

FINAL TECHNICAL REPORT / RAPPORT TECHNIQUE FINAL MASAVA PROMOTING FORTIFIED SUNFLOWER OIL THROUGH EVOUCHERS

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Project Title: MASAVA: Promoting fortified sunflower oil through eVouchers

IDRC Project Number 107790

Research Organizations involved in the study:

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Sokoine University of Agriculture, Morogoro (SUA), Tanzania
University of Waterloo (UW), Waterloo ON

Location of Study: Tanzania (Manyara and Shinyanga Regions)

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Abbreviations

BCC: Behaviour Change Communication

CHW: Community Health Worker

CIFSRF: Canadian International Food Security Research Fund

DHS: Demographic and Health Survey

GAC: Global Affairs Canada

GAIN: Global Alliance for Improved Nutrition

GMP: Good Management Practices

IDRC: International Development Research Centre

IEC: Information, Education and Communication Materials

IUNS: International Congress of Nutrition

MASAVA: Mafuta ya Asili ya Alizeti yenye Vitamini A

MEDA: Mennonite Economic Development Associates

MOH: Ministry of Health

NGO: Non-Governmental Organization

RBP: Retinol Binding Property

SME: Small Medium Enterprise

SUA: Sokoine University of Agriculture

TCDC: Tanzania Communications and Development Centre

TFDA: Tanzania Food and Drug Authority

TFNC: Tanzania Food and Nutrition Centre

UW: University of Waterloo

WHO: World Health Organization

1. Executive Summary

MASAVA aimed to show that small and medium enterprises (SMEs) can fortify unrefined sunflower oil with vitamin A. The project tested whether eVouchers could incentivize sales and hence could support the sustainability of different business models. MASAVA then analyzed the impact of fortified oil on levels of vitamin A deficiency in vulnerable groups, particularly children under the age of five and lactating women, in two regions of Tanzania known to have high levels of deficiency.

The project built on two important technical innovations. First, a pilot test had shown that fortified, unrefined sunflower oil retained retinol (the marker for vitamin A availability) for several weeks. Second, an innovative eVoucher had been shown to support sales of products related to health, such as mosquito nets. This opened the possibility for enabling SMEs (who prefer to produce unrefined sunflower oil) to fortify their edible oil products with vitamin A, and to support the distribution of the new product with an eVoucher scheme.

It took sixteen months from the start of the project to begin the pilot sales of oil fortified by the three participating SMEs, and to ensure retailers were trained to use eVouchers. This required breaking new ground by introducing clean, new packaging to the small-scale sector and getting appropriate regulatory approval for production with suitable equipment and mandated standards. Thanks to a six-month extension of the original two-and-a-half year project, the three SMEs succeeded in selling the oil for distribution through a network of 319 retailers, who were active as of June 2017, and allowed for the fortification of more than 142,000 L of oil – enough for almost half a million people to consume the oil for a week (or a smaller number to consume oil regularly). A Behavior Change Communications (BCC) strategy informed the public about the importance of vitamin A, and the benefits of consuming fortified oil. Fortified oil was sold at scale with a discount (which essentially offset the additional packaging cost) for eighteen months, and for the last two months the discount was removed, and oil sales continued, with demand expanding to other regions of Tanzania.

The project's nutritional impact was documented by baseline and end-line household surveys, involving 568 lactating mothers and an index child under five at baseline, and following up with those individuals (494 were reached) at end-line. The sales experience was documented with two rounds of surveys of retailers, and sales of oil was tracked spatially and temporally using the data generated by the eVoucher system. A separate evaluation of the BCC intervention was conducted with 308 mothers interviewed during formative research, 443 men and women interviewed prior to the BCC campaign, and 442 after seventeen months of the BCC campaign. Both sets of quantitative surveys were supported by qualitative interviews of producers, distributors, retailers, and consumers by MEDA field staff. Finally, two sets of laboratory studies were conducted on the stability of retinol in oil over time.

Laboratory analysis showed that retinol levels in oil, even after six months of storage at ambient temperature, retained over 90-93% of the initial retinol (the better performing oils came from enterprises with better quality control in the milling process). A separate study showed that oil sold as “scoops” (small units from a 20L container) also retained sufficient retinol to meet standards over 16 days (samples retained 89-93% of the original retinol even after 16 days, which was the longest period retailers would take to empty the container in normal retail conditions). Even if the container was open for 16 days at the store, households were purchasing (and consuming the same day) appropriately-fortified oil.

Research findings suggest that in order for the business model to be sustainable for SMEs, the regulatory environment needs some flexibility. MASAVA used a “gold standard” technology (stainless steel mixing tanks) so as to expedite the somewhat lengthy process of getting approval from Tanzania Food and Drug Authority (TFDA). Policy does not currently clearly indicate the standard for tank materials. If small enterprises could use lower cost materials for tanks (i.e. food grade plastic), and medium enterprises could use the same technology observed in large enterprises (mild steel with epoxy), they would be better placed to be able to fortify at a competitive price.

Research on the sales data generated by eVouchers suggested that a consumer-oriented discount did not work as well for products which were bought with high frequency, in an environment with limited cellphone connectivity, and where women (and even children) were the ones buying oil. Although many households possess cellphones, adult men are more likely to control their use. Further, edible oil is a commodity product with a number of alternatives such as unfortified sunflower oil and palm oil. As a result consumers make purchase decisions based primarily on price. The fact that the oil is purchased in

small quantities and therefore the discount is a relatively low value which made it less incentive for the consumers to go through the process of getting the eVoucher discount. Retailers worked around these problems in order to ensure that people purchasing fortified oil could obtain the discount. However the switch to a retailer-oriented discount (eWallet) half-way through the discount period proved much more popular and workable. The eVoucher/eWallet did however provide valuable information on timing and spatial distribution of sales which benefit ongoing research on how BCC affected sales.

The household surveys yielded a wealth of information. Consumption of oil varies considerably by region, with palm oil (a low-cost oil, but imported, and containing saturated fat) being the main oil consumed in Shinyanga, whereas sunflower oil is the preferred oil in Manyara (sunflowers are grown in Manyara) despite its slightly higher cost. Most oil is sold in small quantities: in Shinyanga 50% of purchases on the previous day were of “scoops” of oil in plastic bags, sufficient for one day or even just one meal. In Manyara, more than 40% of oil purchased the previous day was in small bottles (250 ml or 500 ml recycled water bottles being common). This led MASAVA to shift from selling only 1L containers of oil, to obtaining permission to sell also 5L, 10L and 20L containers from which retailers would sell “scoops” in order to reach poorer households. Sales accelerated once the greater variety of packaging was available, with sales of 20L containers dominating the market.

Data from analysis of dried blood spots showed that the findings from the Demographic and Health Survey of 2010 still held true in 2015: there were high levels of vitamin A deficiency in both lactating women and children under five. The household survey showed that diets were monotonous (the dietary diversity index was low), and low in animal products or dairy, which are good sources of vitamin A. Coverage with vitamin A supplements is variable, since the responsibility has been decentralized to district rather than national level as before.

Fortunately, between baseline and endline household surveys, there was statistically significant increase in retinol binding protein level in blood samples from both mothers and children in Shinyanga region (i.e. a reduction in vitamin A deficiency). The intervention areas overall had a significant increase, which did not occur in the control regions for either mothers or children. These findings suggest that fortification is effective at reducing deficiency in vulnerable groups. The main contributor was likely palm oil fortified by large-scale manufacturers (the oil of choice in Shinyanga), with a modest contribution from fortified sunflower oil produced by the three SMEs.

Although the project did not have a specific gender focus (other than beneficiaries being lactating women and their children), there were learnings relevant to gender. Survey findings suggested that the dominant source of information on fortified foods for women were health clinics; whereas for men it was radio. Although women are more likely to be the ones purchasing oil, it is important that men also receive messages such that they support their wife’s choice. It was also important to ensure that influential community leaders (e.g. religious leaders) received the messages as well.

Women in Tanzania face disadvantages in ownership of assets. Following a gender audit, MASAVA made efforts to understand the opportunities and barriers for women retailers, who often have less formal set-ups to sell oil, and who may not always be able to afford fortified oil. Any future project might consider incorporating economic empowerment/small credit components for women.

Results from the project were disseminated at three major stakeholder meetings, one in the regions where the intervention occurred (September 2015), one in Geneva to international organizations (September 2016) and one in Dar-es-Salaam to national government (July 2017), which was subsequently presented in Swahili in each of the two participating regions. At all three meetings (as well as the inception meeting) representatives participated from the Prime Minister’s Office, the Tanzania Food and Drug Authority, the Tanzania Food and Nutrition Centre, and the Ministry of Health. Five posters were presented at Canadian and international meetings on project results, with another presentation scheduled for October 2017 at the high-visibility International Congress on Nutrition, held once every four years. Three student dissertations are in progress (one Tanzanian student PhD, one Canadian student PhD, and one Canadian student Master’s), from which eight papers will be submitted to international journals focused on food and nutrition, over the next twelve months. Two additional papers on the business and eVoucher results will be submitted to appropriate international journals. Results were disseminated to the general public via a video, the project website, and news coverage in Tanzanian press and TV.

2. The research problem:

The four original specific research objectives were:

1. To test whether crude sunflower oil can be fortified by SMEs for local consumption in contexts where inventory turnover is rapid and long shelf-life is not required.
2. To test whether the resulting business models are sustainable.
3. To test whether using electronic vouchers can succeed in promoting consumption of fortified oil.
4. To test whether the fortified product can reduce micronutrient deficiencies in vulnerable groups, specifically targeting the lactating mothers and infants.

The project was timely, in that mandatory fortification of oil by large processors became mandatory in November 2014 and in theory became mandatory for SMEs two years later. The MASAVA project has therefore provided a “test bed” to how fortification might be undertaken by SMEs. In addition, (although this was not originally envisaged) it provided empirical evidence on the impact of mandatory fortification at the household level, through monitoring the retinol levels both in oil consumed at the household level, and in blood samples from vulnerable groups (lactating mothers and children who were at baseline less than five years old). Although the government can get some of this information at a more aggregated level by comparing the 2010 and 2015 Demographic and Health Survey (DHS) results, at the time of writing the DHS results on retinol levels in blood were not yet available. MASAVA data is also more detailed, and (by also collecting oil retinol levels and information about oil consumption) provides a greater understanding of causality.

