The Rockefeller Foundation

Reducing Post-Harvest Loss through a Market-led Approach

Lessons from Smallholder Farmer Sourcing in Kenya's Mango Value Chain & Mozambique's Cassava Value Chain

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List of Acronyms and Abbreviations

AGRA	Alliance for a Green Revolution in Africa
AMPU	Autonomous Mobile Processing Unit
CDM	Cervejas de Moçambique
DADTCO	Dutch Agricultural Development and Trading Company
FAO	Food and Agriculture Organization (of the United Nations)
IFDC	International Fertilizer Development Center
MNC	Multinational Corporation
PHL	Post-harvest Loss
SHF	Smallholder Farmer
SSA	Sub-Saharan Africa

Disclaimer

This publication is currently being peer reviewed by key stakeholders and is therefore not the final version.

Table of Contents

Introduction

The amount of food lost each year due to post-harvest loss (PHL) is enough to feed the total number of undernourished people globally. In sub-Saharan Africa (SSA) alone, which is home to over 230 million people suffering from chronic undernourishment, 30-50% of production is lost at various points along the value chain. Efforts to reduce PHL thus provide an attractive opportunity to improve food security across the globe, and especially in SSA. Importantly, PHL reduction can have a multi-faceted impact on SHF livelihoods (by increasing income), nutritional security (by improving the availability of relatively nutritious crops) and efficient use of resources (by ensuring that resources such as land and water are used to produce food that is eventually consumed rather than wasted).

Elements for Successful Post-Harvest Loss Intervention

Previous investigations into PHL solutions conducted by Monitor Deloitte for The Rockefeller Foundation resulted in two key high-level findings.[1] Firstly, there is no silver bullet for addressing PHL in terms of technology or procurement channel. A holistic view, which takes into account technologies, procurement channels and enabling factors is key to successful intervention. Secondly, a market-led approach is imperative for success. While a number of potential solutions exist, the problem will only be sustainably addressed when multiple actors are mobilized through market-driven motivations.

Learnings from previous interventions have shown that promising technologies have been launched but are too expensive for farmers to purchase without access to credit.[2] Farmer groups can be mobilized to store their crops better, but often have no market outlet for their increased supply. Awareness campaigns about new solutions drum-up interest, but local distribution channels fail to provide appropriate access. In short, many interventions have been tested, but often as one-off activities. To achieve sustainable results, actors need to align on an integrated set of activities which achieve impact across the entire value chain. These learnings suggest that four components are generally required in order to effectively reduce PHL at-scale:

1. ***Technologies***: Cost effective loss-reducing technologies for improving handling, storage and processing of crops (such as hermetic storage bags, metal or plastic silos, heavy molded plastic containers, mobile processing units, etc.) reduce PHL and preserve the crop if market linkages are not immediately available;

2. ***Market Demand & Linkages*:** linkages to demand, whether through traditional market relationships or newer procurement and sourcing channels, form the basis of any intervention and provide the foundation for the other key elements;

[1] For more detail on this analysis, see Rockefeller, Return on Investment Analysis on Post Harvest Technologies
[2] Ibid

3. ***SHF Training and Aggregation:*** Past interventions demonstrate the importance of capacity-building and other technology adoption measures for SHFs to address the needs and requirements of producers. This is often achieved through farmer groups that facilitate aggregation; and

4. ***Access to Capital***: Financing (including loans and leasing models) is generally required to ensure acquisition of PHL technologies in the value chain. Investment capital is also required to fund the scale-up of promising technologies and innovative distribution models;

Lessons Learned from Kenya's Mango Value Chain & Mozambique's Cassava Value Chain

With support from The Rockefeller Foundation, Monitor Deloitte set out to assess whether these four components were present and integrated in the context of two existing agricultural value chains: mangos in Kenya and cassava in Mozambique. If present, these components were studied to determine whether they were driving a reduction in PHL. Where components were not present, Monitor Deloitte assessed the extent to which losses could be reduced by incorporating them into the value chain.

The motivation for selecting these value chains was three-fold. Firstly, they are representative of crop types that typically experience high levels of loss (i.e. fruits and roots & tubers). The selected value chains experience high degrees of PHL: ~60% in Kenya's mango value chain, and ~40% in Mozambique's cassava value chain.[3] Importantly, they have also witnessed significant reductions in losses through successful intervention, and hence, can be used to test the extent to which the four components contributed to this success. Secondly, these two crop types have experienced a recent increase in demand, and associated increases in production. Therefore, these value chains provide an opportunity to assess the way in which market linkages (between demand and production) can be successfully created to drive production increases, without also increasing PHL. Thirdly, both of the selected value chains had large, active buyers at the center of the intervention that sought to improve SHF livelihoods (as would be the case for a PHL intervention). In Kenya, Coca-Cola required a local source of mango in order to avoid importing puree for use in Minute Maid mango.[4] These imports can be costly and are often not derived from the right variety of mango. This also allowed Coca Cola to meet its CSR local sourcing mandate.[5] In Mozambique, SABMiller required a stable source of cassava supply for its new low-cost product, Impala Beer[6,7]. In both cases, Coca-Cola and SABMiller (and the supporting implementation partners) saw an opportunity to significantly improve SHF livelihoods by sourcing from them directly.

[3] See Figure 1 and Figure 4 for more detail on these PHL estimates.
[4] Project will be referenced as "Project Nurture" for the remainder of this document
[5] Project Nurture: Partnering for Business Opportunity and Development Impact, 2013, HKS Corporate Social Responsibility Initiative, at: http://www.TechnoServe.org/files/downloads/project-nurture-partnering-for-business-opportunity-and-development-impact.pdf; Interviews with Coca Cola representatives
[6] Interviews with SABMiller representatives
[7] Project will be referenced as "Project Impala" for the remainder of this document

Notably, each company's involvement was not explicitly designed to reduce PHL. While PHL still exists within these value chains, the efficiencies created led to significant reductions in PHL within both value chains. With respect to the goals of creating stable, cost-effective supply and improving farmer livelihoods, the involvement of both large buyers in both value chains serve as successful case studies for interventions. Lessons learned from these case studies span the four key components required for a successful PHL intervention:

1. *Technologies*

- Access to technologies is of critical importance, but ensuring adoption and behavioral change is equally important. To ensure adoption, SHFs need to see tangible economic benefit to utilize PHL-reducing technologies. For example, in the cassava value chain farmers utilized mobile processing units because it secured their access to new market buyers and thus a stable source of income).

- Even when significant intervention by large buyers occurs, losses can still be experienced unless suitable technologies are provided. For example, in Kenya, losses initially increased after intervention by Coca-Cola as a result of increased production. PHL has since been reduced from 60%[8] to 29%[9], primarily due to the adoption of improved farm-level practices and inputs, thereby improving the quality of production.[10]

2. *Market Linkages*

- Anchor buyers are paramount to the success of a PHL intervention, as they provide the driving source of demand that flows through the entire value chain; however, anchor buyers often require initial partnership/support to directly source from SHFs. This role can be performed by local processors or traders who are able to overcome geographic constraints. Also, NGOs can further support the relationships between large buyers and processors, for example, by helping processors meet the quality standards of large buyers.

