, and produce could be sold), the road from Mbata is particularly difficult to traverse, increasing costs of access and purchases.

In the second year, with the benefit of the SAC and services, costs fell considerably in Mbata. This is because quality inputs became available at a shop in the SAC, and because crops were bulked and marketed at the SAC, individual farmers no longer needed to negotiate and pay for motorbikes to carry individual sackfulls down to the market. In Kambeho, on the other hand, costs increased substantially (reflecting global increases in eg fertiliser and transport fuel prices).

	Average Farmer Costs 2021	Average Farmer Costs 2022
Mbata	$445	$311
Kambeho	$166	$327

Perhaps the best measure of farmer earnings is not the revenue achieved from their sales though, but their profits after costs of farming have been subtracted. Subtracting the average costs from average farm revenue, above, gives us the average annual profit/earnings figures per farm/farming family in the communities. This indicates an increase of 10% for farms in the control community. But for farms in Mbata, with the benefit of the services and infrastructure provided by the SAC, their average increase in profit/earnings is 283%. This suggests that our innovation allows farmers to almost quadruple their earning capacity.

	Average Farmer Profit 2021	Average Farmer Profit 2022	% Increase
Mbata	$802	$3072	283%
Kambeho	$1021	$1119	9.8%

Post Harvest Loss

The data on post-harvest loss/spoilage is complicated of course by the yield fluctuations and other environmental impacts. Some of the perennial crops (avocado, banana, coffee) demonstrated worsening spoilage, but that was principally due to the weather conditions, and these crops were spoiled by the time they were harvested.

Farmers began to use the storage and cold storage functionality of the SAC predominantly in the fourth harvest season, and it is notable

Crop	Yield S1	Spoiled S1	Yield S2	Spoiled S2	Yield S3	Spoiled S3	Yield S4	Spoiled S4
Avocado			5000	0%	3360	8%		
Bananas	152400	1%	22500	0%	17865	15%	2700	3%
Beans	13314	3%	14812	1%	23048	3%	25740	2%
Cabbages	4040	6%	7220	16%	9300	2%	3800	10%
Carrots	150	1%	500	0%				
Cassava	8050	1%	5000	3%	1280	1%	26050	10%
Cauliflower							15000	0%
Coffee	18525	4%	16985	2%	5730	7%	8150	1%
Garlic	280	0%						
Jackfruit					5800	15%	200	1%
Maize	4130	1%	850	4%	3465	5%	5000	2%
Onions	98809	7%	65455	2%	110700	2%	112700	2%
Passionfruit	14400	0%	1200	5%	14020	1%	17500	0%
Peas	1200	0%	1075	0%	4850	8%	8790	1%
Potatoes	4450	5%	2805	5%	20770	12%	39700	10%
Sorghum							55	15%
Sweet potat	1000	0%	950	0%				
Tomato tree	6000	23%	350	0%				
Tomatoes	5400	11%					4700	0%
Yams			500	0%				

that the majority of crops show a reduction in spoilage compared with the previous year. For some high value crops that used the functionality of the cold store in the SAC (cabbage, passionfruit) the reduction in loss was significant. And some new crops, such as cauliflower, that used the storage facilities in the SAC were able to almost eliminate post harvest loss.

Some crops show a worsening in spoilage - either by a small amount (beans, peas) or a large amount (cassava, potato). It is important to note when considering these figures though, that the yield increases of some of these crops were enormous (S4 pea yield up by >8x, potatoes >12x, cassava >5x). With such significant increases in harvests, we expect the community to take a little while to learn how best to use the services of the SAC, and optimise storage timings, to reduce losses in the future.

The Mbata spoilage figures are put into context, however, when we see the equivalent figures for the control community. In Kambeho, almost every single crop shows increased spoilage, whether or not yields have increased overall. The exception are those crops that were not grown in the equivalent season of the first data year, plus banana, where no spoilage was reported. As in Mbata, one of the worst increases in spoilage was for the annual cash crop with the greatest yield increase (onions).