As the project evolved, lessons learned led to more detailed (and additional) research questions which were addressed:

5. It was learned that selling oil in sealed 1L packages discriminated against the poorest households, who purchase oil in “scoops”, i.e. where retailers sell oil in small units of approximately 30 or 60 ml to consumers. Permission was obtained from TFDA to sell fortified oil in 20L packages, from which retailers sell scoops. This led to the question, “does retinol stay stable in such conditions, when packaging is opened and potentially exposed to air and dust?”.
6. It was noted the importance of BCC in stimulating demand for fortified oil. Detailed spatial and time-series data provided by the eVoucher system was utilized to assess the question “how can BCC support oil sales?”.
7. Research on sustainability of the business model led to the question, “what is the cost-effectiveness of oil fortification?”.

Overall, the Masava project demonstrated that it is technically feasible for SME sunflower oil processors to fortify with Vitamin A and that it is essential to reach consumers of sunflower oil, who despite the expansion of palm oil, continue to purchase a higher quality and healthier oil. It was demonstrated that the structure of the regulations (for producers and distributors) have implications on competitiveness of SME product; without enforcement of fortification regulations, SMEs who fortify are placed at a disadvantage for the increased cost they incur. While awareness of vitamin A and cheaper (unrefined) sunflower oil exists on the market, SMEs have difficulty placing a premium price on the product and selling it further down the value chain. It was learned that technical assistance (for example, education in Good Manufacturing Practice (GMP) and encouragement in the market for preblend) will be crucial to the ability of SMEs to compete. It is believed that the findings are generally applicable to other sunflower-producing countries, and provide lessons as to how fortification can reach poorer, more rural, and more vulnerable groups.

3. Progress towards milestones

Milestone	Evidence/Indicator	Comments
Milestones for reporting period August 2014-January 2015		
1.1 Recruitment of key personnel completed with effective mechanism for team work established and collaborative agreements and sub-contracts formalized with third party organizations	Completed on schedule.	
1.2. Ethics approvals obtained to conduct research	Ethics approvals from NIMR received December 29 th 2014.	
1.3. E-voucher application modified for sunflower oil distribution	Completed by March 2015.	
1.4. Research instruments and implementation plans finalized and agreed upon by all partners; research instruments pretested, suppliers for premix identified, study sites identified	Completed by January 2015.	
1.5. Comprehensive gender strategy, communication strategy, and action plans with clear responsibilities and timelines agreed upon by all partners during the inception workshop	Completed and submitted to IDRC in January 2015.	
1.6. Monitoring and evaluation strategy established; revision and agreement by all partners on the detailed list of milestones	Completed and submitted to IDRC in January 2015.	
Milestones for reporting period February 2015-July 2015		
2.1. Baseline surveys completed (at village, retailer and household levels) and baseline biological samples sent for analysis	Completed by July 2015.	
2.2. SMEs and retailers trained (in good manufacturing practices, food safety, nutrition and food fortification)	Completed prior to first production beginning in September 2015.	
2.3. Fortified oil is being produced and sold at initial subsidization level (phase I)	Training of 279 retailers in eVoucher completed June 2015. First production began September 2015. Pilot oil distribution began shortly thereafter	Start date later than anticipated due to lengthy time required to get regulatory approval from TFDA
2.4. Behavior Change Communications to support retail operations ongoing	BCC materials prepared by May 2015; official launch November 2015, followed by ongoing activities.	Rollout commenced once oil distribution began
2.5. Distribution of fortified oil eVoucher initiated; eVoucher	By December 2015, over 2000 eVouchers had been issued, and 1478 redeemed	Rollout commenced once oil distribution began

distribution and redemption data available for targeted women beneficiaries and self-issued broader population		
2.6. Oil samples being tested at factory gate, retailer and household levels; results reporting on stability of fortified oil	Lab tests undertaken by July 2015 indicate stability of oil.	
Milestones for reporting period August 2015-January 2016		
3.1 Oil sales with initial subsidy level (phase 1) completed and with partial subsidy (phase 2) initiated; descriptive statistics compiled on phase 1 oil sales: Results reporting the uptake of fortified oil with subsidy	Oil sales began October 2015 on pilot basis. BCC launch Nov 2015. Additional financial incentives to producers Jan 2016 to assist during low production season; Third SME comes on board March 2016. Switch from consumer-based discount (eVoucher) on 1L bottles (phase 1), to multiple-litre bottles and retailer-based e-Wallet Nov 2016 (phase 2). Phase 2 ended May 2017.	Change in design allowed for response to new learning about market conditions.
3.2. Midterm project stakeholder meeting held	Meeting held in Singida, Nov 24-26 2016. Participants included MEDA, SUA, UW, IDRC, TCDC, KIT (Royal Tropical Institute, NL), and representatives of Prime Minister's Office, Ministry of Health and Tanzania Food and Nutrition Centre (TFNC). Also included a visit to the Regional Commissioner's Office, and project launch event in Manyara.	See Annex 2.1 for public presentation.
3.3. Technical feasibility of small and medium enterprise fortification of unrefined sunflower oil established and technical manuscript drafted.	Production samples from all three SMEs sent to TFDA (regulatory authority). Samples from one SME were completely within the regulatory guidelines, and those from the other two were close enough that permission to distribute was granted.	Work on technical manuscript required results of oil stability testing which took six months in lab, with further eight months delay for analysis by TFDA. Manuscript now drafted; see annex 2.15 for abstract
3.4. Use of e-voucher for fortified oil distribution documented: Draft manuscript on the application of e-vouchers for new applications	Manuscript was drafted and is currently being prepared for submission.	See Annex 2.10 for manuscript abstract
3.5. Mid-line household and retailer survey completed. Emergence of changes in fortified oil and nutritional status. Results presented at international/national conference	Study design changed as neither mid-term household nor retailer survey occurred. First, because of delays in approval for oil production made timeline infeasible. Second, the larger-than-planned baseline and hence end-line survey required more resources than expected.	Mid-term findings presented at GAIN, September 2016: see Annex 2.2. Results of end-line presented to stakeholders July 2017: see Annex 2.3, and to be presented at IUNS conference October 2017: see abstract Annex 2.9
Milestones for reporting period February 2016-July 2016		

4.1 Collection of biological data completed: Preliminary analysis of data on vitamin A to demonstrate emerging results.	Analysis of oil and serum retinol from baseline completed, and results presented at Micronutrient Forum in October 2016 (see annex 1)	See Annex 2.5 and 2.6 (posters presented at Micronutrient Forum, Oct 2016)
4.2 Use of e-Voucher for fortified oil distribution documented: Draft Manuscript on the application of eVouchers for new applications	<ul style="list-style-type: none"> • Manuscript details the progress of the eVoucher in the project life cycle • Instead of full/partial/no discount, design changed to consumer discount/retailer discount/no discount • Provides information on where eVoucher is most applicable 	Abstract attached as Annex 2.10
4.3 . Gender analysis completed: Presentation of gender analysis with recommendations developed	<ul style="list-style-type: none"> • Gender analysis conducted between June 5-12 2016 to assess how the project has responded to gender considerations and gender mainstreaming • Field work included convening of gender advisory committees, engagement of local leaders, etc. to provide feedback on project progress and its gender implications 	Annex 3 contains gender success stories and tip sheets
4.4 Dissemination of results from phase 1 subsidy and initial observations from phase 2 subsidy among stakeholders: Stakeholder workshop organized to discuss preliminary results on subsidised e-vouchers; Communication material suitable for the audience available	Stakeholder meeting held in Geneva in September, 2016.	Public presentation in Annex 2.2
Milestones for reporting period August 2016-January 2017		
5.1 End-line blood collection and household surveys completed and biological samples in process of analysis;	End-line household survey was completed in September 2016. Oil and finger-prick blood samples were collected and have been sent for analysis	Oil and blood sample results were received July-Aug 2017.
5.2 Dissemination of results from phase 1 subsidy and initial observations from phase 2 subsidy among stakeholders: Stakeholder workshop organized to discuss preliminary results on e-vouchers; Communication material suitable for the audience available	<p>Results from eVoucher on phase 1 (the consumer discount) were presented at GAIN in September 2016. Input received from meeting participants from WHO, GAIN, Micronutrient Initiative.</p> <p>Results also presented at National Food Fortification Alliance meetings in January 2016 to Tanzanian stakeholders (including, TFDA, MOH and other NGOs in nutrition)</p>	Decision taken to switch to a retailer discount, rather than a reduced phase 2 consumer discount. Retailer discount (eWallet) began in fall 2016, and continued until end of May 2017.
5.3 Project results and recommendations disseminated to relevant stakeholders: Dissemination through appropriate communication	Project results have disseminated at meeting at GAIN, September 2016, with GAIN, WHO, Micronutrient Initiative staff participating	Annex 2 contains 3 public presentations (PowerPoints), 5 posters presented at conferences and abstracts for 6 papers and 2 dissertations

materials and publications; policy makers committed to use research results to influence oil fortification policy	<p>(PowerPoint presentation, videocast, and archived on GAIN intranet).</p> <p>Project results disseminated at a scale up workshop in Saskatoon, Saskatchewan by Prof Mosha (SUA) and Nadira Saleh (MEDA) to stakeholders from Global Affairs Canada, IDRC and other CIFSRF funded projects.</p> <p>Project results also disseminated at Micronutrient Forum in Mexico, October 2016, in 2 posters, and in Consortium of Universities in Global Health conference in Washington DC, April 2017 in 1 oral presentation, and at IUNS Buenos Aires, Oct 2017</p>	(the 2 dissertations will yield an additional 4 papers in addition to the existing paper abstracts)
Milestones for reporting period February-September 2017		
6.1 Improvement of vitamin A status due to increased consumption of fortified sunflower oil documented: Evidence that consumption of fortified sunflower oil improves vitamin A status among beneficiaries.	Household survey results demonstrate that vitamin A deficiency in lactating women and children under five decreased in intervention areas (but not control) in both Manyara and Shinyanga. Decrease is larger in Shinyanga (which relies on palm oil fortified by large-scale producers) than Manyara (due to smaller coverage of fortified sunflower oil sales)	See slide 17-18, Annex 2.3 (Final stakeholder presentation July 2017)
6.2 Sustainability of business model demonstrated through continued sales of fortified oil: Descriptive statistics and initial analysis on phase I and phase II oils sales compiled to demonstrate the sustainability of the business model.	After conclusion of eVoucher, 31,400 L of fortified oil produced in June, July, and August of which 20,000 L was sold outside project area.	Fortified oil sales continued in June-Aug 2017, after end of eVoucher. Long-term continuation will depend on government regulations of SME
6.3 Manufacturing and distribution of fortified oil and utilization of subsidized e-Vouchers assessed. Project demonstrates that improved availability of fortified sunflower oil combined with the use of e-voucher increases consumption of vitamin A by women.	Total of 140,077L of oil produced to end-August 2017; Of this total 94,541 L were sold in Manyara and Shinyanga, and e-Vouchers redeemed of 54,613.	Slide 15, Annex 2.3, (Final stakeholder presentation, July 2017).
6.4 Contribution of private sector to improve child and maternal nutrition demonstrated: Commitment of private sector.	Private sector produced 140,077L of oil to end-August 2017. Of this total, 31,400 L was sold between June-August 2017 (no discount). Strong impact of fortification on vitamin A status of women and children	See slide 17-18, Annex 2.3 (Final stakeholder presentation July 2017)

4. Synthesis of research results and development outcomes

4.1. Research objective 1: To test whether crude sunflower oil can be fortified by SMEs for local consumption in contexts where inventory turnover is rapid and long shelf-life is not required.