- Processors and traders play a critical role in reducing PHL, by supporting sourcing from SHFs and maintaining linkages with anchor buyers. They are able to do this due to their intimate knowledge of local market dynamics and their incentives to increase volumes sold. For example, in Project Nurture, Coca Cola encouraged sourcing from local SHFs. The processors worked with implementation partners (Technoserve) to develop the linkages with SHFs through local traders. These local traders were able to reach the geographically distributed SHFs, and were motivated by the increased demand from processors.

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[8] Loss figure provided by TechnoServe, from measurements taken in 2010 during Project Nurture

[9] Consolidated loss figures from interviews with TechnoServe and other stakeholders (see appendix for full list of interviewees)

[10] Given that production approximately doubled, this means that the tons of mango lost remained approximately unchanged. Also relevant to note is that these figures correspond to the SHFs that TechnoServe worked with during Project Nurture, which TechnoServe estimates to correspond to approximately 80% of mango production in Kenya.

- Alternative markets are required to optimize for PHL reduction. An increase in demand from anchor buyers can lead to increases in production, which can often not be fully absorbed by anchor buyers. Alternative markets can provide additional demand, thereby absorbing the excess supply. Alternative markets are complex and often need to be built-up and strengthened to maximize demand and potential to absorb excess supply.

3. Access to Capital

- An initial injection of funding provided by donors, NGOs, governments or large buyers, may be needed to initiate the intervention. Once this initial capital hurdle has been overcome the intervention can often run sustainably if the correct economic incentives are in place – such as the incentive to provide the PHL technology, to source from SHFs, or to ensure that the intervention is aligned with market demand. It should be noted that economic motivation need not come in the form of donor funding, as was the case in Project Impala.[11]

- Purchase guarantees can be used as a form of collateral to ensure SHFs gain access to technologies. For example, in the case of Project Impala, SHFs didn't buy the technology themselves (the implementation partner, and processor, DADTCO did), but they did have supply agreements with DADTCO to gain access to the technologies.[12]

4. SHF Training and Aggregation

- SHF training is key to driving adoption of PHL technologies; however, both case studies revealed that in addition to training, trust and open channels for providing information need to be provided.

- Traders can play an important linkage and aggregation role. They are incentivized to increase volumes sold and profit margins by accessing SHFs that would not normally be available to large buyers and by removing non-value adding intermediaries. However, initial aggregation and linkages may require donor-based catalytic support as formation of Farmer Based Organizations (FBOs) can be costly.

[11] Limited donor capital was provided for SABMiller's work in Mozambique's cassava value chain
[12] Interviews with DADTCO representatives

Approach and Methodology

Sources of Information

Monitor Deloitte investigated Project Nurture and Project Impala through both primary and secondary research. Primary research involved interviews with actors from each stage of the value chain. The results of these interviews were also "sense checked" by the other actors in the value chain and compared to secondary data where available. Secondary research included review of internal reports produced by actors within each of the value chains, external reports, and data attained through databases such as World Bank and FAO.

Approach

Monitor Deloitte used an objective approach in assessing and studying each of the value chains and their corresponding interventions. This process involved six key steps:

1. ***Conduct desktop research:*** Reviewed existing external reports on the value chains before and after the intervention

2. ***Review internal reports:*** Assessed the detailed and specific reports produced by actors within the value chain

3. ***Generate hypotheses:*** Developed hypotheses to be tested based on the information learned. These hypotheses focus the research questions and ensured insights would be specific and transferable to other interventions

4. ***Interview implementation partners:*** Conducted interviews with implementation partners in each of the value chains: TechnoServe, Alliance for a Green Revolution in Africa (AGRA) and the International Fertilizer Development Centre (IFDC)

5. ***Interview actors from each stage of the value chain:*** Conducted interviews with approximately 20 actors from each step, including; anchor buyers, traders/processors, FBOs, SHFs and local markets (see appendix for the full list of interviewees)

6. ***Validate data:*** Compared the data obtained from interviews with desktop research and international benchmarks to assess validity

Editorial note: this approach allowed Monitor Deloitte to gain an on-the-ground understanding of the value chains, including estimates of PHL before and after intervention. However, it should be noted that such estimates do not represent a robust nor holistic quantification of PHL, but rather a directionally accurate view of PHL. In other words, the PHL estimates – along with qualitative information obtained – assist in the understanding of the change that occurred within the value chains, but should not be used in isolation.

Specific Lessons from Kenya's Mango Value Chain

The Underlying Challenge

As part of its vision to grow in sub-Saharan Africa, Coca-Cola sought to expand its Minute Maid Mango brand on the continent. Concurrently, import costs for processed mango puree were high, thus finding a local source of mango supply would enable competitive production.[13]

In 2010, Kenya produced approximately 540,000 tons of mango, which includes production of several indigenous (e.g. Ngowe) and imported varieties (e.g. Tommy Atkins).[14] While commercial mango production was historically restricted to the coastal region, it now constitutes about one-third of production; the majority of production occurs in the eastern region.[15] Most mango harvesting occurs during the peak season of November to February, which overlaps with other mango producing countries (e.g. Mexico, India, and South Africa). The coastal region has a second harvest between June and August.[16] As the majority of mangoes in Kenya are produced by SHFs[17], finding a local mango source meant partnership with these farmers.

Coca-Cola was interested in additional potential benefits, such as supporting national and international development goals,[18] but faced a number of challenges in sourcing from SHFs. These challenges included obtaining sufficient quality and quantity of mangoes, and cost-effectively accessing SHFs' supply.[19] In addition to these overarching challenges, a number of specific constraints existed at each stage of the mango value chain, including:

- ***Farmers*** often did not produce mangoes of the right quality (due to poor farming and harvesting techniques) and thus could not find markets for their output;
- ***Traders*** did not have direct links to farmers and buyers and, hence, had to go through additional brokers, making the value chain inefficient and driving down margins;
- ***Processors*** did not have consistent supply of mangoes (of the right quality) and were not accredited to supply to Coca-Cola bottlers;

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[13] Project Nurture: Partnering for Business Opportunity and Development Impact, 2013, HKS Corporate Social Responsibility Initiative, at: http://www.TechnoServe.org/files/downloads/project-nurture-partnering-for-business-opportunity-and-development-impact.pdf

[14] Data from FAOSTAT. Note that the production figure includes mangosteens and guavas.