Crop (Kambeho)	Yield S1	Spoiled S1	Yield S2	Spoiled S2	Yield S3	Spoiled S3	Yield S4	Spoiled S4
Avocado			3200	6%			800	6%
Bananas	30000	0%	1500	0%	5450	0%	950	0%
Beans	5120	1%	4230	3%	9069	4%	5625	5%
Cabbages	1360	15%			2950	5%	2300	7%
Cassava	9480	0%	3200	0%	1890	2%	650	3%
Cauliflower					180	15%		
Coffee	3820	1%	2600	3%	950	5%	320	5%
Maize					190	0%	2200	3%
Mangoes	800	3%			900	20%	1200	2%
Onions	5200	0%	4600	0%	11400	7%	14890	6%
Passionfruit							4310	5%
Peas	4000	0%	2680	0%	2985	3%	3209	5%
Potatoes	3100	0%	1300	0%	1800	2%	2800	3%
Tomato tree			1600	0%				

It therefore seems likely that the storage facilities available at the SAC have helped reduce the crop spoilage in Mbata. The benefits of using the cold and dry storage available in the SAC can be especially seen in the differences in spoilage rate in season 4 for cash crops such as cauliflower, onions, passionfruit and peas.

Discussion of Quantitative Data

As discussed below in the Limitations section, it is challenging to try to demonstrate causality of change from our SAC in a single year, given that farming impact is such a complex issue, depending on so many external variables that cannot be controlled, such as weather, external markets, geopolitical issues, pests and diseases.

The SAC was present in the community of Mbata throughout the second year of data (seasons 3 and 4), and all services were operating and training was being delivered by the fourth harvest season. Normally, such a significant and complex piece of community infrastructure would only “bed in” and demonstrate impact over a longer term - say 3 years - as community members’ caution and risk aversion are overcome from the benefits they witness.

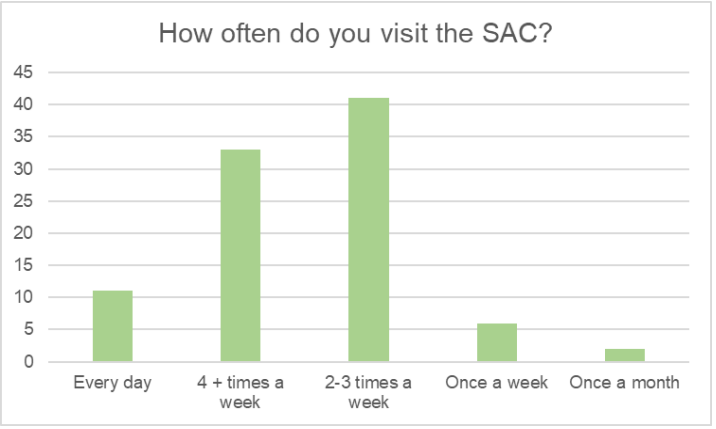
So it is very encouraging to see significant impacts emerging in the data in this first year. The most significant is the increase in farm revenue (and even greater increase in farm earnings/profits). Mbata demonstrated farmer revenues almost trebling (271%) and profits almost quadrupling (383%) as farmer costs reduced by 30%. In the control community, revenue increased by 25%, and profits by 10%, since costs increased by 97%. These differences between Mbata and the control community are clearly attributable to the presence of the SAC and its related services and support.

The situation with yields is more complex, because of the changes in farming patterns and the masking effect of yield decreases from some perennial crops - in percentage terms Mbata's total yield increased by 32% as opposed to a decrease of 12% in Kambeho. This is even against a background of an increased number of farmers growing key crops in Kambeho, whereas in Mbata the two most significant cash crops (whose yields increased by 78% and 38%) were being grown by fewer farmers. And although the significant downturn in coffee and banana yields impacted both communities, Mbata demonstrated an ability to make their farming perform well despite this setback, whereas Kambeho did not demonstrate the same resilience.