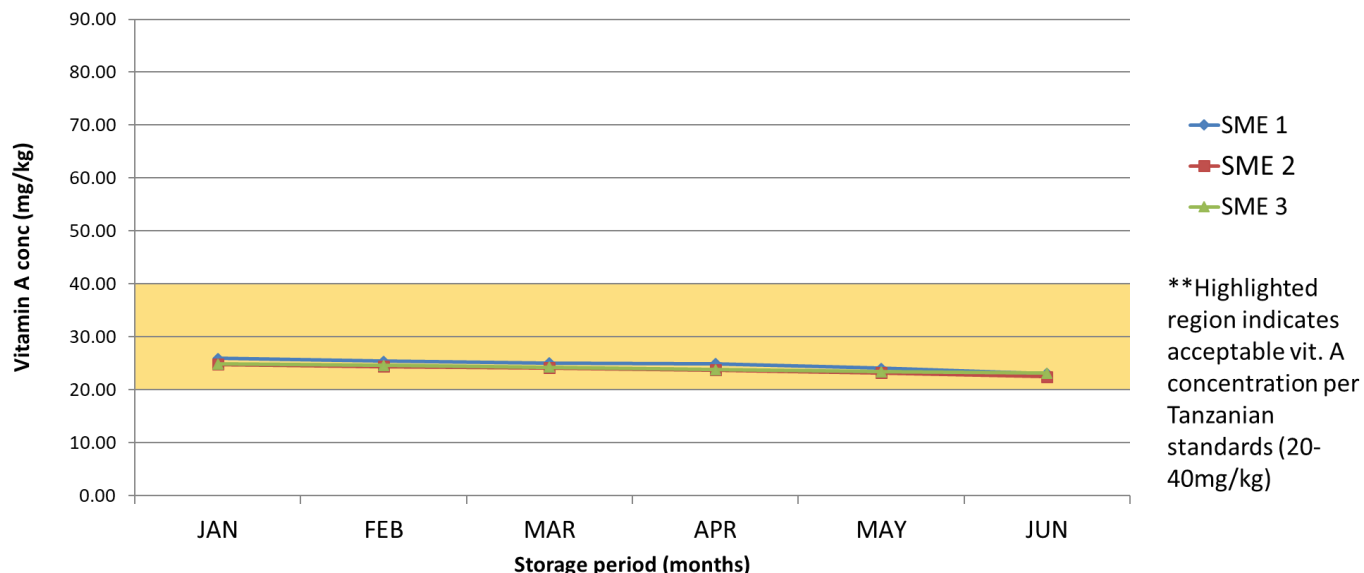


Figure 1 Vitamin A stability in fortified oil stored in ambient condition for up to six months.

In a study of shelf-life of fortified unrefined sunflower oil, samples of oil were taken from each of the three SMEs, along with samples of two brands of palm oil, and stored in ambient conditions at Sokoine University of Agriculture. Samples were tested monthly Jan 15 to June 15 2017, using quantitative spectrophotometric methods to determine Vitamin A content (Figure 1; see also annex 2.15). After six months, the sunflower oil samples lost between 7 and 11% of the original vitamin A, but remained within the recommended range for fortification (20-40 mg/Kg) according to the Tanzanian standard. The two palm oil samples lost 4% and 14% respectively of the original vitamin A, and levels of fortificant in palm oil even after six months far exceeded the Tanzanian standard.

The conclusion from this study is that unrefined sunflower oil fortified by SMEs does indeed retain sufficient fortificant in prevailing retail conditions. See also Annex 2.15 for abstract of the future publication.

4.2. Research objective 2: To test whether the resulting business models are sustainable.

The sustainability of the business model was examined throughout the project. Researchers regularly collected data on production and sales by SMEs of fortified and unfortified oil, and had insight into the expansion of the retail network and how many target clients were reached through the eVoucher/eWallet data. Further, qualitative interviews were conducted at baseline (May 2015), midterm (April 2016) and endline (June 2017) with distributors, retailers and the SMEs (abstract for future case study publication available in Annex 2.11).

Sunflower production is seasonal; seeds are readily available after the June harvest, but prices start to rise later in the year once no new seed is available. While SMEs can provide lower prices during this harvest season, they are at a disadvantage relative to large enterprises since they lack working capital and typically do not have much storage capacity to continue production in the off-season. As a result, SMEs produce more following the harvest in July-December and less from January-June.

The project placed emphasis on equipping SMEs with the technology (stainless steel tanks) and technical assistance necessary to include fortification in their production lines. This included GMP/GHP training, fortification training and

assistance in navigating regulatory standards for packaging and labeling. The latter is especially important as prior to Masava, there was no evidence of oil fortification at the small scale; thus the project chose “gold standard” technology and packaging options that would afford the highest probability of TFDA/TBS approval for fortification. Consequently, the equipment designed and operational is much too expensive for the average SME to take on by themselves (costs, revenue and estimates of profitability will be discussed in a future publication; abstract included in Annex 2.11).

Once SMEs were regularly producing, demand often outpaced production; eVoucher/eWallet data indicated that demand for fortified sunflower oil increased over the life of the project (allowing for seasonality) and there was a marked shift in demand once the larger containers (20L) became available (instead of only the 1L containers). (Figure 2)

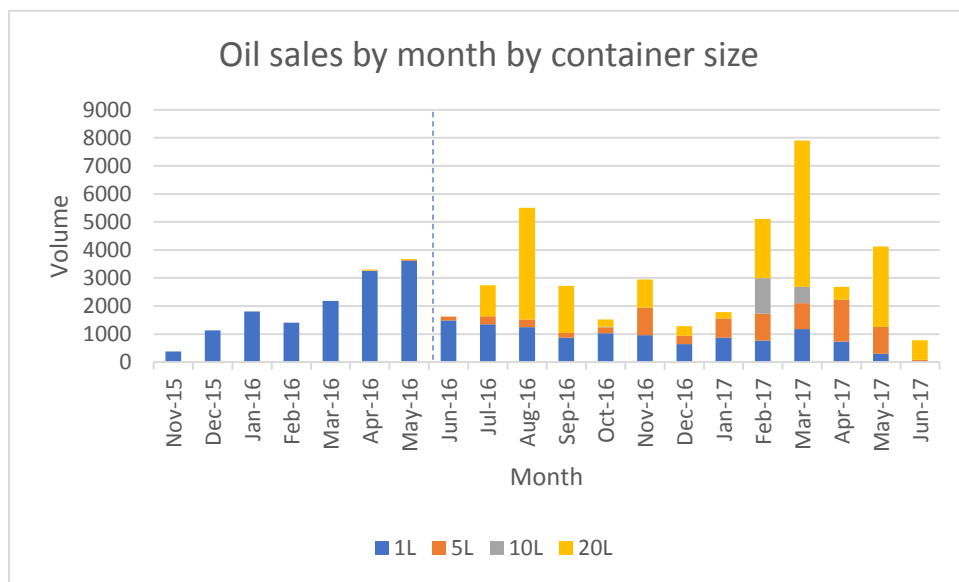


Figure 2 Oil sales over time, and by size of container

The project’s qualitative analysis found that there were bottlenecks along the supply chain for each actor. Producers commented that working capital was a serious issue for them. Profitability of the oil was also important to their decision to produce fortified oil; a function of both the cost of production as well as the demand for the product. While the cost of fortificant can be absorbed by the SME, packaging costs could be markedly higher due to the need to adhere to regulatory standards for opaque packaging. Demand generation improved with the introduction of different container sizes, but still depended on consumer knowledge of vitamin A (an activity which SMEs were not accustomed to influencing).

Like producers, distributors noted that working capital was an issue; if the retailers did not pay distributors on time, they were limited in their ability to order more oil from producers. This was associated with stock outs at retail level, though this became alleviated over the course of the project as the retailer network expanded.

Retailers noted that price is the key factor in consumer demand, especially in a low-income population, and that the discount had an important effect in encouraging consumers to try the product. Masava oil was also considered higher-quality, a trait that is also a very important to consumer. However, they found that stocking Masava oil was an issue: there were times when there was demand for oil but they could not get stock, whereas the competing palm oil could be readily obtained (since the large producers distributing palm do not face similar working capital shortages).

Overall, the project was successful in distributing oil by supporting the SME start-up costs, engaging in Behaviour Change Communications and tweaking the discount scheme to incentive various actors in the supply chain. The researchers find that demand for fortified oil continues to be strong after all project intervention ended (BCC and eVoucher discount). There have been lingering benefits with awareness of the importance of Vitamin A and there have been continued sales even after the discount ended, and an expansion of sales regions beyond the target areas where the project focused.

The SMEs were able to operate profitably during the project, but without project support, sustaining production of fortified oil throughout the year and maintaining the same packaging would reduce the likelihood of profitability substantially. The project finds that if the business model is to be scaled, technology will need to be reconsidered. Moreover, SMEs will need to become more efficient in their operations to be able to absorb the increased cost of fortification themselves, especially as prevailing market conditions make it difficult to pass this cost to consumers through higher pricing. Even if the equipment is cheaper, the running costs to operate fortification equipment and the cost of preblend add small increases that cut into the SMEs' margins. Lastly, the project finds that legislative pressure will need to be present and authorities will need to be engaged. While fortification is seen to be mandatory, there continues to be little enforcement for this, placing fortifying SMEs at a cost disadvantage compared to those not fortifying

4.3. Research objective 3: To test whether using electronic vouchers can succeed in promoting consumption of fortified oil.

During the twenty months of scaled-up distribution of fortified oil (involving a discount), there was a consumer-oriented discount (eVoucher) for ten months, a retailer-oriented discount (eWallet) for eight months; and two months with no discount, prior to the end of the project. The eVoucher/eWallet incentivized consumers to try a new product, and also produced valuable data to analyze regarding temporal and spatial patterns of sales.