[15] Mango Production in Kenya, JKUA Enterprises, at: http://www.jkuatenterprises.com/MANGO_CULTIVATION_IN_KENYA.pdf

[16] Mango Growing in Kenya, Griesbach, J, 2003, at: http://www.worldagroforestry.org/Units/Library/Books/PDFs/97_Mango_growing_in_kenya.pdf

[17] Value Chain Analysis: A Case Study of Mangoes in Kenya, FAO

[18] Project Nurture: Partnering for Business Opportunity and Development Impact, 2013, HKS Corporate Social Responsibility Initiative, at: http://www.TechnoServe.org/files/downloads/project-nurture-partnering-for-business-opportunity-and-development-impact.pdf

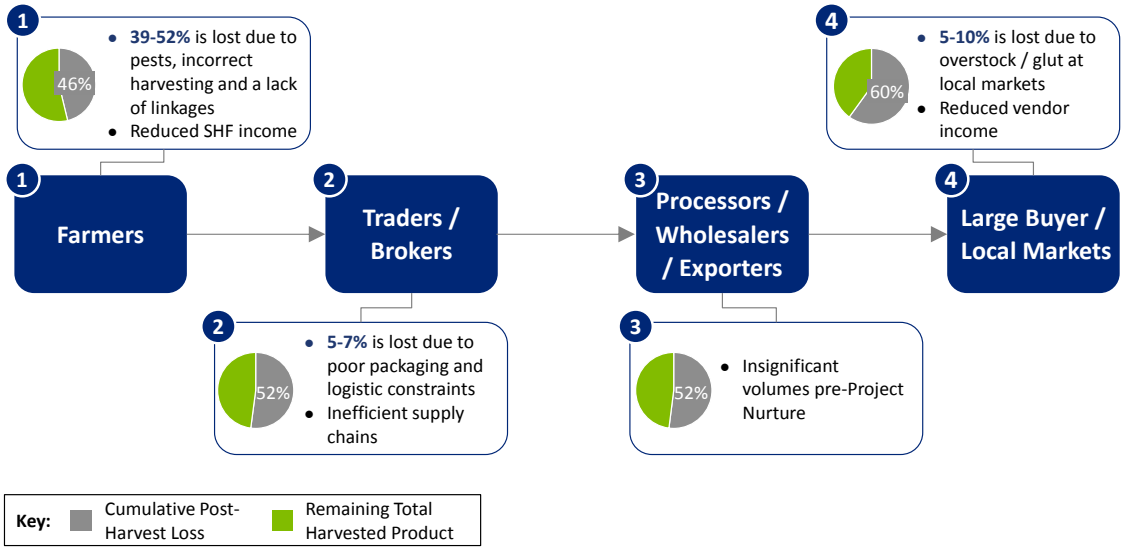
[19] Project Nurture: Partnering for Business Opportunity and Development Impact, 2013, HKS Corporate Social Responsibility Initiative, at: http://www.TechnoServe.org/files/downloads/project-nurture-partnering-for-business-opportunity-and-development-impact.pdf; Interviews with Coca Cola representatives

- ***Wholesalers/exporters*** did not have access to quality mangoes and had to work through many unreliable brokers;
- ***Large Buyers*** (i.e. Coca-Cola) did not have access to quality puree due to capacity issues faced by processors; and
- ***Local markets*** received most unwanted mangoes in gluts often with severe defects, making it difficult to sell these mangoes at a profitable price-point.

Loss within the mango Value Chain before the intervention

These challenges not only contributed to constraints associated with local sourcing, they were also the main contributing factors to PHL, as illustrated in Figure 1 below.

Figure 1: Mango in Kenya: Pre-Intervention by Coca-Cola and TechnoServe



Source: TechnoServe and Stakeholder Interviews

Note: PHL is calculated by estimating the percentage of mango that is lost for several reasons: unmarketable production (18-19%), unsold production (19-31%), harvesting losses (2%), transport losses (5-7%) and not sold at market (5-10%). Estimates are based on December 2010 interviews conducted by TechnoServe business advisors

Most PHL (39-52%) occurred on-farm due to limited off-take from traders and brokers.[20] This was partially a result of poor linkages to traders and brokers, but also a result of poor production and harvesting techniques, such as shaking of trees and allowing the fruit to drop to the ground (resulting in damaged fruit and or harvesting of immature fruit), and not using crop protection products to reduce disease and pests. This led to large volumes rejected by traders/processors and significant PHL.

[20] Based on data collected by TechnoServe in December 2010, and discussed during an interview with Monitor Deloitte in February 2015.

In addition, PHL occurred in transit (5-7%) due to the use of poor packaging (e.g. sacks or cartons instead of crates) and logistical constraints (e.g. poor quality of roads).[21] Additional quantities (5-10%) of mango were also lost at local markets (where the majority of mangoes are sold) due to seasonal gluts in supply as well as inadequate storage to help preservation.[22]

Overall, this meant that over 60% of harvested mangoes in Kenya were not consumed before Coca-Cola's intervention in the value chain.

The Market-led Intervention

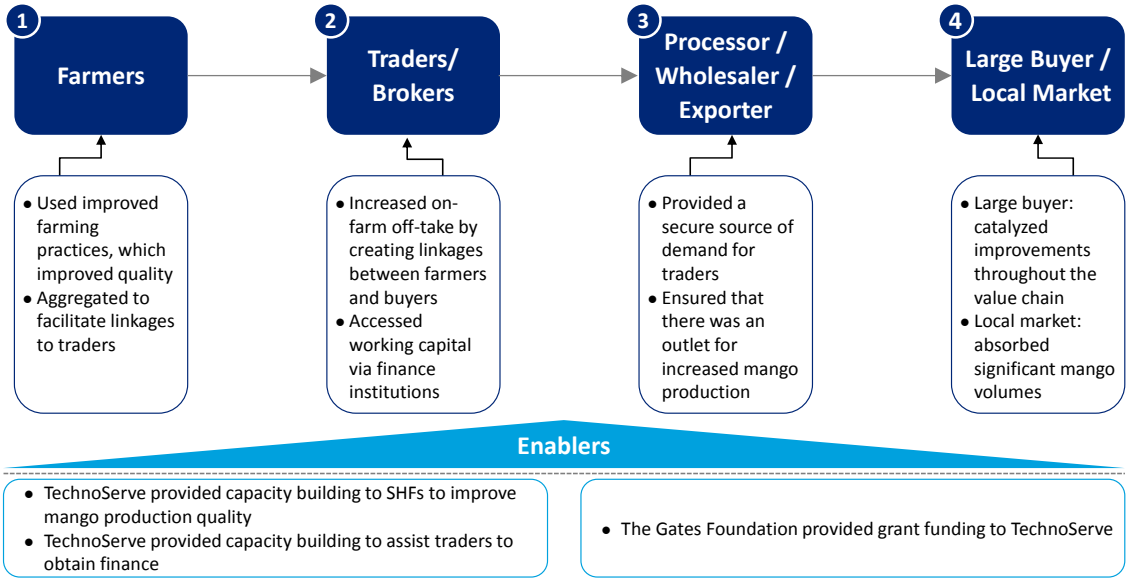
For sourcing from SHFs to be viable, these challenges would need to be addressed. The Bill & Melinda Gates Foundation provided $7.5m in grant capital to TechnoServe (amongst others) to help address these challenges. Coca-Cola shared the objective to improve SHF practices and drive higher SHF incomes across SSA and invested $4m. The aim of this investment was to double incomes from fruit production for 50,000 SHFs.[23, 24]

In addition, Coca-Cola would need to make significant investment in its supply chain to integrate it with the existing Kenyan mango value chain. Through its procurement arm, Grove 2 Glass Trading (G2G), Coca-Cola assisted processors (Sunny Processors and All Fruits Ltd) and bottlers (Coca-Cola Juices Ltd) to become accredited to produce and bottle juice within the Coca-Cola system. This included R&D to ensure that formulations using local mango met strict quality standards. Coca-Cola also provided bottlers with recipes and consumer brand marketing materials.[25]

However, there were a range of challenges that fell outside of the Coca-Cola system, which would need to be addressed with an implementation partner's (i.e. TechnoServe) assistance. A summary of intervention at each stage of the value chain is summarized in Figure 2.