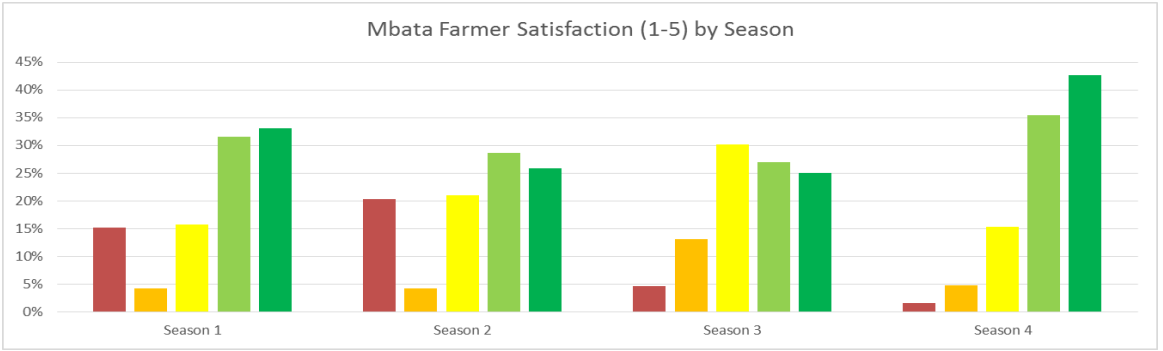
Access to the infrastructure and services of the SAC has also reduced post-harvest loss for most of the main annual cash crops grown in Mbata. The crops which showed an increase in post-harvest loss in the final season also had significant increases in yields (of 5-12x previous volumes). Comparing the loss figures in Mbata with those in the control community, demonstrated the improved loss reduction the SAC facilities are bringing to Mbata. We believe that as usage of the SAC becomes more ingrained in the community, and there is greater understanding of the new flows of harvested crops, it will be possible to optimise the storage and preservation of these high volumes of crops as well, and they will similarly see reductions in spoilage.

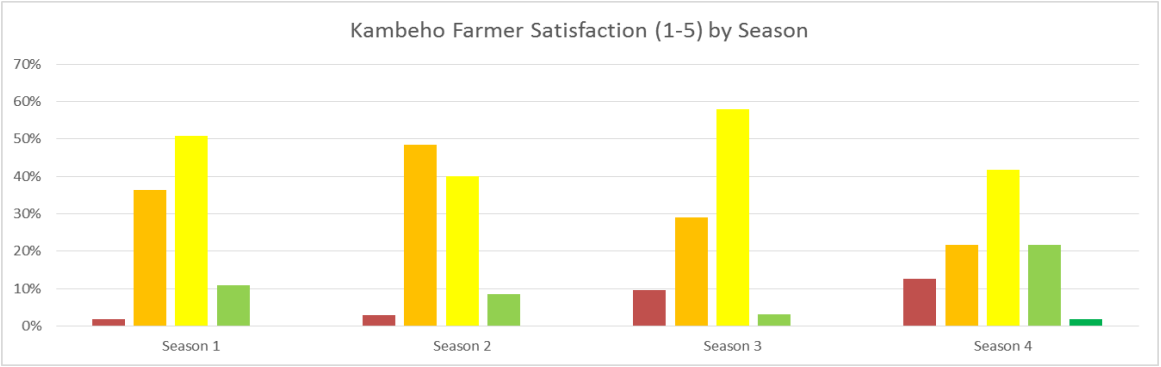
A more important picture emerges from consideration of the data as a whole. The infrastructure, training and support services which our solution provides to a community gives them a greater confidence to change their practices and take more risks. We observe farmers in Mbata more willing to specialise in their farming, and grow fewer crops more efficiently. We observe a willingness to try farming new crops in greater volumes, and achieve more success, than in the control site. And we see that, even when environmental conditions are unfavourable (eg the weather, or pests and diseases), access to the services of the SAC still mean that revenue/earnings are upheld even if yields suffer for some crops. This means that our solution, as well as delivering the immediate "headline" improvement in farm profits across the community also increases the resilience and risk-appetite of that community, allowing them to try new things more readily than communities without access to our solution, and making them less susceptible to the impact of adverse circumstances.

The SAC is also very popular in the community as well. Even though there is no particular farming need to do so, 91% of our survey respondents reported visiting several times weekly, with 60% visiting more than 4 times weekly.