The data for analyzing this topic comes from the eVoucher/eWallet sales database, and also from a face-to-face survey of key informants (retailers, distributors and producers) conducted in June 2017.

The eVoucher scheme experienced some logistical challenges with cellphone reception in rural areas and (primarily women) consumers having access to cellphones. Although consumer-oriented eVouchers have been successful for items purchased somewhat infrequently (such as mosquito nets), they proved not to be popular for small, frequently-purchased items such as oil. In the two project regions, many consumers buy oil on a daily basis due to cash constraints. Although many households have access to cellphones, the women and children (who are more likely to purchase oil) are less likely to have access to the cellphone than the men. Furthermore, cellphone connectivity in Tanzania is very variable, and this made the process of issuing the authorization for the payment slow.

The voucher was also challenged because of the low value of discount that was being applied at the consumer level which did not appear to have enough incentive for the consumers. The change to the eWallet scheme which provided incentives to the retailers combined with the sales of 20L containers proved to be more effective. The 20L volume quickly rose to popularity and despite being introduced much later, almost matched 1L sales (which had the highest discount/L) and which were available since the beginning of the project. Retailer recruitment was also facilitated and by the end of project activities, 319 retailers were registering sales, compared with 203 retailers before the new volumes and eWallet were introduced.

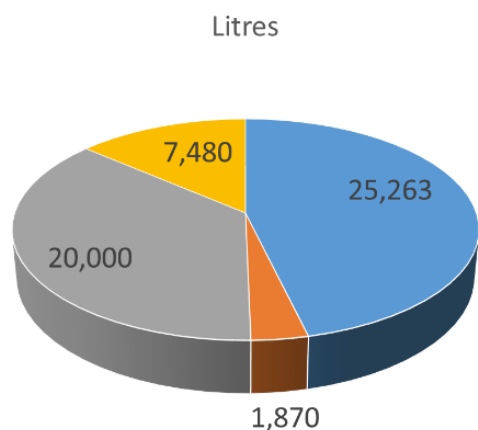


Figure 3 Comparison of utility of different volumes of oil redeemed through eVoucher Nov 2015-June 2017.

While it is difficult to isolate the contribution of the eVoucher to sales, given that there was also a BCC campaign, the project provides evidence that under certain conditions (based on analysis of supply chain dynamics), an eVoucher scheme can provide positive incentive for increasing sales, especially when combined with BCC activities.

The BCC campaign reached an estimated number of almost 100,000 people. However, given that more than half of the retailers interviewed stated that price was the major determinant of demand, the role of the eVoucher/eWallet was clearly important, given that it offset the increase in cost to the consumer due to the requirement of using new packaging. Retailers on average estimated that fortified oil grew from 5-10% of their oil sales early in the project, to 20-50% by the end (and at least one retailer stated a preference for only selling fortified oil).

One benefit of the eVoucher/eWallet data for research is that it will allow a spatial and temporal analysis of the impact of the BCC campaign

(by allowing an analysis of the association between BCC events and subsequent sales, and between BCC events spatially and impacts on sales in the same vicinity). This is the subject of a Master's dissertation (see Research question 7 below). The abstract for the case study of the eVoucher is in Annex 2.10.

4.4. Research objective 4: To test whether the fortified product can reduce micronutrient deficiencies in vulnerable groups, specifically targeting lactating mothers and infants.

In order to provide the strongest possible evidence on reduction of micronutrient deficiencies, the household survey incorporated the collection of fingerprick blood samples as well as household-level oil samples. The study was designed as an observational study with intervention groups (three districts in each of the two regions), and a control group (one district in each of the two regions). The control group received the intervention only until after the end-line household survey was completed, i.e. fourteen months later than the intervention group. In the intervention districts, retailers were recruited to sell fortified oil and trained in use of the consumer-oriented eVoucher. BCC events also took place in those districts. One limitation is that assignment of districts to intervention/control was not done randomly. In order to utilize the eVoucher technology, the intervention districts had to have reasonable cellphone connectivity, and the control areas were slightly more rural as a result.

In addition to the blood and oil samples, a household questionnaire obtained information on asset ownership (to construct wealth quintiles), a brief household roster (age, sex and level of education of all household members), anthropometric data (on the children) and information on the last time the child received a vitamin A supplement, information on purchasing patterns of oil, a dietary diversity survey for both the mother and the child, and a knowledge, attitudes and practices survey on vitamin A. This data formed a rich source of information on possible other factors which affect vitamin A deficiency. It was originally intended to be able to link purchases of fortified oil to individual households, since the eVoucher data permitted this. However, this did not work as well in practice because of workarounds occurring at the retailer level if a household member did not have a phone available at the time of purchase, or borrowed that of another individual.

Three posters have been presented at conferences (annexes 2.4, 2.5 and 2.6), and two doctoral dissertations are underway, one focusing on the mothers (annex 2.14 and 2.16) and one on the children (annex 2.12).

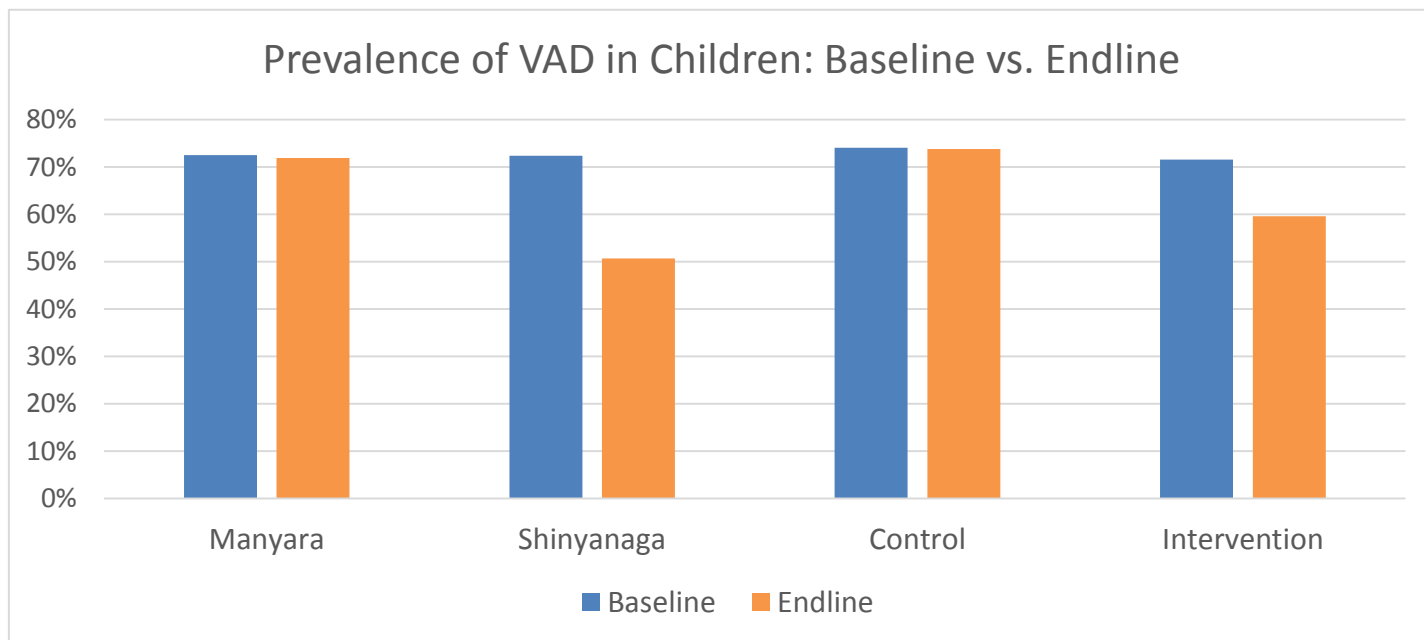


Figure 4 Prevalence of any vitamin A deficiency in children, baseline and end-line survey, by region, and by intervention/control status.

Table 1 Mean retinol binding protein (RBP) level in children, baseline and end-line survey, by region, and by intervention/control status. (Note: **implies that the difference between baseline and endline is significant at 1% level.)

	Baseline Mean RBP mg/mL	Endline Mean RBP mg/mL
Manyara	14.85	15.04
Shinyanga	14.71	18.42**
Intervention	14.83	17.20**
Control	14.74	14.37

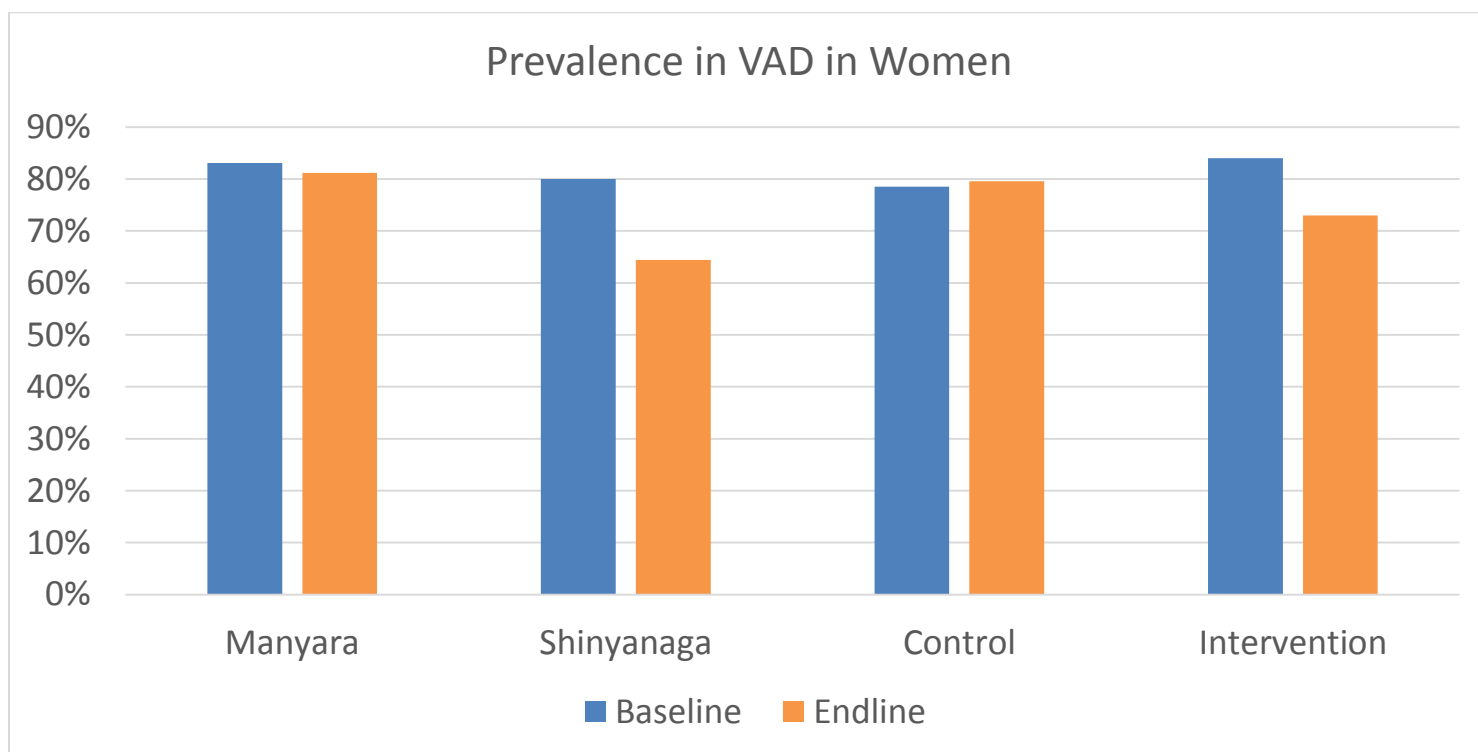


Figure 5 Prevalence of any vitamin A deficiency in mothers, baseline and end-line survey, by region, and by intervention/control status.