[21] Based on data collected by TechnoServe in December 2010, and discussed during an interview in February 2015.
[22] Based on data collected by TechnoServe in December 2010, and discussed during an interview in February 2015.
[23] Project Nurture: Partnering for Business Opportunity and Development Impact, 2013, HKS Corporate Social Responsibility Initiative, at: http://www.TechnoServe.org/files/downloads/project-nurture-partnering-for-business-opportunity-and-development-impact.pdf
[24] We also understand that Phase II of Project Nurture focusing on the Coastal regions will be funded by Coca-Cola.
[25] Project Nurture: Partnering for Business Opportunity and Development Impact, 2013, HKS Corporate Social Responsibility Initiative, at: http://www.TechnoServe.org/files/downloads/project-nurture-partnering-for-business-opportunity-and-development-impact.pdf

Figure 2: Mango in Kenya: Coca-Cola and TechnoServe Intervention



Source: Stakeholder Interviews; 'Project Nurture: Partnering for Business Opportunity and Development Impact', HKS

At the farm-level, TechnoServe provided training to farmers to improve the quality of mango production. Fundamental to this effort was capacity building on effective farm-level practices, including – grafting of trees, pruning, correct application of pesticides, and improved harvesting.[26] Therefore, SHF capacity building (and adoption of the proposed techniques) was a key component of the intervention since improvements in quality would drive an increase in off-take throughout the entire value chain. [27]

In the first two years of the intervention, production and quality improved significantly; however, SHF incomes did not increase substantially because linkages to the market were still not efficient. This meant that PHL increased substantially during this first period. TechnoServe subsequently identified large traders and connected them with buyers and farmers to create these linkages. TechnoServe also worked to improve farmer aggregation, enabling traders to source sufficient volumes directly from farmers rather than via several brokers. On the buyer side, this involved putting traders in contact with processors (supplying Coca-Cola bottlers) as well as alternative markets including other processors, exporters and large domestic wholesalers, enabling them to secure greater demand and no longer using intermediaries / brokers.

[26] As an example, it is understood that when traders arrived to collect mangoes from farmers, harvesting would sometimes be done by shaking the tree to speed up the process. This would mean that many of the mangoes that were ready for harvest would bruise as they hit the ground (making them less appealing for fresh fruit markets), while at the same time many immature fruit would also fall from the tree (processors cannot use immature fruit since the puree produced from these fruit does not meet the standards required for bottlers' formulations). After TechnoServe training, farmers began to pick fruits individually when ripe.

[27] Project Nurture: Partnering for Business Opportunity and Development Impact, 2013, HKS Corporate Social Responsibility Initiative, at: http://www.TechnoServe.org/files/downloads/project-nurture-partnering-for-business-opportunity-and-development-impact.pdf

TechnoServe also improved access to working capital finance. Some traders require financing because processors and other buyers can take several weeks to pay.[28] Finance institutions (e.g. Co-operative Bank and Faulu Bank) were willing to provide loans to traders as long as they could demonstrate a steady revenue stream. Therefore, TechnoServe provided traders with capacity building to formalize the way in which they recorded and reported their transactions.

Importantly, processors within the Coca-Cola system only purchased approximately 17% of mangoes produced (with only a small proportion of this going to Coca-Cola bottlers).[29] This meant that farmers (via traders) also needed to be linked to alternative mango markets including domestic wholesalers (e.g. Meru Greens, which supplies mangoes to retailers such as Nakumatt) and exporters (e.g. East African Growers). TechnoServe also facilitated the linkages between traders and these buyers.

Result of the Market-led Intervention

Project Nurture met its target of reaching 50,000 mango and passion fruit farmers in Kenya and Uganda. In Kenya, 80% of mango farmers were part of the program and, on average, SHF income from mango doubled. Coca-Cola was able to locally source 100% of its mango requirements.

Benefits were not limited to SHFs and Coca-Cola alone. Traders were able to increase and stabilize their revenue stream; alternative buyers had improved access to higher quality mangoes; processors (e.g. Sunny Processors) were in a better position to compete globally due to Coca-Cola's accreditation and the increased awareness of puree produced from uniquely Kenyan mango varieties (e.g. Ngowe) that came from partnership with Coca-Cola.

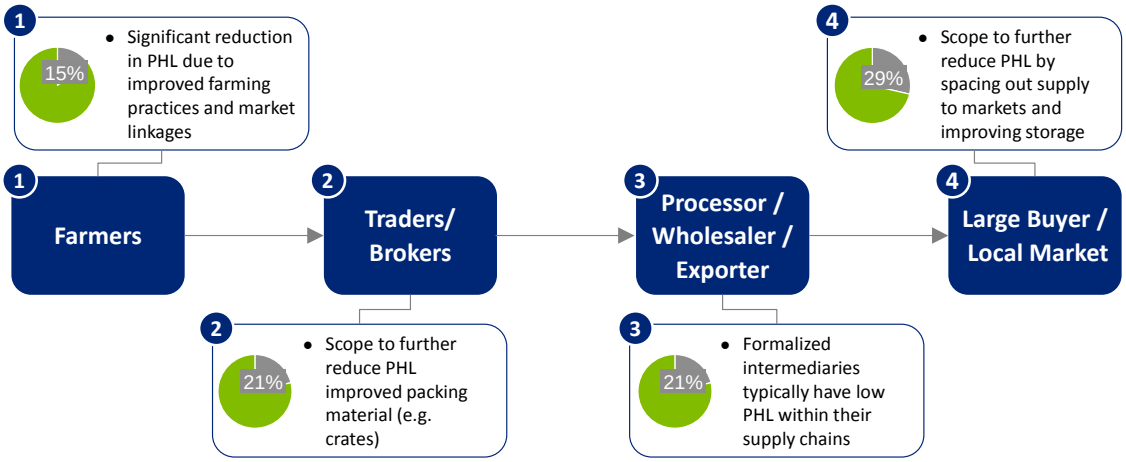
An additional outcome of the intervention – although not a stated goal of the program – was reduction in post-harvest losses. As illustrated in Figure 3, the reduction of PHL primarily occurred on-farm due to increased off-take from traders driven by improved harvesting and transport techniques, and increased demand downstream from processors, wholesalers and exporters. Overall this resulted in PHL being halved across the value chain.