The section below describes the more qualitative results of our survey activities, and the broader benefits to the community of having the SAC in Mbata. But one question we asked the farmers surveyed for each growing season we recorded data for was their satisfaction from 1 - 5 (red to green) in their farming activities. The graphs below clearly demonstrate how having this new infrastructure and services available in their community (especially during season 4, when all services were fully functional) has improved how they evaluate themselves and the quality of their livelihoods.





Qualitative Results

The following table summarises the key themes that emerged for each qualitative question put to the 93 farmers in Mbata who were part of the impact survey, illustrated with direct quotations from those SAC users. A more detailed breakdown of the analysis is one of the Additional Supporting Documents.

Has the SAC impacted your **future plans**? If so, how?	
'It has changed my mindset in relationship to farming as a business' *'Yes I have learnt how to save money'* *'Am planning to produce more crop produce since we have store now, have a shop near or at the facility and planning to have power in my home'* *'My plans has changed because I can now plan for the better farming in the next season'*	**The ways the SAC has impacted end users' future plans ranges from business and farming ambition, to expected health benefits.** 20% of respondents have greater ambitions for their farming productivity, with another 11% reporting more of a 'business mindset' around farming. Other plans involved improvements to their living situations, and some highlighted that their increased savings contributed to more ambitious future plans. 9 people mentioned improved nutrition, which they envisaged leaving them with healthier futures for them and their family.
Has the SAC impacted your **income and savings**? If so, how?	
'Yes, through good agricultural practices taught to us and extensional services. Saving and loan offered to farmers during season increasing my production capacity hence more income' *'So much because I can now sell my produce in bulk because I have where to keep them like in the cold room hence getting some good money'* *'Good market for the products. Learning new methods of farming that has increased my production capacity.'*	**All respondents reported that the SAC had a positive impact on their income and savings.** 25% of people said they had saved money (and just as importantly, time) through not having to travel to access the services now available at the SAC, when previously they had to pay for transport. A myriad of reasons for increased income were reported, which made use of the full range of ways people could interact with the SAC, including accessing higher value markets with better quality produce and collective marketing and bulking practices; saving costs and higher yields having learned better agricultural practices; and better financial management.
Has the SAC impacted your **children and their future**? If so, how?	
'They have also acquired skills from the centre like welding skill which will help them to generate income hence developing the community' *'They are now getting information while they are at the centre through the watching local and international news'* *'Yes, as result of high market prices, I have managed to afford school fees for my children'* *'Yes, through opening their eyes and see the value of education.'*	**92% of respondents stated that their children had been positively impacted by the SAC.** 57% cited positive impact from skills their children (or young adults) had been able to access, which set them in better stead for their own livelihoods. 28% of people mentioned keeping their children in education and being able to afford school fees. Other mentions were on the topic of improved child nutrition and the connectivity their children are getting from access to the internet. Two commented on the crucial link between these benefits to their children, and the positive development this represents for the community now and in the future.