Table 2 Mean retinol binding protein (RBP) level in mothers, baseline and end-line survey, by region, and by intervention/control status. (Note: ** implies the difference between baseline and end-line is significant at 1% level, and * implies the difference between control and intervention is significant at baseline)

	Baseline Mean RBP mg/mL	Endline Mean RBP mg/mL
Manyara	20.21	19.06
Shinyanga	20.32	23.05**
Intervention	19.72	20.41
Control	21.21*	20.48

Figure 4 presents the key findings for the level of “any” vitamin A deficiency in children (note that the threshold includes mild, medium and severe deficiency, so the deficiency reported is higher than the levels presented from the Demographic and Household Survey national data). Table 1 presents the same data using a different indicator, namely the level of retinol binding protein. Both show the same finding: there is a statistically significant improvement in vitamin A status in the intervention districts compared to the control districts, and a significant improvement in Shinyanga compared to Manyara.

Figure 5 presents similar findings for level of deficiency in women, and Table 2 for the levels of retinol binding protein. Findings are similar to those for children: there is a statistically significant improvement in vitamin A status in Shinyanga compared to Manyara.

These are very key findings, since they provide strong (although somewhat circumstantial) evidence that consumption of fortified oil is effective, and can achieve significant improvements in vitamin A status over a relatively short period of time (14 months).

The evidence is somewhat circumstantial since this is an observational trial, not a randomized control trial. However deeper analysis (examining whether other factors such as dietary diversity, prevalence of vitamin A supplementation in children etc.) suggests that there is no alternative explanation with as strong of support.

We cannot infer that it is the fortification of unrefined *sunflower oil* which has caused this improvement. Although over 142,000L of fortified sunflower oil was produced by the three SMEs which could conceivably have reached 500,000 individuals, there are about three million people in Manyara and Shinyanga regions combined. To have a population effect, fortification must reach 80% of the population for 80% of the time according to GAIN (Global Alliance for Improved Nutrition).

Large scale fortification became mandatory about six months before the baseline household survey, and had been underway for a little less than two years at the time of the household endline survey. We know there was a differential effect, since in Shinyanga consumption of palm oil (one type of vegetable oil) predominates, whereas in Manyara, consumption of sunflower oil predominates (Figure 6). Hence the majority of the population in Shinyanga were exposed to large-scale fortification between the two household surveys, while the population of Manyara (who consume locally-produced sunflower oil in preference) consumed largely unfortified edible oil. The impact on blood retinol in Shinyanga was even stronger, given the project’s findings that palm oil is being fortified at about twice the permitted level, whereas the SMEs were fortifying sunflower oil within the government-regulated range (Figure 7).

Ongoing research will further refine the evidence, but broadly speaking, **fortification is effective**. The main issue for policy is to ensure that locally-processed sunflower oil becomes fortified. Sunflower oil is a higher quality oil than palm oil. Sunflower oil contains primarily unsaturated fat, whereas palm oil is has a high proportion of saturated fats. Sunflower oil is locally produced, creates local employment in agriculture and in processing, whereas palm oil is grown in huge plantations primarily in Malaysia and Indonesia and requires foreign exchange, with modest local employment impacts.

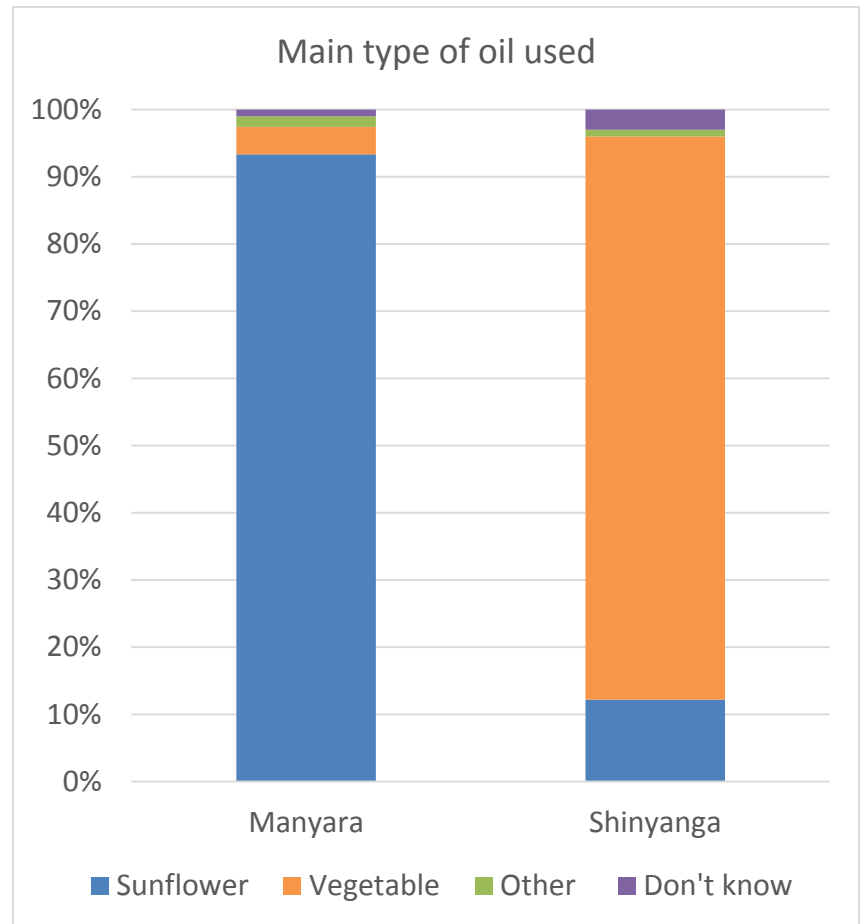


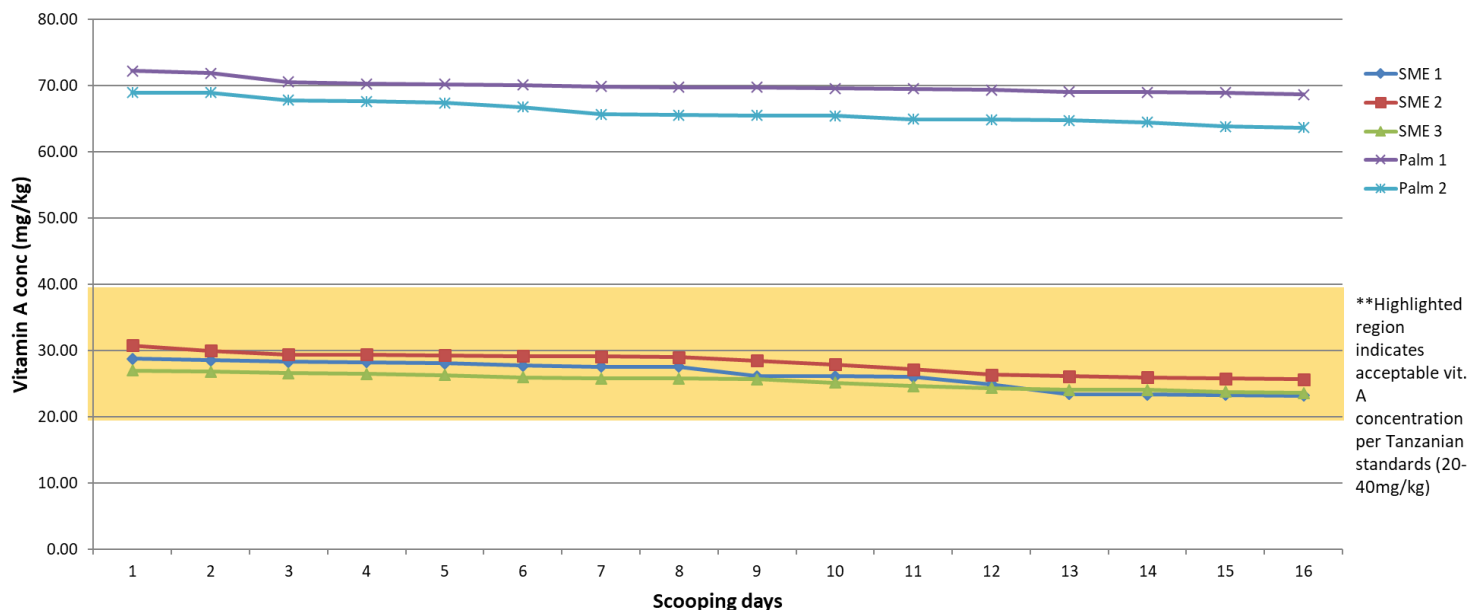
Figure 6 Main type of oil used by household, baseline survey, by region

4.5. Research objective 5: Does retinol stay stable in conditions of “scooping”, when packaging is opened and potentially exposed to air and dust?

In this study, scoops of fortified oil sunflower oil were collected from the same 20L containers in retail stores once daily for up to sixteen days, one container produced by each of the three SMEs. Retailers had stated that the majority of containers were empty before the sixteenth day. The oil samples were then treated with anti-oxidants and transported under cold conditions to the laboratories of TFDA and analyzed using High Performance Liquid Chromatography. After 16 days’ samples from different SMEs had lost between 12 and 20% of the original retinol, but still retained enough to meet the Tanzanian standards (Figure 7).