Given that production approximately doubled, halving the PHL percentage meant that actual tons of PHL remained unchanged. So, while the reduction of the PHL percentage is an achievement, there remains a significant opportunity to reduce PHL within the mango value chain further.

[28] Given the short mango season, waiting for payment from buyers before traders can make another purchase from farmers resulted in significant inefficiencies.

[29] Project Nurture: Partnering for Business Opportunity and Development Impact, 2013, HKS Corporate Social Responsibility Initiative, at: http://www.TechnoServe.org/files/downloads/project-nurture-partnering-for-business-opportunity-and-development-impact.pdf

Figure 3: Mango in Kenya: Post-Intervention



Source: TechnoServe and Stakeholder Interviews

Note: Data are obtained from TechnoServe's on-going interactions with SHFs based on interviews with some of the farmers included in the intervention. These data are consistent with interviews conducted by Monitor Deloitte with actors along the value chain

General Lessons Learned

Monitor Deloitte's assessment of the Kenyan mango value chain emphasizes that market-led interventions – in this case, with the support of an external catalyst – can be profitable for large buyers, thus motivating them to source from SHFs. Furthermore, the presence of a large buyer can also lead to significant improvements in local rural livelihoods (i.e. farmers, traders and other value chain actors).

With respect to technology adoption, Project Nurture showed that SHFs can access and optimally use technologies if the appropriate support is provided. Importantly, SHFs will choose to adopt (and pay) for these technologies if the economic incentive exists to do so (i.e. use of technology results in improved quality of mangoes, thus attracting buyers to sell to them).

More specific to a PHL intervention, Project Nurture showed that large buyer involvement can reduce PHL even if this is not an explicit aim of the buyer's involvement. Buyers' willingness to source locally – and the efficiencies introduced in the value chain in order to do so – can effectively reduce losses. Importantly, increased demand from large buyers can lead to increased production, which the large buyer will not always be able to absorb. Therefore, linkages to alternative markets are vital to ensure that large buyer involvement does not translate into increased PHL.

Opportunity to Optimize for PHL Reduction

Opportunities for further reducing PHL still exist as ~30% of mango produced in Kenya is currently lost, while production has increased significantly. With a concerted focus on PHL in addition to local sourcing – and incorporation of the four elements for a successful PHL intervention – losses could be driven down even further.

A range of potential causes exist for the remaining on-farm losses. Based on interviews with farmer groups, it was noted that a proportion (up to a third) of their crop is not collected by traders because it is not yet mature. However, volumes of this later maturing fruit are too small to warrant a further trip from traders, and farmers are not able to access markets individually due to the high cost of transport. These farmers noted that if they could aggregate these later harvesting mangoes, they would be able to share the costs of transport and get the produce to market. Therefore, there appears to be an opportunity for aggregation of later-harvested mangoes to further reduce on-farm PHL.

Stacking crates would significantly reduce losses at the farm and during transit.[30] Transporters that currently use crates generally report losses of less than ~ 5%. Use of this technology (and the finance that may be required to facilitate access to it) could serve to reduce PHL during transport.

A large proportion of PHL occurs at local markets. Introduction of technologies (e.g. tarps) could serve to prolong the time that mangoes can be stored at local markets, and thus reduce PHL. Similarly, improved linkages to alternative markets (e.g. domestic wholesalers) would serve to reduce the quantity of mangoes stored at local markets, potentially further reducing PHL.

By eliminating PHL completing in Kenya's value chain, the incomes of SHFs and other value chain actors could be significantly improved, and the availability of a nutritious crop to consumers could be further strengthened.

[30] This may be less necessary within the processing channel because there is less concern over aesthetic deficiencies such as bruising that would be avoided through the use of crates

Specific Lessons from Mozambique's Cassava Value Chain

The Underlying Challenge

SABMiller saw an opportunity to formalize the local beer consumption market in Mozambique and access a new market segment by developing a cassava-based beer (that is locally sourced and produced). Due to the fact that SHFs produce the majority of the ten million tons of cassava grown annually in Mozambique, effective commercialization of cassava could enhance SHF wellbeing as well as potentially increase the societal contribution of the cassava sector.

Cassava is widely consumed across SSA, notably in West Africa, Angola, DRC and Mozambique. Despite its ubiquitous presence in these economies, cassava is a difficult crop to commercialize. Although Mozambique is a significant producer of cassava, yields remain low. In 2010, the estimated yield was 6 tons per hectare, compared to the African average of 9.3 tons.[31] Disease has contributed to depressed yields in recent years, necessitating the introduction of new disease-resistant varieties by, for example, IFDC. Cassava has a short shelf life – between 24-48 hours –and it is typically grown by SHFs located in Central and Northern Mozambique with limited access to transport or adequate transport infrastructure.[32] Cassava is also heavy in raw form due to its high water content. In order to successfully implement the SABMiller program, this and other specific challenges needed to be overcome across each stage of the value chain, including –

- ***Farmers*** produced cassava mostly for subsistence purposes and had difficulty finding markets for their produce; as a result, only ~15% of the cassava crop in Mozambique is sold in local markets;
- ***Processors*** had not gained a strong foothold into the cassava industry as it was relatively underdeveloped due to both the difficulty in working with cassava and Mozambique's historical weak operating and economic climate;
- ***Wholesalers and exporters*** typically required processed cassava at commercial scale and therefore did not engage in the cassava value chain given it was primarily sold in raw form;
- ***Large buyers*** (i.e. SABMiller) were not able to source sufficient volumes from geographically dispersed SHFs to make centralized factories economically viable;
- ***Local market players*** demanded relatively small quantities of fresh cassava, making it difficult for smallholders to rely on them as their primary income source.

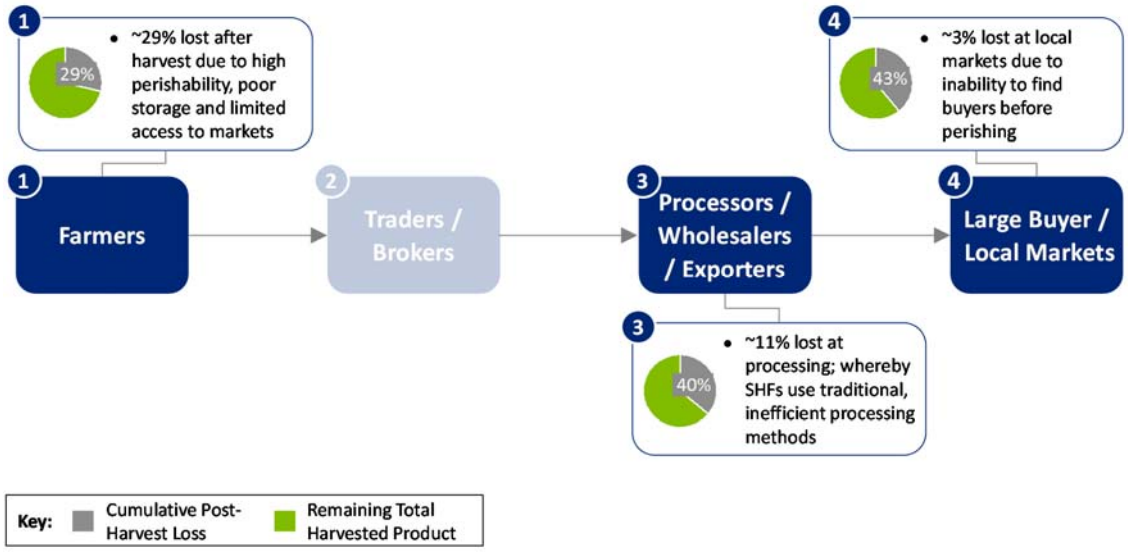
[31] Analysis of Incentives and Disincentives for Cassava in Mozambique, 2012, FAO, at: http://www.fao.org/3/a-at576e.pdf
[32] FAO, 2013