Has the SAC impacted the **ways you make money**? If so, how?	
'Ever since the SAC came I have managed to be processing my products like cassava using the milling machine that's here hence getting some good money.' *'Through trainings like in trading agricultural produces, tendering cassava milling machine, welding, juice processing, Cooling food store'* *'Yes because I now get good money on time after selling my products because I now have where to keep them like the cold room here'* *'Much better because I used to do farming on a small scale ever since I was taught the best methods I changed to a bit big hence my income increased.'*	**99% of those surveyed said that the SAC had provided new ways to make money and access to new value chains.** 23% of respondents specifically pointed at the cold store as impacting the way they make money, and 56% mentioned collective marketing and collective bulking. These methods of aggregating produce, either managed by individual farmers or by the cooperative, enable higher value markets to be reached. The storage facilities at the SAC, both cold and dry storage, are therefore playing a crucial role for the farmers. Other value chains they discussed that they are now able to participate in are milling, juicing, and welding.
Has the SAC impacted the **environment** here? If so, how?	
'Through farm trainings that involve environmental conservation and promotion of clean water, clean light at the SAC and the surrounding community' *'Productive use of solar energy have saved the environment from bad fumes which used to come from diesel machines for milling and pulping coffee'* *'We used to dig a lot of soil to make bricks but the use of interlocking bricks will reduce on soil erosion because for it, it doesn't need a lot of soil.'* *'Yes because we used to use lamps candles which used to pollute the environment but we now have solar power that lighted our public places like the hospital that's being constructed near by the SAC which has the solar power'*	**96% of people said that there had been a positive impact on the environment due to the SAC**. What is interesting is that while 18% discussed receiving training on environmental aspects (reforestation, sustainable agri-practices), many more people remarked on the environmental sustainability of the SAC itself. 39% talked about the sustainability of the solar energy, with awareness that this has displaced fossil fuel use and deforestation. The only other way these services could be provided in Mbata would be through diesel generators, given the lack of grid extension to Mbata. 6 people honed in on the displacement of kerosene for lighting due to the electricity from the SAC. 10% of people also highlighted the sustainability of the construction method of the SAC, which used bricks which do not require any firewood to be burnt. Another 10% remarked upon the reduction of tree felling.
Has the SAC impacted your **knowledge**? If so, how?	
'Yes, through mindset change in governance, financial management, post harvesting handling and the farmer field gap' *'Yes, through new technologies introduced like cold storage and use of solar panels to add value on our products'* *'I never knew the idea of savings but now I do'* *'My knowledge has changed about the good methods of farming where I have started getting much yields'* *'I am able to have a year plan that I never thought of previously'*	**Everyone stated that the SAC increased their knowledge in one way or another.** A key theme was talking about how their knowledge had increased through interacting with new technologies - 34% of people talked about how access to the cold store, internet, and other services had increased their knowledge. Out of the 46 people who talked about how the training they attended improved their knowledge, 11 of these specifically stated they had changed mindsets as a result. Others highlighted which areas they had experienced knowledge growth in - use of the cold store for post harvest loss reduction (18%), improved farming practices (16%), and how to save money (18%).
Has the SAC impacted the **opportunities available** here? If so, how?	

'Yes, we the farmers are using the opportunities of internet services, milling machine, agro input shop to generate income' *'So much because the solar system that is here has assisted us to be adding valve on products like the welding machine that has helped us to make modern doors'* *'It has created employment opportunity through enterprise establishment like welding, milling machine, input shop and the saloon'* *'Reduction on theft, knowledge and skills on good agronomic practices, increase on budgeting and planning'*	**98% stated that the SAC had increased opportunities in Mbata.** A common response was to highlight the opportunity for setting up their own small enterprises or gaining employment due to the SAC - 37% cited how people could be employed by existing services or set up their own enterprises. 23% of people referenced the opportunity for skill enhancement at the SAC due to the training sessions they could access there. Many other people focused on the opportunity to access various new services at the SAC. Popular answers were being able to source metal work products in Mbata due to the welding service (42%), use of the milling machine (14%), and internet access (9%). 20% of people highlighted the electricity access provided by the SAC and that this has led to lighting for their public buildings and areas.
What **training** did you receive and what was the impact?	
'*Governance and leadership which has assisted me to work together with my workers at my farm.'* *'Training on financial management and this help me to know how it can management my financial resources for sustainable development'* *'Farmer field camp training that helps me to change my mind set for traditional farming to modern farming'* *'Agronomic practices, pests and diseases management, and post harvest management which has helped me to produce in large quantities'*	**97% of farmers had attended training sessions at the SAC and found positive benefits on economic literacy, farming practices, governance, and construction methods.** Respondents described how training on post-harvest management contributed to lower post-harvest losses, and training on pest management and other best agronomic practice led to higher yields. 31% of people talked about gaining skills in financial management and record keeping to better keep track of their farming activities. 12% of people described learning to make ISSBs, with some stating that they then used this new more sustainable construction method for their own building projects.