This study therefore addressed concerns that the half-empty containers of oil would rapidly lose retinol content, under conditions in the stores (often hot, in direct sunlight, and with the risk of oxidization through exposure to the air and dust). In fact, retinol content remained adequate during the normal sales cycle. This was an important finding, since TFDA’s authorization of permission to sell 20L containers of fortified oil, was conditional on undertaking this study. It also enhances the likelihood that fortified oil will reach the poorest households, who have least cash and are most likely to buy oil in scoops. (For abstract of a future article for submission for publication, see Annex 2.15).

Figure 7 Vitamin A stability in oil scooped from open containers in retail environment, over 16 days.



4.6. Research objective 6: How can BCC support oil sales?

The BCC campaign included a wide range of activities aimed at publicizing fortified oil, including clinic demonstrations, cooking demonstrations, road shows, and cultural shows. In order to appeal particularly to men, there was also social marketing of fortified oil at bicycle races and at soccer games. There were also written educational materials and posters, and (after the end-line household survey was completed) radio was utilized during the final two months. The campaign design was undertaken by Tanzania Communications and Development Centre (TCDC): see Figure 8 for examples of print materials/cultural show.



Figure 8 Examples of BCC materials/activities (poster and cultural show)

Data to analyze this question comes from a variety of sources. TCDC undertook three surveys: a formative research study Dec 2014-Jan 2015 (in order to design the strategy), a survey prior to the BCC campaign opening in November 2015, and an end-line survey in May 2017 as the campaign ended. The formative survey targeted only women, whereas the pre- and post-intervention surveys interviewed both men and women.

The household baseline and end-line surveys also contained a knowledge, attitudes and practices module concerning vitamin A. The questionnaire was directed at women only. As part of the household survey, oil samples were collected at household level. This allowed practices to be examined directly (by measuring the level of retinol in oil consumed by the household). A final source of information to examine the effect of BCC consists of the availability of data both over time and space, both for sales and for the BCC events, which will allow for regression and GIS analysis of association.

The household and TCDC surveys occurred at different times (the household end-line survey occurred prior to the use of radio for BCC, so as not to contaminate the control area). Whereas the household survey respondents were all women, the TCDC survey respondents included both men and women. They did not use the same questions.

Figures 9 and 10 show the difference between men and women in source of information about fortified oil (TCDC) and about vitamin A (household survey). Women were most likely to hear of fortified oil from clinic shows, and their main source of information about vitamin A was likewise the clinic. Health workers are trusted sources of information on health issues.

The main source of information for men, by contrast, is radio. Although women are the ones generally the ones purchasing edible oil, they need to have buy-in from men in the household. Hence these survey findings are useful for designing social marketing campaigns. Analysis of the spatial and temporal association of BCC interventions and sales of oil is in process (see Annexes 2.8 and 2.13).

Figure 9 Sources of information about fortified oil for men and women based on results of TCDC survey

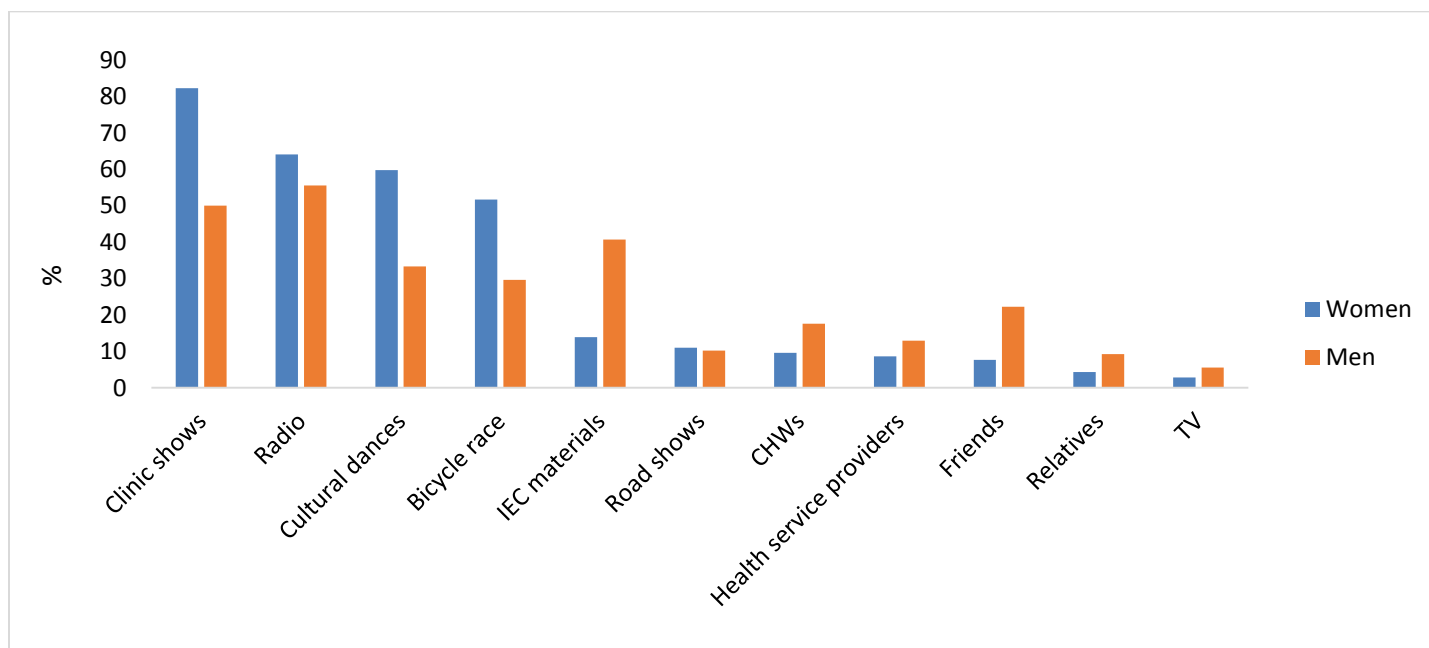
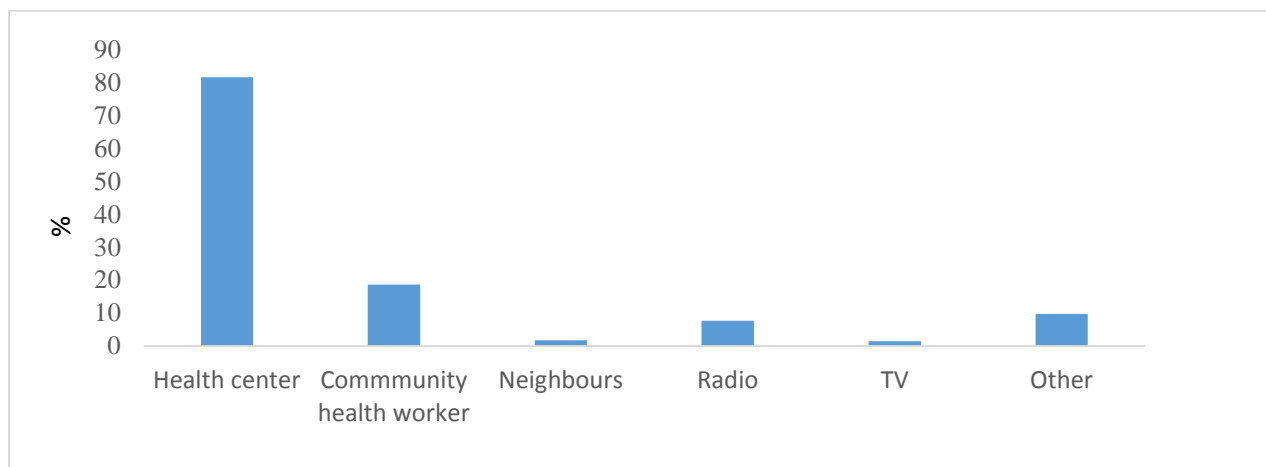


Figure 10 Sources of information about fortified oil for women based on results of household survey



4.7. Research objective 7: What is the cost-effectiveness of oil fortification?

Research objective 2 examined sustainability of the oil fortification business, which is primarily from the perspective of the business owner. Research objective 7 instead examines cost-effectiveness which takes more of a government, or social perspective. Both questions rely on some of the same data, namely the costs of production. But while business sustainability compares this to revenue, cost-effectiveness compares this to health outcomes and aims to generate cost per unit of health outcome.

Studies of fortification suggest that it is a highly cost-effective intervention because of its modest costs compared to widespread population benefits. A cost-effectiveness analysis of large-scale oil fortification in Uganda (Fiedler and Afrida, 2010) suggested that the cost was \$18 per disability-adjusted life-year averted, i.e. among the most cost-effective health interventions possible.

On the benefits side, fortified oil is a good investment, since it reduces all-cause mortality of children under five by a substantial amount. It is on the cost-side for SMEs that innovation is needed in order to reduce the costs from the level in the three-year MASAVA project. The current levels of the cost of technology (stainless steel tanks) is not going to allow SMEs to compete with large enterprises who can spread the investment cost across a much larger production volume. The requirement for SMEs to use clean, new packaging currently adds too much to the cost to allow fortified oil to compete with unfortified oil in recycled packaging, when facing rural households with very limited cash income. The exact numbers are presented in the papers summarized in annexes 2.7 and 2.9.

4.8. Potential uptake of research for development purposes (all four research themes)

MASAVA's research has shown that it would be over-optimistic to assume that fortification by SMEs will catch on and become self-sustaining at the end of the three years of this project, using the current technology and removing the discount. What has been shown is that it is possible to fortify unrefined sunflower oil at scale using SMEs, and demonstrated the conditions that need to exist for this to become self-sustaining. These conditions include:

- Fortification should be mandatory for all firms of a certain size; but very small firms (e.g. those which focus primarily on toll milling for individual farmers) could be exempted;
- Fortification regulations need to be enforced, such that there is a level playing field among SMEs and those that fortify are not at a cost disadvantage;
- Technical requirements for producers to meet regulatory approval need to be clear, but also appropriate (particularly in the packaging and equipment requirements, which may not be identical for small and large producers);

Promoting sunflower seed production is a government priority. It is cited as an important strategy in the National Development Plan 2016/17-2020/21, as is sunflower's share of the edible oil market (Market Development Ltd, 2016). The government imposed a tariff on imported palm oil in 2016 to protect the development of the domestic industry. The government of Tanzania has also demonstrated a strong commitment to nutrition goals, including fortification. Both of these factors make for a favourable environment for scaling up fortification in the SME sector.