SABMiller's Impala Beer is the world's first commercially-made cassava-based beer, and has become an affordable, high-quality alternative to informal or illicit alcohol. As described in further detail below, Impala Beer demonstrates that commercialization of SHF cassava production is feasible, but requires deep emersion into the supply chain through near-farm processing and ongoing farmer contact.

Loss within the Cassava Value Chain before the Intervention

These challenges not only contributed to constraints associated with local sourcing, they were also the main contributing factors to PHL, as illustrated in Figure 4 below.

Figure 4: Cassava in Mozambique: Pre-Intervention by SABMiller and DADTCO



Source: FAO Global Food Losses and Food Waste, 2011

Note: PHL estimates presented above are for roots and tubers for sub-Saharan Africa at different stages of the value chain (Agricultural Production: 14%; Postharvest Handling and Storage: 18%; Processing and Packaging: 15%; Distribution 5% and refer to the percentage that enters each step); the typical causes of PHL at each stage are taken from stakeholder interviews in Mozambique and other research reports. Due to the difficulty of working with cassava and the relative immaturity of Mozambique's cassava industry, traders do not play a significant role in the cassava value chain

Before the intervention, approximately 29% of the crop was lost on-farm due to the high perishability of the crop, inefficient harvesting and storage methods, and an inability to access markets.[33] Processors – using hand grinders and traditional sun-drying processes – experienced losses of approximately 11%. Losses at local markets were typically quite low as smallholders would often sell cassava for very low prices to avoid it spoiling. In sum, this resulted in a cumulative loss of ~43%, representing a significant foregone economic opportunity for players across various stages of the cassava value chain.

The Market-led Intervention

To overcome these challenges in sourcing cassava, SABMiller partnered with the Dutch Agricultural Development and Trading Company (DADTCO). DADTCO is a social enterprise that pursues the dual-bottom line of poverty alleviation and profits. DADTCO provides one-sided purchase guarantees to farmers; it guarantees to purchase the SHFs' entire crop, enabling SHFs to have a secure sales channel and DADTCO to have a secure source of supply.[34] Extension services are provided by the IFDC, who provide disease resistant planting material and train SHFs on agricultural best practices to increase yields.[35]

Financial support has been provided by a number of key actors. The Dutch government, DADTCO and the IFDC have formed a public-private partnership, for which the Dutch government provides funding. The government of Mozambique has supported the project by providing excise tax relief. The African Enterprise Challenge Fund (AECF) provided initial catalytic finance to SABMiller to pilot the concept.

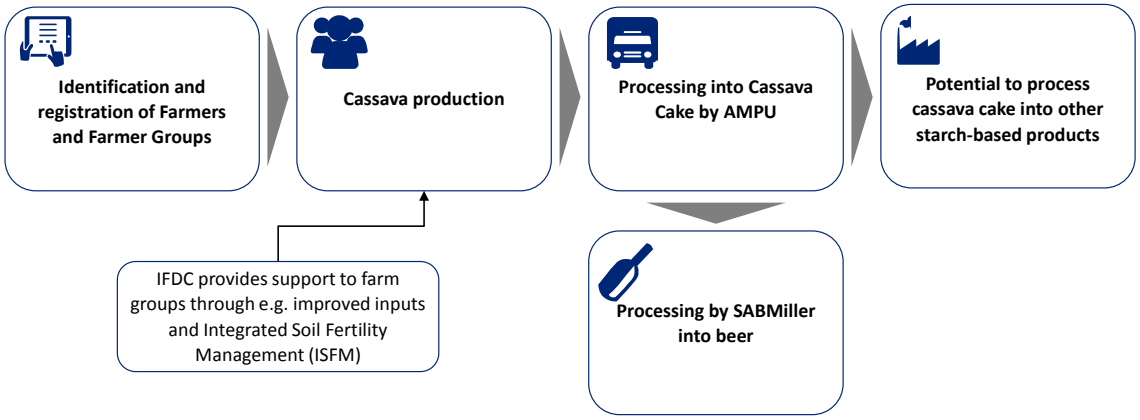
DADTCO is able to purchase the cassava and reduce loss due to the development of an Autonomous Mobile Processing Unit (AMPU) and a de-centralized processing and sourcing model for cassava. Through this model, DADTCO is able to process cassava at the farm in rural areas where SHFs grow their crops. An illustrative visual of this supply chain is presented in Figure 5.

[10] However, it should be noted that cassava can remain in the ground for up to 48 months, which means that SHFs can delay harvesting until they require the crop for subsistence purposes or are able to sell a portion of the crop in local markets, which can mitigate against PHL.

[34] The agreements have some flexibility and allow farmers to sell into other markets, if they are able.

[35] However, DADTCO has demonstrated an ability to source successfully from farmers who have not yet had access to IFDC services.