The qualitative data shows the many ways which people have seen their interactions with the SAC affect their lives significantly. Ambitions for farming productivity and enterprise have increased, as people make plans for buying more land and continuing to increase their productivity. Every person reported having increased revenue and more savings due to the services available at the SAC and the practices those services make possible, such as collective bulking and value addition. In essence, they show how the SAC creates numerous pathways for them to access higher value markets for their produce. Increased disposable income has resulted in school fees being payable, such that the SAC has had an impact in keeping children in formal education. Respondents value the training available at the SAC and the new knowledge they've gained by interacting with the services there very highly, pointing out how it will not only benefit their futures, but also that of their children and the development of their community. There are even health benefits attributed to the SAC, with respondents stating that their own and their children's nutrition has improved. Finally, the environmental benefit of the SAC includes increased use of lower-cement (and so lower carbon) sustainable construction methods, clean solar energy being used rather than diesel generators, and more sustainable farming methods adopted.

This qualitative dive into the impacts of the SAC reinforces the quantitative data on increased profits and reduced costs, but also paints a rich picture of deeper, more wide-ranging impacts, on their children, futures, health, and general development outlook.

Limitations

The recognised limitations of our methodology are listed below, along with their explanations.

Size of community

As our solution is a community-wide one, it means that we cannot control for all situational factors. Much can change in a community within a year as it is a large sample size from which to gather data. We have controlled for this as much as possible by carefully checking and validating that the following external factors did not change over the year: road access, grid access, population change.

Reliance on memory

Our methodology relies on farmers remembering and reporting the profit they have received for crops over a period of a year. This is not ideal, as farmers may not always keep detailed records. However, we have determined that this is still the most appropriate and feasible method available to us, in order to gain accurate data, as we cannot control conditions and record these metrics ourselves across a whole community and multiple growing seasons.

Sample size

The sample size in Mbata reduced from 99 to 93 farmers between the first and second survey rounds. This was due to unavailability of some farmers during the second survey period. Given this is a difference of just 6% of original sample size, this does not impact the accuracy of conclusions we can draw from the data. The sample size for the control site was, due to a lack of available resource to spend more time surveying, and a desire not to create any false expectations in the control community, smaller than that for Mbata.

Time period

This trial took place out of necessity over the course of one complete year of the Smart Agri-Centre being available in the community, and full services were only available during the final growing season. It should be recognised that a year is a relatively short space of time over which to see drastic improvements in the lives of a community with a complicated infrastructure solution such as the SAC, as it takes time for farmers to adopt new practices. Furthermore, since farming is a complex issue with many variables that cannot be controlled for (like the weather, diseases, geopolitical situations and market fluctuations), one year is a very short period of time in which to draw accurate conclusions about causality of impact across an entire community. We are very pleased with the impacts that we have seen in this first year however, and will continue to measure them over the coming years to draw even clearer conclusions. We are convinced from this early data that impacts will continue to grow over the coming years.

Conclusion

The opportunity that the Milken Motsepe Prize has afforded us to be able to collect detailed impact data across an entire community for our pilot SAC is invaluable.

The data clearly shows significant impacts for farmers in the pilot community, in addition to clear social and environmental benefits. These include:

- average yield increase of 32% despite adverse circumstances for some significant crops (yields fell by 12% in the control community)
- average reduction of farmer costs of 30% (97% increase in the control community)
- increase in farm sales/revenue of 171% (25% in control community)
- increase in farm profits/earnings of 283% (10% in control community)
- significant reduction in post-harvest losses in pilot community, completely eliminating losses for some key crops (in control community average losses increased for almost all crops)
- social impacts on economic planning and livelihoods

- improved skills and opportunities in the community
- improved ability to invest in children and education
- improvements in farming practice and knowledge
- improved health and environmental benefits
- Improved quality of life, satisfaction and enjoyment

In addition the data demonstrate a greater resilience in the community and in individual farming practices as a result of the SAC services and infrastructure. People are more willing to take risks and try new things (jobs and farming practices), are better able to adapt to changing situations (eg particular perennial crops failing during the season), and are able to build up personal and community savings which increase the economic resilience of the whole community.

People enjoy having the SAC in their community, and are proud of what it represents and means for the development of their community.