The Government of Tanzania (as represented by Dr. Assery from the Prime Minister's Office, focal point for nutrition, and Dr. Assey from the Ministry of Health) has shown consistent interest in results from the project. Both attended all three meetings in Tanzania (the inception meeting in Arusha November 2014; the stakeholder meeting/BCC launch event in Singida September 2015, and the final stakeholder meeting in Dar-es-Salaam July 2017. They also met with Global Affairs Canada representatives in February, 2017 to receive an update on the project's progression. Dr. Assery viewed the doctoral student posters at the Micronutrient Forum meeting in October 2016. Both Dr. Assey and Dr. Assery participated in the Global Affairs Canada visit to Tanzania in February 2017. There has been continuous engagement by MEDA with these individuals, and likewise continuous engagement by SUA with the government technical agencies, TFDA and TFNC. One of the former SUA faculty members is on the committee advising on technical aspects of fortification standards.

The Government of Tanzania is reviewing fortification policy implementation in fall 2017, and requested suggestions from Masava partners regarding imported inputs to fortification which might be considered for import duty reductions/exemptions. Masava has also increased its visibility through regular presentations to the Tanzania National Food Fortification Alliance. The latest of these meetings was a National Food Fortification Summit in August 2017 where Dr. Mosha presented Masava's results in a session highlighting "Innovations in Fortification Technology." Similarly, Dr. Mosha was invited at the final stakeholder meeting in July 2017 to submit a policy brief to the government for its deliberations on fortification. Project findings from the analysis of oil samples at retail and household level show that imported palm oil was fortified to a level twice that of the permitted standard.

Further development impact requires additional technical work. The three-year Masava project has identified the circumstances in which unrefined sunflower oil fortification is going to be most successful, namely:

- if undertaken in areas which traditionally have a preference for consumption of sunflower oil;
- if a supplier of premix can be sourced (through a market mechanism)
- if there is appropriate flexibility in the technological specifications for production equipment permitted by TFDA, and if SMEs receive the same support in purchasing and installing the additional equipment, as was received by large enterprises
- if there is marketing or behavior change communication of fortification in general (e.g. radio, TV, to have the maximum impact)
- if community health workers are informed about the benefits of fortification, and include this message in their community work

A considerable amount of detailed research was undertaken in the three years of the current project, and a considerable amount learned about what does – and does not – work. It is extremely important that momentum is maintained to ensure scaling up.

5.Synthesis of results towards AFS themes

5.1. Accessibility

Masava worked to facilitate understanding between the public and private sector by making it possible for small and medium enterprises to contribute to the government's food fortification agenda. Specific assistance in the project included:

- Assisting the small enterprises to apply for regulatory approval for fortification
- Assisting the small enterprises to obtain supply of approved packaging and of premix containing the fortificant
- Training in Good Manufacturing Practices to ensure that manufactured oil was of good quality, and hence that the added retinol would remain stable
- Providing conditional loans to enable seed purchase in low season, to commence production of fortified oil

- Providing Behavior Change Communications to inform the population of the advantages of fortified oil and help create a demand

Without the technical advances pioneered by Masava, the project's support for regulatory approval for fortification, and for getting approval for packaging, small and medium enterprises would not be able to comply with requirements for mandatory fortification.

MASAVA worked to address *gender constraints hindering women as consumers* and their ability to purchase oil. During the gender audit in 2015, which was facilitated by an external gender consultant, it was revealed that the project's marketing approach needed improvement as there were misconceptions about fortified oil. Patriarchal social norms play an important role in the project area for women's purchasing power, so even when women are informed about the benefits of Vitamin A in fortified sunflower, they need to involve their male spouses when opting to use it at the household level. Therefore, following the gender audit, MEDA and its collaborating behavior change communication partners, adapted their strategy to ensure that both men and women – district staff and project beneficiaries – received targeted messages with information about the benefits of fortified sunflower oil. Based on the recommendations of the gender audit, MASAVA also started targeting religious leaders that are important stakeholders and communicators for the project. By engaging men in the process, it permitted women to purchase and use fortified sunflower oil from the MASAVA project. It also allowed men and women to have dialogues about nutrition and allowed men to become agents for change as they understood the reasons and benefits of the change (instead of feeling threatened or destabilized).

The redesign of the eVoucher was also intended to address *gender constraints facing women as consumers*. The design of the initial e-voucher system (consumer-oriented, requiring the consumer to bring a cell-phone at time of purchase) was too time-consuming for busy women, who often suffer from a triple burden of domestic, productive, and community managing work. It was especially difficult for them to wait to receive mobile messages at the retail shop as the original design called for. Additionally, there was a lack of mobile phone penetration, especially for women who did not own mobile phones or lacked literacy to access the e-vouchers. MASAVA took this feedback and changed the design of the eVoucher to be retailer-focused.

MASAVA worked to address *gender constraints hindering women as retailers*. The project initially started without a specific gender lens in terms of trying to enhance the market for fortified oil. Both male and female retailers suffer from a low capital base, however women in Shinyanga and Manyara region lack ownership of assets and property, which limits the capital for their business. MEDA noted this aspect, and recruited both men and women retailers. Some of the retail businesses were family owned and promoted joint ownership of retail business hence both men and women were economically empowered. During the life of the project, MEDA recruited a grand total of 318 retailers, 70 were female owners, 22 joint owners, and 226 were male owners (Figure 11). As this was not a female targeted project, MASAVA did not provide any additional financial or capacity building support to their female retailers. But when possible, the project would encourage women to participate and to own property at the household level, so that they could have more capital to become a retailer, as seen success story three of Odilia Bartholomew (see Annex 3)

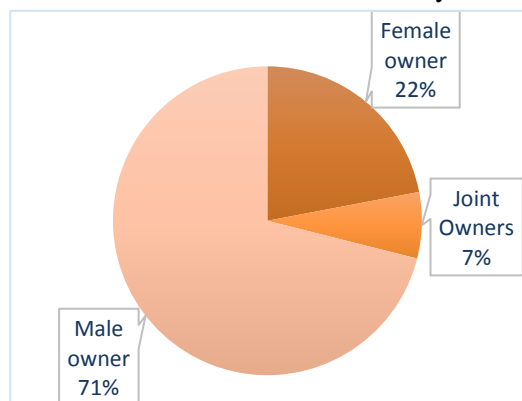


Figure 11 Gender composition of ownership of retail stores in 2017.

Masava field staff worked closely monitoring the voucher system and providing support to SMEs, retailers and distributors to assist with market entry. One jointly owned retailer shared how the project staff taught them how to use the voucher system, even late at night, following up, and explaining the benefits of fortified sunflower oil. The gender awareness training among the MASAVA team and its partners, helped the project to pick up on disparity between male and female owned retail outlets. This reflection along with the sex-disaggregated data collected helped to shape strategies and considerations for scale up plans.

MASAVA worked to address *gender constraints in production of oil (milling)*. Following the gender audit, it became evident that women are typically part-time employees of the milling firms, doing the outside work of sorting seeds to remove broken and rotted seeds. Women are thus key

to improving oil quality, which is in turn key to maintaining levels of retinol in the oil during storage. However, initially millers had only included their full-time employees in the Good Manufacturing Practices training, and there was recognition that including women in such training is important.

MASAVA also worked to make fortified oil accessible to *poor households*. In June 2016, the Masava project provided support to the SMEs for expanding the packaging of fortified sunflower oil beyond the one litre container. MASAVA saw the larger volumes of 5,10, 20 Ls as economic opportunities and a way for the project to increase its access to vulnerable populations, who may not be able to purchase a 1L container, but could scoop a portion that they could afford for the day's cooking for their household. The practice of scooping, where customers purchase very small quantities of oil from retailers, is common when purchasing oil in Tanzania. It is also an economic opportunity for retailers, who can purchase a supply of fortified sunflower oil at a subsidized price in order to sell small volumes to rural consumers of different economic means, including low income earners.

MASAVA worked to make fortified oil more accessible to *rural households*. These households are less likely to access oil produced by large-scale enterprises, as shown by recent studies for eight other countries (Aaron et al, 2017). Figure 12 (on right) shows that the same was true for Tanzania at baseline, for both regions in which the project intervened. At the present time ousehold level has not been completed.

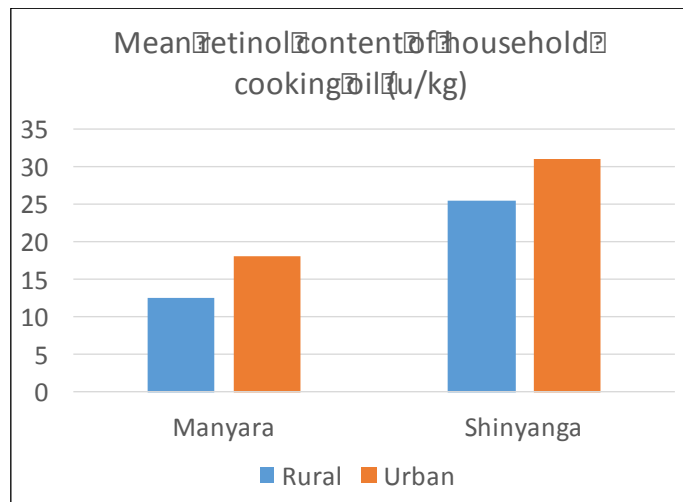


Figure 12 Results from baseline household survey

5.2. Improving nutrition (utilization)

- MASAVA contributed to *adequate and diversified diets* through the promotion of improved vitamin A in the diet. This is of specific importance to women and children. Children are particularly susceptible to infection (and mortality) if they have subclinical vitamin A deficiency and for children less than six months old who rely on breastmilk, their vitamin A stores come from the mother (during pregnancy and from breastmilk). See section 4.4 above for detailed discussion. Fortifying sunflower oil has additional nutritional benefits compared to fortifying imported palm oil (as is done by the largest millers), as palm oil contains predominantly saturated fats, whereas sunflower oil consists primarily of unsaturated fats. For appropriate nutrition, people require both kinds of fat. However, most recommendations are for a higher proportion of unsaturated fats which are associated with higher “good cholesterol” and prevention of cardiovascular disease.
- MASAVA is contributing to *improved post-harvest food processing and storage techniques* via educating millers about Good Manufacturing Practices, specifically focusing on improved cleaning of seeds prior to milling (to remove broken and rotten seeds): refer also to section 5.1.
- *Equity*: Fortified unrefined sunflower oil can reach poor and rural consumers. There is a strong preference for sunflower oil in Manyara. Levels of vitamin A deficiency are highest in the second-poorest quintile of the population in Manyara and Shinyanga; and rural consumers currently are less likely to consume fortified oil (work is underway in the two dissertations described in Annexes 2.14 and 2.14). Poor, rural households are more likely to consume oil processed by small and medium producers as compared to richer and urban households. Accordingly working with SMEs can enhance equity.