Figure 5: Illustrative DADTCO Supply Chain



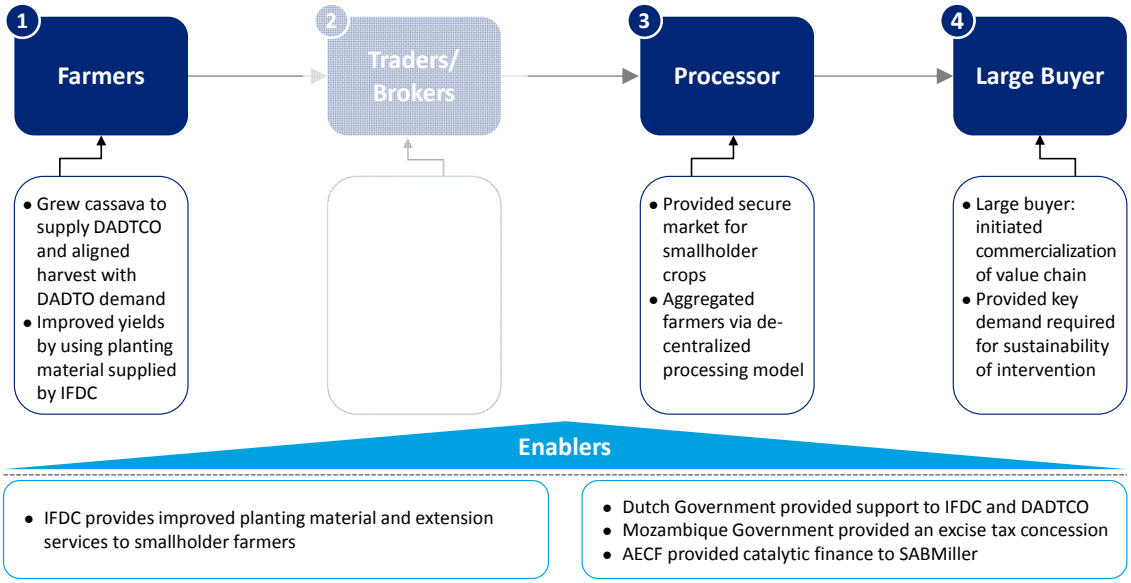
DADTCO's AMPU is typically set up on a concrete platform for a period of 3-4 months before it is moved again to a different area, allowing the company to harvest from local farmers in the area. This flexible, de-centralized, processing model allows DADTCO to circumvent some of the issues typically experienced by centralized cassava processors, while at the same time acting as an aggregator and consolidator of SHFs, who grow the crops used by SABMiller in the production of Impala beer.

Figure 6: DADTCO's Autonomous Mobile Processing Unit (AMPU)

DADTCO interacts with SHFs through field mobilizers who communicate and coordinate harvest times with the farmers. Field mobilizers are typically drawn from the communities in which DADTCO sources from. The field mobilizers use SMS, phone calls and in-field visits to connect with farmers. In this way DADTCO builds relationship and trust with the farmers, acts as an aggregator and provides information and support.

While DADTCO created the key linkage between the farmers and SABMiller, SABMiller created the market demand, allowing the supply chain to operate sustainably. Without an anchor buyer with robust and sufficient demand, the intervention would not have had the same success. In order for the anchor buyer to address these challenges, intervention was required at each stage of the value chain as summarized in Figure 7.

Figure 7: Cassava in Mozambique: SABMiller and DADTCO Intervention



Source: Stakeholder Interviews

Result of the Market-led Intervention

Through the production of Impala beer, SABMiller and DADTCO have sourced cassava from approximately 6,000 smallholder farmers. Since 2011, SABMiller has sold 28 million bottles of Impala, which has become one of Mozambique's most popular beers. 143 million Meticais (~4 Mn USD) have been paid in taxes and over 1 million Meticais (~27,000 USD) are injected into the local economy every month.[36]

Participating farmers have experienced significant improvements in their livelihoods as a result of participating in the Impala Beer supply chain. In interviews, DADTCO mobilizers suggested that this improvement in livelihoods is evidenced by an increase in the proportion of households that own livestock over time and by an increase in the number of visible home improvements.

While Impala beer did not explicitly seek to address the issue of PHL, the intervention was required to solve for loss implicitly due to the difficult nature of working with cassava. By leveraging DADTCO's de-centralized processing model, SABMiller was able to source sufficient volumes of cassava while experiencing minimal losses.

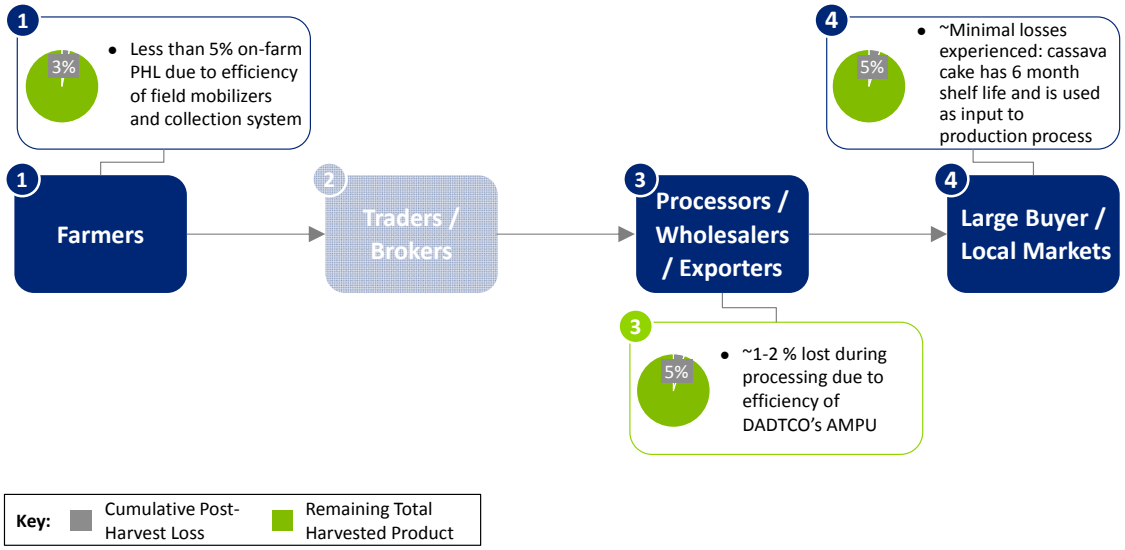
[36] Cervejas de Mocambique, 2014, Annual Reports and Accounts, at http://www.sabmiller.com/docs/default-source/investor-documents/reports/2014/financial-reports/annual-report-2014.pdf?sfvrsn=8

Key to this success was DADTCO's system of employing field mobilizers. The mobilizers coordinate harvesting times with smallholders to ensure farmers harvest only when there is sufficient demand from SABMiller for their crop. Secondly, harvesting times are aligned with collection activities as DADTCO collects the majority of the crops via small trucks. The combination of these processes ensures that very little crop is lost on-farm.

The AMPU itself is very efficient in its operations and the unit reportedly only experiences between 1-2% losses during processing. The AMPU transforms cassava into a cassava cake with reduced moisture content, extending the shelf life of the crop for at least six months. The cassava cake is used as an input to SABMiller's production process, where minimal losses are experienced.

Reducing PHL to a total of only 5% was a positive spillover benefit from a successful intervention where SHFs are included in anchor buyer supply chains. Outside of the Impala beer ecosystem, however, losses still remain significant (~30%) and smallholders do not have sufficient access to markets. This is potentially accentuated by the fact that use of improved inputs could have served to increase production, while there is limited opportunity to sell cassava outside of the SABMiller supply chain.

Figure 8: Cassava in Mozambique: Post-Intervention Losses



Source: Stakeholder Interviews

Note: Estimates of PHL were derived from interviews with DADTCO representatives who stated that losses during processing were between 1-2% and that overall losses in the value chain were likely to be less than 5%; this was affirmed by Smallholder Farmers in DADTCO's supply chain; PHL estimates relevant for SABMiller's supply chain

General Lessons Learned

Monitor Deloitte's assessment of the Mozambican cassava value chain highlights that large buyers can source successfully from smallholder farmers to produce a profitable product. In parallel, by linking to farmers, the buyers implement efficiencies within their supply chain that optimize for PHL. Partners create the requisite links and provide a conducive operating environment.

In the case of Impala Beer, DADTCO provided the key link to the farmers and provided the farmers access to important extension services. An important corollary is that creating this link may require building relationships with farmers; this is typically achieved through deep investment and immersion in the value chain and ongoing contact with farmers, which can have implications on input costs in the short term.

The success in reducing loss within the Impala value chain show great promise, future efforts should therefore be focused on increasing the scale, from the 6000 SHFs currently reached by the system, to the majority of SHFs who currently produce cassava. Further demand currently exists from SABMiller but also from other large buyers.

Opportunity to Optimize for PHL Reduction

While PHL has been significantly reduced within the SABMiller and DADTCO ecosystem, there remains opportunity to further reduce PHL outside of it, which could come via incorporation of the four elements for successful PHL intervention. By scaling the model to new buyers, for example, more smallholders can be incorporated into DADTCO's cassava cake supply chain, and PHL will thus be further reduced. New sources of market demand and new buyers are required to create sustainable linkages.

To activate these new sources of market demand alternative uses of the cassava cake are required. Cassava starch can be used in the manufacture of cassava flour, glue and other starch-based products such as soup and stock cubes (although this may require further capital investment and processing of the cassava cake). New buyers will leverage these opportunities in cases where there is potential for import substitution, evidence of local demand, and the initiative economics are attractive.

Activating secondary markets is a complementary activity to attracting new anchor buyers. Cassava and cassava-based products are widely consumed in Mozambique at a subsistence level, which points to latent market demand for the crop. By linking farmers to local markets and less structured demand, PHL can be further reduced.

Due to the difficulties in transporting cassava, a decentralized processing model is likely to remain a key component of any successful intervention. These processing sites are an ideal platform from which farmers can aggregate and extension services and training can be delivered. A decentralized processing model can be achieved through either the facilitation of access to smaller mobile processing technologies to farmer groups or through scaling DADTCO's existing model. Typically these technologies are owned by either the processor or farmer associations and not by the smallholder themselves due to the high cost. Farmer organizations may require additional finance to support the purchase of processing technologies.

The impact of reducing PHL further is likely to improve farmer incomes as more crops reach the market. Similarly, income consistency will improve as processed cassava has a longer shelf life. Although cassava does not have high nutritional content, it is an important staple crop that contributes to food security. In terms of the environment, cassava is a water intensive crop, thus reducing PHL implies that the water used to grow the cassava is used more efficiently.[37]

[37] Cassava grown by smallholder farmers is typically rain-fed

Conclusion

Monitor Deloitte conducted two value chain assessments to inform the development of The Rockefeller Foundation's model for reducing post-harvest losses in sub-Saharan Africa. The mango value chain in Kenya and the cassava value chain in Mozambique were chosen given their demonstrated success sourcing from SHFs, reducing post-harvest losses, and improving supply chain efficiencies.

These case studies demonstrate the potential for leading multi-national companies (Coca-Cola and SABMiller,) to develop profitable supply chains that incorporate smallholder farmer sourcing. Both the buyers and smallholders have benefitted from these projects: anchor buyers gain security of supply at competitive prices, while smallholder farmers experience significant improvements in income, and as result, livelihoods.

In both case studies, ***market demand*** is the first and essential component underpinning the success and sustainability of the projects. Both Coca-Cola and SABMiller established supply chains to profitably fulfill consumer demand. Similarly, the projects would not have been so successful without the use of PHL reduction ***technologies***; by bringing mobile processing units to the farm, DADTCO was able to substantially reduce PHL from the cassava value chain. However, without ***access to finance***, SHFs, traders and processors would not have been able to access the technologies and solutions required for the projects' success. Lastly, even with strong market demand and use of appropriate technologies, ***aggregation & training*** were essential to ensuring that traders, processors, and anchor buyers could cost-effectively source from SHFs.

PHL is fundamentally a supply chain inefficiency. Even though PHL reduction was not an explicit goal of the interventions described, the efficiencies that Coca-Cola and SABMiller brought to their respective value chains served to reduce PHL. However, significant PHL still exists within these value chains, meaning that there are still opportunities to reduce PHL further. In the case of mango, PHL remains at approximately 30% (down from 60%) alongside large increases in production, while only a small proportion of cassava production has benefited from the PHL decline experienced within SABMiller's supply chain.

These case studies highlight to other organizations that sourcing from SHFs *and* optimizing for PHL reduction can be both financially attractive and create significant positive social impact.

Therefore, reducing PHL through sustainable, long-term solutions represents a vital area for The Rockefeller Foundation to focus potential efforts. For mangoes in Kenya, the spacing out of harvests to reduce gluts, the provision of containers to facilitate handling, and the provision of tarpaulins to facilitate storage at markets, are all viable strategies that could further reduce losses. For cassava in Mozambique, building links to secondary markets through processing technologies and aggregation points are likely to activate latent market demand.

Appendix: Interviews Conducted

Figure 9: List of Interviews Conducted

Project Nurture		
	Name	**Organization, Position**
	Tabitha	Baraka Farmer Group, Secretary
	Francis Kinyanjuni	Kakuku Fruit Growers, Chairman
	Alex Mwathi	Allfruit EPZ, Plant Manager
	Mr Githae	ALOHA Exporters, TBD
	Sajani Dutta	East African Growers, Business Head
	Nicky Nyamasyo	Hillside Green, Head of Operations
	Rosemary Muthomi	Meru Greens Horticulture, Director
	Abdul Sidi	Mugoya Vegetables, Managing Director
	Kushal Patel	Sunny Processors, Director
	Hassan Hameza	Trader
	Esther Mwangi	Trader
	Joseph Njunge	Trader
	Kaaria	Trader
	Martin Mutura	Coca-Cola, Supply Chain Manager
	John Mathiaka	Coca-Cola Juices, Procurement Manager
	Dickson Mbando	TechnoServe, Project Nurture Lead
	Carolyne Maina	TechnoServe, Business Advisor

Impala Beer		
	Name	**Organization, Position**
	Numerous SHFs	DADTCO, Suppliers
	Vasconcelos Naene	DADTCO, Supplier
	Samuel Alfredo Gove	Associação Josina Machel, Head
	Suzanne Vlakveld	DADTCO, Value Chain Manager
	Hubert van Melick	DADTCO, Managing Director
	Teofilo Chilenge	DADTCO, Supply Chain Manager
	Nelson Joachim	DADTCO, Supply Chain Assistant
	Anna Swaithes	SABMiller, Head Water, Food Security
	Alexander Femando	IFDC, Mozambique Country Director
	Jake Walter	TechnoServe, Country Director
	Isabel Mazive	AGRA SSTP, Agronomist
	Paulo Mole	Agra, Country Head
	Anabela Manhica	Agra, Lead
	Anabela Zacarius	IIAM, Researcher
	Constantino Cuambe	IIAM, Researcher

Growers/Production Groups Traders / Processors Manufacturers / Bottlers Implementation/ Research Partners