- *Gender equity:* Vitamin A is especially important for pregnant and lactating women, a key target beneficiary group of the MASAVA project. However, broader equity impacts on women were also considered in the redesign of the eVoucher, in the recruitment and training of retailers, and the inclusion of women in the Good Manufacturing Process, as describe in section 5.1. Furthermore, MASAVA convened regular Gender Advisory Committee meetings which can help to create lasting ties in the community that not only reinforce the gender sensitivity of this project but also the importance of fortified food and balanced diet for gender leaders in the target communities.

5.3. Informing and/or influencing the development and implementation of food security policies

- *Engaging policymakers*
- *Demand for the research results from the policymakers*
- *Successes and bottlenecks in reaching policymakers*

Engaging policymakers has been key to the potential development impact of the intervention. Please refer to section 4.8 for a detailed discussion.

6. Project outputs

The MASAVA project team made three public presentations of results to stakeholders. A public presentation in Singida (Annex 2.1) was made to representatives of the two project regions (Manyara and Shinyanga) in September 2015, and also in Babati to government representatives (Prime Minister's Office, Ministry of Health, TFNC and TFDA). A public presentation was made in Geneva (Annex 2.2) to staff from World Health Organisation and GAIN (Global Alliance for Improved Nutrition) in September 2016, and the final stakeholder presentation was made in Dar-es-Salaam in July 2017 to government representatives (Prime Minister's Office, Ministry of Health, TFNC, TFDA). Donor organizations were also invited. The Tanzania-based events were covered in the press (details available on request). Other project outputs aimed at a broad public audience include a project video available at <https://vimeo.com/144065269>, and the MASAVA website <http://www.meda.org/masava>

Three students are working on dissertations (Dylan Walters, University of Toronto, PhD; Edna Ndau, Sokoine University of Agriculture, PhD; Daphne Wu, University of Waterloo, MSc). The two PhD dissertations will each yield three published papers, and the Master's two. MASAVA team members have presented five posters at national and international meetings. See Annexes 2.4, 2.5, 2.6, 2.7 and 2.8 for the five posters, one by Nadira Saleh from MEDA as first author, and the other four by Dylan Walters, Edna Ndau and Daphne Wu as lead authors.

There are at least ten papers documenting project findings in various stages of draft. Two papers on the experience of eVouchers and the business sustainability model are in draft, being prepared for submission to *Food Chain* or *Enterprise Development and Microfinance* or similar journals, aimed to reach industry practitioners (Annexes 2.10 and 2.11). Three papers are expected to come from Dylan Walters' PhD dissertation. The first of these has been accepted for presentation at the International Congress of Nutrition in Buenos Aires, October 2017, and will be submitted to a special supplement of *Maternal and Child Health*: see annex 2.9; and see annex 2.12 for an abstract of Dylan Walters' dissertation). Two papers are expected to come from Daphne Wu's Master's dissertation (see annex 2.13). Three papers will come from Edna Ndau's PhD dissertation (see annex 2.14, 2.15 and 2.16 for abstracts).

All dissertations are publicly available from the universities concerned. The research papers will be submitted preferentially to journals with open access; if accepted by a journal without open access, the papers will also be archived in the open access spaces maintained by University of Waterloo (UWSpace).

7. Problems and Challenges:

The project encountered two different sets of challenges. One set was due to the inevitable delays in the ambitious timelines in fieldwork. These were substantially mitigated by IDRC accepting the request for a six-month extension. The other set of

challenges were due to unexpected challenges in design and implementation. These were also substantially mitigated by IDRC's flexibility in permitting changes in design along the way.

Delays

- Delays in initiating production at scale of fortified oil were due in part to substantial delays in getting approval for SME production. The regulatory authority (TFDA) was not used to working with SMEs, and did not have guidelines for what type of production equipment would be acceptable. It took time for MEDA to get an engineer's report on specifications that were likely to be acceptable, and to get the equipment manufactured. Thus, the first pilot production of fortified oil only began in October 2015, 14 months after the beginning of the project.
- Delays in receiving coded survey research data: solved by switching to use of tablets and iForm software for household end-line and store end-line surveys.
- These delays, combined with the decision to use a larger-than-planned sample for the baseline household survey, led to a decision not to undertake the initially-proposed mid-line household survey. Resources were instead directed to the baseline and end-line household surveys. In retrospect, this was a good decision, given the resources available for data collection, data entry and data analysis, and the larger household size increased the sample power for the analysis, and provided a buffer against the normal sample attrition.
- Delays in processing blood samples at TFDA: data had to be analyzed in Tanzania according to Ethics Approval; but delayed because the same lab analyzed the 2015 Demographic and Health Survey, and gave that priority. Results from the end-line survey were received in July 2017 as a result of considerable effort by the SUA team.
- Delays in processing oil samples at TFNC: the equipment has to be calibrated differently, according to the kind of oil sample being tested. It was more efficient for TFNC to wait for the conclusion of the storage and scooping studies in order to run all the project oil samples at one time. The storage study took six months, and could not be initiated until oil production was occurring at scale. Results from the oil analysis were therefore not received until July 2017, again requiring considerable effort by the SUA team.
- The delays in availability of data has meant that, though the project successfully created five posters and one in-person presentation at an international conference, papers are still in the pipeline for publication.

Design issues

- SMEs are highly capital-constrained and were unable to procure sufficient seed during lean season to produce oil: solved by MEDA arranging conditional matching grants to procure seed. This was essential, since with the delays in achieving regulatory approval, full scale production only began in January 2015, six months after the main sunflower seed harvest. In the absence of the conditional grants, a further delay in production would have ensued.
- Challenges with the initial eVoucher design (a consumer-based discount): feedback to MEDA staff and a field survey undertaken in April-May 2015 suggested that all stakeholders – households, retailers and producers – found this cumbersome. The switch to eWallet (retailer-based discount) meant that the link between survey households and their oil purchases was no longer possible; however the retailer-based discount worked much more successfully to support sales.
- Issues with business model and sustainability: the existing model is difficult to scale without external support. It relies on a “gold-standard” and costly technology (i.e. a separate 3-tank process to undertake fortification, rather than integrating this into the main production line for the SME, using stainless steel). As a pilot project, these tanks were a successful proof of concept, but this design will need to be modified in a scale up.
- Issues with packaging: When producing unfortified oil, SMEs do not use new plastic packaging, but rely on recycled packaging. Using new packaging every time with fortified oil adds considerably to cost of oil (about a 20% increase for the 1 litre bottle which is unaffordable for poor consumers). This was solved by obtaining permission to sell in larger containers (5L, 10L and 20L) and – subject to undertaking a study of retinol stability – to permit sales of fortified oil in “scoops” from the larger containers.

8.Overall assessment and recommendations

We would like to express our thanks to IDRC for offering the flexibility for a no-cost extension, and for permitting the flexibility to make some changes in the project design in order to respond to changes in circumstances, as discussed in the previous section.

The project overall succeeded in its major aims: over 142,000L of fortified oil were sold, potentially reaching 400-500,000 consumers in two target regions with high vitamin A deficiency. The technical studies demonstrated that SMEs could produce oil of high enough quality that it retained retinol sufficient to reach households in normal market conditions. The continued supply of and demand for fortified oil after project intervention demonstrate that a business case does exist for fortified oil. The household survey data demonstrated that fortified oil is strongly associated with the observed reduction in vitamin A deficiency both in lactating mothers and in children under five, and that fortification is indeed the most plausible causal explanation for this reduction. Project partners

The three partners (MEDA, SUA and UW) are grateful to IDRC for its support and flexibility. We benefited from the strong interaction with the project officer Annie Wesley as well as her colleagues. Annie attended all five major meetings (initial workshop in Waterloo, inception meeting in Arusha, stakeholder meeting in Singida, dissemination meeting at GAIN, Geneva, and final stakeholder presentation in Dar-es-Salaam). Annie was also available by email to respond to questions and requests. This was extremely helpful in solving issues along the way.

References

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- Fiedler, J. L., & Afidra, R. (2010). Vitamin A fortification in Uganda: Comparing the feasibility, coverage, costs, and cost-effectiveness of fortifying vegetable oil and sugar. *Food and Nutrition Bulletin*, 31(2), 193-205.

List of Annexes:

1. Project timeline
2. Research outputs and abstracts accepted
 - 2.1. Presentation to stakeholders, Singida, September 2015
 - 2.2. Presentation to GAIN (Global Alliance for Improved Nutrition), Geneva, September 2016
 - 2.3. Presentation to final stakeholders meeting, Dar-es-Salaam, July 2017
 - 2.4. Poster presented at Canadian Conference on Global Health (lead, Nadira Saleh), October 2015
 - 2.5. Poster presented (lead, Dylan Walters) at Micronutrient Forum, October 2016
 - 2.6. Poster presented (lead, Edna Ndau) at Micronutrient Forum, October 2016
 - 2.7. Poster presented at Consortium of Universities in Global Health (lead, Dylan Walters), April 2017
 - 2.8. Poster accepted for Canadian Conference on Global Health (lead, Daphne Wu), October 2017
 - 2.9. Abstract accepted for International Congress on Nutrition, October 2017 (and for submission to special issue of *Maternal and Child Nutrition*).
 - 2.10. Abstract of paper (on eVoucher) for submission to journal (draft, September 2017)
 - 2.11. Abstract of paper on business sustainability for submission to journal (draft, September 2017)
 - 2.12. Abstract of Dylan Walter's PhD dissertation proposal (draft, August 2017)
 - 2.13. Abstract of Daphne Wu's Master's dissertation proposal, August 2017
 - 2.14. Abstract of paper "Factors influencing vitamin A status of lactating mothers in Manyara and Shinyanga regions of Tanzania" for submission to journal (lead author: Edna Ndau: draft, August 2017)
 - 2.15. Abstract of paper "Physico-chemical characteristics of oil consumed at the household level and shelf-stability of vitamin A in fortified vegetable oil in Manyara and Shinyanga, Tanzania" for submission to journal (lead author: Edna Ndau: draft, August 2017).
 - 2.16. Abstract of paper "Change in vitamin A status of lactating mothers in Manyara and Shinyanga, before and after the expansion of availability of fortified oil" (lead author: Edna Ndau, draft, September 2017)
3. Gender tips and stories.